Adverse Selection in the Annuity Market and the Role for Social Security

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Social Security

- The largest government program in the U.S.

- Many debates over reform/privatization

- Central question to this debate
  - What useful aspects are lost (that market can't replicate)?

- This paper talks about one
  - Mandatory annuity insurance

Mandatory annuity insurance

- Is a **key** feature in almost all social security systems
- Can be **desirable** when there is adverse selection

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  Forces everyone (including high mortality) to join

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  Forces everyone (including high mortality) to join
- Thereby

  Provides insurance at higher (implicit) rate of return

Question

- We know
  - Social security has mandatory annuitization
  - It can be a desirable feature
  - Private markets cannot replicate it

- Question

  How important is it quantitatively?

▸ Feldstein's quote

This paper

- Develops model of annuity market with adverse selection
  - Heterogeneous mortality
  - Private information
  - Market structure: linear contracts

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  - Heterogeneous mortality
  - Private information
  - Market structure: linear contracts
    - Annuities: financial contracts, difficult to observe/monitor
    - Lack of observability $\Rightarrow$ Contracts are non-exclusive
    - Little evidence on screening in the market

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  - Private information
  - Market structure: linear contracts
- Calibrates the model to match US facts
- Compares welfare between three benchmarks

Three benchmarks

- **'Private annuity markets'**
  - No social security
  - Annuity is available only through private markets
- **'Current U.S. system'**
  - 'Stylized' features of U.S. social security
  - Private markets
- **'Ex ante efficient allocations'**
  - Solution to utilitarian planner's problem

Overall ex ante gains

- If welfare is evaluated ex ante

  i.e., before mortality type is realized, then ...

- Welfare gains between

  - ‘Private annuity markets’ and ‘current US system’

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- Who loses and who gains ex post,

  i.e., after mortality type is realized?

autarky

Social Security has two effects

1. Transfers from high mortality types to low mortality types
   - About 9% suffer losses: high mortality - low survival
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- Can we use laternative policy to minimize this effect? Yes!

Related literature

- **Theoretical models**: Abel(1986); Eichenbaum and Peled(1987); Eckstein, Eichenbaum and Peled(1985)
  - Welfare enhancing role for mandatory annuitization
- **Detecting AS**: Finkelstein and Poterba(2002,2004,2006); Mitchell, Poterba,Warshawsky and Brown(1999); Friedman and Warshawsky (1990)
  - Evidence for adverse selection in the annuity market
  - Measure the value of access to actuarially fair annuity
- **Estimate welfare cost of asymmetric information**: Einav, Finkelstein and Shrimpf(2010)
  - preference heterogeneity as well as risk heterogeneity
- **Benefits of annuitization in social security**: Hubbard and Judd (1987)

Model

Environment: information

- Individuals have private type θ known at date zero
  - θ indexes their mortality
  - It determines their individual survival probabilities
  - Distribution at date zero: $G_0(\theta)$
- The only heterogeneity is in θ
- The only risk is time of death

Environment: preferences

- Everyone lives between 0 and T and has preferences

$$\sum_{t=0}^{T} \beta^t P_t(\theta)[u(c_t) + \beta(1 - x_{t+1}(\theta))\xi u(b_t)]$$

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  - ξ : weight on bequest, b_t

Technology

- Inelastic labor supply up to age $J < T$

- n units of labor produces wn units of consumption good

- Saving technology $R = \frac{1}{\beta}$

Annuity contracts

- Can be purchased at age J (last period before retirement)

- Makes survival contingent payment starting age $J + 1$

- Unit cost of annuity is q

Individual's problem

$$\max_{c_t, k_{t+1}, a \geq 0} \sum_{t=0}^{T} \beta^t P_t(\theta)[u(c_t) + \beta(1 - x_{t+1}(\theta))\xi u(Rk_{t+1})]$$

subject to

$$c_t + k_{t+1} = Rk_t + w(1-\tau) \quad \text{for } t < J$$

$$c_t + k_{t+1} + qa = Rk_t + w(1-\tau) \quad \text{for } t = J$$

$$c_t + k_{t+1} = Rk_t + a + z \quad \text{for } t > J$$

Insurers

- Insurers do not observe individual demand for each type θ

- However, they know the demand function $a(\theta, q)$

- They anticipate the fraction of total sales, purchased by θ

$$dF(\theta) = \frac{a(\theta; q) dG_J(\theta)}{\int a(\theta; q) dG_J(\theta)}$$

- Insurers use $F(\theta)$ to evaluate their profit

Annuity insurers problem

$$\max_{y \geq 0} \quad qy - y \int \left(\sum_{t=J+1}^{T} \frac{P_t(\theta)}{P_J(\theta)} \frac{1}{R^{s-t}} \right) dF(\theta)$$

- $F(\theta)$ is anticipated distribution of pay-outs
  - Determines fraction of y sold to type θ
  - Taken as given by the insurer

Government Budget Constraint

$$\int \tau w \left(\sum_{t=0}^{J} \frac{P_t(\theta)}{R^t} \right) dG_0(\theta) = \int z \left(\sum_{t=J+1}^{T} \frac{P_t(\theta)}{R^t} \right) dG_0(\theta)$$

Equilibrium

- Households and firms optimize + markets clear
- $F(\theta)$ is consistent with individual decisions

$$dF(\theta) = \frac{a(\theta)dG_J(\theta)}{\int a(\theta)dG_J(\theta)}$$

- Government budget constraint

▸ Skip Example

Properties of Equilibrium: Two period case

Two lessons

Use two period example to illustrate two properties

1. In this environment there is adverse selection
   - Equilibrium price is higher than aggregate risk
2. Increasing social security tax and benefit
   - Crowds out annuity market
   - Increases equilibrium price of annuity

A two period example

$$\max u(c_1) + Pu(c_2)$$

subject to

$$\begin{aligned} c_1 + qa &\leq w(1-\tau) \\ c_2 &\leq a + z \end{aligned}$$

- P is probability of survival (with distribution $G(P)$)
- Aggregate risk of survival is $\int PdG(P)$
- The goal is to show in equilibrium

$$q > \int PdG(P)$$

Adverse selection

- Consider the zero profit condition

$$\underbrace{q \int a(P;q)dG(P)}_{\text{Total sale}} = \underbrace{\int Pa(P;q)dG(P)}_{\text{Total expected payment}}$$

Adverse selection

- Consider the zero profit condition

$$q = \frac{\int Pa(P;q)dG(P)}{\int a(P;q)dG(P)}$$

Adverse selection

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$$q = \int P \frac{a(P;q)dG(P)}{\int a(P;q)dG(P)}$$

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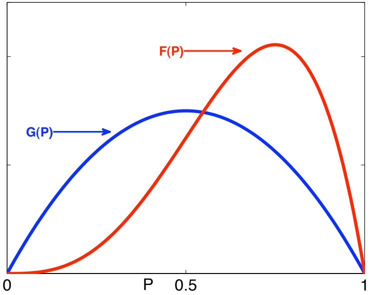

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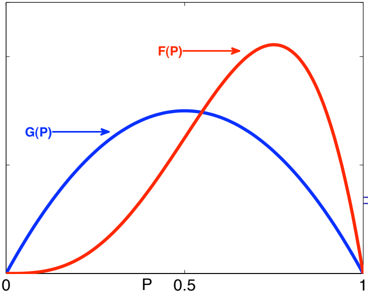

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- $a(P;q)$ is increasing in P

$\Longrightarrow$ $F(P)$ is more skewed relative to $G(P)$

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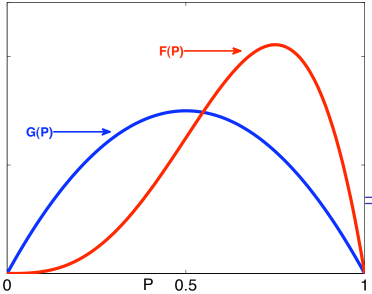
$$q = \int P dF(P) > \int P dG(P)$$



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Therefore, equilibrium price is higher than aggregate risk

Effect of increasing social security

- SS benefit is a substitute for annuity

  ⇒ increasing SS reduces demand for annuity

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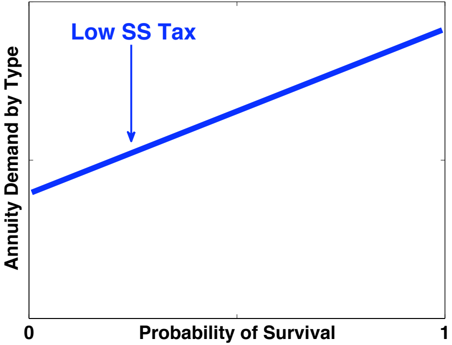

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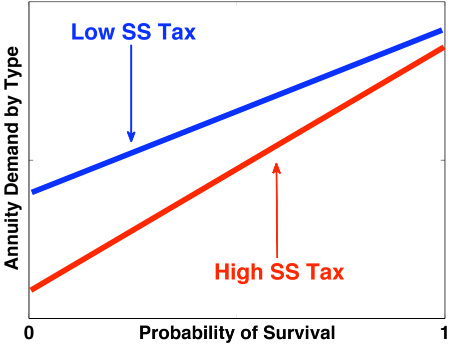

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  $a(P;q)$ shifts down

  And becomes steeper

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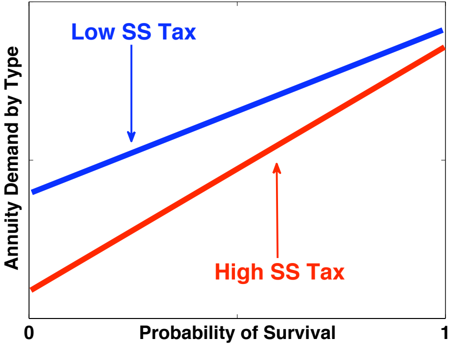

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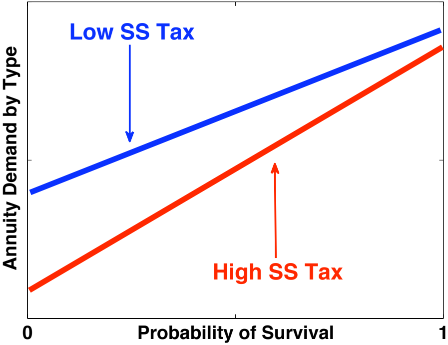

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What about wlefare?

Calibration

Calibration

- Mortality parameters
  - Survival probabilities, $P_t(\theta)$, for each t and θ
  - Initial distribution of θ: $G_0(\theta)$
- Preference/technology parameters
  - Curvature of utility function
  - Weight on bequest
  - Return on saving and time preference
- Policy parameters
  - Social security tax and benefits

Calibrating mortality parameters

- Observe data on
  - Average survival probabilities (from life tables)
  - Individuals' own assessment about longevity (from HRS)
- Use these observations to back out
  - $P_t(\theta)$ for each θ
  - The distribution $G_0(\theta)$
- Need to impose restriction on $P_t(\theta)$
  - Standard assumptions from demography

Assumptions on $P_t(\theta)$

- Let $H_t(\theta)$ be cumulative mortality hazard for type θ, define

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

- **Assumption 1**: θ shifts mortality hazard

$$H_t(\theta) = \theta H_t$$

- **Assumption 2**: Initial distribution of θ is gamma

$$g_0(\theta) \sim Gamma(\frac{1}{k}, k) = k^k \theta^{k-1} \frac{\exp(-k\theta)}{\Gamma(k)}$$

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- What are implications of these assumptions?

Implication of the assumption $H_t(\theta) = \theta H_t$

- Suppose type θ has 50% chance of surviving to age t

- Then, type 2θ has 25% chance of surviving to the same age

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- Suppose type θ has 50% chance of surviving to age t

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- Once $P_t(\theta)$ (or $H_t(\theta)$) is known for one θ

  It is known for all θ

Identifying survival probabilities

- Unknowns are
  - H_t
  - Parameter of distribution G_0

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$$\bar{P}_t = \int P_t(\theta) dG_0(\theta)$$

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- Given $G_0(\theta)$ the above identity can be solved to find H_t

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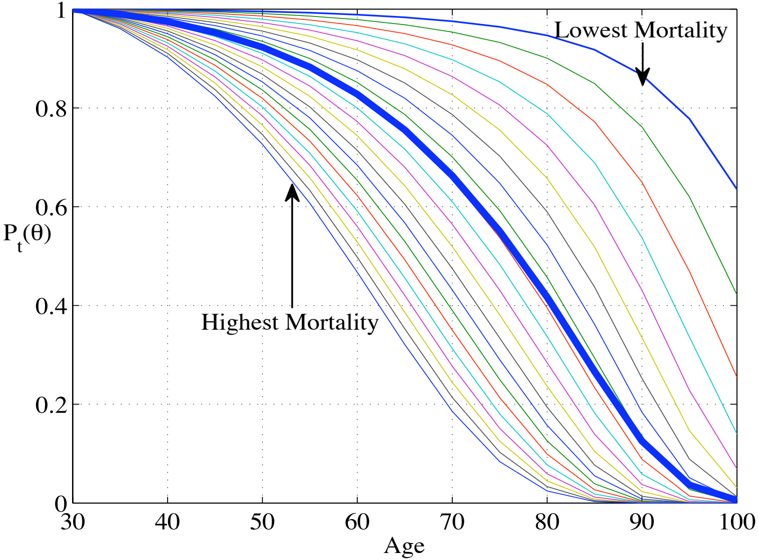
- How do we find $G_0(\theta)$?

Subjective survival prob. in HRS

- HRS asks individuals their subjective prob. of living to 75
- Hurd & McGarry(1995,2002): responses are consistent with
  - Life tables
  - Ex post mortality experience
  - Individuals' health data
- Use Gan-Hurd-McFadden(2003)'s method to estimate $G_0(\theta)$

Details

Individual survival curves: $P_t(\theta)$



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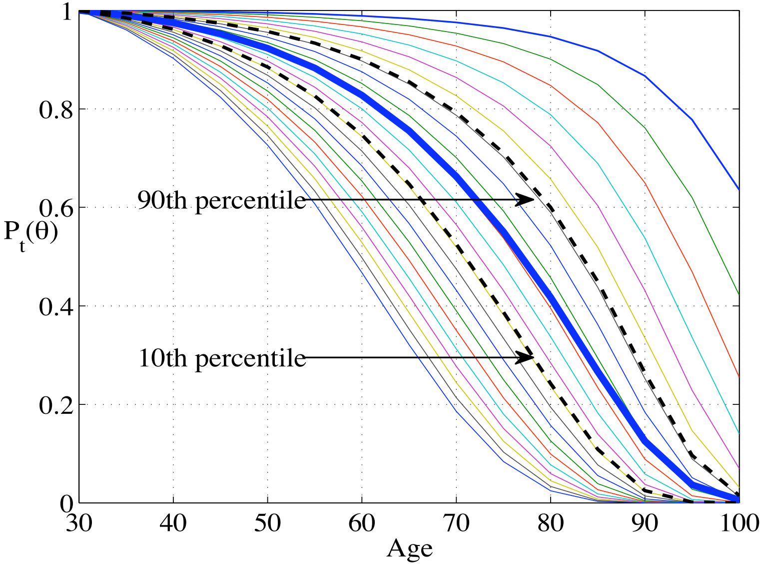

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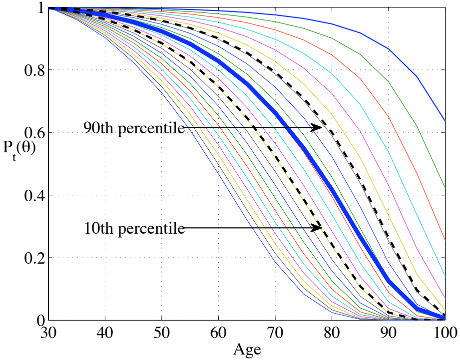

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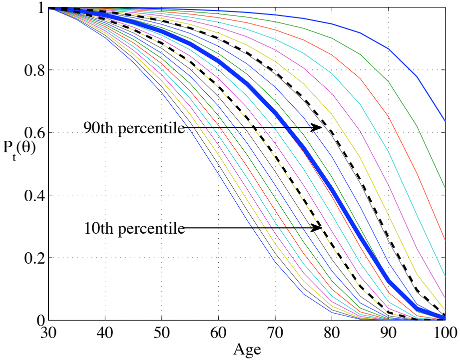
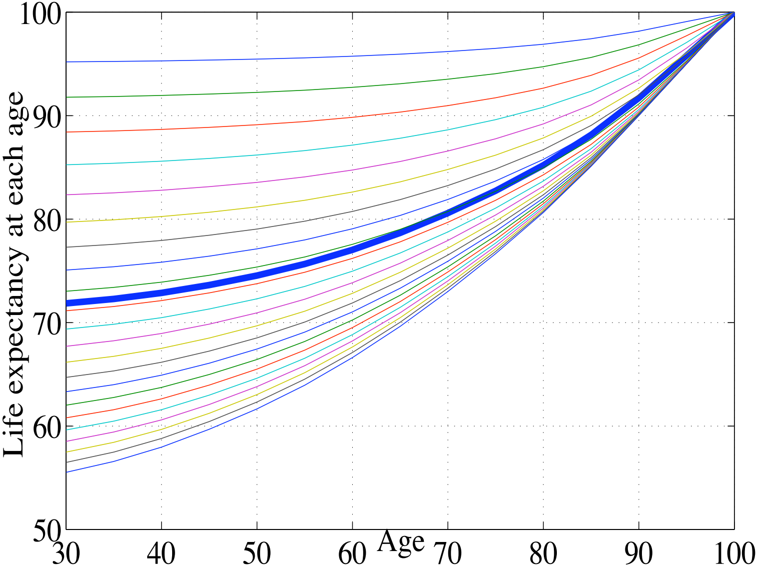


Average Life Expectancy at 30: 44 yrs (74 years old)

Standard deviation : 4 yrs

Profile of Life Expectancy by age



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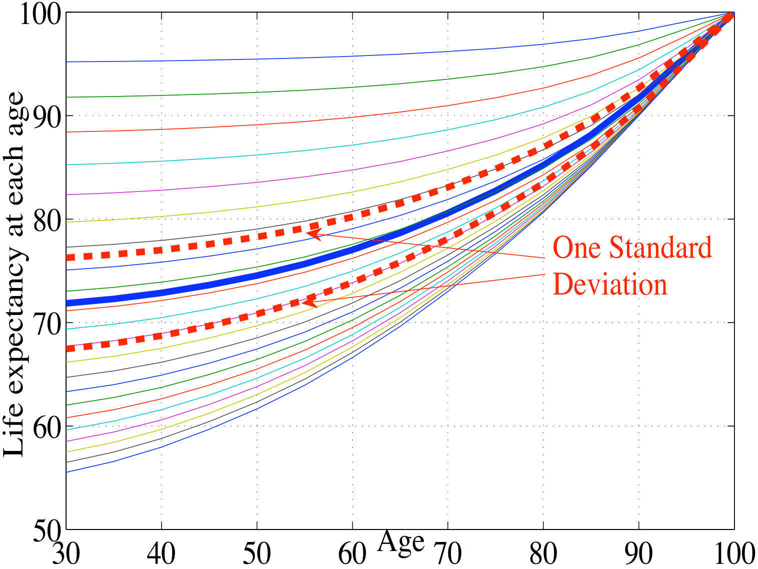

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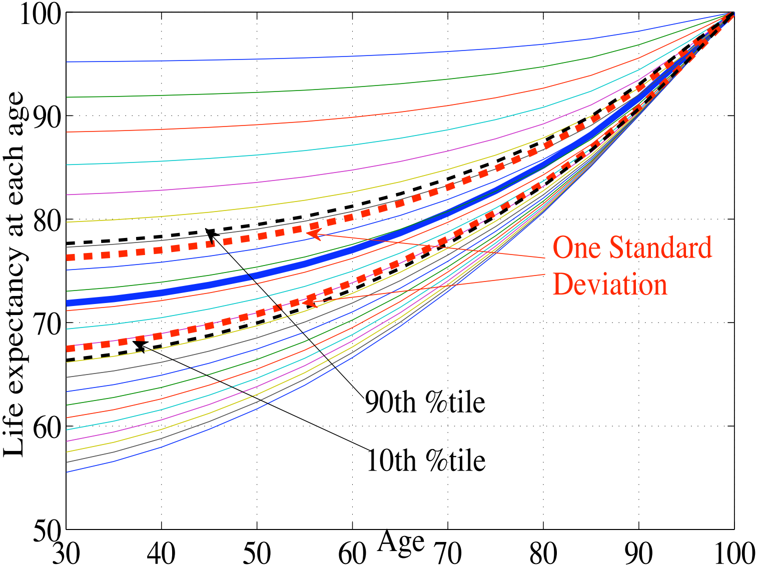


Calibration: preferences + social security

- CRRA utility function

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

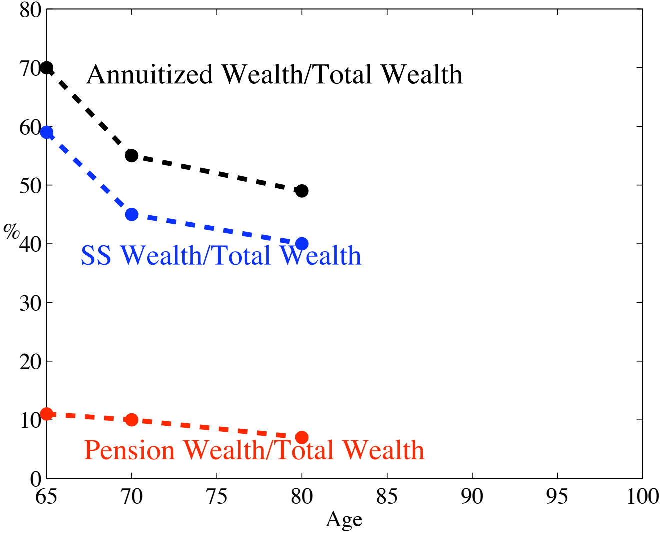
- Preference parameters are chosen to match
  - Fraction of pension wealth for 70 yrs old in HRS $\xi = 0.8$
  - Fraction of SS wealth for 70 yrs old in HRS $\gamma = 1.47$

- Social security tax: chosen to match %45 replacement ratio

Calibration summary

Parameter	Value
risk aversion, γ	1.47
weight on bequest, ξ	0.8
discount factor, β	0.97^5
return on savings, R	1.03^5
SS tax, τ	0.08
variance of $g_0(\theta)$, $\sigma_\theta^2 = \frac{1}{k}$	0.12

Fraction of wealth annuitized , average ____



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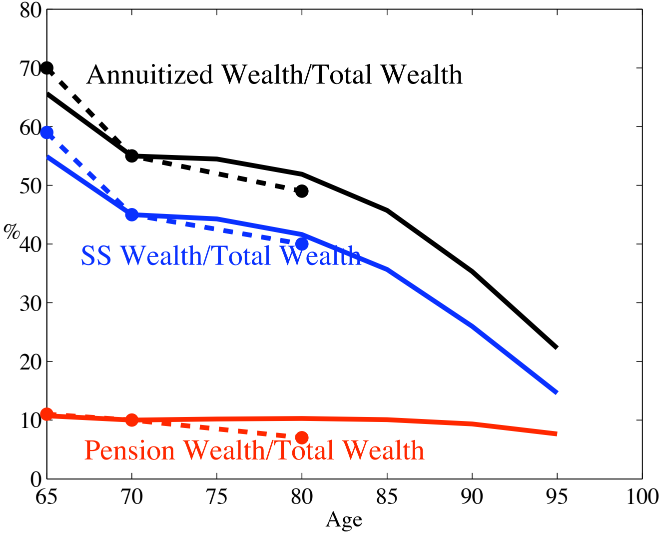

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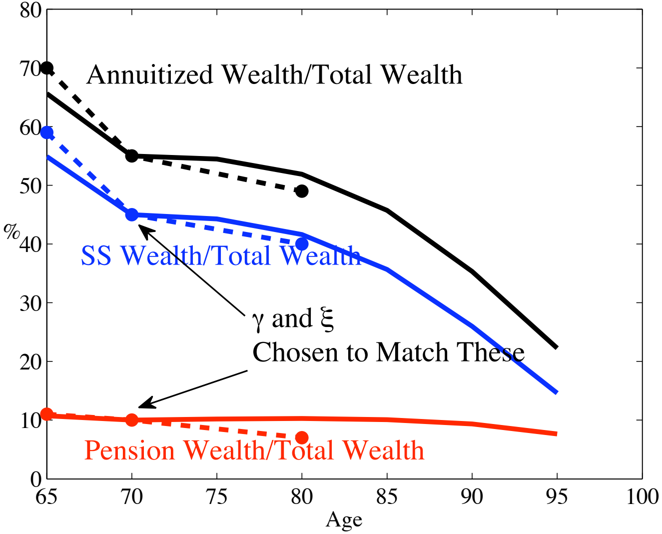


Findings

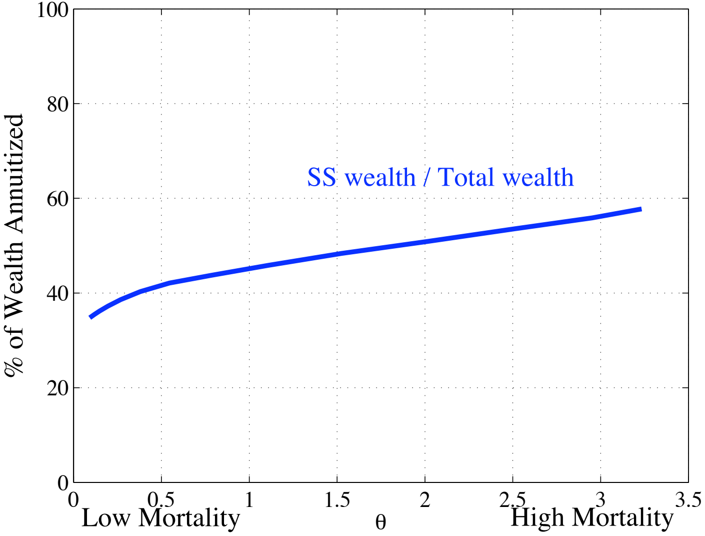
Use the model to ask

- How does annuitization decision vary by mortality type?

- How do these decisions change by removing SS?

- Welfare comparison

Fraction of wealth annuitized at 70, by type



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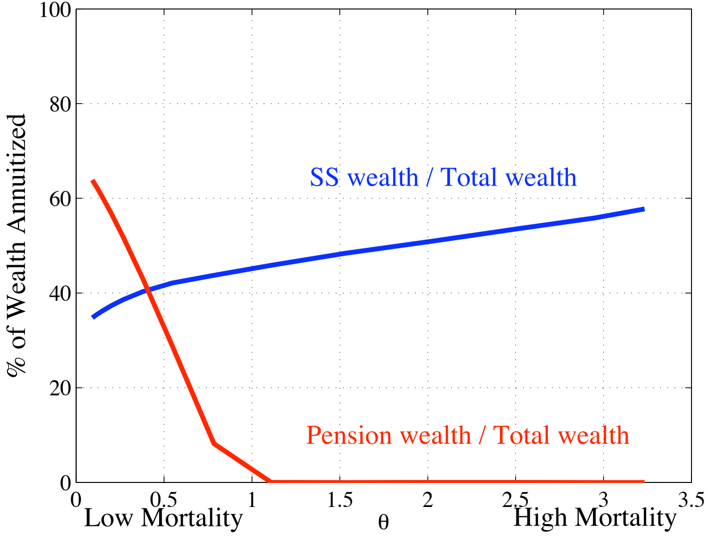

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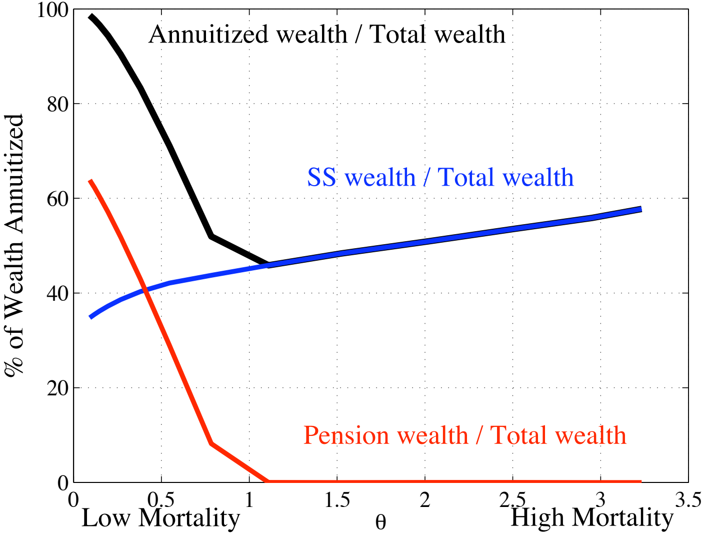

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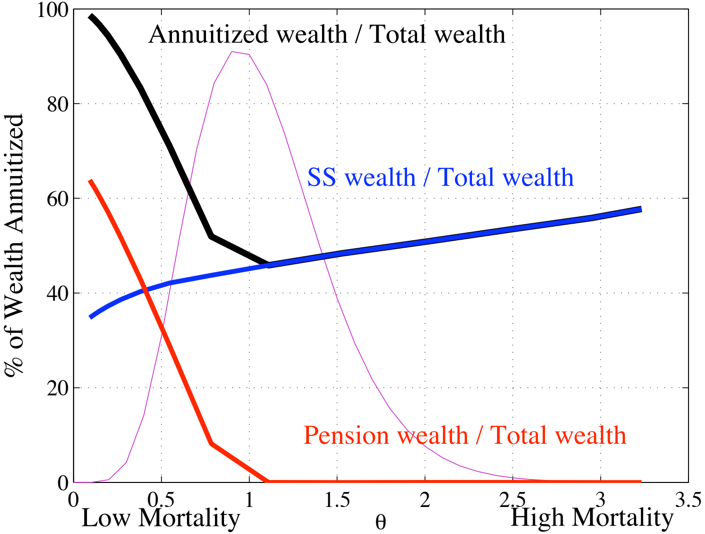

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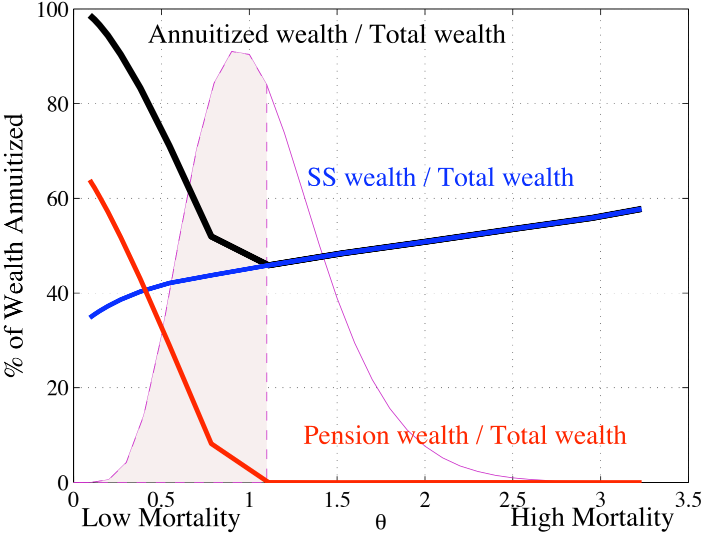

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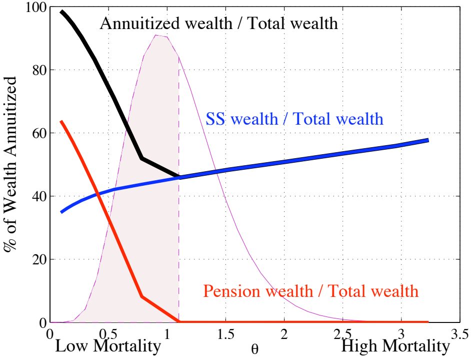

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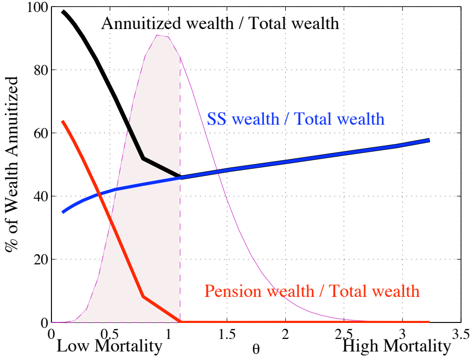

60% hold annuity

Consistent with evidence in HRS

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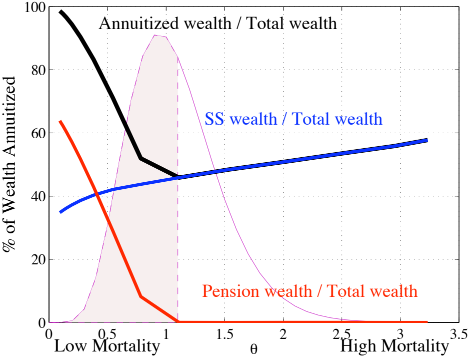

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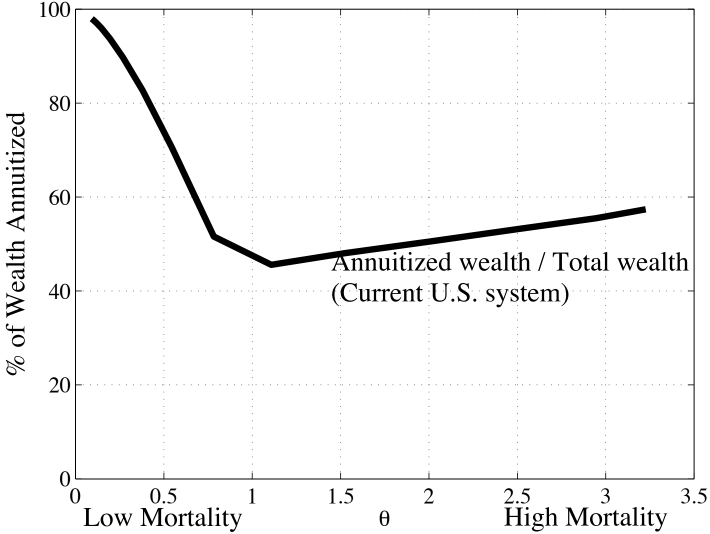
Consistent with evidence in HRS

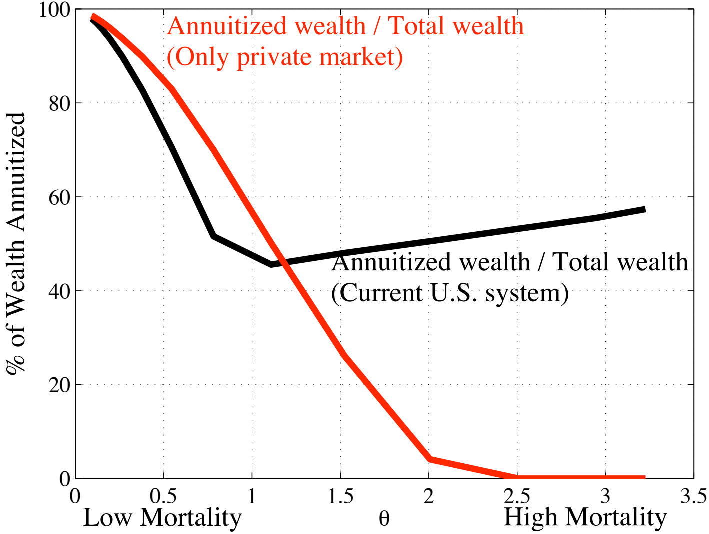
- Johnson-Burman-Kobes(2004) evidence from HRS

  43% of all adults (52% of males) hold pensions

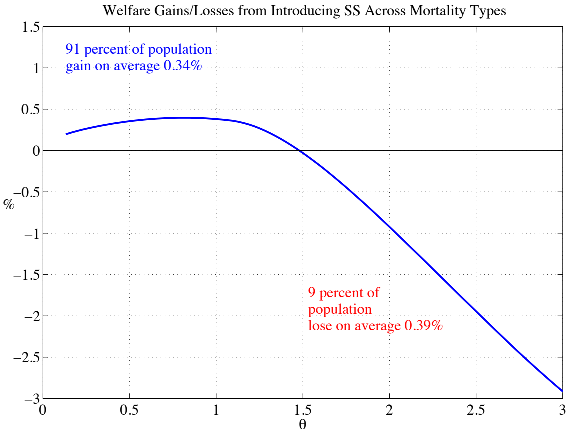
Only market vs Current U.S.



Only market vs Current U.S.

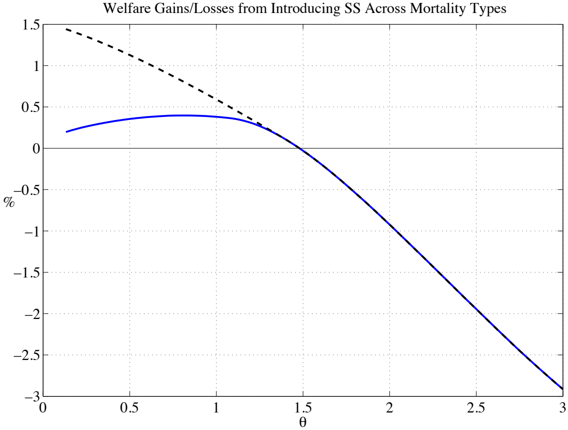


Ex post gain/loss



Ex ante gain = **0.27%**

Ex post gain/loss



- Counter-factual: fix price at the equilibiurm level without SS
- Without price increase the ex ante gain is **0.56%**

Can we do better?

- Social security forces individuals to pool their mortality risk

  But keeps this pool separate from market pool

- This derives good risk types out of the market.

- Alternative policy:
  - Return contributions to people at retirement
  - Force them to buy annuity in the market

Can we do better?

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- This derives good risk types out of the market.

- Alternative policy:
  - Return contributions to people at retirement
  - Force them to buy annuity in the market

- Ex ante welfare gain increases to **0.36%**

Gains from implementing ex ante efficient _

- What is the maximum ex ante welfare gain from policy?

- We need to find the solution to utilitarian planner's problem

Planner's problem

$$\max \int \left[\sum_{t=0}^{T} \beta^t P_t(\theta)[u(c_t(\theta)) + \beta(1 - x_{t+1}(\theta))\xi u(b_t(\theta))] \right] dG_0(\theta)$$

subject to

$$\int \sum_{t=0}^{T} \frac{P_t(\theta)}{R^t} \left[c_t(\theta) + \frac{(1 - x_{t+1}(\theta))}{R} b_t(\theta) \right] dG_0(\theta) = \int w \sum_{t=0}^{J} \frac{P_t(\theta)}{R^t} dG_0(\theta)$$

Planner's problem

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Planner chooses consumption and bequest

Planner's problem

$$\max \int \left[\sum_{t=0}^{T} \beta^t P_t(\theta) [u(c_t(\theta)) + \beta(1 - x_{t+1}(\theta)) \xi u(b_t(\theta))] \right] dG_0(\theta)$$

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Notice : No I.C constraints!

Planner's problem

$$\max \int \left[\sum_{t=0}^{T} \beta^t P_t(\theta)[u(c_t(\theta)) + \beta(1 - x_{t+1}(\theta))\xi u(b_t(\theta))] \right] dG_0(\theta)$$

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It turns out they don't bind

Planner's problem

$$\max \int \left[\sum_{t=0}^{T} \beta^t P_t(\theta) [u(c_t(\theta)) + \beta(1 - x_{t+1}(\theta)) \xi u(b_t(\theta))] \right] dG_0(\theta)$$

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Ex ante efficient allocations have very simple form

Ex ante efficient allocations

- Perfect insurance against risk type θ

$$c_t(\theta) = c_t(\theta') = c_t$$

$$b_t(\theta) = b_t(\theta') = b_t$$

- Perfect insurance against time of death,

$$u'(c_t) = \beta R u'(c_{t+1}) = \beta R \xi u'(b_t)$$

Ex ante efficient allocations

- Perfect insurance against risk type θ

$$c_t(\theta) = c_t(\theta') = c_t$$

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- Perfect insurance against time of death, assume $R\beta = 1$

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Ex ante efficient allocations

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$$c_t = c \ , \ b_t = b \text{ and } u'(c) = \xi u'(b)$$

Ex ante efficient allocations

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- Perfect insurance against time of death, assume $R\beta = 1$

$$c_t = c \text{ , } b_t = b \text{ and } u'(c) = \xi u'(b)$$

- Can be implemented by
  - Type-independent social security tax and benefit
  - Type-independent survivors benefit

Implementation

Ex ante efficient allocation can be implemented useing

- Type-independent taxes: 0.14 (compare this to 0.08)
- Replacement ratio: 0.71 (compare to 0.45)
- Survival benefit before retirement (small)

Comment

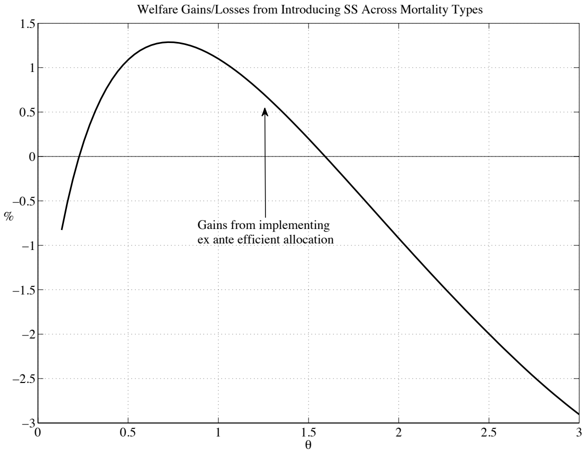
- There are two key assumptions

    1. **Only** heterogeneity is in mortality

    2. Individuals (and planner) are expected utility maximizers

$\Rightarrow$ Type-independent policy is optimal

Ex post gain/loss



Ex ante gain = **0.91%**

Conclusion

- Goal of the paper
    - Measure the gains from mandatory annuitization in S.S
- Welfare gain from mandatory annuitization

  'current U.S. system' over 'private markets': **0.27%**

- Large impact on price with negative welfare implications
- Simple policy change can aleviate this negative price effect

Extensions

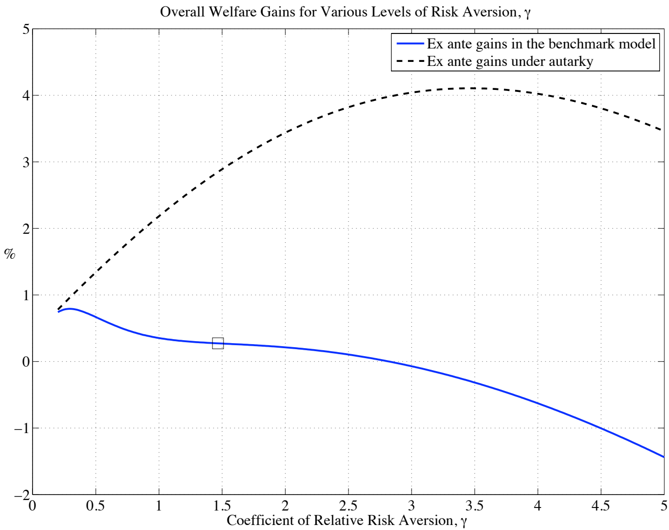
- Introducing other heterogeneities
  - Heterogeneity in preference for bequest
  - The link between measures of income and mortality

- Detailed model of altruism and intergenerational link

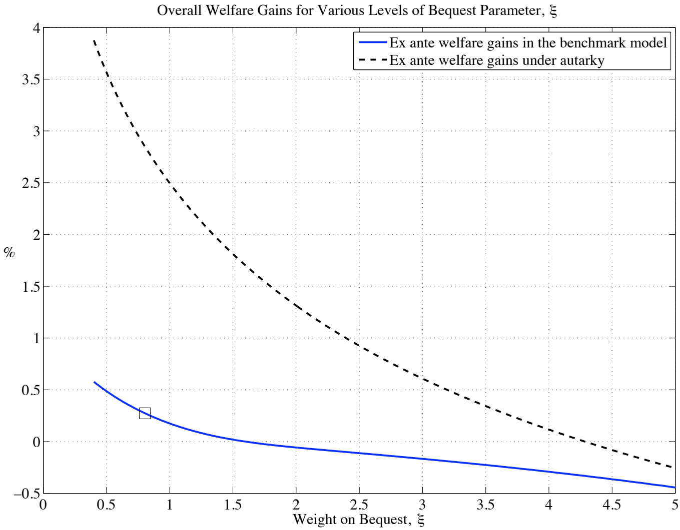
- Alternative equilibrium notions

Backup slides

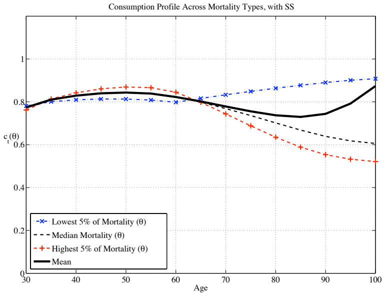
Sensitivity: Risk aversion

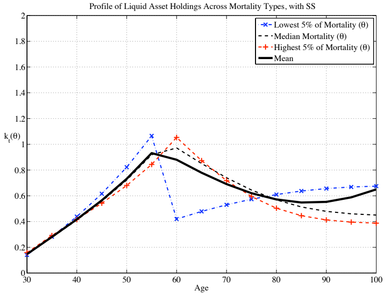


Sensitivity: Bequest Parameter

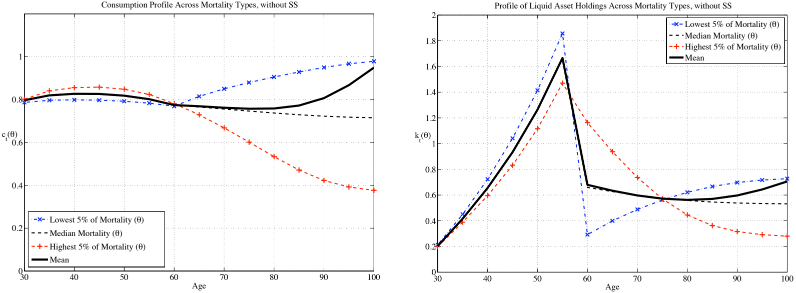


Consumption/Saving profiles (w/ SS)





Consumption/Saving profiles (w/o SS)



Backups: Calculations under autarky

- Welfare gains going from

  - Private saving to current US system **2.85%**
  - Current US system to ex ante efficient **0.84%**

  3.71%

- When there is no annuity market, gains are large

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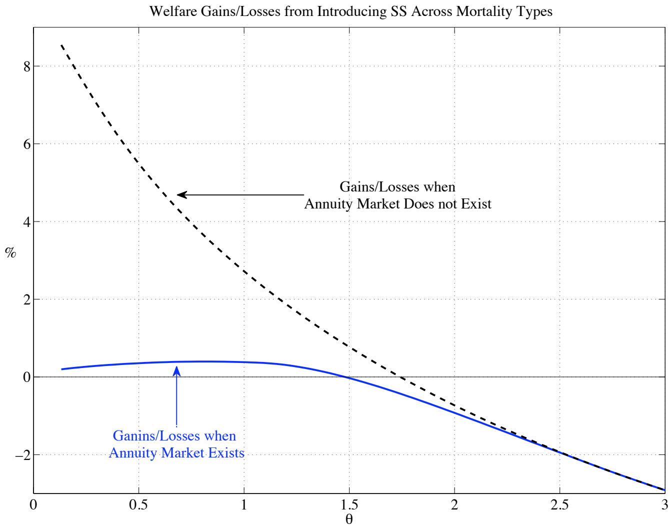
Ex post gain/loss



Estimation procedure

- What is observed in HRS
  - Response to the question on subjective survival prob.
  - Ex post mortality/survival
- Problem : there are many 0's and 1's in responses
- Solution: assume error in reports
  - Type θ at age t makes report r with prob. $f(r|\frac{P_{75}(\theta)}{P_t(\theta)})$

Estimation procedure (cont.)

- Observing report, r, we can estimate θ using Baye's rule
  - Prior on θ is given by $G_t(\theta)$
  - Report, r and $f(\cdot|\cdot)$ can be used to form a posterior
  - Use posterior mean as estimate for θ
- Use estimates to form likelihood functions for survival
- Estimate parameters of $G_t(\theta)$ and $f(\cdot|\cdot)$ using MLE

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Feldstein's quote

"the existence of asymmetric information may justify a social insurance program (a government annuity in this case) but does not necessarily do so. The case for a mandatory annuity program depends on calculations that could be done but that have not yet been done."

Martin Feldstein, presidential address (2005)

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