Age-Dependent Risk Aversion: Re-Evaluating Fiscal Policy Impacts of Population Aging

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Preview

- Population aging poses challenges to fiscal sustainability
- Studies have tried to find best policy response, on the criteria of welfare efficiency, when dealing with such problem
- This study, however, argues that conventional assessment omits at least two important aspects:
  - Age-dependent risk aversion
  - Consequent changes in future uncertainties
- This study finds that welfare ranking of possible reforms can change when the above aspects are incorporated

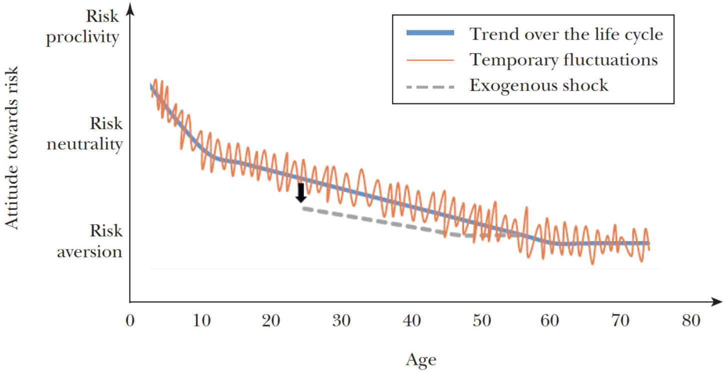
A quick glance at OLG literature

- Overlapping Generations (OLG) models have been pre-eminent in analysing the impacts of demographic changes.
- Inter- and intra-cohort heterogeneity are keys
- The seminal work by Auerbach and Kotlikoff (1987) studied the sustainability of the social security system under a demographic transition
- Subsequent studies covered the topics of, for instance
  - Social security privatisation (e.g., Kotlikoff et al., 1999; Nishiyama and Smetters, 2007)
  - Welfare and macroeconomic effects of different tax reforms (e.g., De Nardi et al., 1999; Huggett and Ventura, 1999; Altig et al., 2001; Vogel et al., 2017)
  - Optimal taxation and social security replacement rate (e.g.,Imrohoroglu et al., 1995; Gottardi et al., 2015)

Conventional OLG models leave out some important aspects

- First, most OLG studies assume that risk aversion is constant
- Risk aversion is at the heart of OLG model, predicting how individuals consume, save and work and shaping welfare efficiency
- However, empirical studies have shown that risk aversion tends to increase with age
  - Quantitative estimation on Arrow (1965) and Pratt (1964)'s concept of risk aversion: Morin and Suarez (1983),Palsson (1996), Bellante and Green (2004)
  - Incentivized experiment: Albert and Duffy (2012), Dohmen et al. (2011), Roalf et al. (2011)
  - Self reported questionaires: e.g. German Socio-Economic Panel

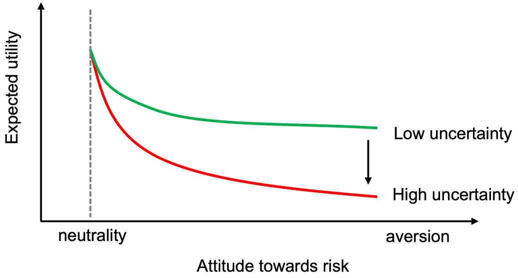
Illustration of age-dependent increasing risk aversion



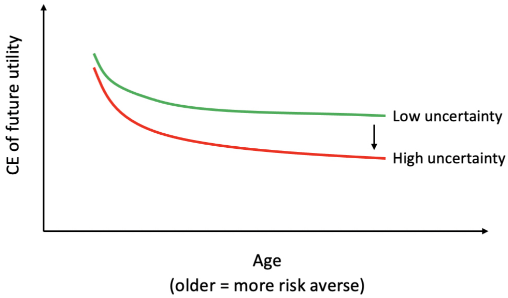
Source: Schildberg-Horisch (2018)

Disregard of uncertainties

- Secondly, most OLG studies use time-additive preferences which only consider the first moment of utility
- Would you prefer stable income/consumption to volatile ones during old age?
- Ability to follow through life plan with certainty is desirable for risk averse individuals, i.e., they always prefer sure outcome over a gamble with equal expected value



Putting the theoretical framework together



- Higher uncertainties will lower utility/welfare to different extents depending on how highly risk averse they are, or expect themselves to be, at a given time
- Individuals make optimal plans given their declining willingness to take risk as they age and how they expect uncertainty to unfold

What this paper does?

Research question

How would incorporating aspects of age-dependent risk aversion and uncertainty changes our understanding of behaviors and welfare under different reforms?

- Employ a structural OLG model with risk sensitive preferences
- Two risk aversion assumptions: constant risk aversion (CRA) and age-dependent increasing risk aversion (IRA)
- Evaluate demographic change impacts on life-cycle behavior and welfare
- Three self-financing policy alternatives: increasing payroll tax rate, cutting social security benefits, extending retirement age

Model Overview

- General equilibrium heterogeneous-agent OLG model with idiosyncratic wage and mortality shocks (somewhat resembling those of Nishiyama (2015), Kitao (2014))
- Endogenous saving, consumption and labor supply
- Risk-sensitive preferences (the only class of recursive preferences that is monotonic (Bommier et al., 2017))
- Social security benefit is a concave piecewise linear function of the Average Indexed Monthly Earnings (AIME) as in French (2005)

Households: Preferences

- With an assumption of unit elasticity of substitution, we can convert EZW preferences into risk-sensitive preferences by following the approach of Tallarini (2000).

$$V_t^j = \left[(c_t^j)^{\nu}(1-l_t^j)^{1-\nu}\right]^{1-\beta}\left[\mathbb{E}_t\left(V_{t+1}^{j+1\,(1-\gamma^j)} \,\middle|\, \eta^j\right)^{\frac{1}{1-\gamma^j}}\right]^{\beta}. \quad (1)$$

Taking logs, transform, and rearrange give

$$\tilde{V}_t^j = \left(\nu \ln c_t^j + (1-\nu)\ln(1-l_t^j)\right) - \frac{\beta}{\psi^j}\ln \mathbb{E}_t\left(e^{-\psi^j \tilde{V}_{t+1}^{j+1}} \,\middle|\, \eta^j\right) \quad (2)$$

- To see how it incorporates uncertainty, apply Taylor expansions to (2)

$$\rho^{ent}(V_{t+1}^{j+1}) = \frac{1}{\psi^j}\ln(\mathbb{E}(e^{-\psi^j V_{t+1}^{j+1}})) \xrightarrow{\text{Taylor expansions}} \mathbb{E}(V_{t+1}^{j+1}) - \frac{\psi^j}{2} Var(V_{t+1}^{j+1}) \quad (3)$$

- See Bommier et al. (2017) for further discussion

Households: Dynamic Programming Problem

$$V_t = \max_{\{c_t^j, l_t^j, a_{t+1}^{j+1}\}} \Big\{ \Big(\nu \ln c_t^j + (1-\nu)\ln(1-l_t^j)\Big) - \frac{\beta \xi_{t+1}^{j+1}}{\psi^j} \ln \mathbb{E}_t\big(e^{-\psi^j V_{t+1}} \,\big|\, \eta_t^j\big)\Big\}, \tag{4}$$

subject to the following constraints

$$a_{t+1}^{j+1} = \frac{1}{1+\mu}\Big[(1+r_t)a_t^j + w_t h^j l_t^j + beq_t + pen - T(x_t) - c_t^j\Big], \tag{5}$$

$$T(x_t) = \tau^c c_t^j + \mathrm{Tax}(TI) + \tau^s \min\{w_t h^j l_t^j, y_t^s\}, \tag{6}$$

$$c_t^j > 0, \quad 0 \le l_t^j \le 1, \quad a_t^j > 0, \tag{7}$$

Retirement benefits

- Following French (2005), the amount of social security benefits is determined as a concave function of an individual's average lifetime earnings

$$e_{t+1} = \begin{cases} e_t + \frac{y_{L,t}}{35} & \text{for } 20 \leq j \leq 55 \\ e_t + \max\left\{0, \frac{y_{L,t}-e_t}{35}\right\} & \text{for } 55 < j \leq J_R \end{cases} \quad (8)$$

$$y_{L,t} = \min\{w_t h^j l_t^j, y_t^s\}. \quad (9)$$

and benefits are calculated as (following SSA's 2019 formula)

$$pen = \begin{cases} 0.9 \times e_t & \text{if } e_t \leq \$11,112 \\ \$10,001 + 0.32 \times (e_t - \$11,112) & \text{if } \$11,112 < e_t \leq \$66,996 \\ \$27,884 + 0.15 \times (e_t - \$66,996) & \text{if } \$66,996 < e_t. \end{cases} \quad (10)$$

Calibration summary

- Demographics follow SSA's projection
- Age-earning profile of working cohorts follows the estimate of G. D. Hansen (1993)
- Income shocks follow the first-order Markov process calibrated to match the variance of log labor earnings from the empirical study of Storesletten et al. (2004)
- Government spending = 20% GDP; VAT = 5.54% (US simple average across states); progressive income tax follows the work of Keane and Wasi (2016)
- Discount rate calibrated to match capital-output ratio of 3.0
- Taste parameter of consumption calibration to match the fraction of time spent on working

Calibration: Age-dependent Risk Aversion in Future Utilities

- For IRA case, assume risk aversion to linearly increases with age
- Risk aversion values are constructed in such a way that the average value of risk aversion is the same under IRA and CRA cases
- Specifically, values of risk aversion under IRA case satisfy

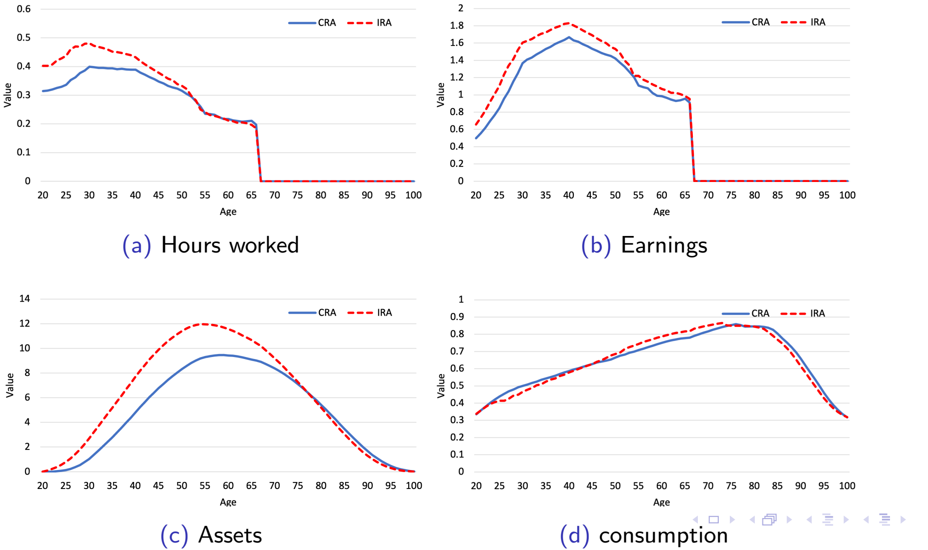
$$\sum(m_j \cdot \gamma_j) = 3 = \gamma_{CRA} \quad \text{and} \quad \gamma_{old-young} = \gamma_{JJ} - \gamma_1 \tag{11}$$

- Other preference parameters of IRA case follow those of CRA (assuming people are myopic about their risk aversion or IRA is the minority in the economy during benchmark year)

Results Overview

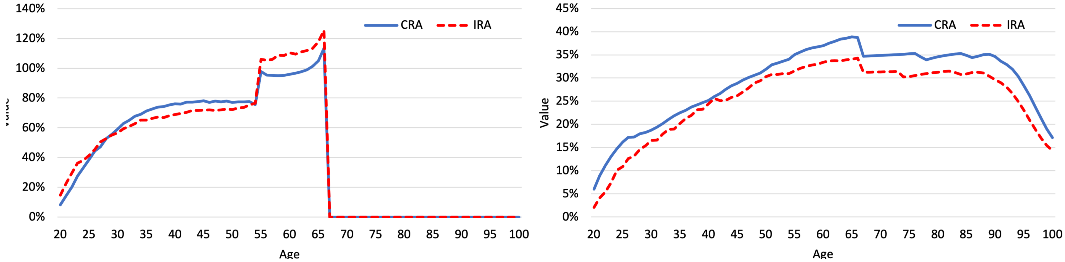
- Two groups of people: CRA and IRA
- For IRA, assume oldest person is more risk averse than the youngest by a factor of 3 in RRA term (for illustration purpose only)
- Evaluate long run demographics (match the dependency ratio in 2100 of SSA's projection)
- Three reform options:
    1. Proportionally increase payroll tax rate (baseline) : by about 9%
    2. Scale down the social security benefits: by about 50%
    3. Extend the retirement age: from 67 to about 80 years old
- Evaluate long run behaviors and welfare

Life cycle behavior of households in the long run baseline (2100)



Volatility of income and consumption

1. IRA group is more likely to adjust hours worked to smooth out productivity shocks
2. IRA group has lower consumption volatility $\leftarrow$ higher precautionary savings
3. However, controlling volatility is costly (same level of consumption despite more hours worked)



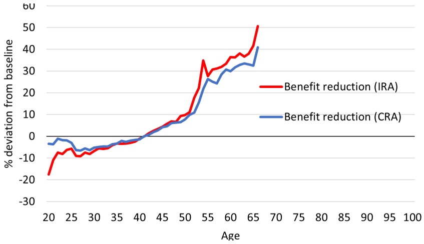
(a) Volatility of income (b) Volatility of consumption

Figure: Volatility over life cycle

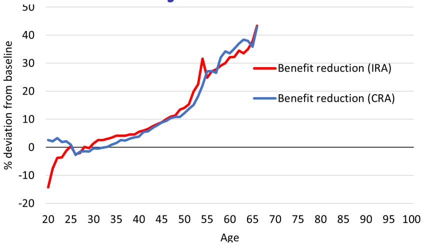
Impacts of alternative reforms on household behaviors

- Under both options, lower payroll tax rate compared to the baseline → income and substitution effects
- Benefit reduction:
  - expect lower benefits → more self-dependent
  - pension tied to average income → scaled down benefit means less reward for work
- Retirement age extension
  - extend working and shorten benefit periods → affect saving motives (precautionary and life-cycle)

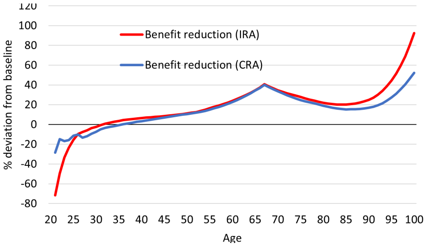
Benefits reduction vs baseline: life-cycle behaviors



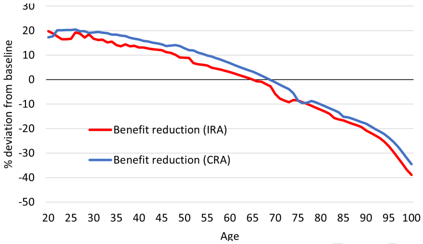
(a) Hours worked



(b) Earnings



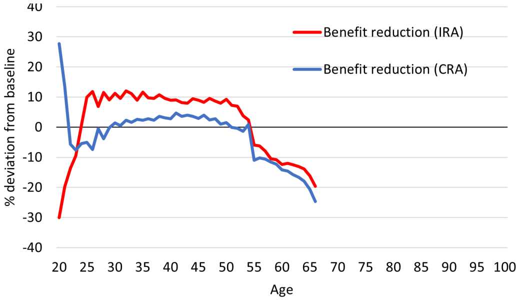
(c) Assets



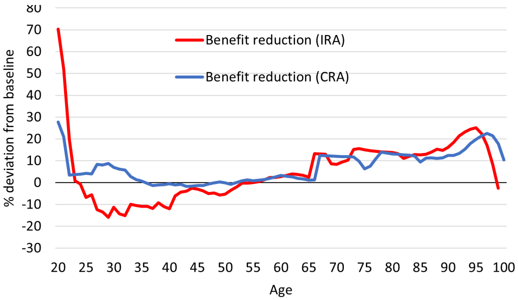
(d) Consumption

Benefits reduction vs baseline: Volatilities

- Benefits cut → self-dependent → save more from a stream of stochastic income → wider possibilities in old age consumption
- IRA pay higher cost to keep consumption volatility low



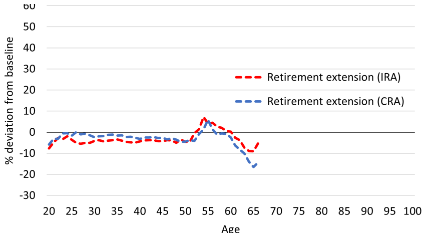
(a) Volatility of income



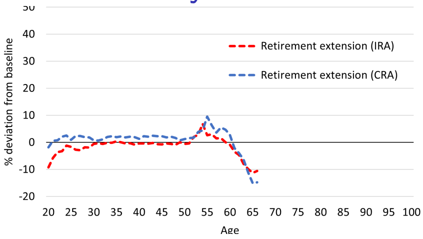
(b) Volatility of consumption

Figure: Deviation of volatilities over life cycle from the case of contribution rate increase

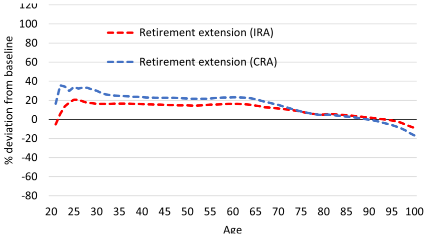
Retirement extension vs baseline: life-cycle behaviors



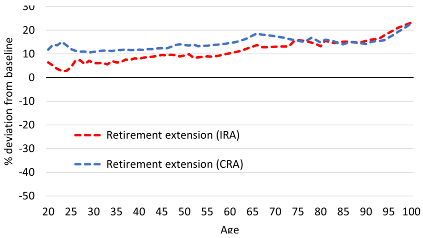
(a) Hours worked



(b) Earnings



(c) Assets

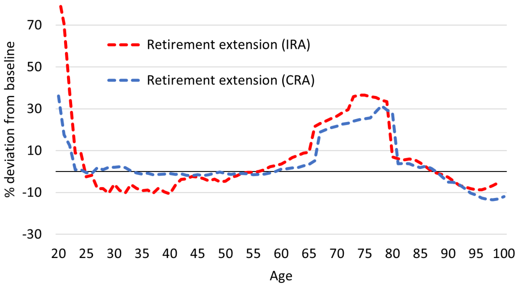


(d) Consumption

Retirement extension vs baseline: volatilities

- Retirement extension → longer exposed to stochastic income shock
- Once again, IRA pay higher cost to keep consumption volatility low

(a) Volatility of income



(b) Volatility of consumption

Figure: Deviation of volatilities over life cycle from the case of contribution rate increase

Framework for welfare analysis

- Hicksian equivalent variation
- Comparing between CRA and IRA:
  - Common welfare determinants: changes in levels of life-cycle consumption and leisure
  - Difference: weight put to uncertainties around a stream of consumption-leisure bundles (which in turn affect life-cycle decision)
- Optimal responses to reforms and remaining uncertainty involve trade-off between instantaneous and future utility, first and second moments
- Expectation of IRA leads to decisions that favor old age certainty → more resources are spent to control the second moment rather than raising the first

Welfare

- There is increasing cost of uncertainty with higher degree of IRA (more resources spent to keep uncertainty low, sacrificing consumption)

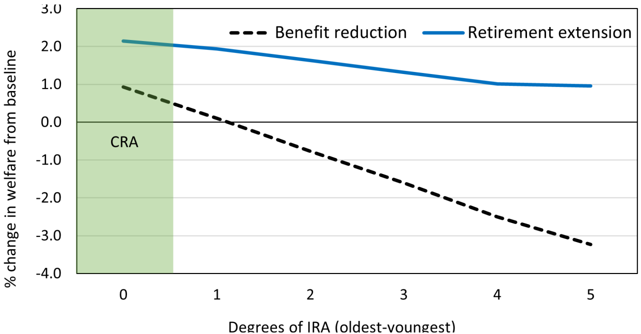


Figure: Welfare change from the case of contribution rate increase

Conclusion

- Developed OLG model with risk-sensitive preferences and age-dependent increasing risk aversion to re-evaluate policy options against aging population
- CRA may underestimate (overestimate) risk aversion of old (young) cohorts, leading to inaccurate welfare implications
- The model gives insight into how IRA and uncertainty shape household optimal behavior and welfare
- Reducing social security benefits and extending the retirement age results in higher future volatility, possibly hurting welfare for people with IRA