The impact of demographic shocks on the political arrangement of pay-as-you-go pension systems

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Motivation

Major developments of PAYG pension systems were triggered by either financial or demographic shocks:

- they were introduced following shocks that reduced the savings of old agents (UK, US, Germany, Italy, Japan);
- they were expanded following other major economic downturns (early retirement schemes and decreases in retirement age in France, Netherlands, Spain, US and Poland);
- they started to be reformed beginning with the 1980s when demographic developments worsened:
  - most countries increased contributions and decreased benefits (western European countries, US);
  - Eastern European and Latin American countries partially or totally switched to fully funded pension systems.

Our paper

Does the presence of the demographic shocks interfere with the role of the PAYG pension system of protecting against financial shocks?

- We build a model with both shocks to the real rate of return (financial shocks) and to the population growth rate (demographic shocks).
- The size of the PAYG pension system is determined by voting, each period, after the shocks have materialized;
- Financial markets are incomplete, agents cannot trade with the unborn - the PAYG pension system can help agents to partially protect against financial shocks by organizing transfers to the old after the shocks materialized.

Results (1)

The model can replicate the major developments of PAYG pension systems:

- following a decrease in the return on capital, contributions and benefits increase;
- following a decrease in the population growth rate, contributions increase but benefits decrease;
- the pension system can help agents share both financial and demographic risks if contributions and benefits are adjusted accordingly each period.

Results (2)

The characteristics of the demographic process influence the sharing of financial risks and determine the size of the pension system in the political equilibrium:

- for most of the parameter space we analyze, a lower mean or a higher variance of population growth rate leads to a lower size of the PAYG pension system;
- in the Ramsey planner's problem a lower mean or a higher variance of population growth rate leads to a higher size of the PAYG pension system.

The model

We build on the setup of the D'Amato and Galasso (2010) model:

- two overlapping generations alive at each moment: young and old;
- gross population growth rate (demographic shock) is stochastic $G(n_t) \sim (\bar{n}, \sigma_n^2)$;
- small open economy, return on capital (financial shock) is exogeneous but stochastic $F(R_t) \sim (\bar{R}, \sigma_R^2)$. We assume that $\bar{R} > \bar{n}$;
- wages are fixed;
- agents consume only when they are old;
- utility function is quadratic:

$$u(c_{t+1}) = -\frac{(c_{t+1} - \gamma)^2}{2}$$

- the parameter γ is inversely related to the agent's risk aversion.

Politico-economic equilibrium (1)

- Agents make no economic choices;
- Political equilibrium $\rightarrow$ probabilistic voting game as in Persson and Tabellini (2000). Politician's problem:

$$\max_{\tau_t} u(c_t) + \phi n_t E_t u(c_{t+1})$$

$$c_t = R_t s_{t-1} + \tau_t n_t \quad (1)$$

$$s_t + \tau_t = 1 \quad (2)$$

$$c_{t+1} = R_{t+1} s_t + \tau_{t+1} n_{t+1} \quad (3)$$

- ϕ - political weight of the young generation relative to the old generation;
- We focus on differentiable Markov policies, i.e. policies that depend only on current state variables $\tau_t = f(s_{t-1}, R_t, n_t)$.

Politico-economic equilibrium (2)

First order condition of the politician's problem:

$$u'(c_t) = \phi E_t \left[\left(R_{t+1} - n_{t+1} \frac{\partial \tau_{t+1}}{\partial \tau_t} \right) u'(c_{t+1}) \right] \tag{4}$$

- $n_{t+1} \frac{\partial \tau_{t+1}}{\partial \tau_t} > 0 =$ "strategic effect": an increase in contributions at period t lowers current savings, makes young agents poorer and incentivizes the future period politician to increase contributions;
- the higher the strategic effect, the higher the return of the PAYG system: young agents dislike pensions less.

The trade-off faced by young agents: risk vs return

Young agents' marginal utility:

$$\frac{\partial U^y}{\partial \tau_t} = cov\left[c_{t+1}, R_{t+1}\right] - \gamma E_t\left[R_{t+1} - n_{t+1}\frac{\partial \tau_{t+1}}{\partial \tau_t}\right] - \\ - cov\left(c_{t+1}, n_{t+1}\frac{\partial \tau_{t+1}}{\partial \tau_t}\right) + E_t c_{t+1} E_t\left(R_{t+1} - n_{t+1}\frac{\partial \tau_{t+1}}{\partial \tau_t}\right) \quad (5)$$

$$cov\left[c_{t+1}, R_{t+1}\right] = (\bar{R}^2 + \sigma_R^2)(1 - \tau_t) + cov(b_{t+1}, R_{t+1}) \quad (6)$$

- the PAYG pension system lowers $cov\left[c_{t+1}, R_{t+1}\right]$, especially if benefits are negatively correlated with the return on capital...
- ... but capital offers a higher expected return than the PAYG pension system: $E_t\left[R_{t+1} - n_{t+1}\frac{\partial \tau_{t+1}}{\partial \tau_t}\right]$.
- second effect is proportional with γ.

The politician's policy function

The following policy functions for the contributions to and benefits from the pension system solve the politician's problem:

$$\tau_t = \frac{A^P - R_t s_{t-1}}{B^P + n_t} \tag{7}$$

$$b_t = \tau_t n_t \tag{8}$$

- contributions are inversely related to the demographic and financial shocks and to the wealth of old;
- benefits are inversely related to the financial shock and the wealth of the old, but directly related to the demographic shock;
- the PAYG pension system offers old agents partial protection against financial shocks.

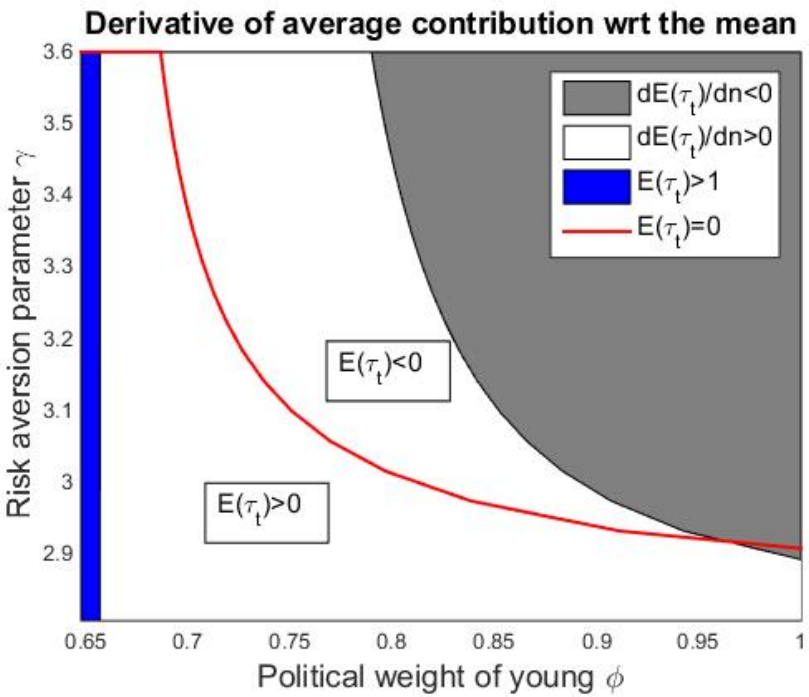
The interaction between shocks (1)

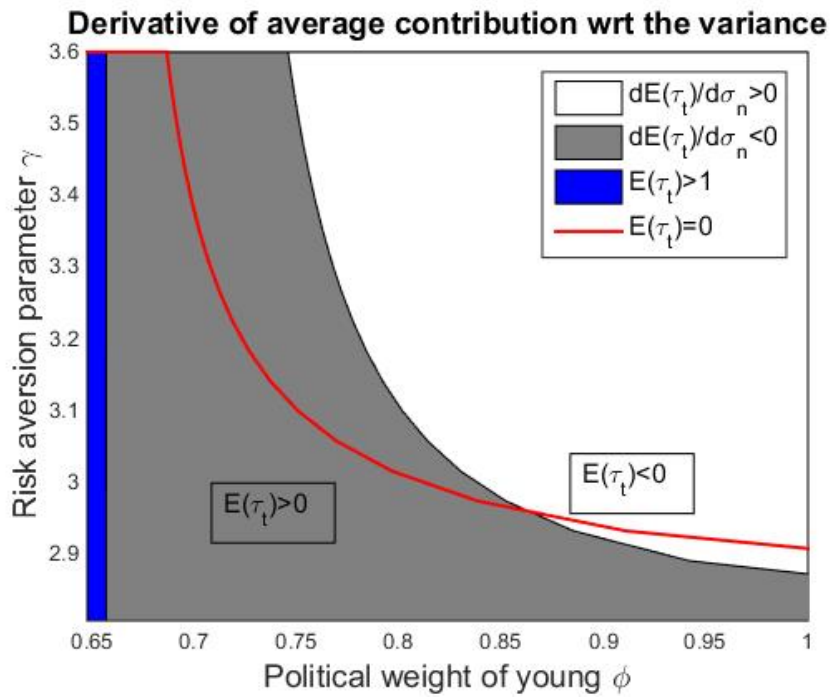
A lower mean ($\bar{n}$) or a higher variance (σ_n^2) of the population growth rate leads to:

- a policy function that is less sensitive to the wealth of the old (higher B^P) $\Rightarrow$ the politician has less room to compensate old agents for their losses from financial shocks;
- the pension system offers less protection against financial shocks $\rightarrow$ young agents need to invest more in the pension system to achieve the same level of risk sharing $\Rightarrow \tau_t \uparrow$
- the strategic effect is also lower, so the pension system becomes less attractive in comparison to capital $\Rightarrow \tau_t \downarrow$;
- the strategic effect dominates for most of the $\{\phi, \gamma\}$ parameter space $\Rightarrow E(\tau_t) \downarrow$;
- For very high values of ϕ (young agents have high political power), the strategic effect is not very sensitive to $\bar{n}$ and σ_n^2, so the size of the pension system may increase.

The interaction between shocks (2)

$$\bar{R} = 2.6262, \sigma_R = 0.6907, \ \bar{n} = 1.19, \sigma_n = 0.127$$





The Ramsey planner's problem

The Ramsey planner can commit to implement the optimal path of contributions and benefits set at time 0:

$$\max_{\{\tau_t\}_{t=0}^{\infty}} \sum_{t=-1}^{\infty} \rho^{t+1} E_0[N_t u(c_{t+1})]$$

$$\text{s.t. } s_t + \tau_t = 1 \tag{9}$$

$$c_{t+1} = R_{t+1} s_t + \tau_{t+1} n_{t+1} \tag{10}$$

given N_{-1}, s_{-1}, R_0 and N_0.

The following policy function solves the Ramsey planner's problem:

$$\tau_t = \frac{A^R - R_t s_{t-1}}{B^R + n_t} \tag{11}$$

Comparison between the politician's and the Ramsey planner's policy function (1)

Consider that the Ramsey planner and the politician use the same weights for the young generation $\rho = \phi$. Then:

1. The contribution to pension system set by the politician is higher than the contribution set by the Ramsey planner;

2. Following a financial or a demographic shock, the politician and the Ramsey planner change the contributions and benefits in the same direction;

3. Following a financial or a demographic shock, the politician adjusts the contributions to the pension system more than the Ramsey planner.

Comparison between the politician's and the Ramsey planner's policy function (2)

4. A lower $\bar{n}$ or a higher σ_n^2 leads to a higher average contribution to the pension system in the Ramsey planner's case.

- this is opposite to the result obtained in the politician's problem;
- it is due to the absence of the strategic effect in the Ramsey planner's case.

Conclusions

- PAYG pension systems can partially protect against financial shocks even in the presence of demographic shocks if contributions and benefits are changed to accomodate both shocks;
- However, the size of the pension system depends on the characteristics of of the demographic process. A lower mean or a higher variance of the demographic shock:
  - can lead to a downsizing of the pension system in the political equilibrium...
  - ... but will increase the size of the PAYG pension system set by a Ramsey planner.