Long-Run Effects of Employment-Related Pensions: PAYG vs. Funded Pensions

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Motivation

1) Differences in pension designs across developed countries, with many relying on

   (I) **PAYG** public social insurance system with PAYG payroll tax financing and defined old-age benefits (e.g., the US); while others have

   (II) Established Funded Pension (**FP**) system with mandatory contributions and illiquid retirement asset/private pension accounts (e.g., Australia)

   - These "universal" schemes could have potentially *large but different* behavioural lifecycle, welfare and aggregate effects in the long run

2) **Pension reforms** common in developed world over last 3 decades

   - Reforms to unfunded PAYG system ((partial) privatization of it) common in the past
   - More recently, some countries with FP systems moved the opposite directions (nationalizing them) (e.g., Poland)

Objective / approach

- Quantify **which system (PAYG vs. FP system) is better** in terms of long-run effects on household lifecycle behaviour, welfare & macroeconomy
- Our approach is to employ a **general equilibrium lifecycle** model to examine:
  - (I) **PAYG privatization** with different rates of funded pension mandate (i.e., SG rate set to 0% or 6% or 12%)
    - using (i) benchmark calibrated to the US with current PAYG system
  - (II) **FP nationalization** with lowering SG rates from 12%, to 6% or 0%, or + shift to PAYG system
    - using (ii) benchmark calibrated to Australia with mandatory superannuation
- In this paper, focus on **long run** steady state effects in the economy with **rational agents**

Methodology

- We develop a **general equilibrium lifecycle** (also called overlapping generations (OLG)) model that
  - incorporates life-cycle behaviour of heterogenous households (by skill type) with stochastic labor productivity, endogenous labor supply & solving constrained optimization problem;

(I) is calibrated to the US, drawing on US macro data, its PAYG pension system, income taxation & closed economy (CE) market structure

(II) is calibrated to Australia, assuming its FP system (with SG=12%), income taxation & small open economy (SOE) market structure with exogenous r

  - Thus, differences in the 2 benchmarks are due to contributory pension system design, income taxation & market structure, while
  - Population inputs, preference parameters, labour productivity & shocks are the same in the 2 benchmarks.

Literature

(I) Strand studying **PAYG social security and old age pension** reforms, using OLG models:

- e.g., Kitao (2014), Hosseini & Shourideh (2019) for the US; Kitao (2015), Braun & Joines (2015) for Japan; Kudrna et al. (2019, 2022) for Australia

(II) Strand studying voluntary or mandatory tax-preferred **private pensions** (retirement accounts), using OLG models:

- e.g., Nishiyama (2011), Ho (2017), Lin et al. (2021) for the US; Fehr et al. (2008), Fehr & Kindermann (2010) for Germany; Kudrna & Woodland (2013), Kudrna (2022) for Australia

- **Our contribution**: To combined the two strands by studying both privatization (of PAYG system) nationalization (of FP system), using different benchmarks

The model: Key features

- Type: Stochastic general equilibrium with overlapping generations – Macroeconomic model that accounts for lifecycle household behaviour
- Agents/sectors: Households, production, government (and foreign sector if SOE)
- Market structure: Closed economy (CE) (if benchmark with PAYG) or small open economy (SOE) (if benchmark with FP)
- Demographic structure: Stationary demographics with current population growth rate and survival rates

Household sector and behaviour

- Structure: Overlapping generations of heterogenous households by skill type, facing labor income & survival uncertainty
  - 16 age cohorts = 20-24, 25-29,...., 95-99
  - Low-, middle- & high-skilled based on educational attainment
- Labor productivity & supply: Stochastic labour productivities (AR(1) process); endogenous labor supply (discrete choice of working hours); retirement is exogenous at j_R
- Optimization problem: Consumption/saving & leisure/labor decisions over life-cycle, to maximize lifetime utility, subject to budget & time constraints
  - Household behaviour impacted by pension designs (differently if PAYG vs. FP system)

Government

- There are 2 roles of government in the model:

(1) Administering/regulating contributory pension system (either PAYG or FP system), and

(2) Imposing/collecting income taxes (that solely fund government consumption at a given G/Y)

PAYG SYSTEM (US)

- PAYG system with pension benefits pb linked to former earnings; annual earnings up to a contribution ceiling over working life computed as proxies for AIME, with PAYG rights accumulation a_r as:

$$\begin{aligned} a_r^+ &= a_r + \min[y; 2.47\bar{y}]/(j_R - 1) && \text{if } j < j_R \\ a_r^+ &= a_r, && \text{if } j \geq j_R \end{aligned}$$

- At $j \geq j_R$, agents receive pb defined by US social security formula:

$$pb = \begin{cases} 0.9 \times a_r & \text{if } a_r \leq 0.2\bar{y} \\ 0.18\bar{y} + 0.33 \times (a_r - 0.2\bar{y}) & \text{if } 0.2\bar{y} < a_r \leq 1.24\bar{y} \\ 0.5243\bar{y} + 0.15 \times (a_r - 1.24\bar{y}) & \text{if } a_r > 1.24\bar{y} \end{cases}$$

PAYG pension budget constraint:

$$\tau^p \int_{\mathcal{Z}} \min[le(z); 2.47\overline{y}] \mathrm{d}X(z) = f^p \int_{\mathcal{Z}} pb(z) \mathrm{d}X(z)$$

FP system (Australia)

- The FP system based on compulsory superannuation funded by SG contributions (at rate τ^{SG} accumulating in illiquid accounts, also earning interest income); we abstract from any additional taxation
- FP assets accumulate (and from $j \geq j_R$ decumulate) according to:

$$a_r^+ = (1+r)a_r + \tau^{SG} pc - pb,$$

where FP contributions: $\tau^{SG} pc_j$ with $pc_j = \min[le_j; x\overline{y}]$ iff $j < j_R$ $(= 0,$ otherwise) and FP benefits: $pb_j = \zeta_j(1+r)a_{r_j}$ iff $j \geq j_R$ $(= 0,$ otherwise)

- **Pension fund constraint** (budget constraint of private pension fund that government regulates):

$$\tau^{SG} \int_{\mathcal{Z}} pc(z)dX(z) + (r-n) \int_{\mathcal{Z}} a_r(z)\mathrm{d}X(z) = \int_{\mathcal{Z}} pb(z)\mathrm{d}X(z)$$

Income taxation

- Income taxation is assumed to be progressive, with **total income tax base**: $\widetilde{y} = le - \tau^p pc + ra_l$ (labor earnings minus PAYG or FP contributions plus liquid asset income).

- Following Heathcote et al. (2017), we use this **income tax function**:

$$t(\widetilde{y}) = \widetilde{y} - \tau_0 \widetilde{y}^{1-\tau_1},$$

where τ_1 determines the progressivity of tax function (same in the 2 benchmarks $= 0.151$), while τ_0 determines the level

- **Government (fiscal) budget constraint**:

$$f^y \int_{\mathcal{Z}} t(\widetilde{y})(z) dX(z) = G$$

with a scalar f^y balancing this fiscal budget (also targeting different G/Y in US and Australian benchmarks)

Rest of the model

- **Production** represented by perfectly-competitive firms with demands for capital & labor to produce an output good ($Y = \kappa K^{\alpha} L^{1-\alpha}$) & factor prices = marginal products ($w = MPL$, $r = MPK - \delta$)
- **Bequests** satisfy

$$\int_{\mathcal{Z}} b(z_j) dX(z_j) = \int_{\mathcal{Z}} (1 - \psi_{j+1}) \left[(1 + r) a_{j+1}(z_j) \right] \mathrm{d}X(z_j),$$

  where $a = a_l$ if **PAYG**, while $a = a_l + a_r$ if **FP**

- **Market clearing** for labor, capital & goods markets (with closed economy (CE) assumed below)

$$L = \int_{\mathcal{Z}} e_j \cdot \exp\left[\eta_j\right] l s_j \mathrm{d}X(z_j)$$

$$K = \int_{\mathcal{Z}} a(z_j) \mathrm{d}X(z_j)$$

$$Y = \int_{\mathcal{Z}} c(z_j) \mathrm{d}X(z_j) + G + (n + \delta) K$$

Solving the model (code)

- Benchmark solution (for each framework) obtained by numerically solving the model for an initial steady state equilibrium (US or Australia)
- The computation method follows the Gauss-Seidel procedure outlined by Auerbach and Kotlikoff (1987), which for stochastic OLG models is explained by Fehr and Kindermann (2018).
  - The numerical solution process begins with guesses for aggregate variables, bequest distribution, and exogenous policy parameters.
  - Then, the factor prices and individual decision rules and value functions are computed.
  - The latter involves the discretization of the state space.
  - Next, we obtain the distribution of households and aggregate assets and government budget-balancing instruments
  - This information allows us to update the initial guesses, and the procedure is repeated until the initial guesses and the resulting values for capital, labor, bequests, and endogenous taxes have sufficiently converged.

Parameterization

Table 1: Parametrization of the two benchmark models

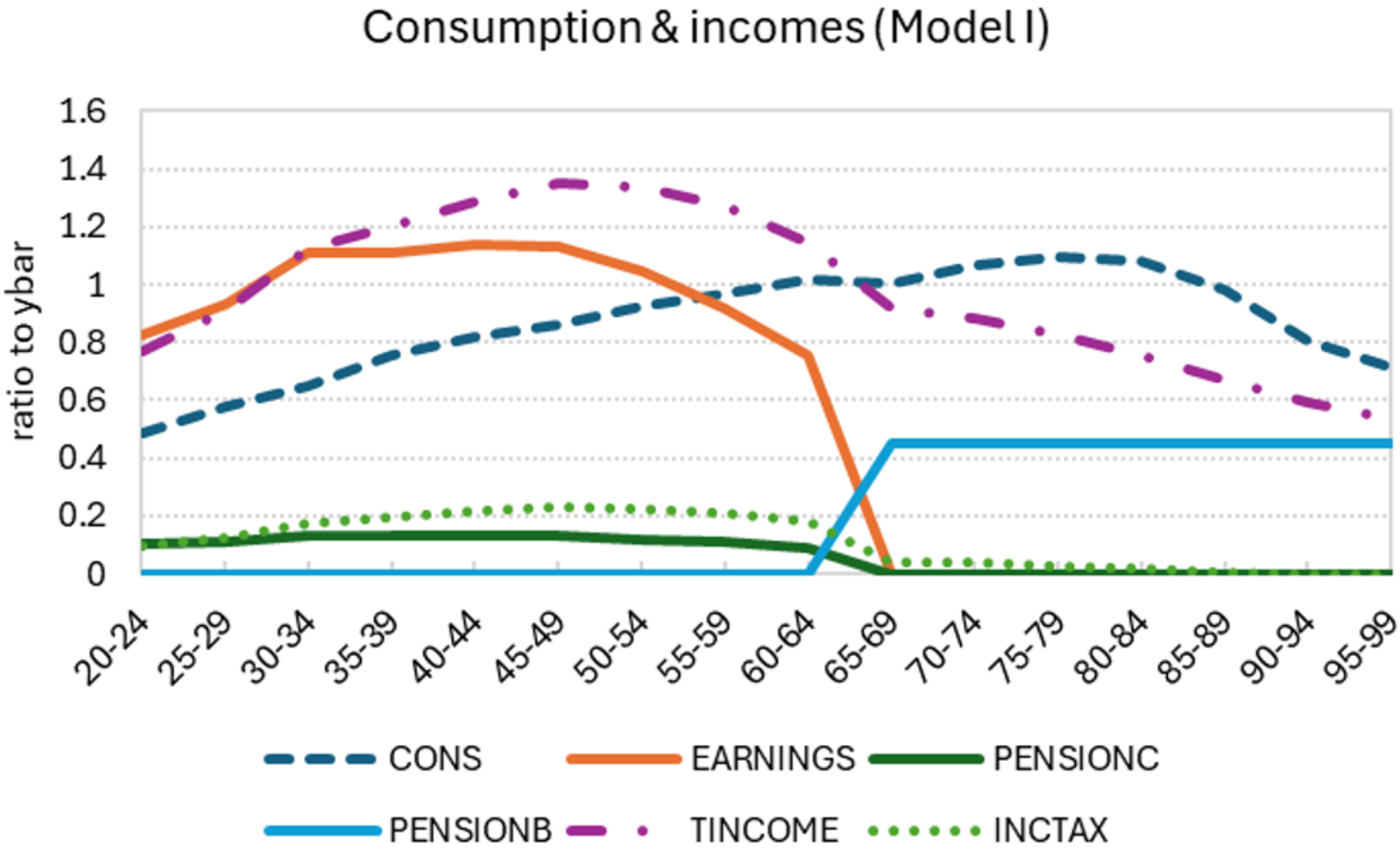
Parameter/input	Model I (calibrated to) US with PAYG system	Model II (calibrated to) Australia with FP system
Same in the 2 models		
Population inputs	Australian data	
Labor productivity	Australian data	
Utility/preferences	Literature/calibration to US data	
Production function	Literature/calibration to US data	
Different in the 2 models		
Pension system	PAYG, taup=12%	FP, tauSG=12%
Income tax scalar	to target G/Y=0.11	to target G/Y=0.17
Market structure	CE	SOE

Calibration/performance

Table 2: Calibration/performance of the two benchmark models

Variable	Model I (calibrated to) US with PAYG system	Model II (calibrated to) Australia with FP system
Capital labor ratio	5.8	5.8
Hours worked	0.33	0.30
Wage rate	1	1
Consumption to output ratio	0.61	0.66
Investment to output ratio	0.28	0.28
Capital to output ratio	3.5	3.5
Liquid asset to output ratio	3.5	2.9
FP asset to output ratio	0.0	3.9
Wealth to income ratio	7.7	14.9
Interest rate (% p.a.)	4.6	4.6
Pension benefits (% of output)	7.1	17.1
Average pension replacement rate	46.4	78.5

Life-cycle solutions (US benchmark)



Long-run effects of PAYG-FP reforms (CE)

Table 3: Long run effects of counterfactual scenarios (from PAYG to FP, CE)*

Variable	S1 taup=0% tauSG=0%	S2 taup=0% tauSG=6%	S3 taup=0% tauSG=12%
Effective labor	5.26	6.07	6.56
Wage rate	12.27	15.6	19.47
Output	18.15	22.62	27.31
Consumption	11.09	12.95	14.26
Capital stock	40.51	52.41	66.26
Liquid assets	40.37	7.31	-20.25
Total assets	40.37	52.44	66.29
- low skill	31.67	40.11	50.56
- middle skill	35.56	48.4	60.36
- high skill	54.15	67.37	86.62
Interest rate (p.p.)	-1.57	-1.94	-2.34
Welfare effects[a]			
Average	4.37	4.01	3.72
Low skill	3.4	2.89	2.44
Middle skill	4.18	3.82	3.49
High skill	5.41	5.19	5.07

Notes: *% change (or percentage point p.p.) relative to benchmark (with PAYG & taup=12%), using Model I with closed economy (CE) assumed; [a]% change in discounted lifetime utility relative to benchmark.

Long-run effects of PAYG-FP reforms (SOE)

Table 4: Long run effects of counterfactual scenarios (from PAYG to FP, SOE)

Variable	S1 taup=0% tauSG=0%	S2 taup=0% tauSG=6%	S3 taup=0% tauSG=12%
Effective labor	-2.42	-3.07	-4.44
Wage rate	0	0	0
Output	-2.42	-3.07	-4.44
Consumption	10.95	14.55	18.11
Capital stock	-2.43	-3.07	-4.44
Liquid assets	68.51	34.46	5.93
Total assets	68.51	90.19	115.41
- low skill	58.13	75.99	95.58
- middle skill	66.03	87.15	113.04
- high skill	79.56	104.77	132.63
Interest rate (p.p.)	0	0	0
Welfare effects[a]			
Average	5.05	4.69	4.31
Low skill	4.83	4.41	3.95
Middle skill	5.02	4.64	4.28
High skill	5.26	4.96	4.63

Notes: *% change (or percentage point p.p.) relative to benchmark (with PAYG & taup=12%), using Model I with small open economy (SOE) assumed; [a]% change in discounted lifetime utility relative to benchmark.

Long run effects of FP-PAYG reforms (SOE)

Table 5: Long run effects of counterfactual scenarios (from FP to PAYG, SOE)

Variable	S(1) taup=0% tauSG=6%	S(2) taup=0% tauSG=0%	S(3) taup=12% tauSG=0%
Effective labor	2.99	4.66	5.21
Wage rate	0	0	0
Output	2.99	4.66	5.21
Consumption	-1.37	-3.78	-16.05
Capital stock	2.99	4.66	5.21
Liquid assets	37.39	81.76	-4.76
Total assets	-11.75	-23.05	-59.68
- low skill	-9.46	-20.33	-52.86
- middle skill	-11.37	-22.7	-58.62
- high skill	-13.64	-25.13	-65.14
Interest rate (p.p.)	0	0	0
Welfare effects[a]			
Average	0.98	1.72	-4
Low skill	1	1.76	-3.63
Middle skill	0.99	1.74	-3.93
High skill	0.94	1.68	-4.38

Notes: *% change (or percentage point p.p.) relative to benchmark (with FP system & tauSG=12%), using Model II with small open economy (SOE) assumed; [a]% change in discounted lifetime utility relative to benchmark.

Sensitivity: What drives welfare effects

- Many of the effects (of PAYG privatization) common in literature
- However, increasing size of FP system (with higher mandated SG rate) is welfare worsening in long run, relative to SG=0%

  => contradicting **positive** welfare effects of Kudrna (2022) for a higher SG rate in long run; **Why?**

  - Kudrna (2022) uses more detailed model calibrated to Australia
    - with different bequest redistribution & non-contributory, means-tested age pension
- (to be done) Sensitivity analysis of
  - US model (simulations) to (a) bequest redistribution to younger households
  - Australian model (simulations) to (a) + (b) means-tested age pension

Summary & main takeaways

- Key (long-run) findings:
  - **FP better than PAYG** $=>$ higher household consumption & wealth (particularly under SOE); positive effects on labor, capital, output under CE
  - **Strong positive** (*negative*) **welfare effects of** privatizing PAYG with **shift to FP system** (*nationalizing FP with shift to PAYG*)
  - **However:** zero (or lower) contribution rate to FP system shown to be welfare improving (compared to a higher rate of 12%) in both models (with reforms in opposite direction)
    - What would make future generations to prefer FP system with higher SG rates?
    - Sensitivity to economies with higher interest rates, different bequest redistribution (to younger households) or including non-contributory, means-tested age pension (to be done)

Future research

- **Future/concurrent projects** related to contributory pensions (focusing on FP system):
  - **Transition path** and also studying optimal rates of the SG mandate under transition path – now a revised version of Kudrna (2022)
  - **Housing** – using a model with tenure choice, housing construction firm & rental agency, accounting for interactions with FP system (Kudrna, Tran & Woodland (2024))
  - **Present biased households** (e.g. with self-control preferences) – extension of Wheadon, Castex, Kudrna & Woodland (2024) (who study age pension means testing) to (incorporate) focus on the role of mandatory superannuation

Thank you

Thank you for your attention!

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Paper (and other research) available at:
sites.google.com/site/georgekudrna/research