Inequalities in an OLG economy with heterogeneous cohorts and pension systems

(with Marcin Bielecki, Krzysztof Makarski and Marcin Waniek)

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Motivation

- Wealth inequality increases due to:
  - Demographic transition
  - Pension reform: defined benefit $\rightarrow$ defined contribution
- Effects for consumption inequality: unclear

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- Effects for consumption inequality: unclear

- Can policy instruments help?
  - minimum pensions: $\uparrow$ pensions; $\downarrow$ labor supply incentives
  - contribution caps : obligatory savings replaced with private savings
- Intuition insufficient

Literature review

- Distributional effects of pension systems: OLG models with *ex post* heterogeneity:
  - Castaneda et al. (2003, JPE); Fehr et al. (2008, RED); Song (2011, RED); Bucciol (2011, MD); Cremer and Pestieau (2011, EER); Kumru and Thanopoulos (2011, JPubE); Fehr and Uhde (2014, EM); St-Amant and Garon (2014, ITPF)

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- *Ex ante* + *ex post* heterogeneity: education affects mortality rates
  - Hairault and Langot (2008, JEDC):
  - McGrattan and Prescott (2014, NBER)
  - Kindermann and Krueger (2014, NBER)

Our approach

- Question 1: distributional effects of a pension system reform
- Question 2: are standard instruments effective in reducing the increase in inequality

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Ex ante heterogeneous agents: age + _within cohort_

- endowments + preferences ← not a stand
- separate endowments from preferences
- most countries: no data on mortality by education / income groups

Results preview

- DB $\rightarrow$ DC reform: both wealth and consumption inequalities $\uparrow$

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- DB $\rightarrow$ DC reform: both wealth and consumption inequalities $\uparrow$
- Demographic transition $\Rightarrow$ inequalities $\uparrow$, more than due to reform
- Minimum pensions:
  - reduce inequality from the reform by 40-50%
  - work on the endowments margin, but not on preferences
- Effects of the contribution cap: unnoticeable

Outline

Method

- Model
  - Deterministic
  - OLG
  - *ex ante* heterogeneity: endowments + preferences
- Calibrate to Poland in 1999

Households I

- "Born" at age 20 ($j = 1$) and live up to 100 years ($J = 80$)
- Subject to time and cohort dependent survival probability π
- Belong to a type k:
  - productivity level ω
  - time discounting δ
  - relative leisure preference ϕ
- Choose labor supply l endogenously
- Maximize remaining lifetime utility derived from consumption c and leisure $1 - l$:

$$U_{j,k,t} = \sum_{s=0}^{J-j} \left[\delta_k^s \frac{\pi_{j+s,t+s}}{\pi_{j,t}} \left[c_{j+s,k,t+s}^{\phi_k} \left(1 - l_{j+s,k,t+s}\right)^{1-\phi_k} \right] \right]$$

Households II

- Subject to the budget constraint

$$
\begin{aligned}
(1+\tau_t^c)c_{j,k,t} + s_{j,k,t} = {} & (1-\tau_t^l)(1-\tau)w_t\omega_k l_{j,k,t} && \leftarrow \text{ labor income} \\
& + (1+(1-\tau_t^k)r_t)s_{j-1,k,t-1} && \leftarrow \text{ capital income} \\
& + (1-\tau_t^l)b_{j,k,t} && \leftarrow \text{ pension income} \\
& + beq_{j,k,t} && \leftarrow \text{ bequests} \\
& - \Upsilon_t && \leftarrow \text{ lump-sum tax}
\end{aligned}
$$

- There *exists* a closed-form solution to this problem

Producers

- Perfectly competitive representative firm
- Standard Cobb-Douglas production function

$$Y_t = K_t^{\alpha}(z_t L_t)^{1-\alpha}$$

- Profit maximization implies

$$w_t = z_t(1-\alpha)\hat{k}_t^{\alpha}$$
$$r_t = \alpha\hat{k}_t^{\alpha-1} - d$$

where d is the capital depreciation rate
and $\hat{k}$ is capital per effective unit of labor

Government

- Spends a fixed share of GDP (g) on government consumption
- Collects taxes T
- Closes the gap between pension system contributions and benefits
- Can take on debt D

$$T_t + D_t = (1 + r_t)D_{t-1} + gY_t + subsidy_t$$

We fix debt at constant 45% debt to GDP ratio.
Consumption tax varies to satisfy the government constraint.

Pension System

- Pay As You Go Defined Benefit (PAYG DB)

$$b_{\bar{J},k,t} = \rho \cdot \text{gross wage}_{\bar{J}-1,k,t-1}$$

- Pay As You Go Defined Contribution (PAYG DC)

$$b_{\bar{J},k,t} = \frac{\text{accumulated sum of contributions}_{\bar{J},k,t}}{\text{expected remaining lifetime}_{\bar{J},t}}$$

- Pensions indexed by the rate of annual payroll growth

Instrument 1: minimum pensions

- Definition

$$b_{j,k,t} \geq \rho_{\min} \cdot \text{gross average wage}_t$$

We set $\rho_{\min} = 0.2 \rightarrow 4\%$ coverage (consistent with the data)

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- Expectations
  - Directly affects only the left tail of income distribution
  - Increases lifetime incomes of targeted group $\rightarrow$ consumption inequality should decrease
  - Lower incentives to work $\rightarrow$ possible reduction in hours worked
  - Lower incentives for private savings $\rightarrow$ possible increase in consumption

Instrument 1: contribution cap

- Definition:

$$\tau_{j,k,t}^{\text{eff}} = \min\left\{\tau, \frac{\tau_{\text{cap}} \cdot \text{gross average wage}_t}{w_t \omega_k l_{j,k,t}}\right\}$$

To replicate 2% coverage, $\tau_{\text{cap}} = 1.7$ (lower than *de iure* 2.5)

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- Expectations
  - Affects directly only the right tail of income distribution
  - Lower contributions of targeted group → higher voluntary saving rates → wealth inequalities ↑
  - Matters because market interest rates and social security indexation differ

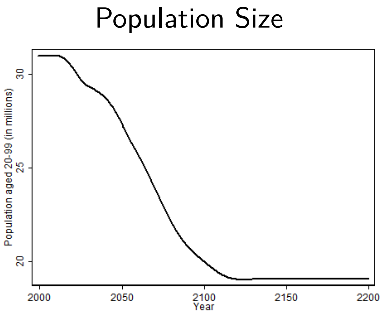
Solution procedure

- Gauss-Seidel iterative algorithm
- Steady states (initial and final)
  1. Guess an initial value for $\hat{k}$
  2. Use it to compute the prices
  3. Have households solve their problem given prices
  4. Aggregate individual labor supply and savings to get new values for L and K
  5. If the new value for $\hat{k}$ satisfies predefined norm, finish, else update $\hat{k}$ and return to point (2)
- Transition path
  1. Basing on the initial and final steady state values for $\hat{k}$ guess an initial path between the terminal points

     ⋮

Exogenous assumptions

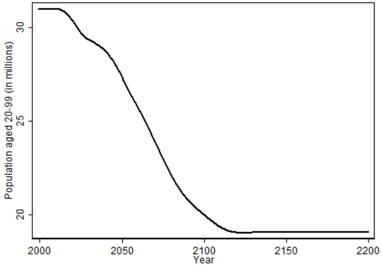
Projections for Poland provided by the European Commission



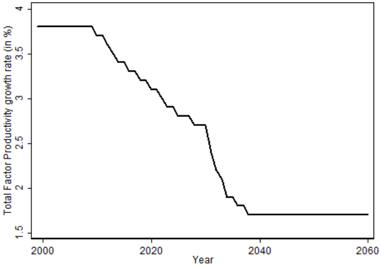
Exogenous assumptions

Projections for Poland provided by the European Commission

Population Size



TFP Growth

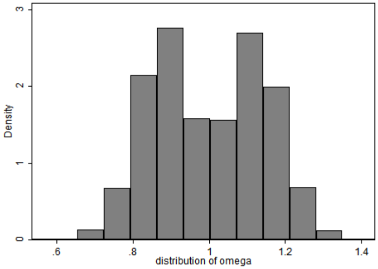


Kept constant across scenarios, don't affect results

Within cohort heterogeneity - endowments

Structure of Earnings Survey, 1998, Poland

Productivity ω

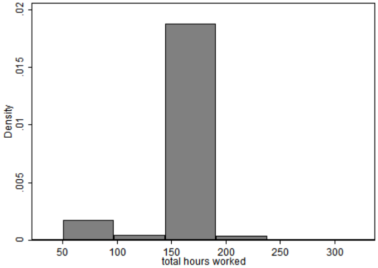


Resulting: 10 values for ω

Within cohort heterogeneity - leisure preference

Structure of Earnings Survey, 1998, Poland

Leisure Preference ϕ



Resulting: 4 values for ϕ

Within cohort heterogeneity - time preference

- Again: no data on mortality rates or wealth by income or education groups

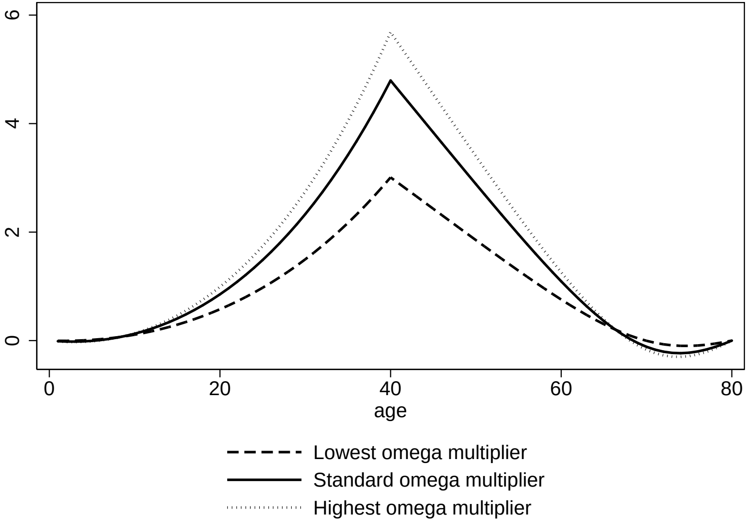
- Calibrate the central value of δ to match the investment rate
- Split population *ad hoc* to 3 groups:
  - discount factors are $(0.98\delta, \delta, 1.02\delta)$

Within cohort heterogeneity - summary outcomes I

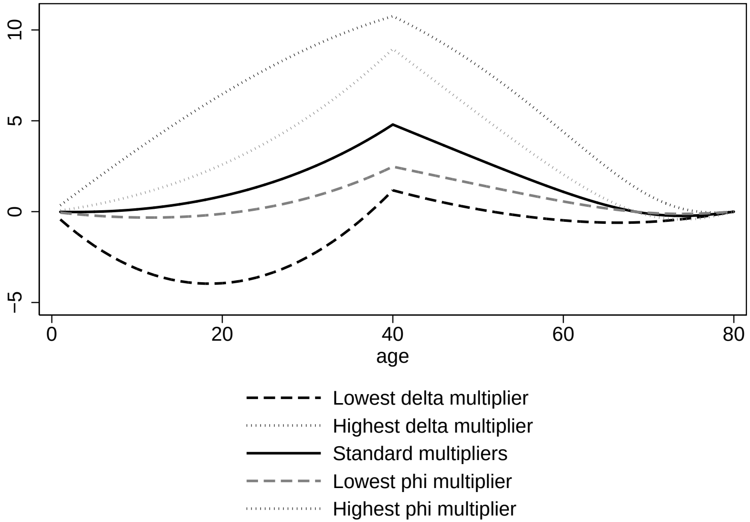
In total we have 120 types within each cohort

The resulting consumption Gini index in the initial steady state is 25.5, consistent with Brzezinski (2011)

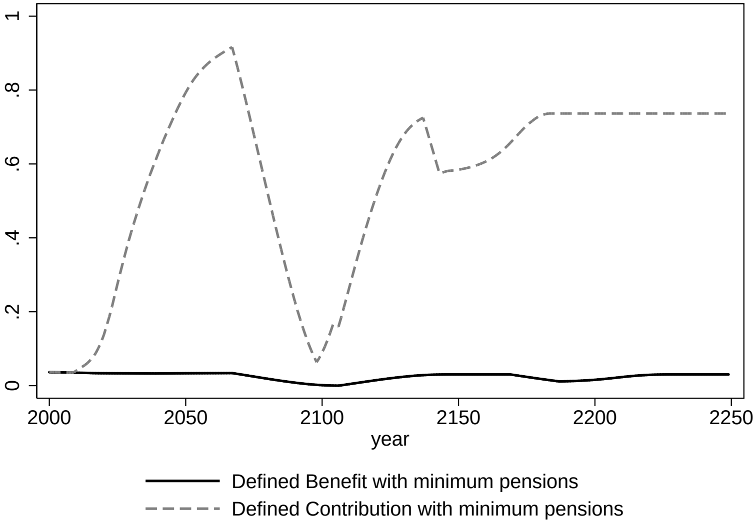
Within cohort heterogeneity - summary outcomes II



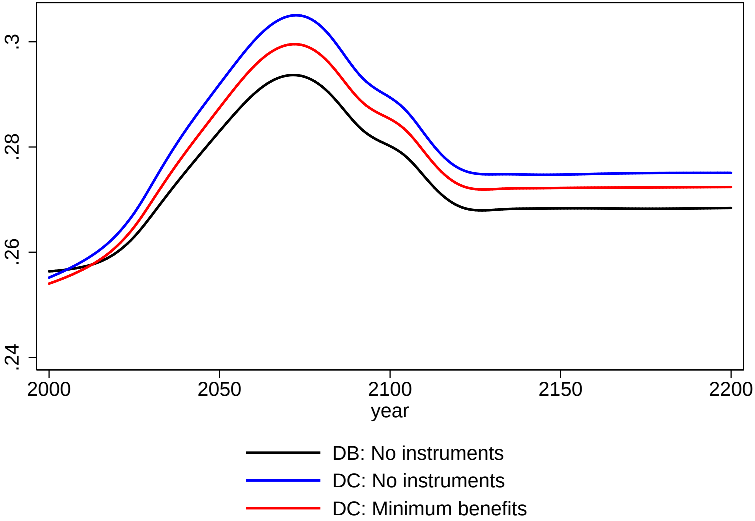
Within cohort heterogeneity - summary outcomes III



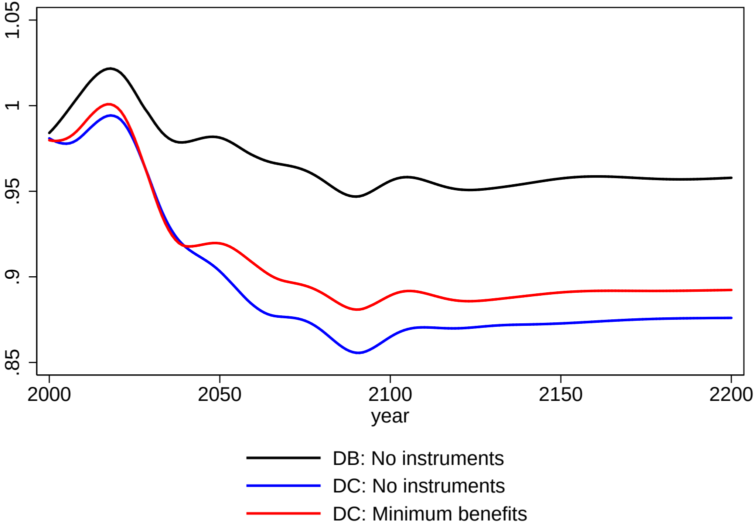
Minimum pensions coverage



Consumption Gini



Wealth Gini



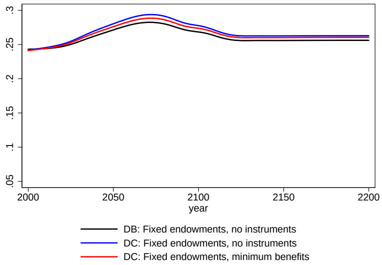
GRAPE

Inequality decomposition – endowments vs preferences

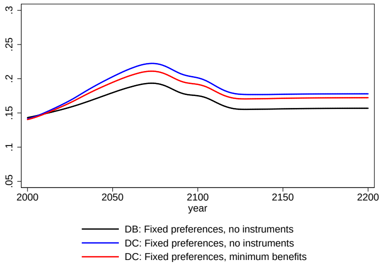
- Instruments should reduce inequality stemming from endowments (luck) but not from preferences
- To isolate the effects of the two sources:
  - Shut down each channel separately
  - Keep prices constant from the full model to avoid GE effects
  - Solve for decisions of households in partial equilibrium

Consumption inequality decomposition

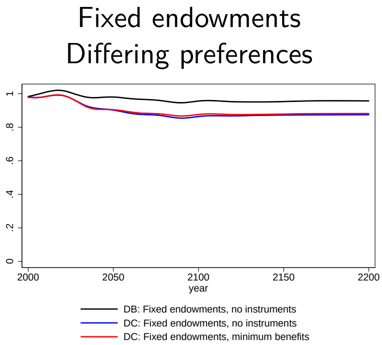
Fixed endowments
Differing preferences

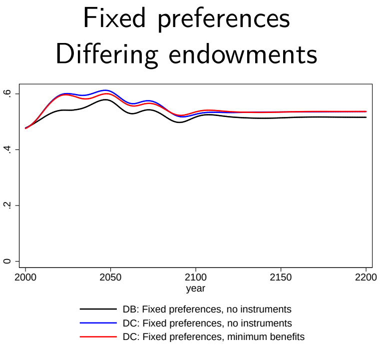


Fixed preferences
Differing endowments



Wealth inequality decomposition

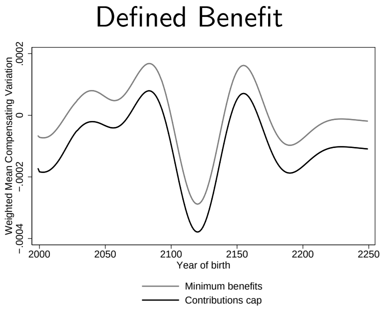


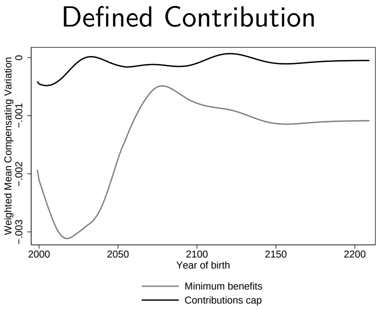


Macroeconomic effects

	No instrument		Minimum pension		Contribution cap	
	DB	DC	DB	DC	DB	DC
Capital	52.6%	60.4%	52.7%	60.3%	52.6%	60.5%
	Consumption tax rate (τ^c)					
initial	11.00	11.00	11.00	11.00	11.00	11.00
final	15.44	10.95	15.43	11.99	15.46	10.95
	Pension system deficit					
initial	1.46		1.56		1.46	
final	3.95	0.00	4.02	0.87	3.97	0.00

Welfare effects





Conclusions

- Consumption inequalities increase due to
  - aging processes
  - DB→DC reform
- Minimum pensions
  - effective in reducing consumption inequalities resulting from the DB→DC reform by 40-50%
  - with 80% coverage minimum pension costs 1 pp higher consumption tax (transfer of about 0.9% GDP)
  - wealth inequality increases
- Contribution cap has virtually no effects

Thank you for your attention

Household Sector Closed Form Solution I

For $j < \bar{J}$ (working):

$$c_{j,t} = \frac{\Omega_{j,t} + \Gamma_{j,t}}{(1+\tau_t^c)\left[\sum_{s=0}^{\bar{J}-j-1}\left((1+\phi)\,\delta^s \frac{\pi_{j+s,t+s}}{\pi_{j,t}}\right) + \sum_{s=\bar{J}-j}^{J-j}\left(\delta^s \frac{\pi_{j+s,t+s}}{\pi_{j,t}}\right)\right]}$$

$$l_{j,t} = 1 - \frac{\phi(1+\tau_t^c)c_{j,t}}{(1-\tau_t^l)(1-\tau)w_t}$$

$$s_{j,t} = (1-\tau_t^l)(1-\tau)w_t l_{j,t} + (1+(1-\tau_t^k)r_t)s_{j-1,t-1} - (1+\tau_t^c)c_{j,t},$$

with

$$\Omega_{j,t} = \sum_{s=0}^{\bar{J}-j-1} \frac{(1-\tau_{t+s}^l)(1-\tau)w_{t+s} + beq_{j+s,t+s} - \Upsilon_{t+s}}{\prod_{i=1}^{s}(1+(1-\tau_{t+i}^k)r_{t+i})}$$

$$\Gamma_{j,t} = \sum_{s=\bar{J}-j}^{J-j} \frac{(1-\tau_{t+s}^l)b_{j+s,t+s} + beq_{j+s,t+s} - \Upsilon_{t+s}}{\prod_{i=1}^{s}(1+(1-\tau_{t+i}^k)r_{t+i})}.$$

Household Sector Closed Form Solution II

For $j \geq \bar{J}$ (retired):

$$
\begin{aligned}
c_{j,t} &= \frac{\Gamma_{j,t}}{(1+\tau_t^c)\left[\sum_{s=\bar{J}-j}^{J-j}\left(\delta^s \frac{\pi_{j+s,t+s}}{\pi_{j,t}}\right)\right]} \\
l_{j,t} &= 0 \\
s_{j,t} &= (1-\tau_t^l)b_{j,t}^{\iota} + (1+(1-\tau_t^k)r_t)s_{j-1,t-1} - (1+\tau_t^c)c_{j,t},
\end{aligned}
$$

with

$$
\Gamma_{j,t} = \sum_{s=0}^{J-j} \frac{(1-\tau_{t+s}^l)b_{j+s,t+s} + beq_{j+s,t+s} - \Upsilon_{t+s}}{\prod_{i=1}^{s}(1+(1-\tau_{t+i}^k)r_{t+i})}.
$$