Demographic transition and monetary policy in a small open economy

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Outline

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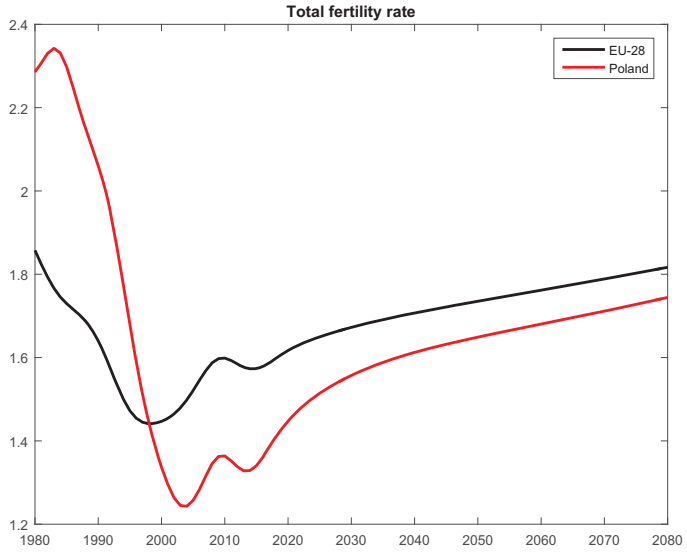
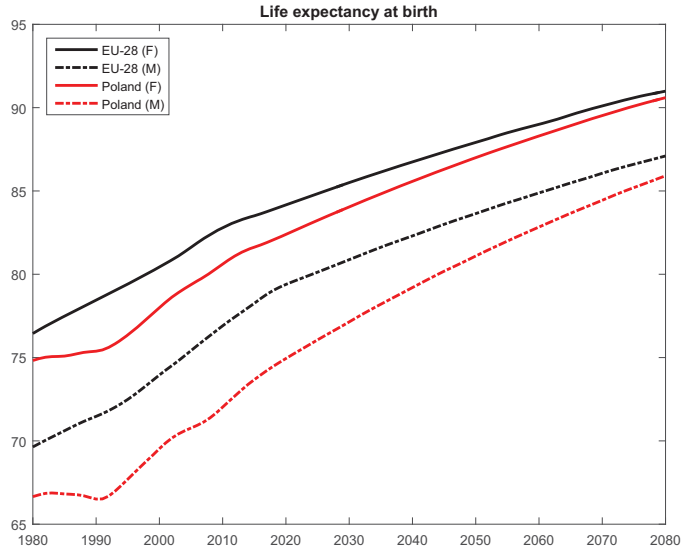
Motivation

- Demographic transition (ageing):
  - Declining fertility
  - Declining mortality risk
- Affects many countries
- Speed and timing differs accross countries
- Poland particularly affected

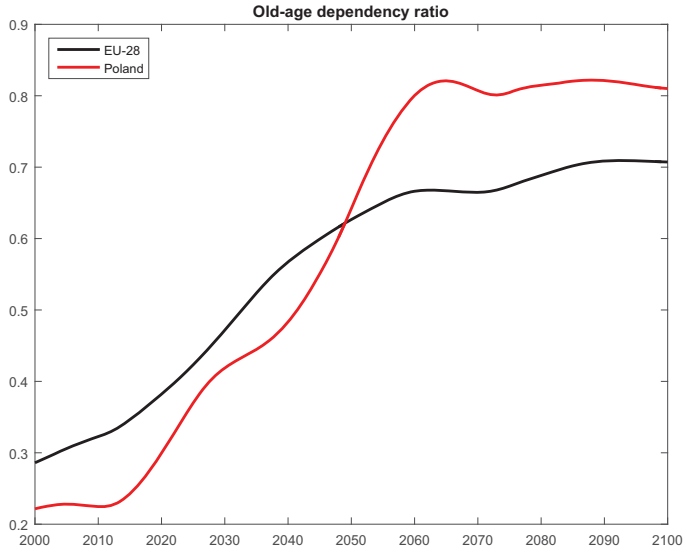
Demography: fertility rate



Demography: life expectancy



Demography: old-age dependency ratio



Macroeconomic implications of ageing

- Economic growth
- Pension system sustainability
- Size and composition of fiscal expenditures
- Housing market
- ...
- Monetary policy

Monetary policy implications in the literature

- NRI declines (Kara and von Thadden 2016; Carvalho et al. 2016), but
  - closed economy OLG
  - unclear importance for monetary policy (negligible in K&vT, substantial in Carvalho et al.)
- Capital flows from aging economies (Boersch-Supan et al. 2006; Krueger and Ludwig 2007), but
  - no monetary policy in the models (OLG)
- Monetary transmission may change because older people are less responsive to interest rates (Wong 2016, empirical study)
- Aging affects social preference towards inflation (Bullard et al. 2012, Vlandas 2016)

This paper

- Impact of aging on monetary policy in open economy
  - Quantitative impact of ageing, especially on NRI
  - Spillovers from foreign demography
  - Quantify implications for inflation
  - Quantify implications for ZLB

Main findings

- Impact of ageing on NRI substantial:
  - Decline by 1 p.p. in Euro Area between 2000 and 2030
  - Decline by 1.8 p.p. in Poland between 2010 and 2050
- Important to account for fall in NRI in real time.
  Slow learning results in prolonged period of low inflation:
  - Estimated bias: 0.6-1.1%
- Implications for ZLB risk:
  - Moderate under perfect information
  - Significant under learning
- Direction and strength of foreign spillovers
  depends on relative ageing speed

Outline

Model structure: overview

- Small open economy New Keynesian model with life-cycle features:
  - 80 cohorts of overlapping generations of households (ages 20-99)
  - Age and time-dependent mortality risk
  - Age-specific productivity
- Rigidities: sticky prices, investment adjustment costs
- Monetary policy: Taylor-like rule
- Exogenous processes:
  - Deterministic: growth rate of initial young, mortality risk (both at home and abroad)
  - Stochastic: productivity, time preference, monetary policy, international risk premium, foreign VAR

Households

- Maximize expected lifetime utility:

$$U_{j,t} = \mathbb{E}_t \sum_{i=0}^{J-j} \beta^i \frac{N_{j+i,t+i}}{N_{j,t}} \exp\{\varepsilon_{u,t}\} \left[\ln c_{j+i,t+i} - \phi_{j+i} \frac{h_{j+i,t+i}^{1+\varphi}}{1+\varphi} \right]$$

subject to:

$$P_t c_{j,t} + A_{j,t} = W_t z_j h_{j,t} + R_t^a A_{j-1,t-1} + Beq_t$$

Investment funds

- Operate under perfect competition
- Balance sheet:

$$A_t = Q_t k_t + B_t + S_t B_t^* + \int_0^1 P_t^d(i)\, d_t(i)\, \mathrm{d}i$$

- Maximize expected gross return:

$$\mathbb{E}_t \frac{1}{R_t} \left[\begin{array}{c} [R_{t+1}^k + (1-\delta) Q_{t+1}] k_t + R_t B_t + S_{t+1} \Gamma_t R_t^* B_t^* \\ + \int_0^1 \left[(1+n_{t+1}) P_{t+1}^d(i) + F_{t+1}(i) \right] d_t(i)\, \mathrm{d}i \end{array} \right]$$

- where the international risk premium follows

$$\Gamma_t = \gamma \left(\exp\left\{ -\frac{S_t B_t^*}{P_{H,t} g d p_t} \right\} - 1 \right) + \exp\{\varepsilon_{\Gamma,t}\}$$

Producers

- Final good produced using domestic and foreign intermediates:

$$c_t + i_t = \left[\eta^{\frac{1}{\phi}} y_{H,t}^{\frac{\phi-1}{\phi}} + (1-\eta)^{\frac{1}{\phi}} y_{F,t}^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}}$$

- Capital good producers face adjustment costs:

$$(1+n_{t+1})k_t = (1-\delta)\, k_{t-1} + \left[1 - S_k \left(\frac{i_t}{i_{t-1}} \right) \right] i_t$$

- Intermediate good producers employ capital and labor to deliver differentiated products:

$$y_{H,t}(i) + y_{H,t}^*(i) = \varepsilon_{z,t} k_t(i)^{\alpha} h_t(i)^{1-\alpha}$$

- and face Calvo-type price stickiness.

Monetary policy

Feedback rule:

$$R_t = \max\left\{1, R_{t-1}^{\gamma_R}\left[\tilde{R}_t^e\left(\frac{\pi_t}{\pi}\right)^{\gamma_\pi}\left(\frac{g_t}{\tilde{g}_t^e}\right)^{\gamma_y}\right]^{1-\gamma_R}\exp\{\varepsilon_{R,t}\}\right\}$$

where:

- $g_t \equiv \frac{gdp_t}{gdp_{t-1}}$ and $\tilde{g}_t^e \equiv \frac{\tilde{gdp^e}_t}{\tilde{gdp^e}_{t-1}}$ denote growth rates of actual and natural (flexible price) output
- $\tilde{R}_t^e$ is perceived natural (flexible price) interest rate
  - observed in real time (baseline)

$$\tilde{R}_t^e = \pi\tilde{r}_t$$

  - or gradually learned

$$\tilde{R}_t^e = \tilde{R}_{t-1}^e + \lambda(\pi\tilde{r}_{t-1} - \tilde{R}_{t-1}^e)$$

Calibration and data

- Demographic data:
  - PL: Eurostat (1990-2015) and EUROPOP 2013 (2016-2080)
  - EA: Eurostat (1986-2015) and EUROPOP 2013 (2016-2080)
- Age-specific productivity:
  - PL: Kolasa (2016)
  - EA: Gourinchas and Parker (2002) estimates for US
- Structural parameters taken from literature
  or matched to means observed in data:
  - Real interest rate, investment rate, foreign debt to GDP ratio
- Taylor rule and EA VAR estimated outside of the model
- Speed of learning set to $\lambda = 8\%$ annually, consistent with literature:
  - Branch and Evans (2006); Milani (2011); Malmendier and Nagel (2016)

Moment matching

- Stochastic shocks:
  - Foreign shocks: estimated VAR for EA
  - Other shocks: to match moments

Variable	Standard dev.		Autocorrelation		Corr. with GDP	
	Model	Data	Model	Data	Model	Data
GDP	1.77	1.84	0.77	0.68	1.00	1.00
Inflation	1.50	1.77	0.25	0.37	0.39	0.72
Interest rate	1.97	1.97	0.34	0.34	0.40	0.57
Real exchange rate	5.52	5.55	0.36	0.22	0.03	0.31

Solution methods

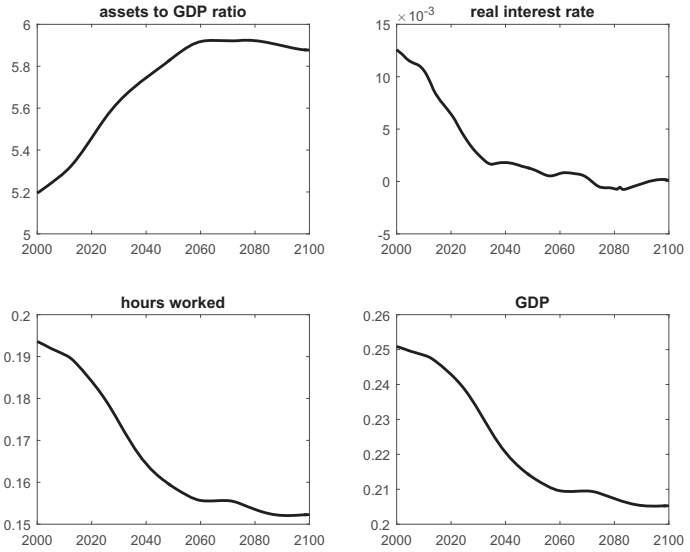
- Deterministic simulations:
  - First simulate EA (closed), plug solution into PL (open) and simulate
  - Initial steady state in 1900, final in 2300
- Stochastic simulations:
  - First-order VAR for EA: output, inflation, interest rate
  - PL hit by stochastic shocks:
    productivity, preference, risk premium, monetary, foreign
  - Taylor expansions around points on deterministic path
  - ZLB: Dynare OBC (Holden, 2016)

Outline

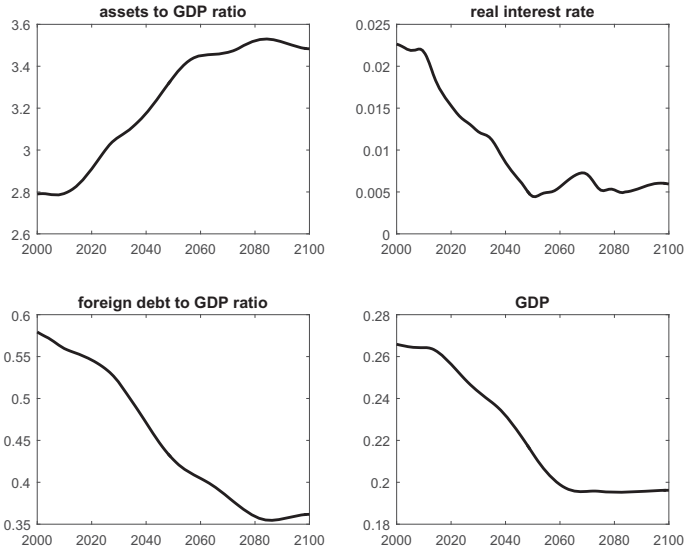
Overview of simulations

- Impact of demographic transition:
  - Euro Area
  - Poland
- Consequences for monetary policy:
  - Inflation
  - ZLB risk
- Spillovers form foreign demography

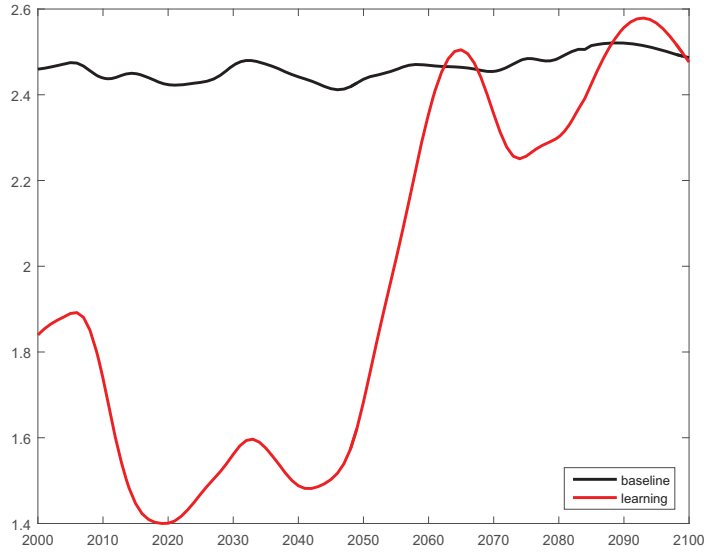
Impact of demographic transition: Euro Area



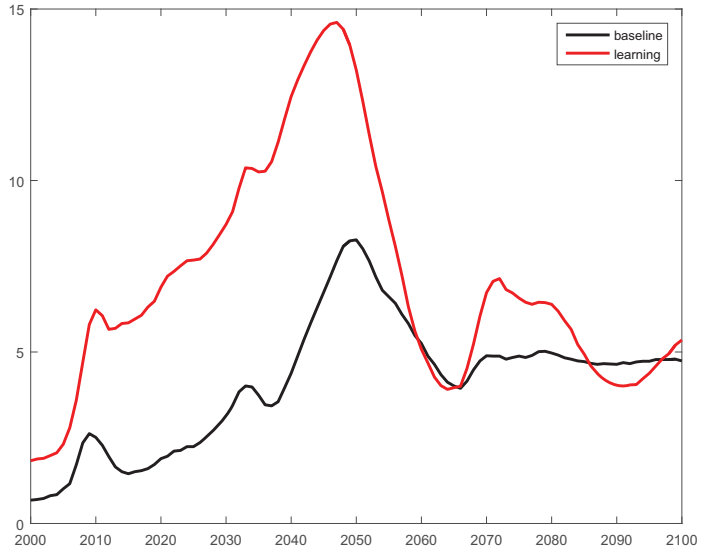
Impact of demographic transition: Poland



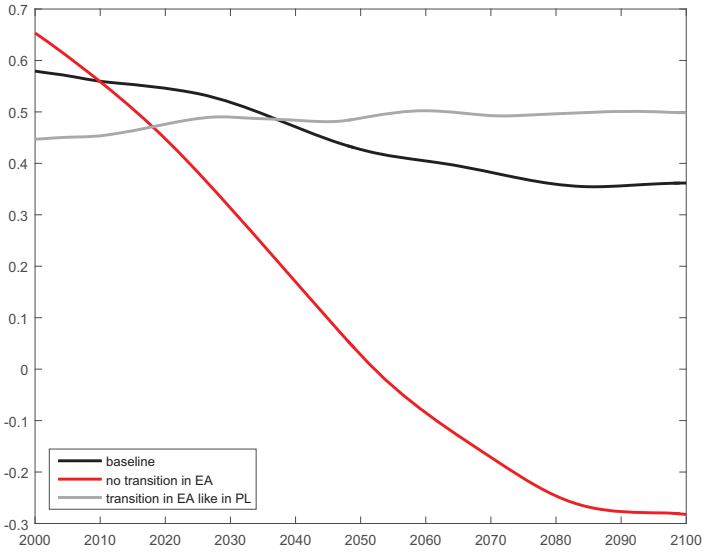
Inflation rate (Poland)



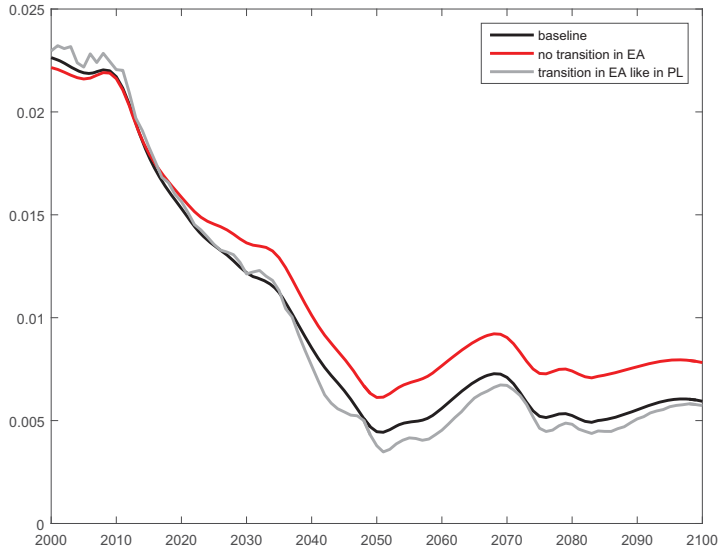
Probability of hitting the ZLB (Poland)



Spillovers from abroad: foreign debt to GDP ratio



Spillovers from abroad: real interest rate



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Conclusions

- Impact of ageing on NRI substantial:
  - Decline by 1 p.p. in Euro Area between 2010 and 2050
  - Decline by 1.8 p.p. in Poland between 2010 and 2050
- Despite "glacial" rate of demographic changes, important to account for fall in NRI in real time:
  - Avoid deflationary bias
  - Reduce ZLB risk
- Different rates of ageing influence strongly current account
- Ageing in other countries pressures NRI further down

To do list

- Euro Area: stochastic calibration and ZLB risk analysis
- Sensitivity of results to pension system setups
- Impact of demography on monetary transmission mechanism and inflation-output volatility tradeoff