Demographic transition and monetary policy in a small open economy

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NBU-NBP Conference
Kyiv, 18-19 May 2017

Outline

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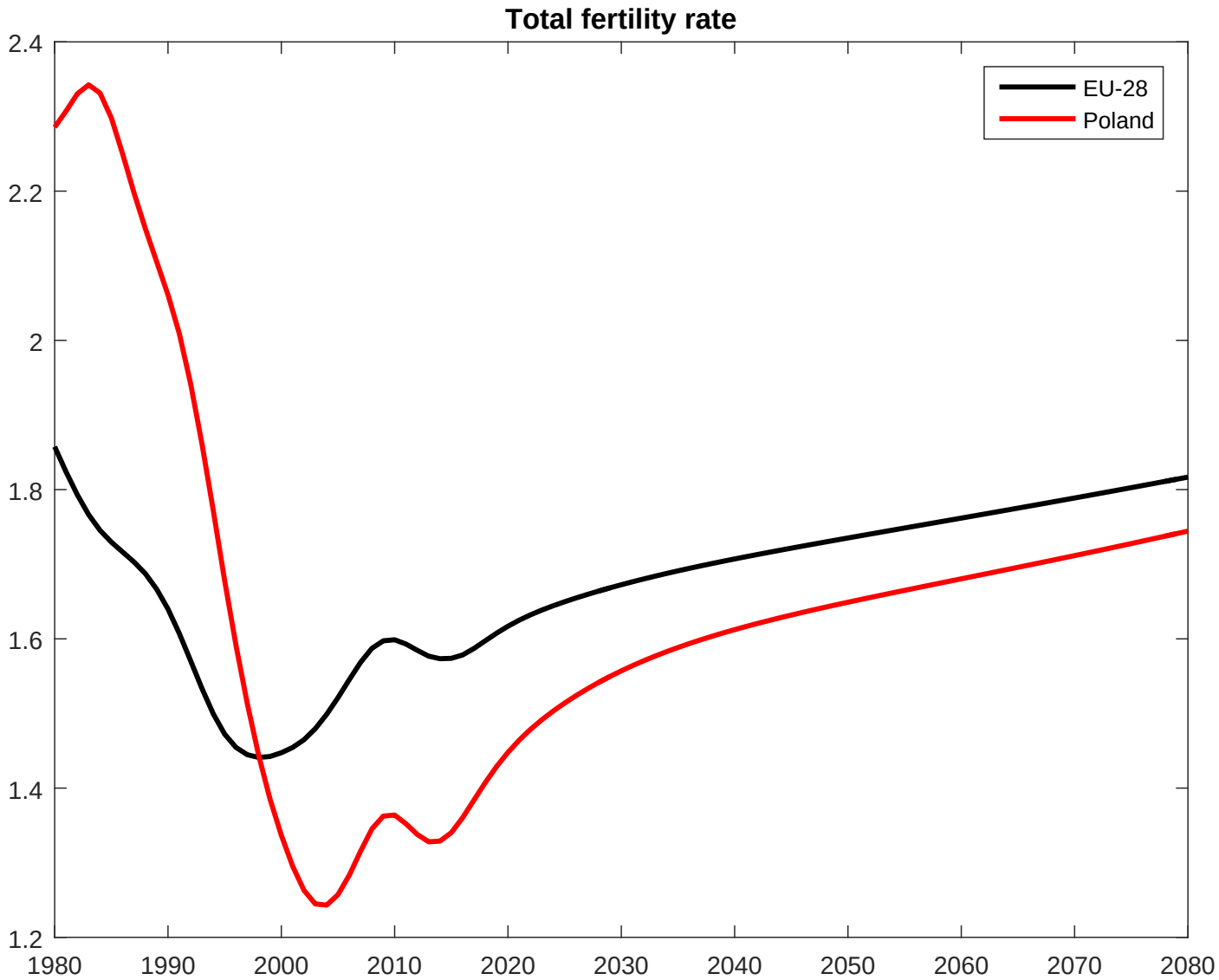
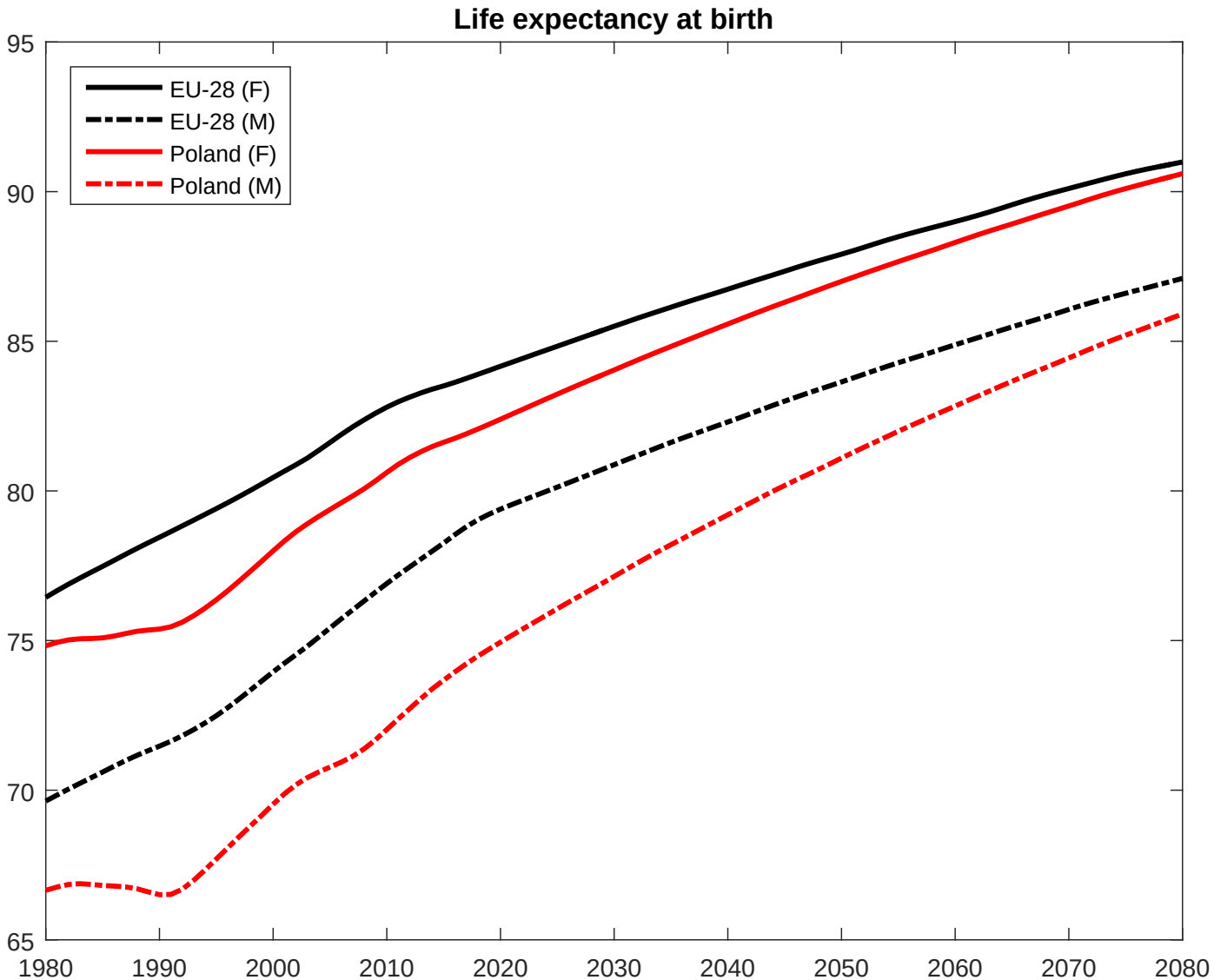
Motivation

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

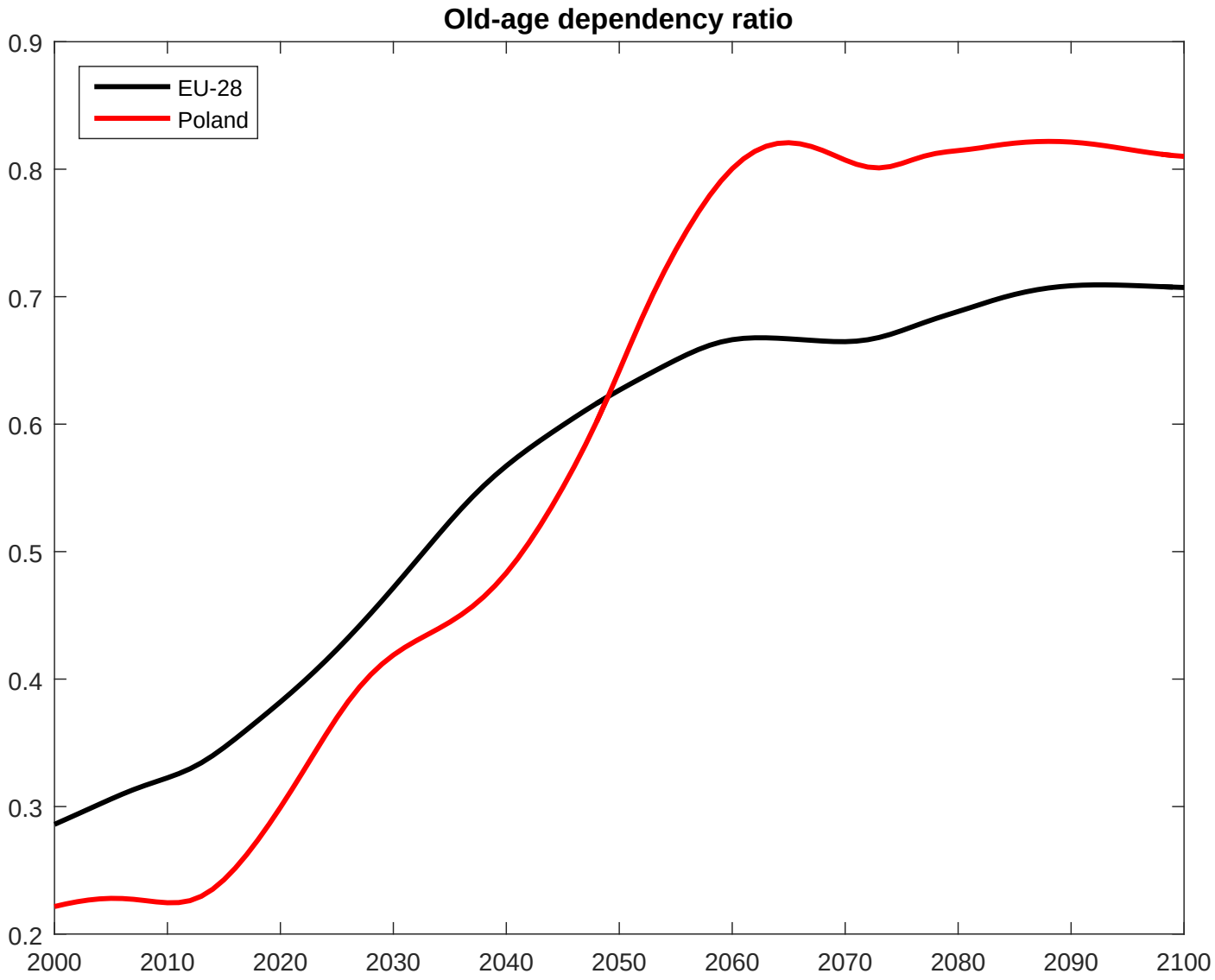
Demography: fertility rate



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

Possible implications for monetary policy

- Drop in the natural real rate of interest (NRI)
- Adjustment in external balances
- Changes in transmission of monetary policy and shocks
- Increased probability of hitting the zero lower bound (ZLB)
- Shift in preferences towards inflation-output volatility trade-off

This paper

1. Quantitative impact of ageing, especially on NRI
2. Role of foreign demography
3. Importance of observing NRI in real time by the central bank
4. Quantitative 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
- Role of foreign spillovers limited, domestic demography is key

Literature

- Closed economy, focus on NRI decline:
  - Kara and von Thadden (2016); Carvalho et al. (2016)
- Open economy, focus on capital flows,
  world rate of return and distribution effects:
  - Boersch-Supan et al. (2006); Krueger and Ludwig (2007)
- ZLB risk and impact of learning:
  - ???

Outline

Model structure: overview

- Small open economy New Keynesian model with life-cycle features:
  - 80 cohorts of overlapping generations of households (age 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 shocks

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

- 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

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

- International risk premium

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

Producers

- Final goods produced using home-made and imported components

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

- Capital good producers face investment 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 goods firms employ capital and labor to produce differentiated products

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

- 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 $\tilde{g}_t^e \equiv \frac{g\tilde{d}p^e{}_t}{g\tilde{d}p^e{}_{t-1}}$ denote growth rates of actual and potential (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 rules and EA VAR estimated outside of the model
- Speed of learning set to $\lambda = 0.08$
  - 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

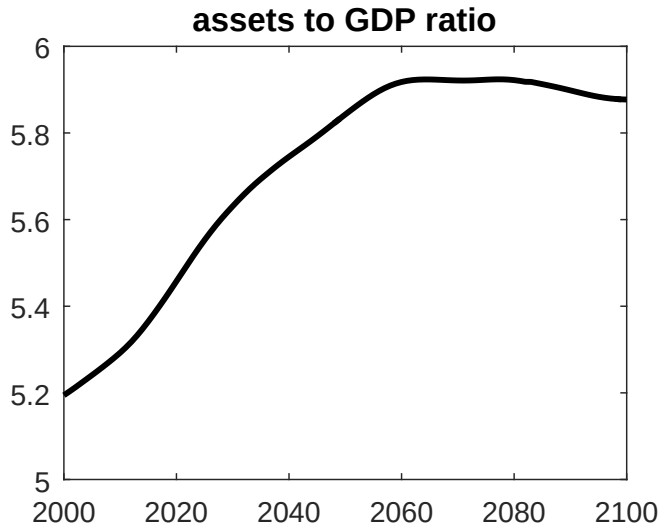
- Deterministic simulations:
  - First simulate EA (closed), then use this solution to simulate PL (small open)
- Stochastic simulations:
  - First-order approximation around points on deterministic path
  - Allowing for ZLB: Dynare OBC (Holden, 2016)

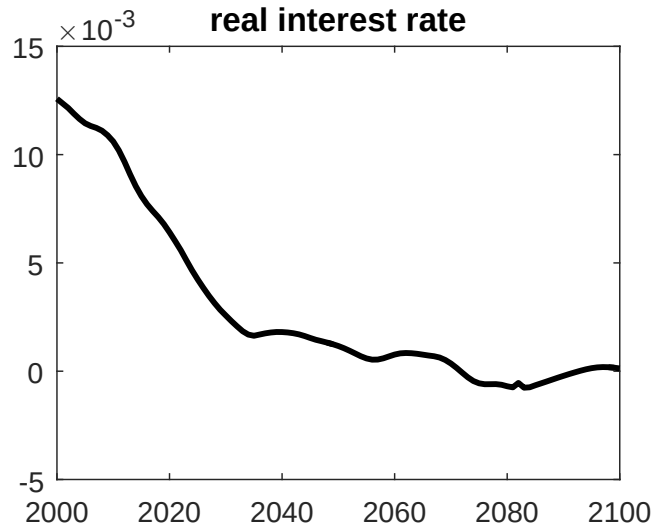
Outline

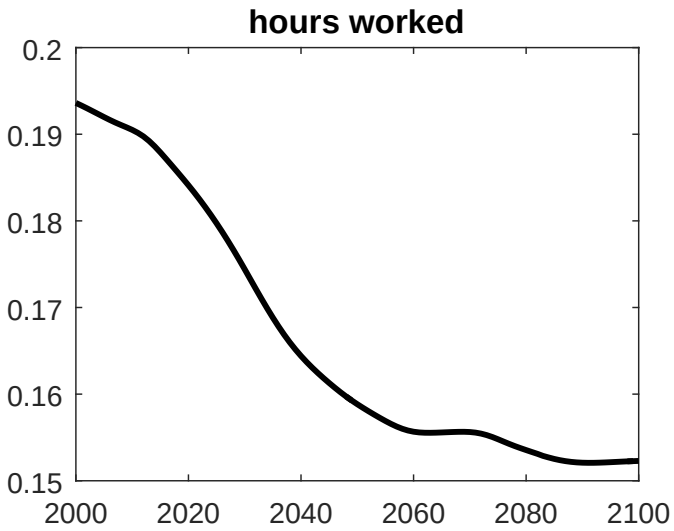
Overview of simulations

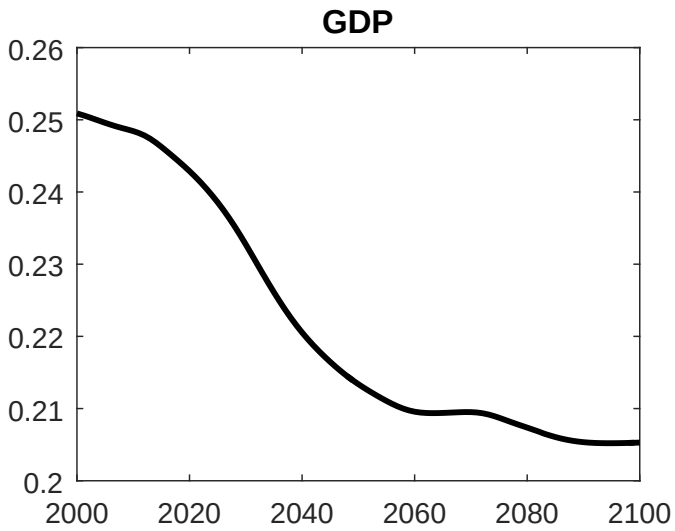
- Impact of demographic transition:
  - Euro Area
  - Poland
- Consequences for monetary policy:
  - Inflation
  - ZLB risk
- Spillovers from foreign demography

Impact of demographic transition: Euro Area

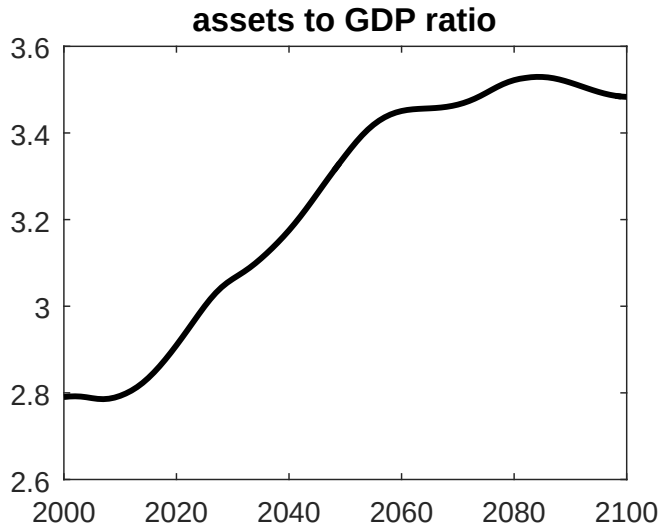


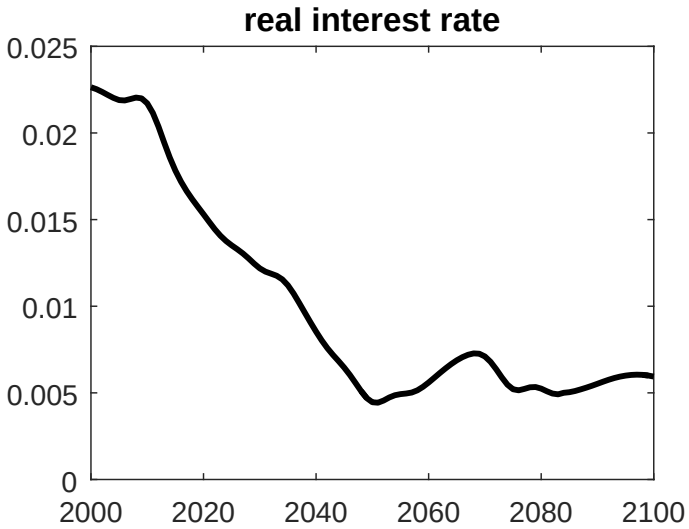


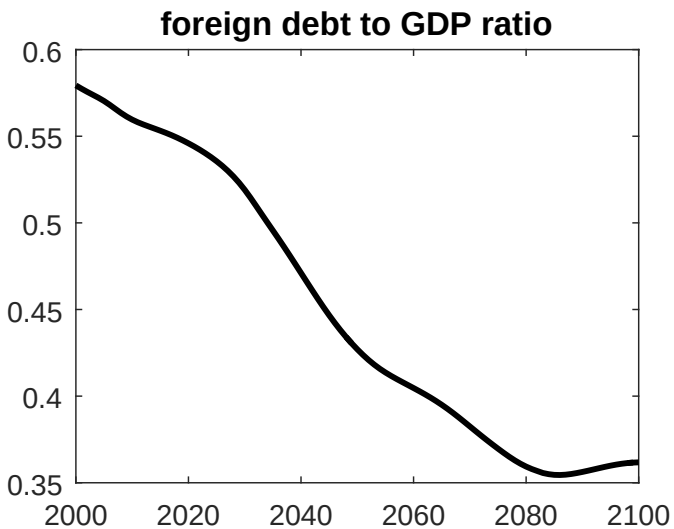


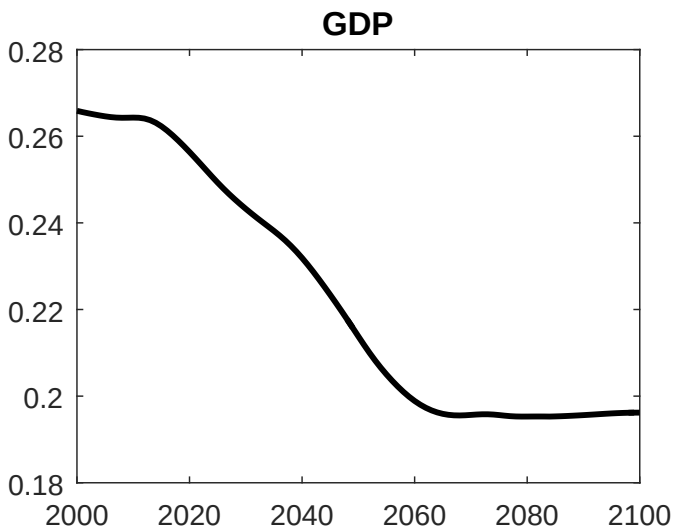


Impact of demographic transition: Poland

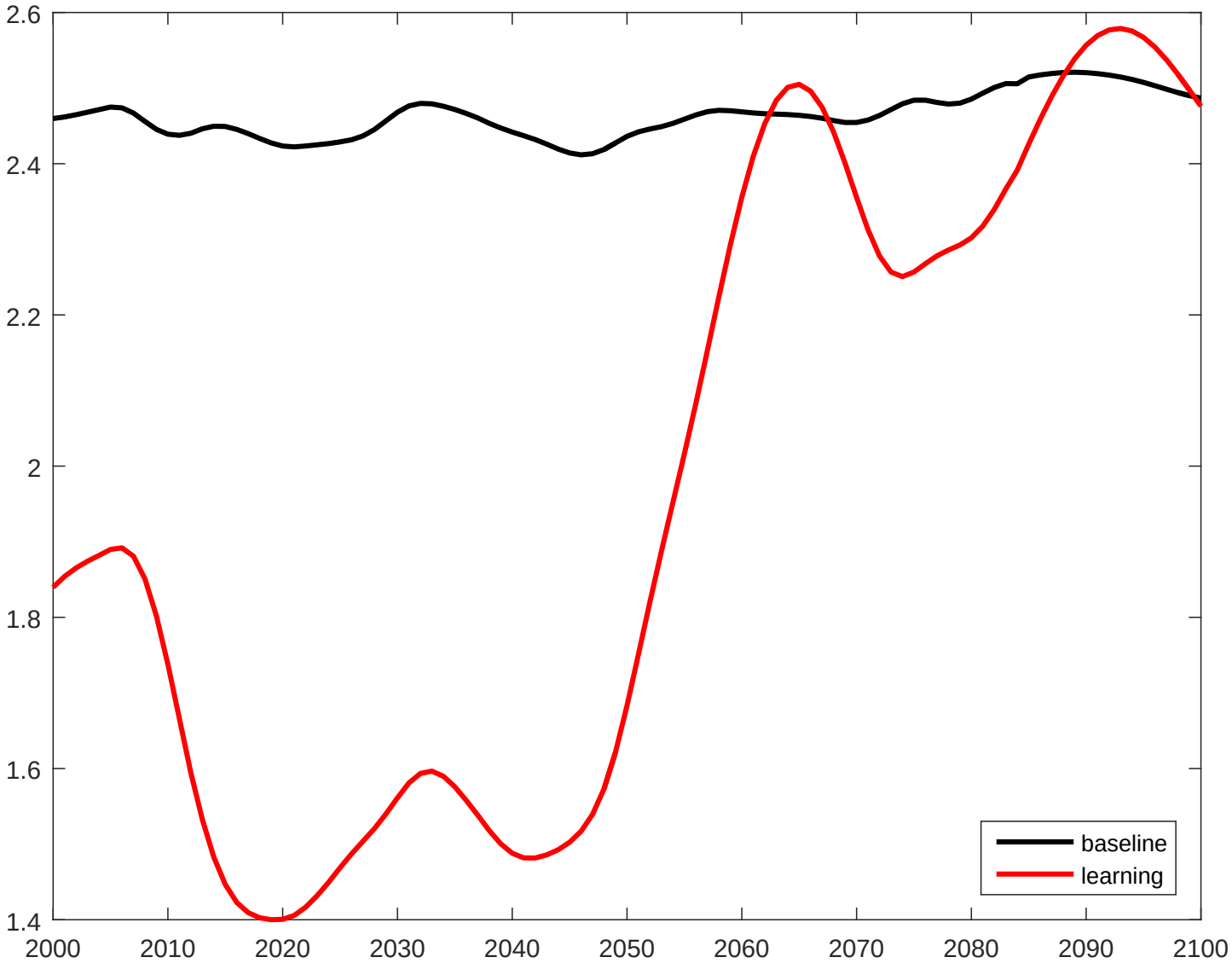




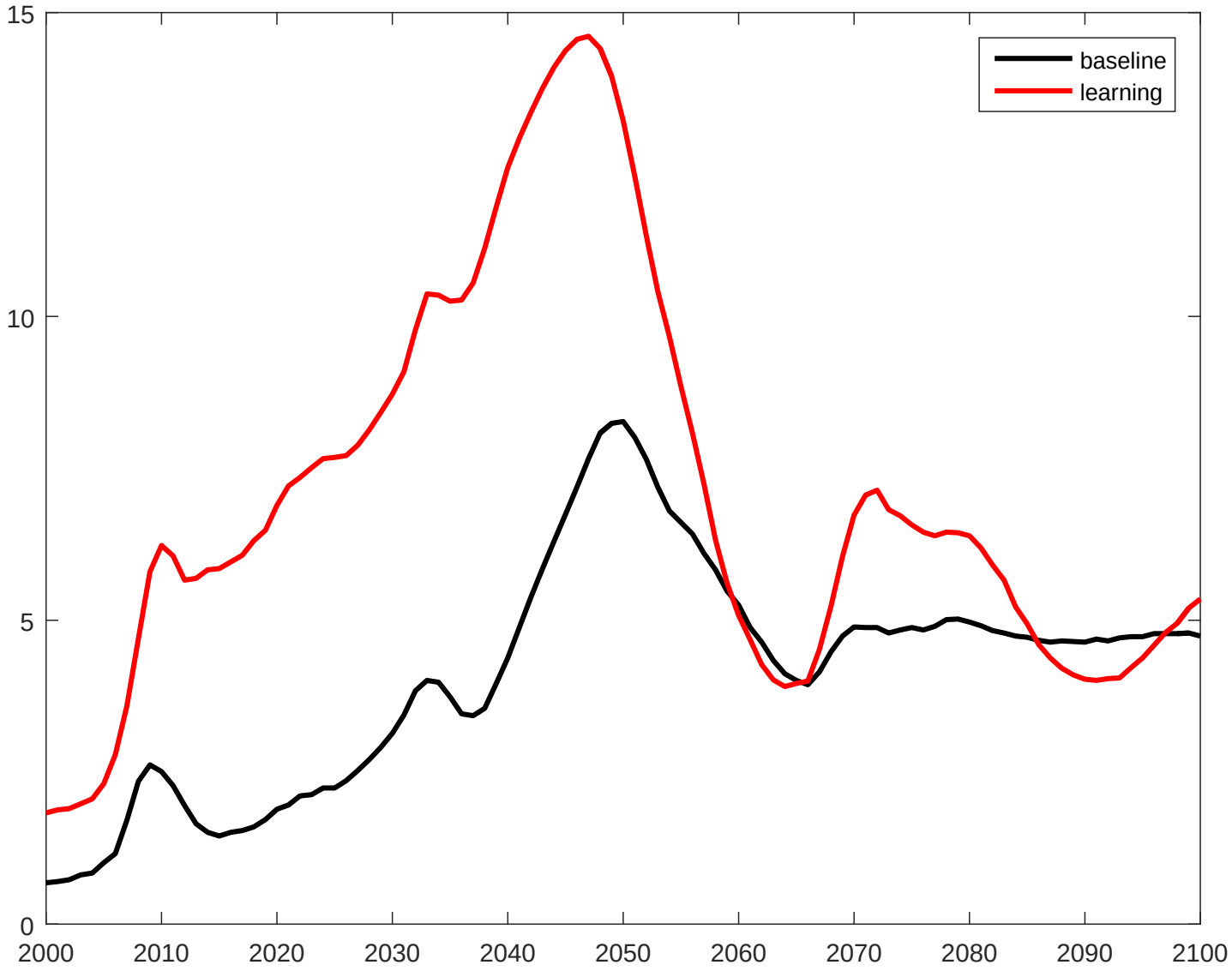




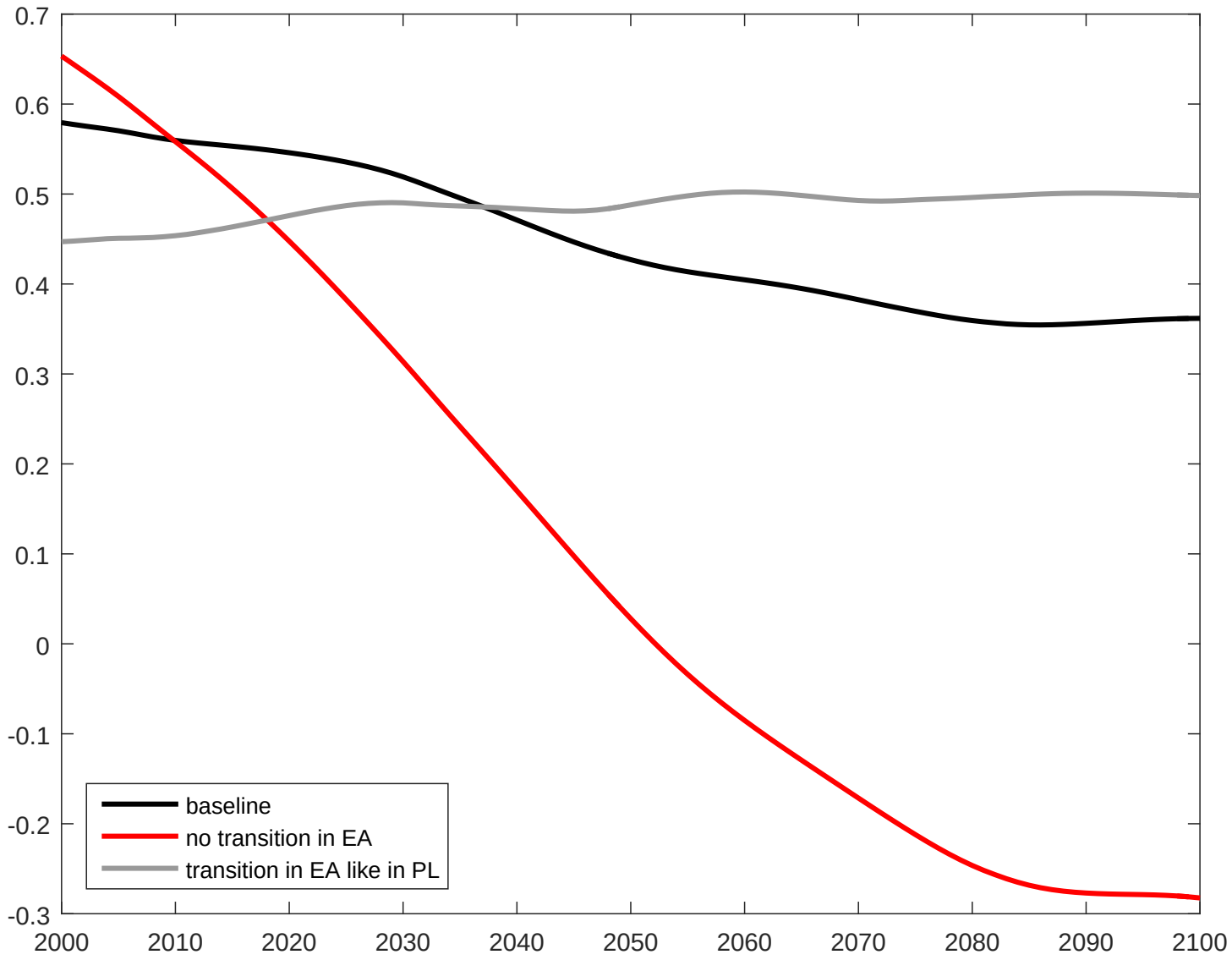
Inflation rate (Poland)



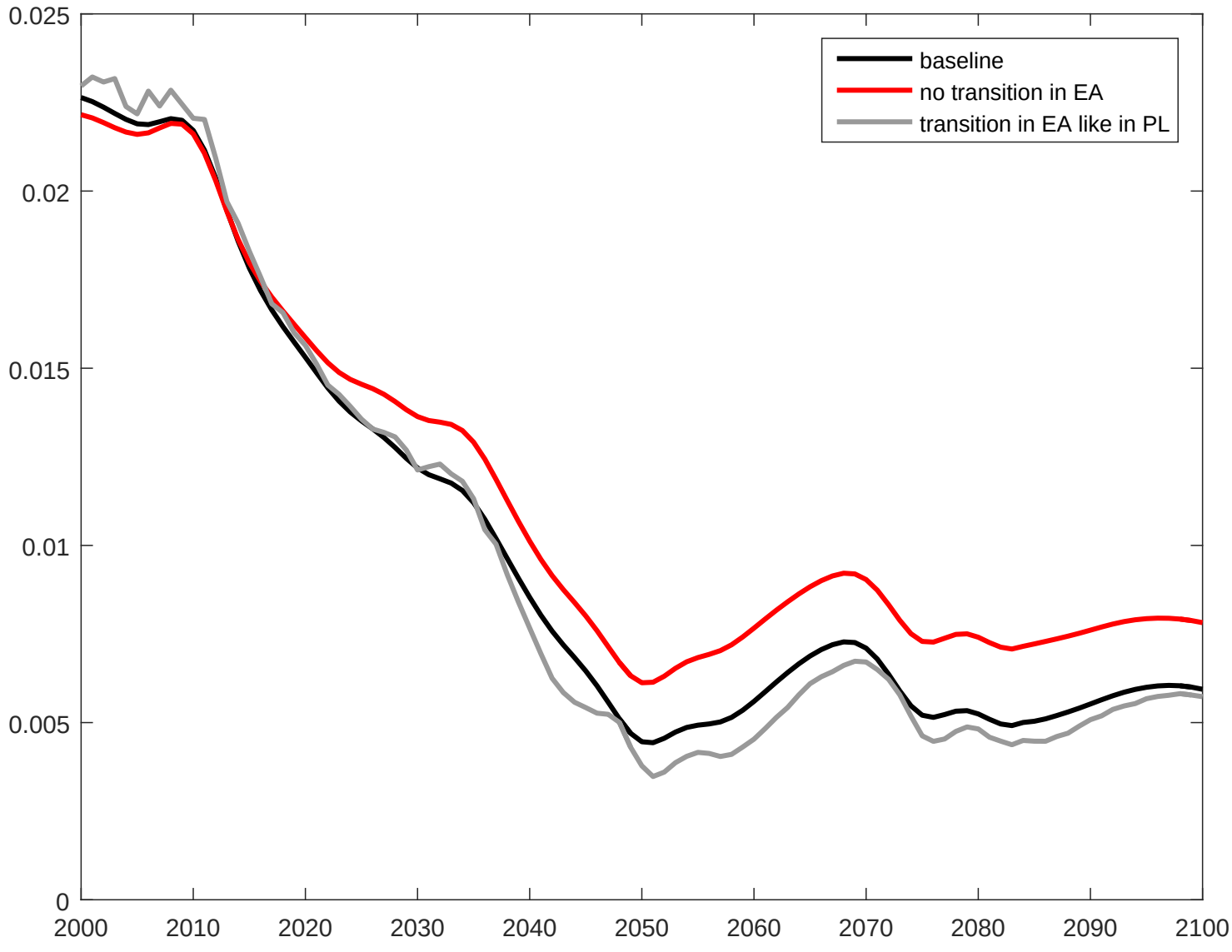
Probability of hitting ZLB (Poland)



Role of foreign demography: Foreign debt to GDP ratio



Role of foreign demography: Real interest rate



Outline

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
- Ageing processes abroad important for current account, less so for NRI