Demographic transition and monetary policy in a small open economy

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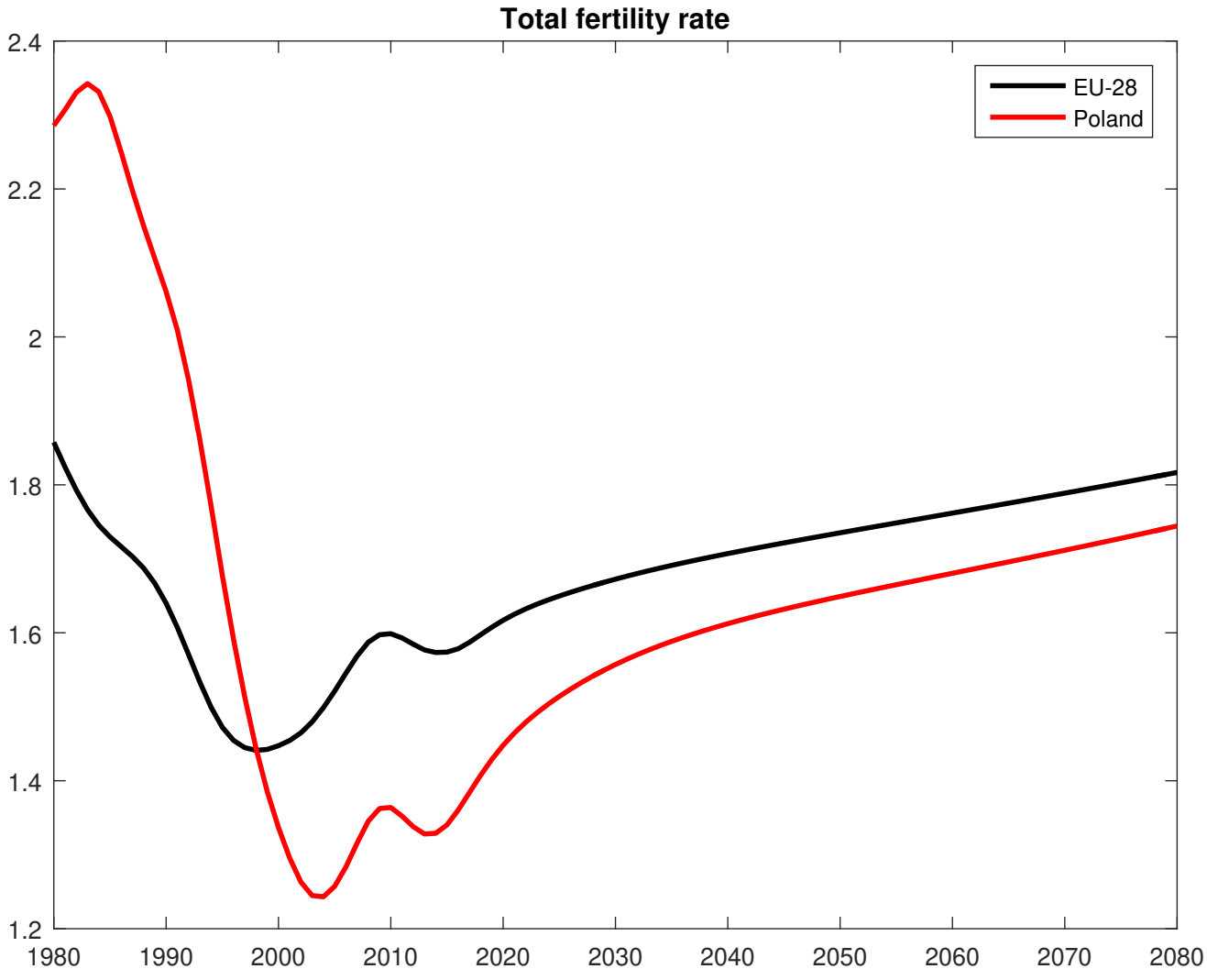
Outline

Motivation

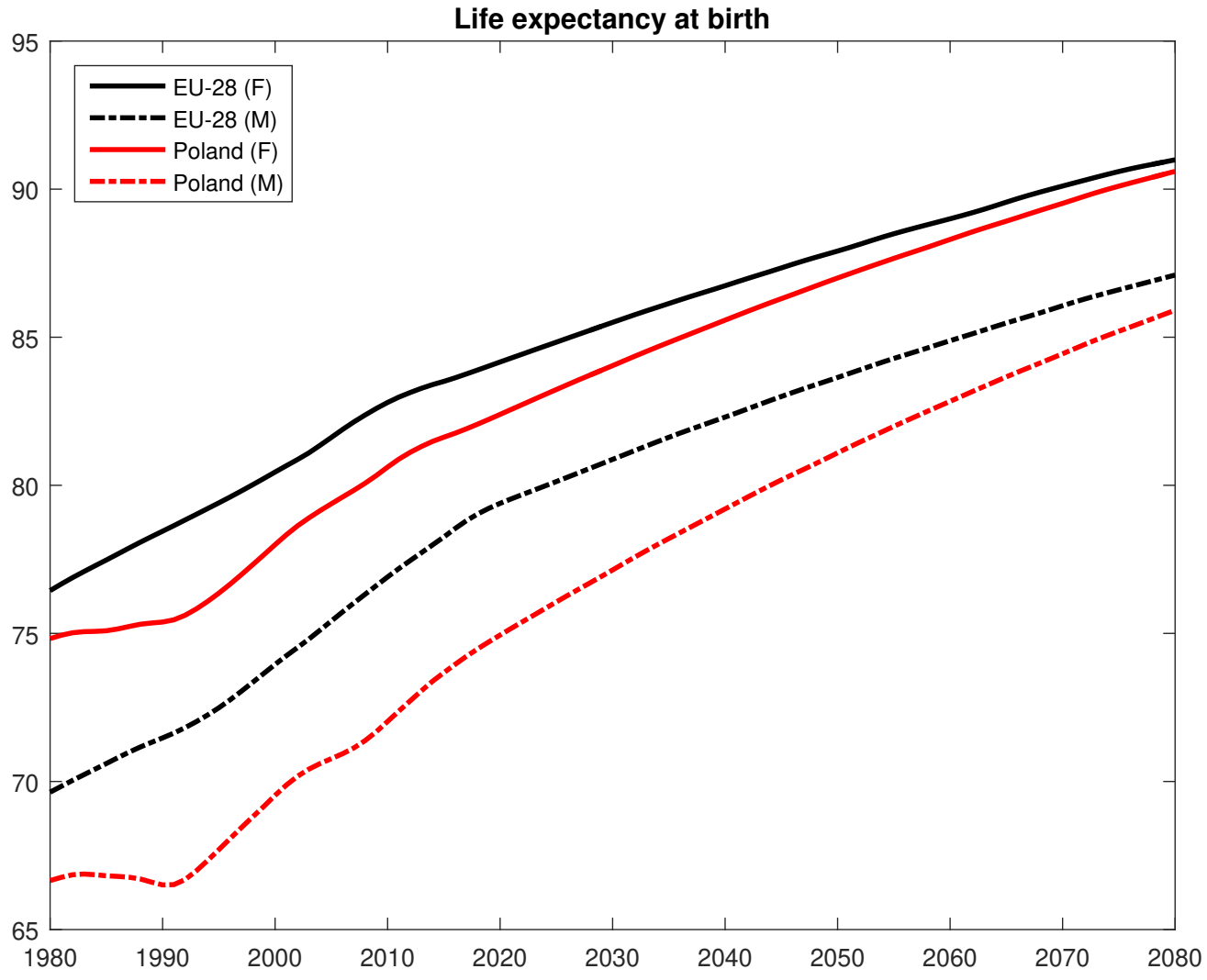
Motivation

- Demographic transition (ageing):
  - Sub-replacement fertility
  - Increasing life expectancy
- Observed in many economies
- Speed and timing differs accross countries
- Poland particularly affected

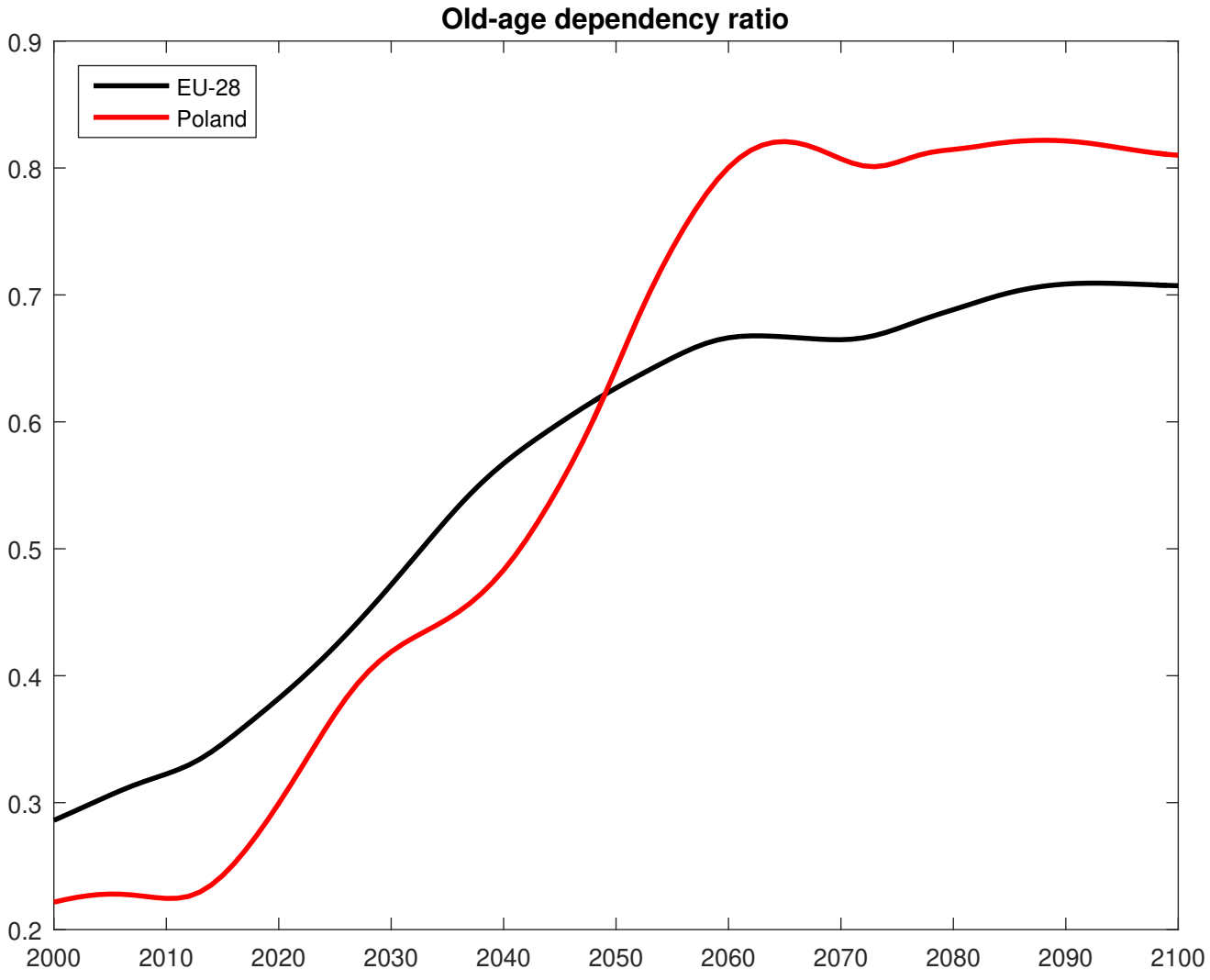
Demography: fertility rate



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
- ...

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- Economic growth
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- **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

Literature

- Impact on NRI:
  - Kara and von Thadden (2016); Carvalho et al. (2016); Eggertsson et al. (2019)
  - All these papers project declining NRI
- Open economy, focus on capital flows, world rate of return and distribution effects:
  - Boersch-Supan et al. (2006); Krueger and Ludwig (2007)
- ZLB risk (in quantitative terms) and impact of learning:
  - ???

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 inflation and ZLB

Main findings

- Impact of demography 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
  - Life expectancy more important than fertility
- 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
  - Exacerbated under learning
- Role of foreign spillovers limited for the NRI,
  domestic demography is key

Model

Model structure: overview

- 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, ZLB
- Exogenous processes:
  - Deterministic: growth rate of initial young, mortality risk (home and abroad)
  - Stochastic: productivity, time preference, monetary policy, international risk premium, foreign shocks

Households

- Maximize expected lifetime utilityIncluding the euro area

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

  subject to

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

- Assets managed by investment funds

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

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

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

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

- Calvo-type price stickiness and local currency pricing (also for imports)

Monetary policy

- Feedback rule

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

  where:

- $g_t \equiv \frac{gdp_t}{gdp_{t-1}}$ and $\tilde{g}_t^e \equiv \frac{g\tilde{dp}_t^e}{g\tilde{dp}_{t-1}^e}$ 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

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

Market clearing

- Standard market clearing conditions for goods, capital and labor markets
- Financial markets:
  - Domestic bonds

$$B_t = 0$$

  - Shares

$$d_t(i) = 1$$

  - Law of motion for Net Foreign Assets

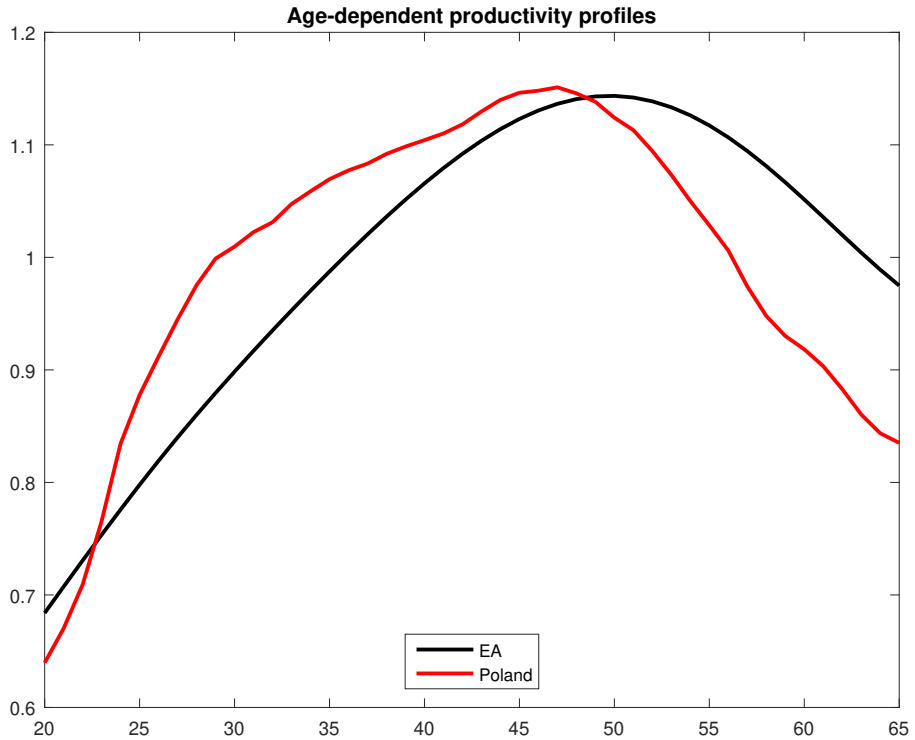
$$(1 + n_{t+1})\, S_t B_t^* = S_t \Gamma_{t-1} R_{t-1}^* B_{t-1}^* + S_t P_{H,t}^* y_{H,t}^* - P_{F,t} y_{F,t}$$

Solution procedure

- Deterministic simulations:
  - Simulate EA (closed)
  - Use solution for EA to simulate PL (small open)
- Stochastic simulations:
  - First-order approximation around points along the deterministic path
  - Allowing for ZLB: Dynare OBC, Holden (2019)

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:



Poland: Kolasa (2017); EA: Gourinchas and Parker (2002) estimates for US

Calibration and data - continued

- Estimated outside of the model:
  - Taylor rule parameters
  - EA VAR
- Other structural parameters taken from literature or matched to means observed in data:
  - Real interest rate:
    - PL: 2.1% (2003-2012)
    - EA: 1.2% (1999-2008)
  - Foreign debt to GDP ratio in PL: 55% (2003-2012)
- 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

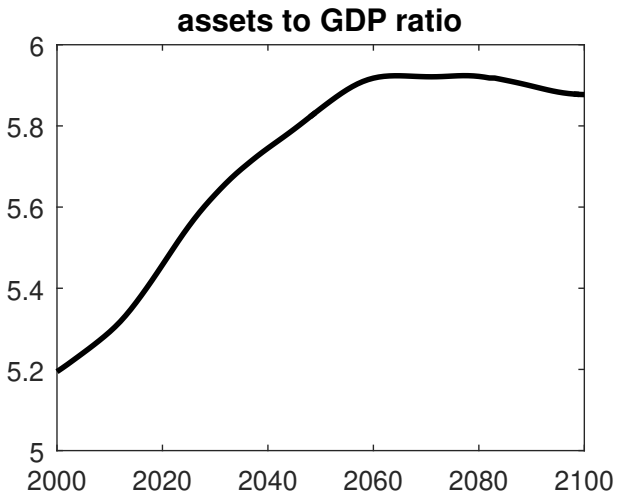
Variable	Standard dev.		Autocorrelation		Corr. with GDP	
	Model	Data	Model	Data	Model	Data
GDP	1.77	1.84	0.77	0.68	1.00	1.00
Inflation	1.50	1.77	0.25	0.37	0.39	0.72
Interest rate	1.97	1.97	0.34	0.34	0.40	0.57
Real exchange rate	5.52	5.55	0.36	0.22	0.03	0.31

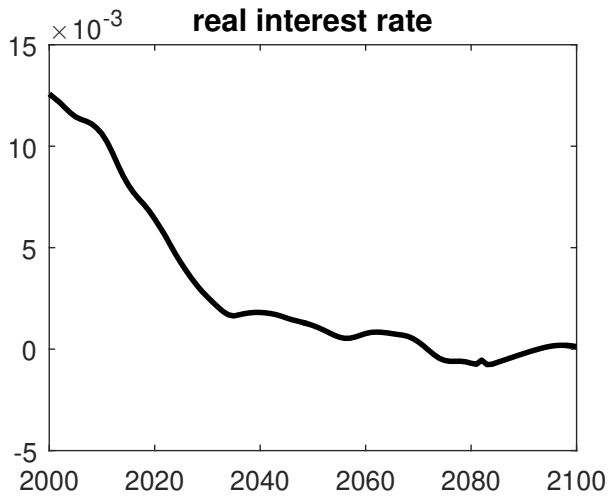
Results

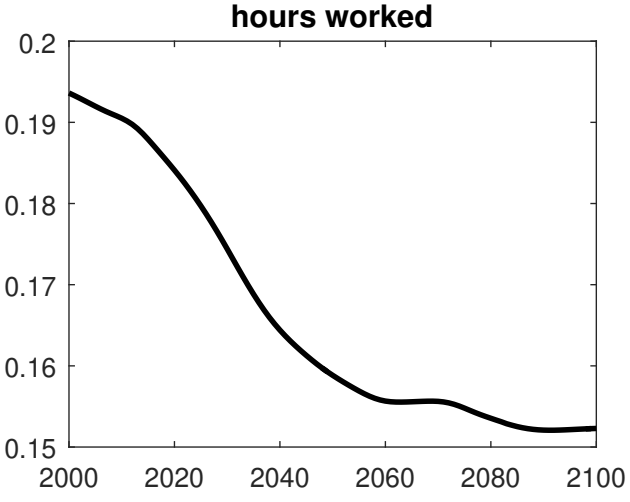
Overview of simulations

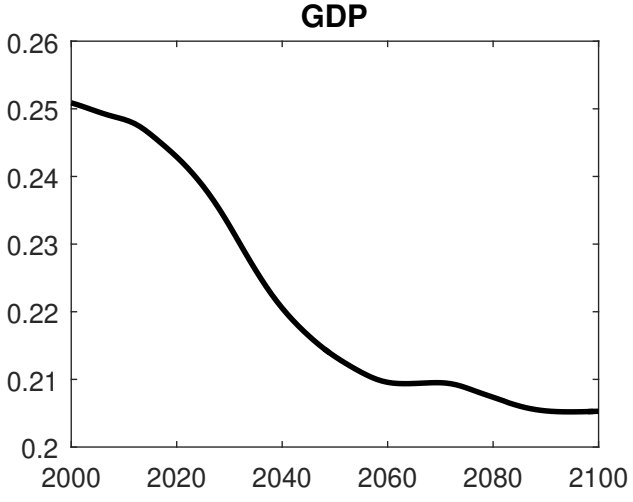
- Impact of demographic transition:
  - Euro Area
  - Poland
- Consequences for monetary policy:
  - Inflation
  - ZLB risk
- Spillovers from foreign demography

Impact of demographic transition: Euro Area

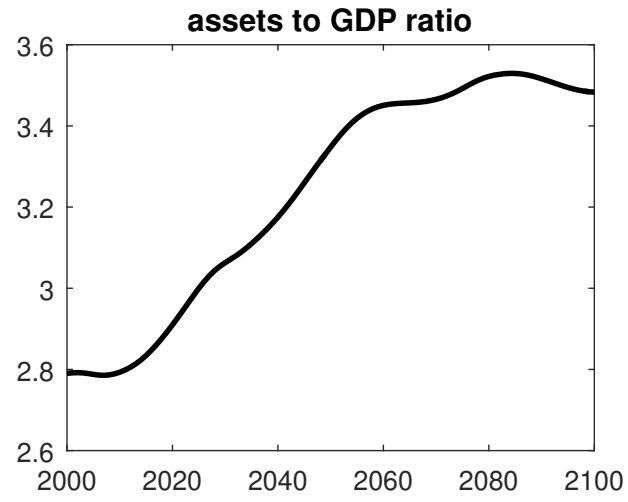


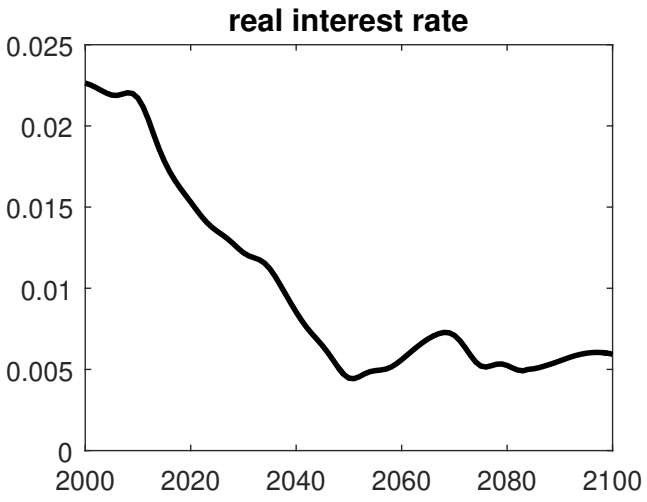


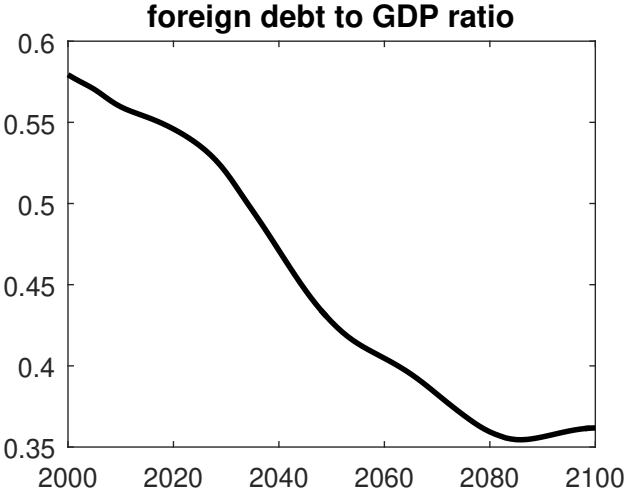


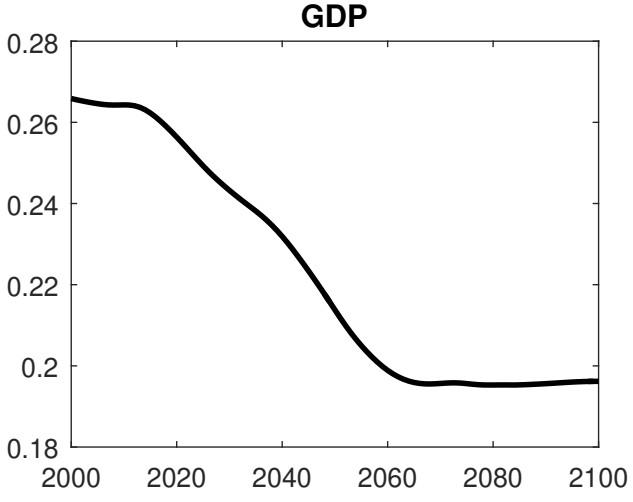


Impact of demographic transition: Poland

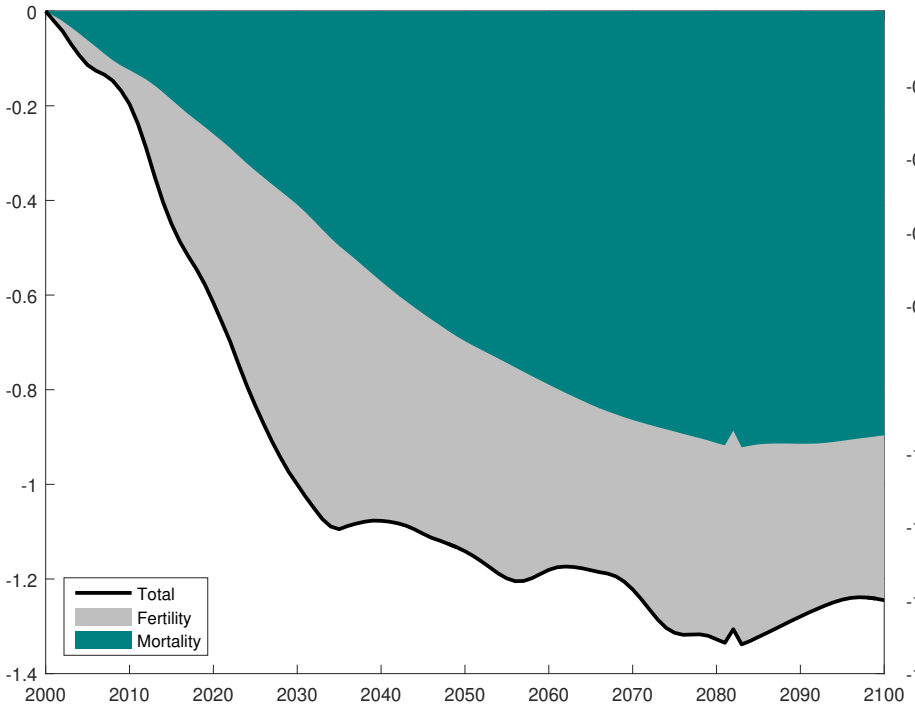




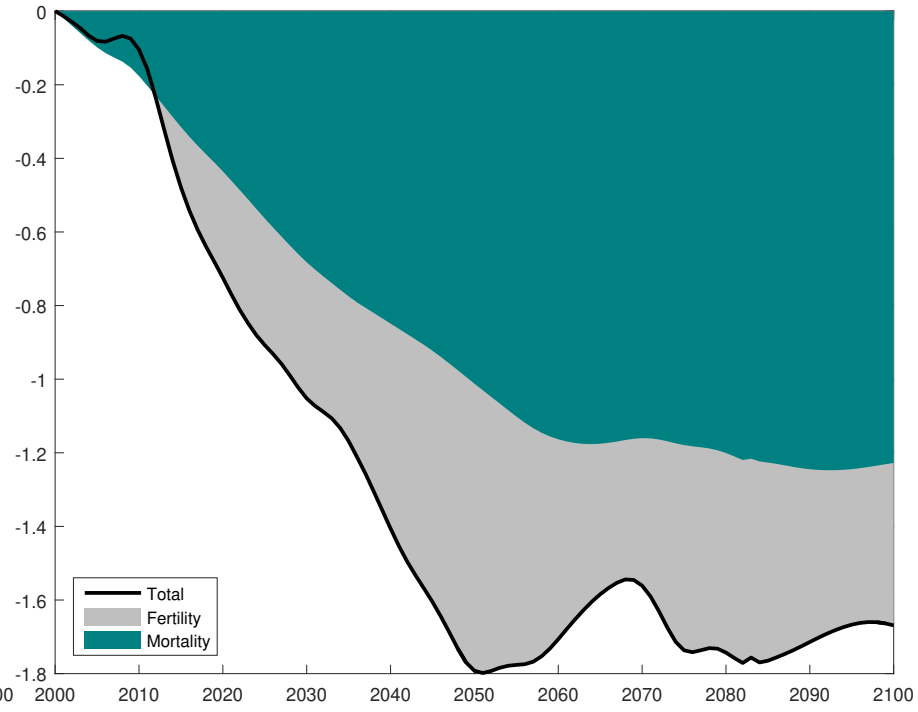




Decomposition of changes in NRI

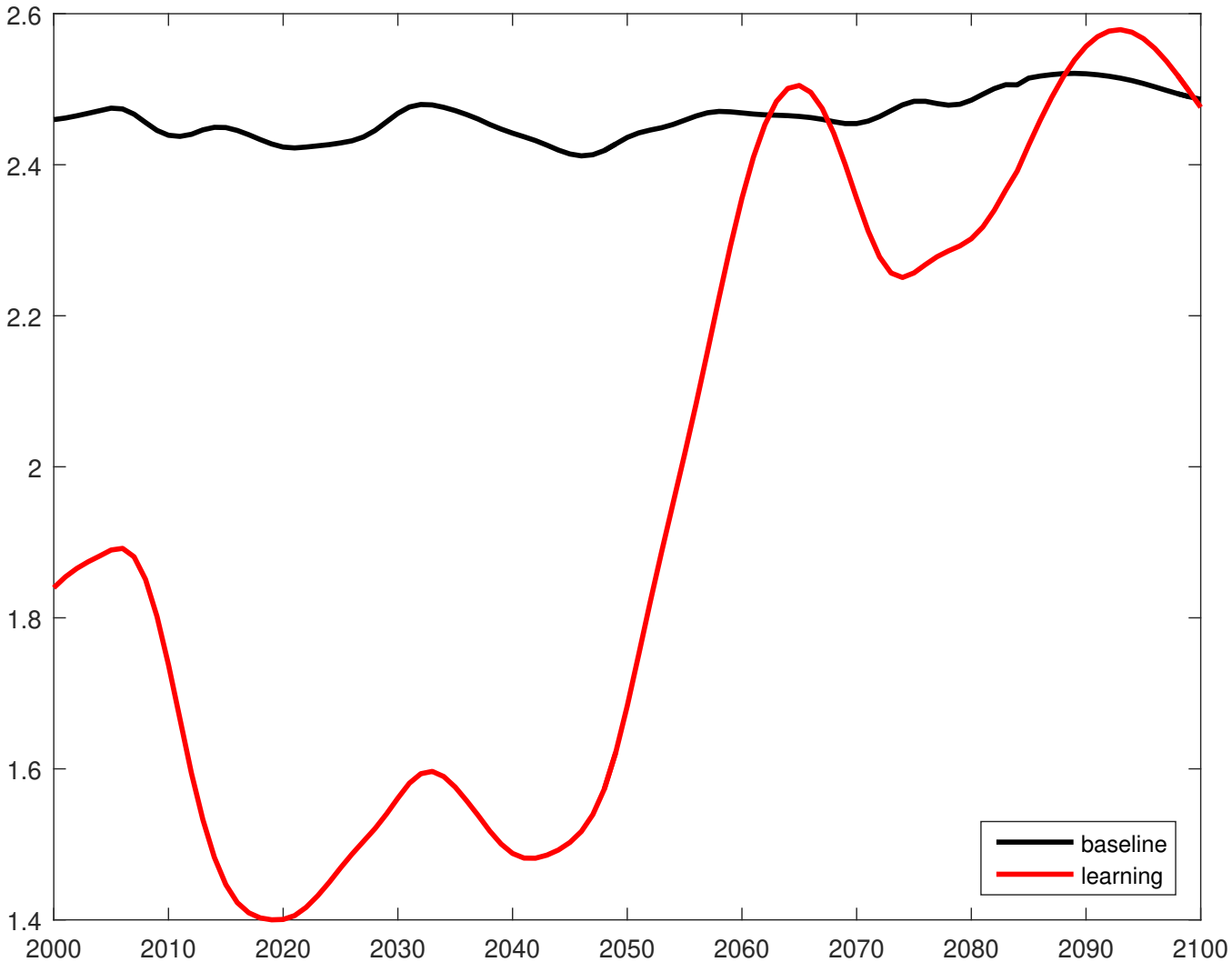


Euro Area

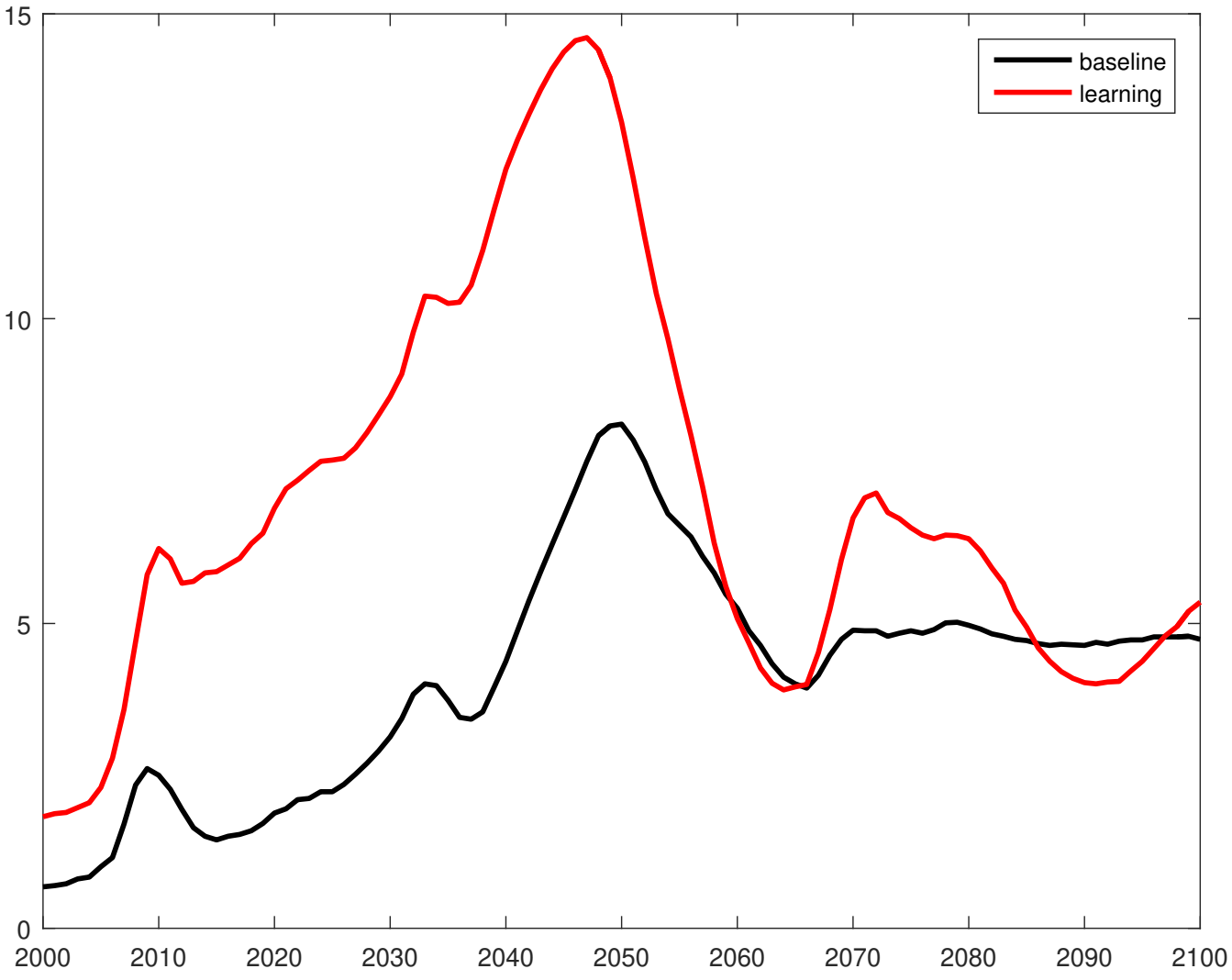


Poland

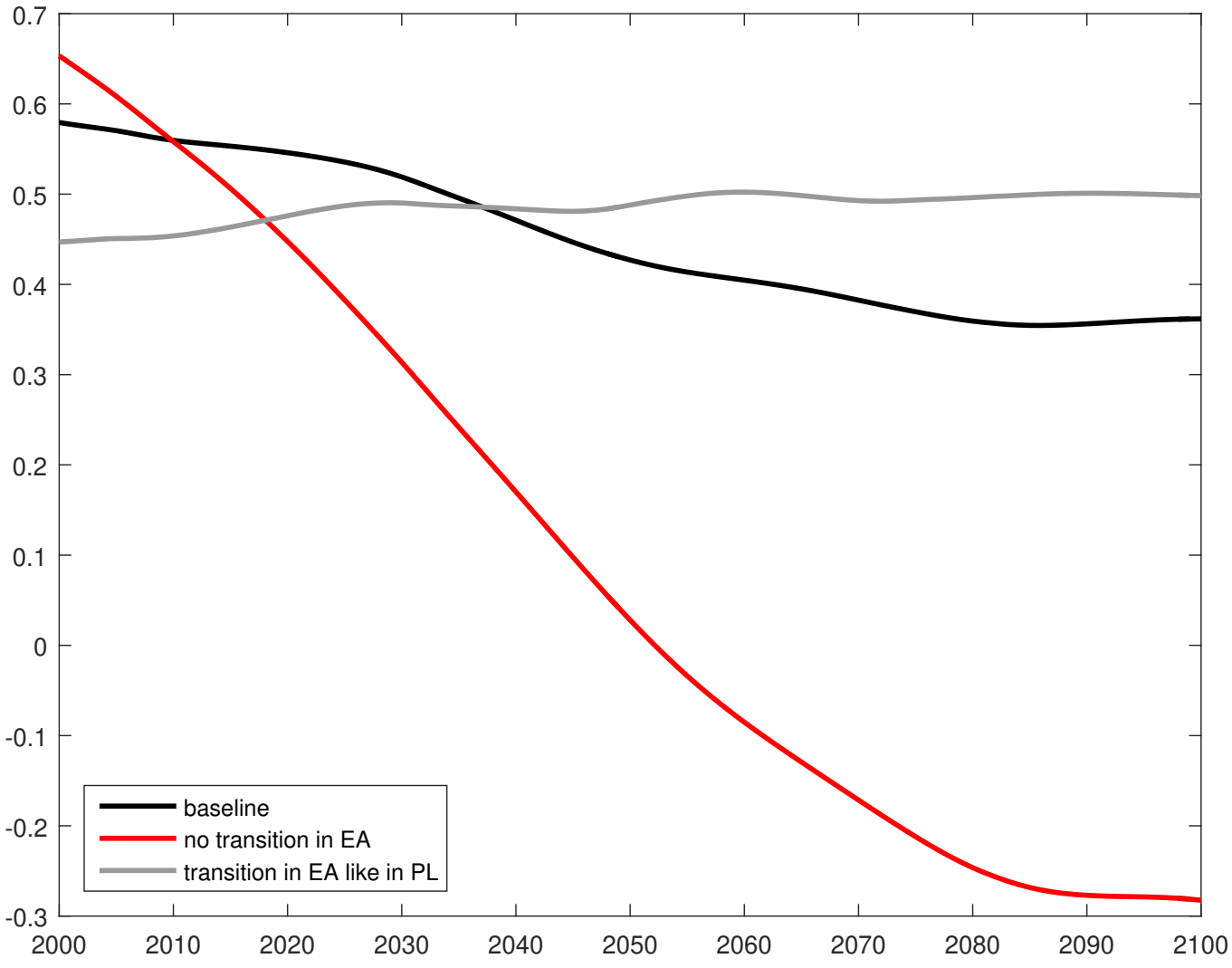
Inflation rate (Poland)



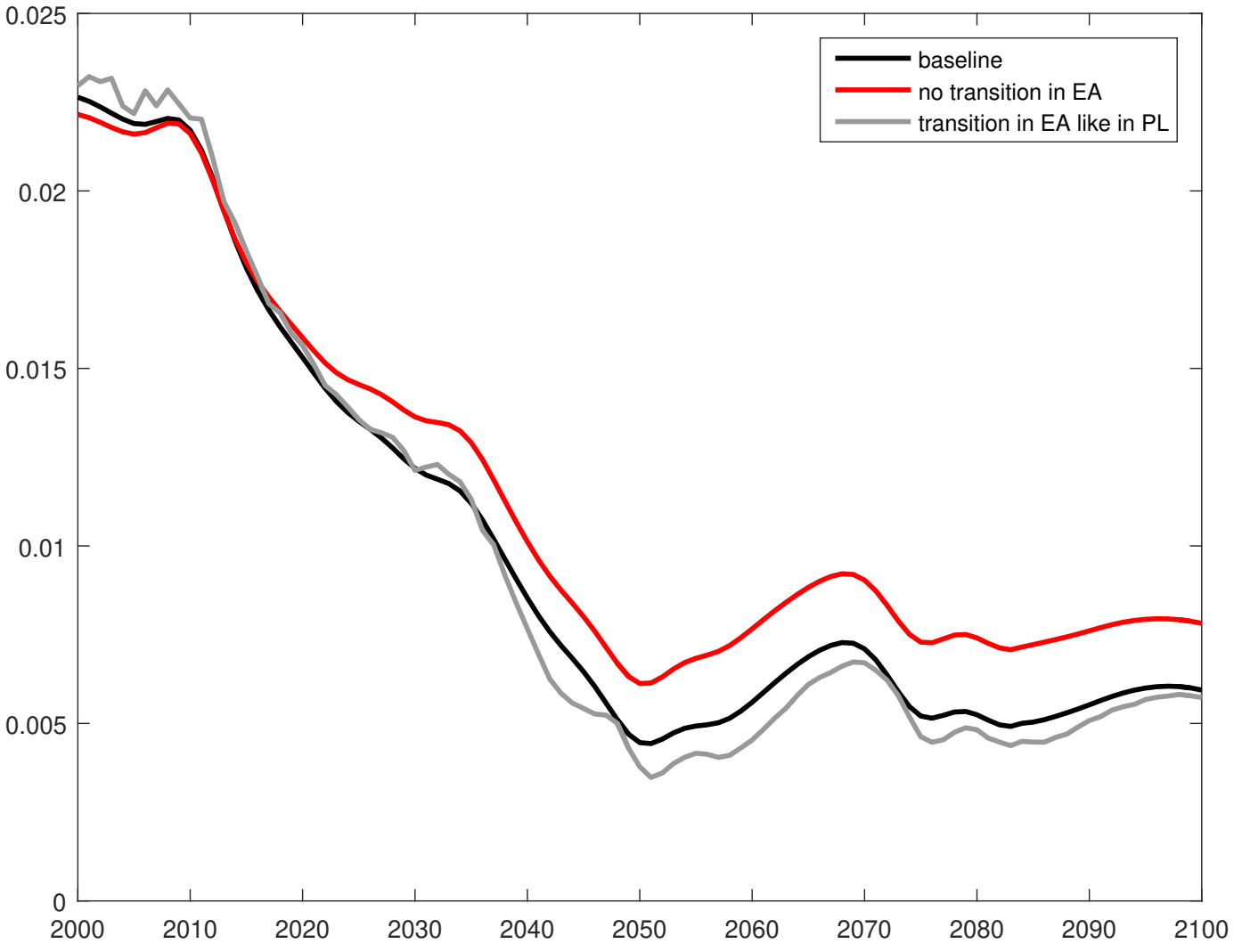
Probability of hitting ZLB (Poland)



Role of foreign demography: Foreign debt to GDP ratio



Role of foreign demography: Real interest rate



Conclusions

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 abroad important for current account, less so for NRI in Poland

Thank you!

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