Unstable Monetary Unions
- The Role of Expectations and Past Experience

Michał Kobielarz
KU Leuven

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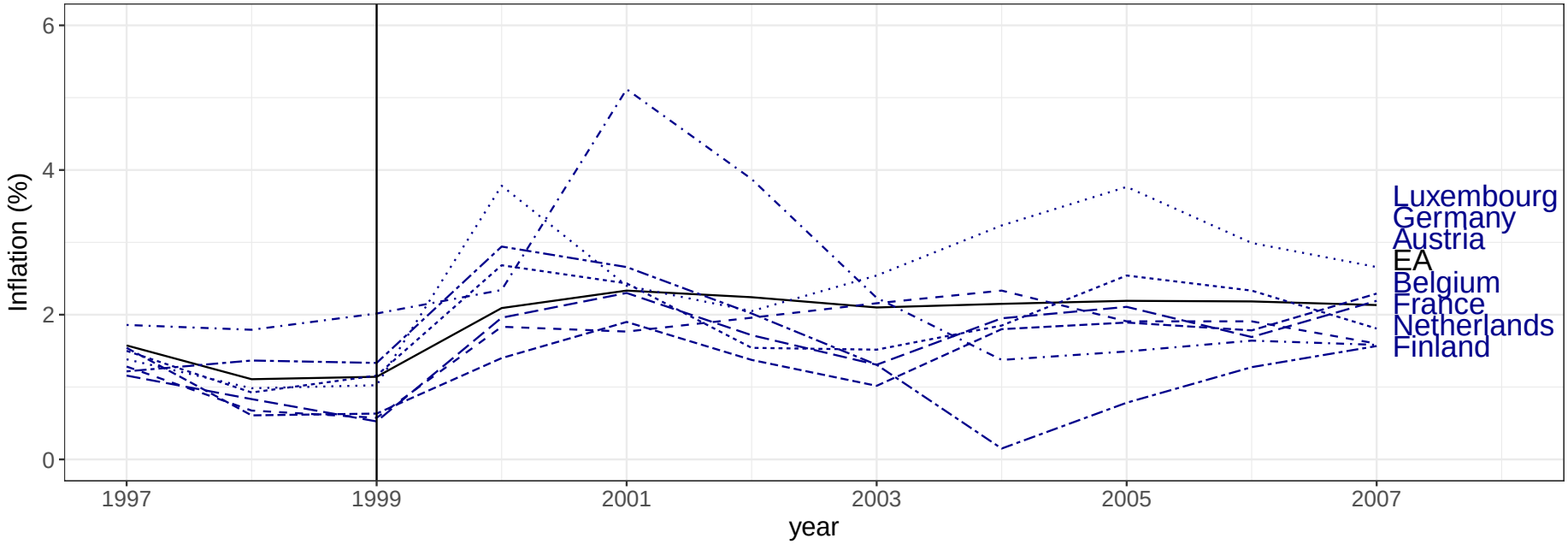
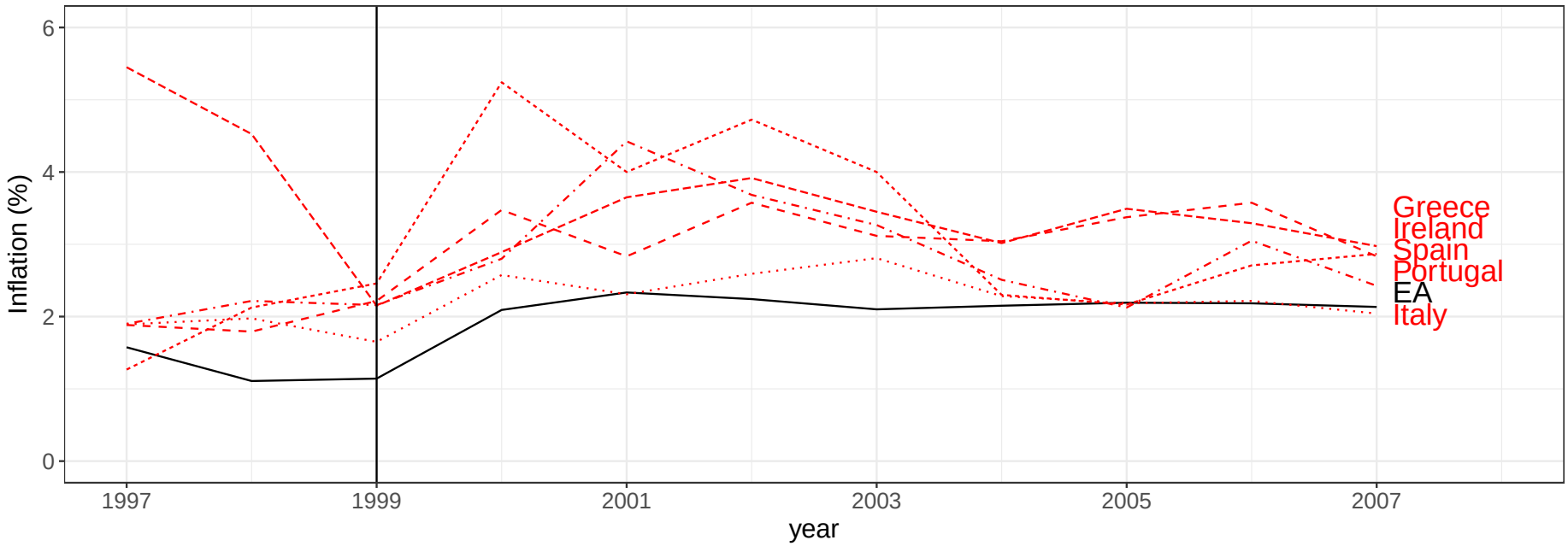
Inflation in the Eurozone



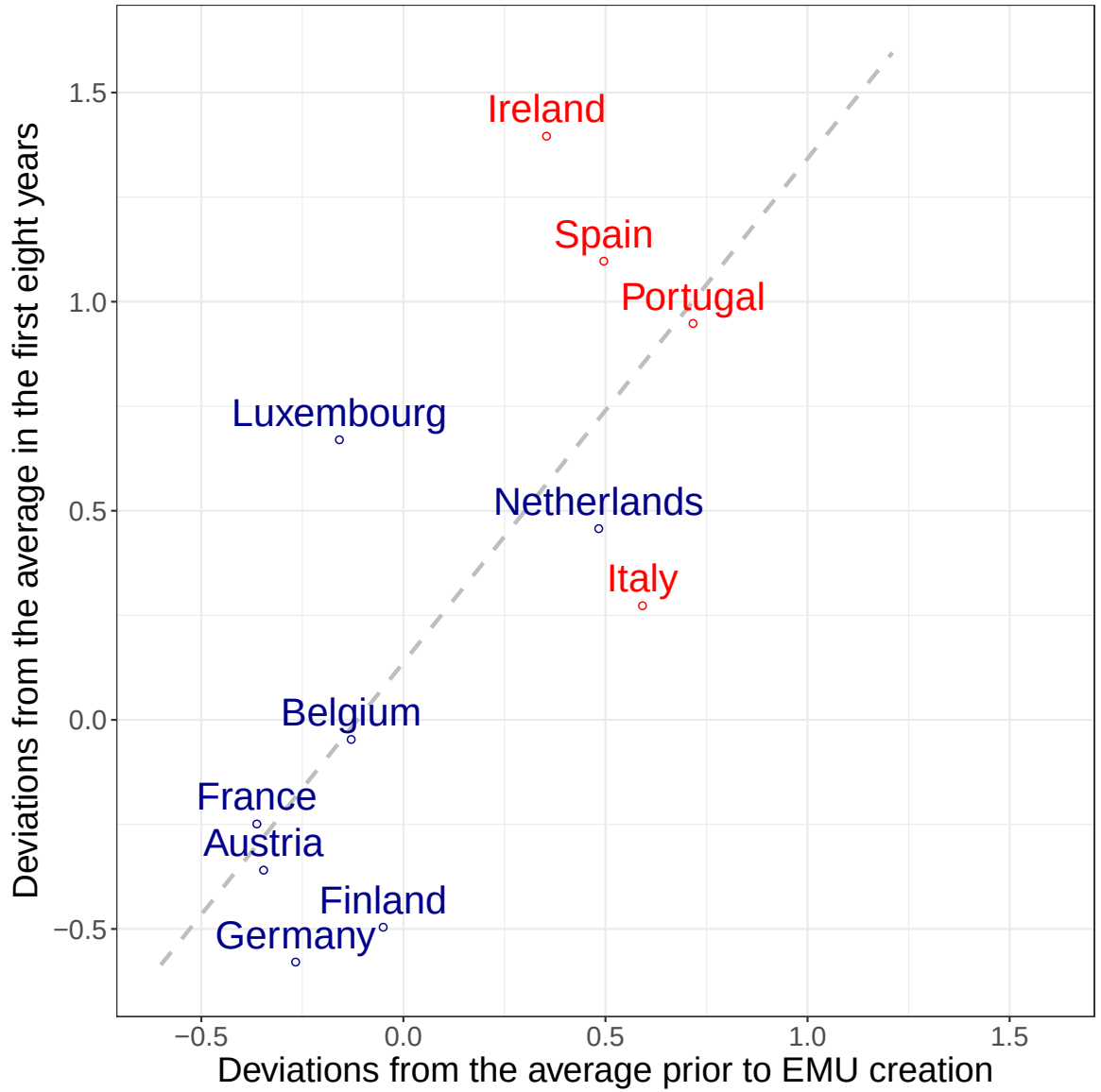


Research question

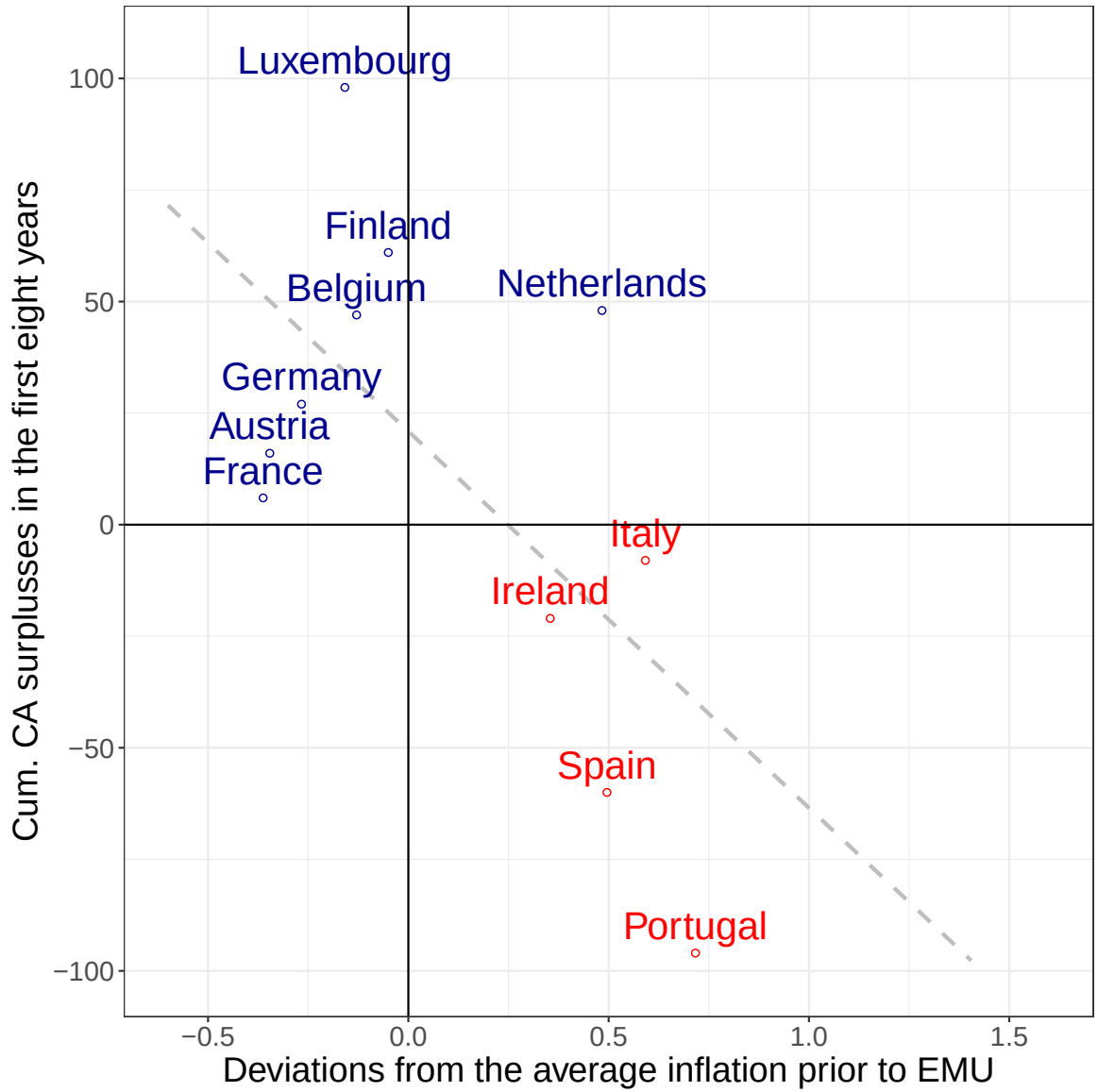
Persistent differences in inflation rates across members of MU:

- where do they come from?
- what are their consequences?

Pre- and Post-Euro Introduction Inflation Rates



Pre-Euro Inflation and Euro CA Imbalances



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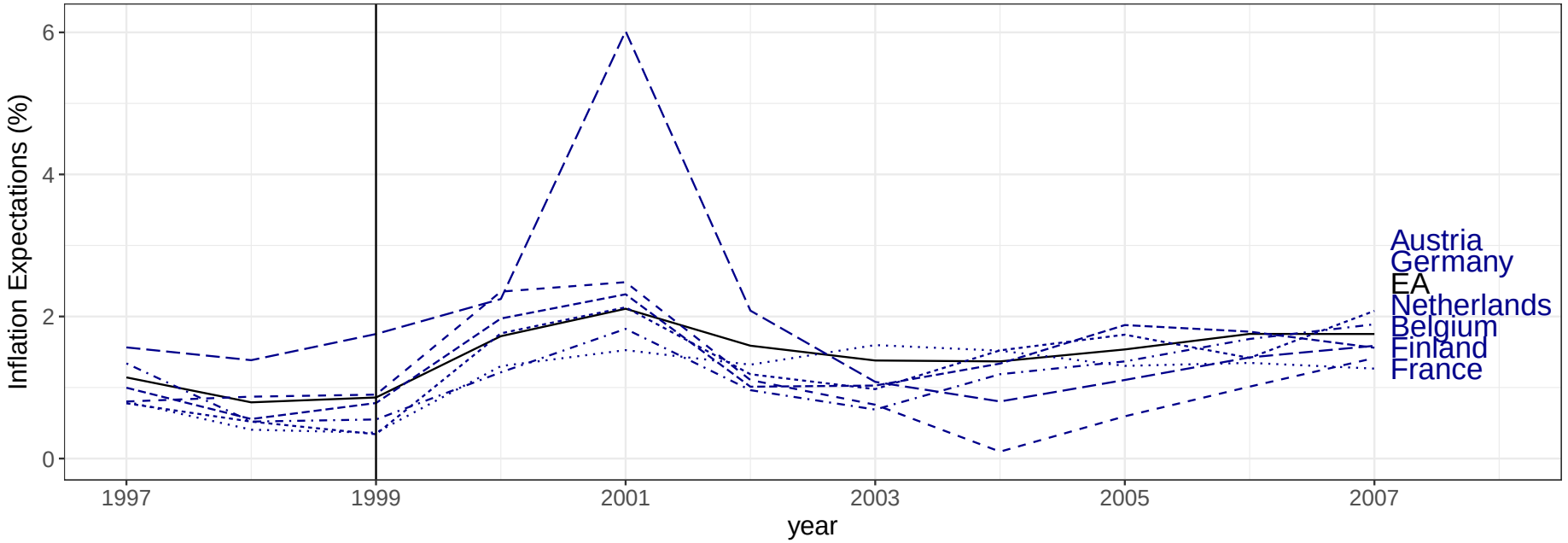
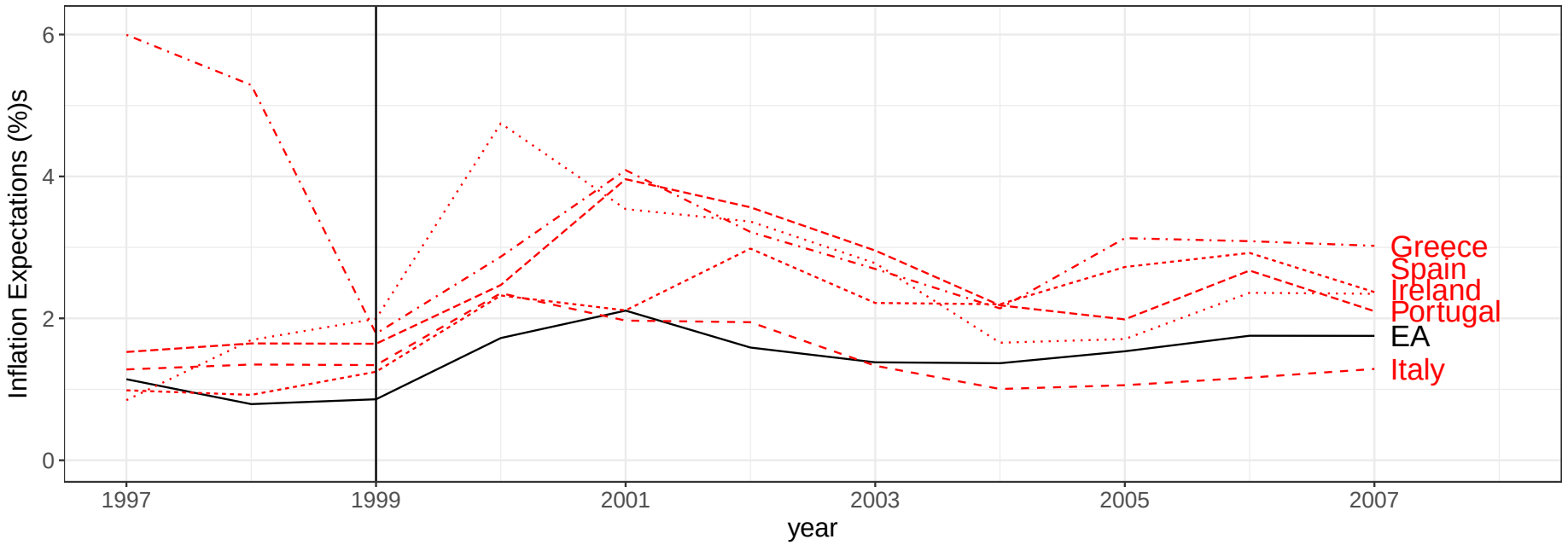
Past inflation experience, driving inflation expectations

Main mechanism

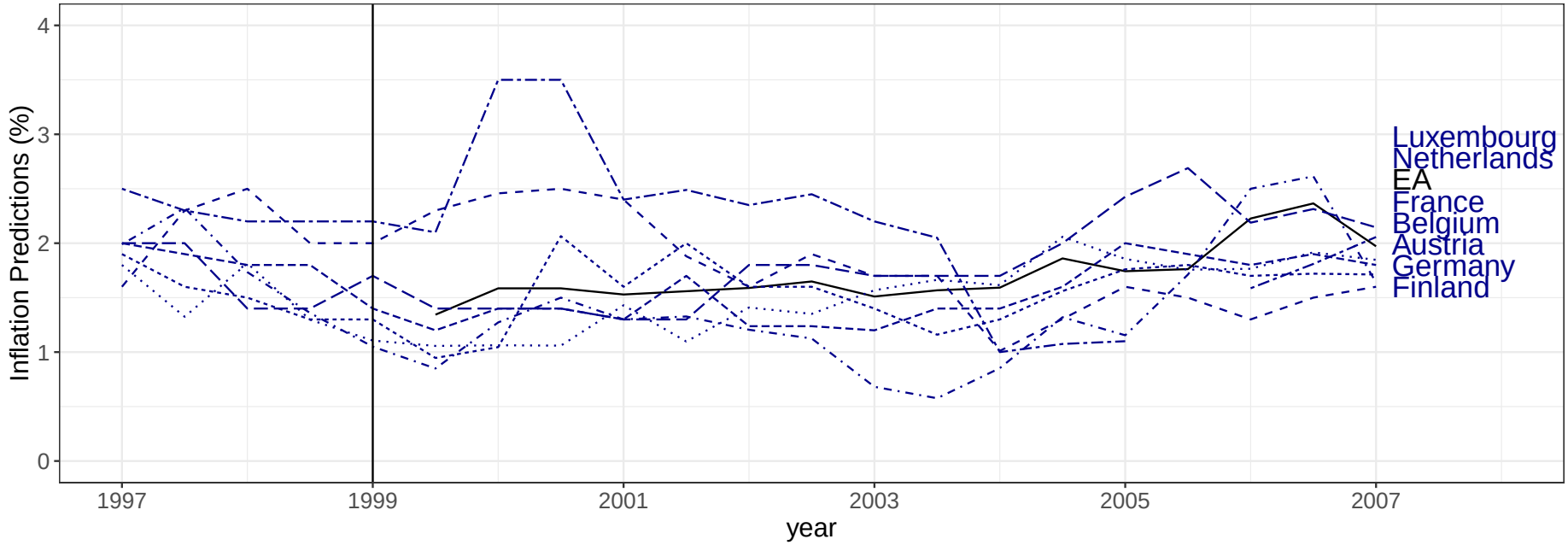
- Prior experience influences expectations
- High inflation expectations + Uniform nominal interest rates $\Rightarrow$ Low real interest rates
- Low real rates stimulate economy $\Rightarrow$ High inflation
- (Partially) self-fulfilling expectations dampen learning
- Persistent inflation differences and build-up of external debt
- Potentially: Instability

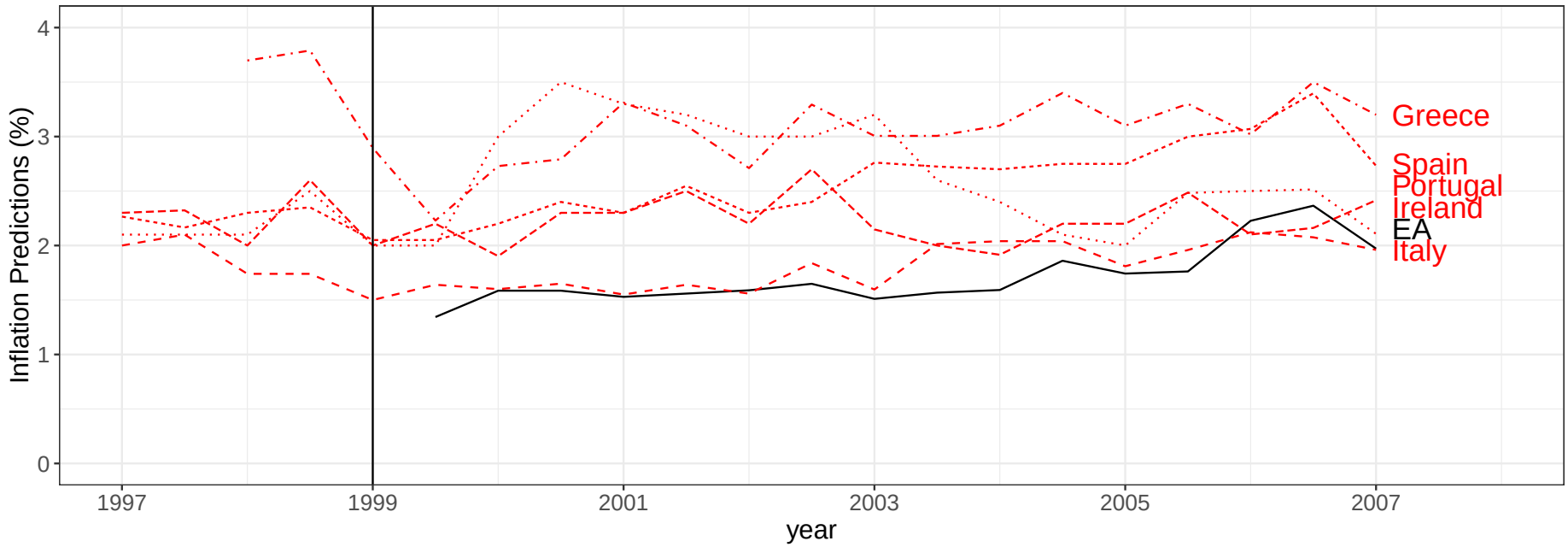
Inflation Expectations - survey data





Inflation Forecasts (IMF WEO)





Setup of the paper

- Role of (inflation) expectations within a monetary union
- Theoretical model of SOE joining Monetary Union
- Private agents form expectations based on perception of economy
- Need to learn (estimate) the new environment
  - e.g. economic dynamics and policy rules
- Importance of different initial conditions

Why?

Related Literature

- **Instability under learning:** Primiceri (QJE 2006), Lubik & Matthes (JME 2016), Cogley, Matthes & Sbordone (JME 2015), Branch & Evans (JMCB 2017)
- **Monetary economics of a monetary union:** Benigno (JIE 2004), Gali & Monaceli (JIE 2008), De Paoli (JIE 2009), Ferrero (JIE 2009)
- **Imbalances within the Eurozone:** Aguiar et al. (QJE 2015), Gopinath et al. (QJE, 2017), Baldwin & Giavazzi (CEPR 2015), Piton (2017), De Ferra (2017)

Outline

1. Motivation
2. **Overview**
3. Basic model
4. Learning
5. Quantitative analysis

Model setup

Two regions:

- Small Open Economy,
- Rest of the World - Monetary Union,
- Structurally identical,
- Differ in steady-state inflation (targets).

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Scenario:

- Small Open Economy begins independent, but joins the Union,
- Common monetary policy $\Rightarrow$ Common inflation target,
- Convergence of inflation rates?

Model economy

Households:

- work and consume,
- home bias in preferences,
- access to incomplete financial markets.

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Central Bank:

- Taylor rule (inflation targeting).

Households

Maximize expected lifetime utility:

$$\max_{C_t, L_t, B_{H,t}, B_{F,t}} \hat{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^i)^{1-\sigma} - 1}{1-\sigma} - \phi \frac{(L_t^i)^{1+\varphi}}{1+\varphi} \right]$$

subject to

$$P_t^i C_t^i + \frac{B_{H,t}}{1+i_t} + \frac{S_t B_{F,t}}{(1+i_t^*)\Psi\left(\frac{S_t \bar{B}_{F,t}}{P_t}\right)} = B_{H,t-1} + B_{F,t-1} + W_t L_t + \Pi_t,$$

where

- $B_{H,t}, B_{F,t}$ - holdings of home and foreign bonds
- $\Psi(\cdot)$ - cost of international borrowing
- "$*$" - foreign variables

Households

Consumption is a composite index:

$$C_t = \left[\nu^{\frac{1}{\eta}} \left(C_{H,t}^i \right)^{\frac{\eta-1}{\eta}} + (1-\nu)^{\frac{1}{\eta}} \left(C_{F,t}^i \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}},$$

where $\nu > n$ represents home bias in consumption.

Prices

- Goods are priced P_H and P_F, depending on origin
- Law of one price for individual goods: $P_{i,t} = S_t \cdot P^*_{i,t}$
- But not for price indices:

$$P_t = \left[\nu \left(P_{H,t}\right)^{1-\eta} + \left(1-\nu\right)\left(P_{F,t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}} \neq P^*_t$$

Firms

- Simple production function:

$$y_t(i) = A_t \cdot n_t(i)$$

- Firms face monopolistic competition

- Price rigidities - Calvo pricing:
  - each period fraction $1 - \theta$ of firms resets prices
  - others keep old price

Monetary Policy

Monetary authority:

- chooses interest rate, i_t
- to control domestic inflation, π_t

Simple Taylor rule:

$$i_t = \bar{i} + \phi_\pi \left(\pi_t - \bar{\pi}\right) + m_t$$

- $\bar{i}$ - steady state interest rate
- ϕ_π - policy reaction coefficient, > 1
- m - monetary policy shock

Equilibrium

A set of choices made by households, firms and monetary policy, such that:

- goods markets,
- labor markets,
- capital markets

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Expectations are hidden in the equilibrium definition - agents use their expectations when making decisions.

Learning

Private agents:

- know the structure of the economy
- but not the coefficients
- like econometricians - estimate parameters

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Each period:

- use new observations to update estimates
- form expectations as forecasts
- make decisions (based on expectations)
- receive new data

Model dynamics - Rational Expectations

The model:

$$X_t = a_0 + a_1 E_t X_{t+1} + a_2 X_{t-1} + a_3 Z_t,$$

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The law of motion for the model:

$$X_t = b_0 + b_1 X_{t-1} + b_2 Z_t.$$

Model dynamics - Adaptive Learning

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The Perceived Law of Motion is estimated:

$$X_t = \hat{b}_{t,0} + \hat{b}_{t,1} X_{t-1} + \hat{b}_{t,2} \hat{Z}_t,$$

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Formed expectations

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The Actual Law of Motion depends on PLM:

$$\begin{aligned} X_t &= a_0 + a_1 \hat{E}_t X_{t+1} + a_2 X_{t-1} + a_3 Z_t \\ &= a_0 + a_1 \left(\hat{b}_{t,0} + \hat{b}_{t,1} X_t + \hat{b}_{t,2} \hat{E}_t \hat{Z}_{t+1} \right) + a_2 X_{t-1} + a_3 Z_t. \end{aligned}$$

Adaptive Learning - Updating

$$\begin{aligned} \hat{b}_{t+1} &= \hat{b}_t + g_t R_t^{-1} X_{t-1} \cdot \left(X_t - \hat{b}_t X_{t-1} \right) \\ R_t &= R_{t-1} + g_t \cdot \left(X_{t-1} X_{t-1}^T - R_{t-1} \right) \end{aligned}$$

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Learning algorithms:

- Recursive Least Squares Learning: $g_t = \frac{1}{t}$
- Constant Gain Learning: $g_t = g$

Adjustment channels in the SOE

1. Monetary Policy
2. Nominal Exchange Rate
3. Relative Prices (Real Exchange Rate) - Trade channel

Joining Monteray Union

1. Common monetary policy - zero weight on SOE inflation

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3. Only left: trade channel

Independence vs Monetary Union

1. NK Philips curve (SOE)

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa_1 \hat{y}_t - \kappa_2 \hat{y}_t^* - \kappa_3 \hat{q}_t - \kappa_4 \varepsilon_t$$

2. (Dynamic) IS curve (SOE)

$$E_t \Delta \hat{y}_{t+1} = \lambda E_t \Delta \hat{y}_{t+1}^* + \frac{1-\lambda}{\sigma} \left[\hat{\imath}_t - E_t \hat{\pi}_{t+1} \right] + \frac{\lambda + \gamma\sigma}{\sigma} E_t \Delta \hat{q}_{t+1}$$

3. Household budget constraint (SOE)

$$\beta \hat{b}_t = \hat{b}_{t-1} - \frac{\lambda}{1-\lambda} \left(\hat{y}_t - \hat{y}_t^* \right) + \frac{\gamma + \lambda}{1-\lambda} \hat{q}_t$$

Foreign

Independence vs Monetary Union

4. No-arbitrage condition

$$\hat{\imath}_t = \hat{\imath}_t^* - \delta \hat{b}_t + \frac{1}{1-\lambda} E_t \Delta \hat{q}_{t+1} + E_t \left[\hat{\pi}_{t+1} - \hat{\pi}_{t+1}^* \right]$$

Independence vs Monetary Union

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simplifies to

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$$\hat{\imath}_t = \phi_\pi \hat{\pi}_t + m_t$$

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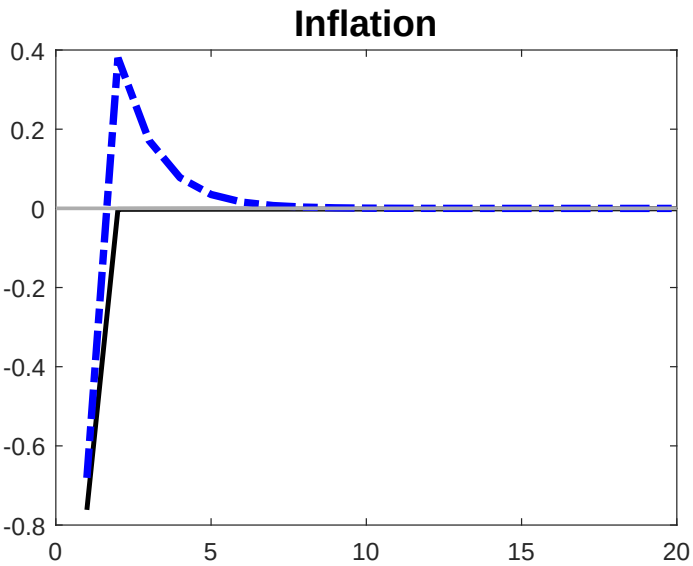
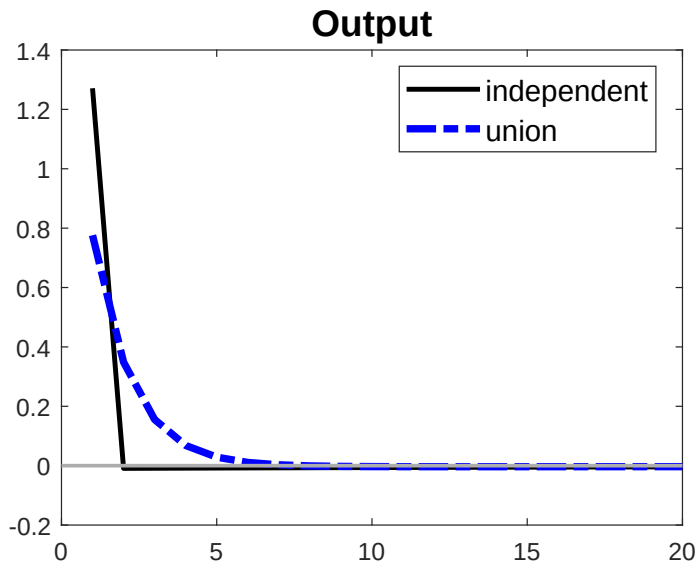
$$\hat{\imath}_t = \phi_\pi \hat{\pi}_t + m_t$$

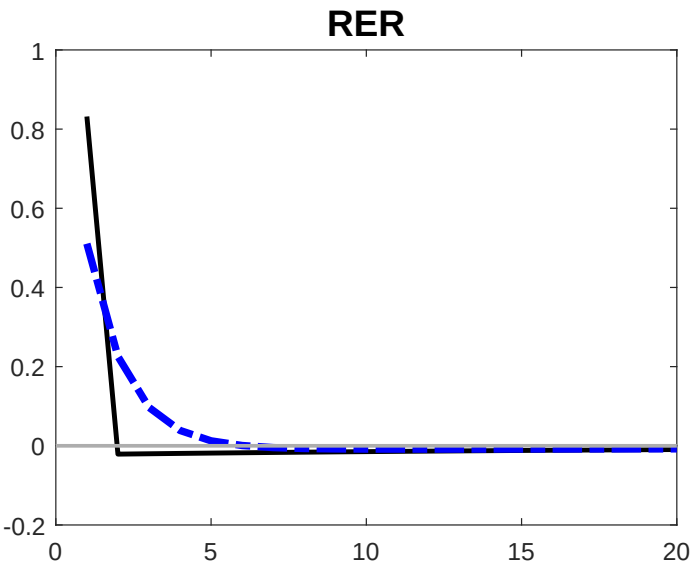
is replaced by evolution of the real exchange rate

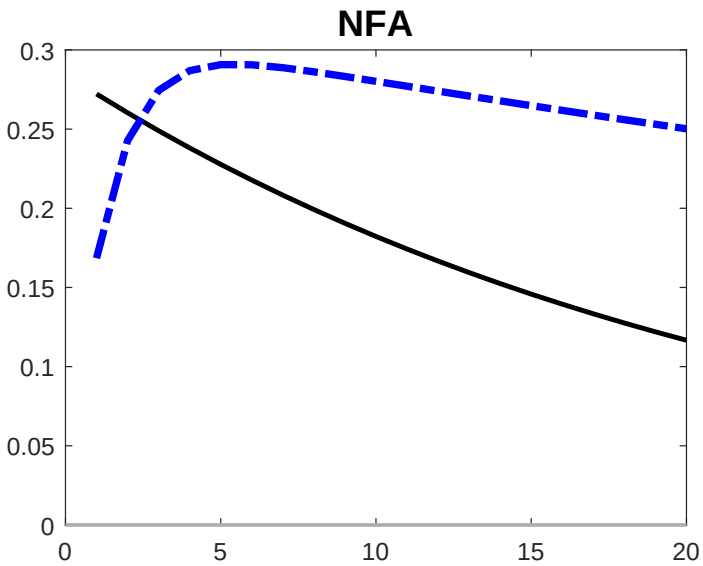
$$\hat{q}_t = \hat{q}_{t-1} + (1-\lambda) \left[\hat{\pi}_t - \hat{\pi}_t^* \right]$$

IRF to technology shock

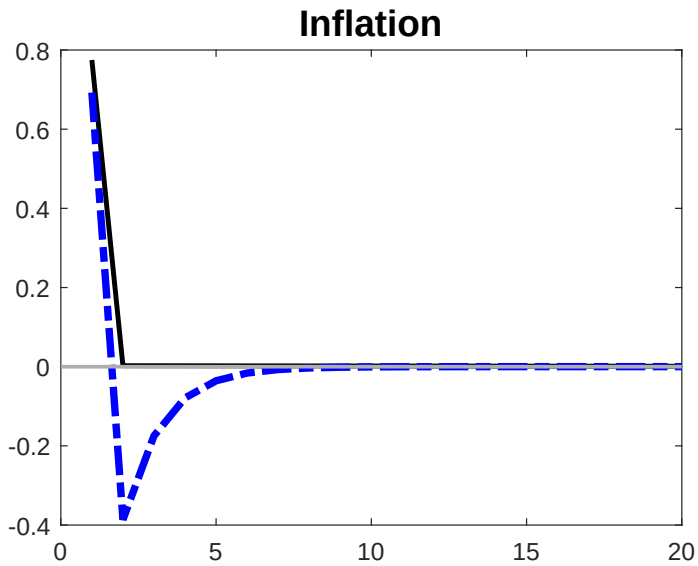


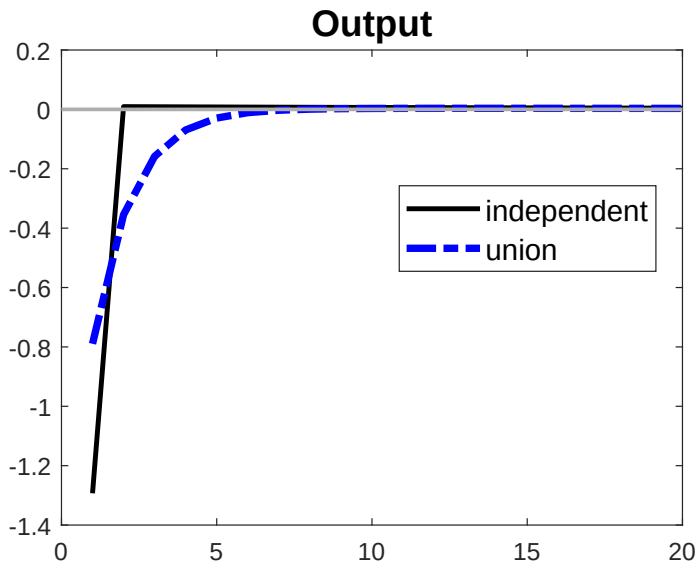


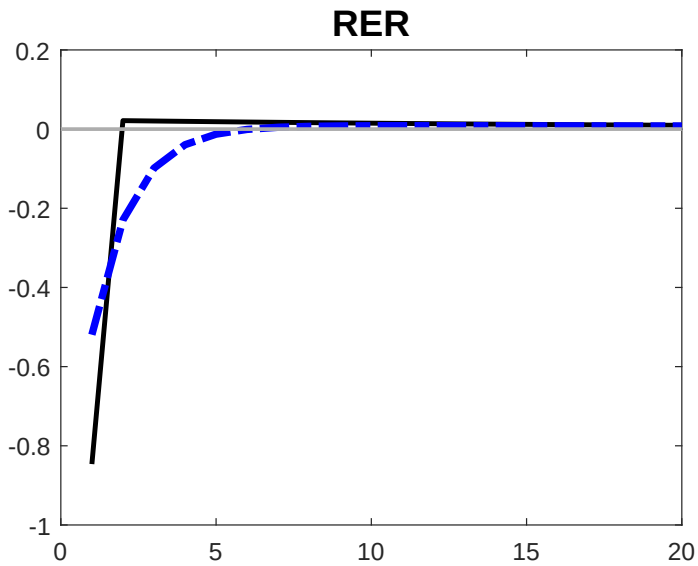


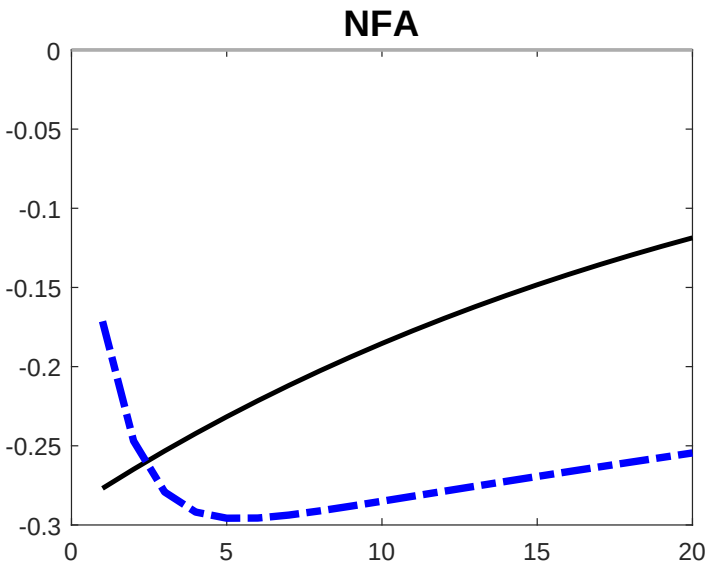


IRF to cost-push shock









Simulation exercise

Setup:

- Training period: 60 quarters (initial estimates) - outside of MU
- Start of exercise: SOE joins MU

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Setup:

- Training period: 60 quarters (initial estimates) - outside of MU
- Start of exercise: SOE joins MU
- Agents need to learn the new environment
- Rational Expectations vs Learning
- Two economies differ only in inflation history:
  - low inflation - prior to joining MU inflation at the MU steady state level
  - high inflation - prior to joining MU inflation 1pp above MU steady state (satisfies convergence criteria)

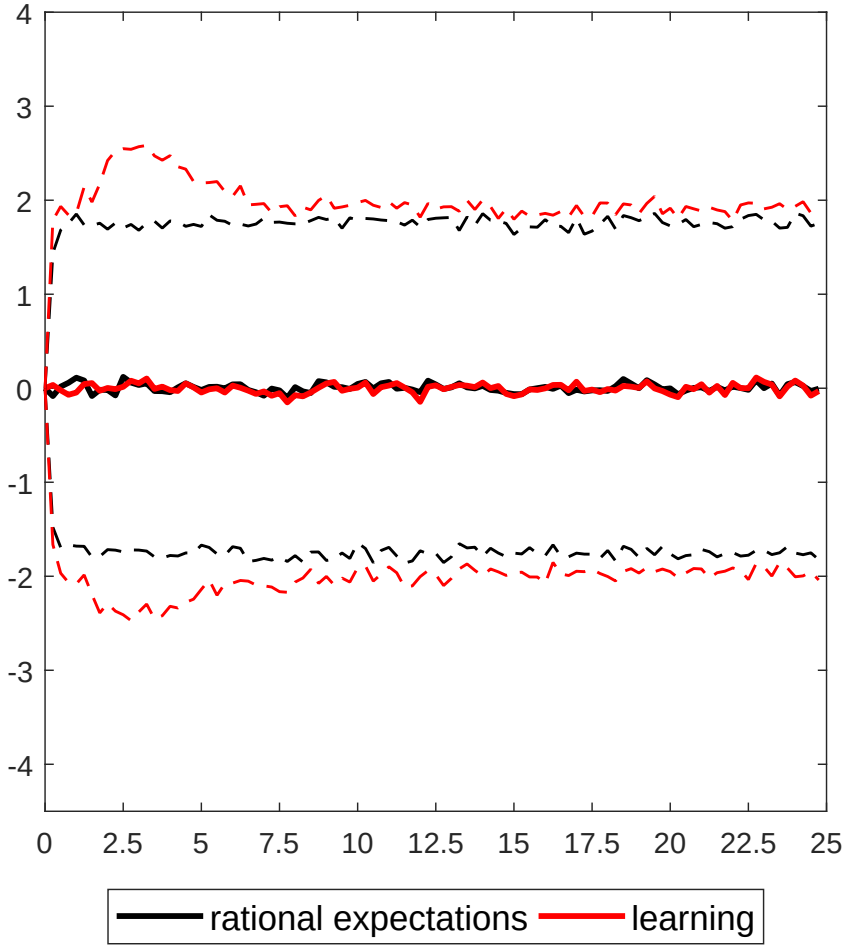
Calibration

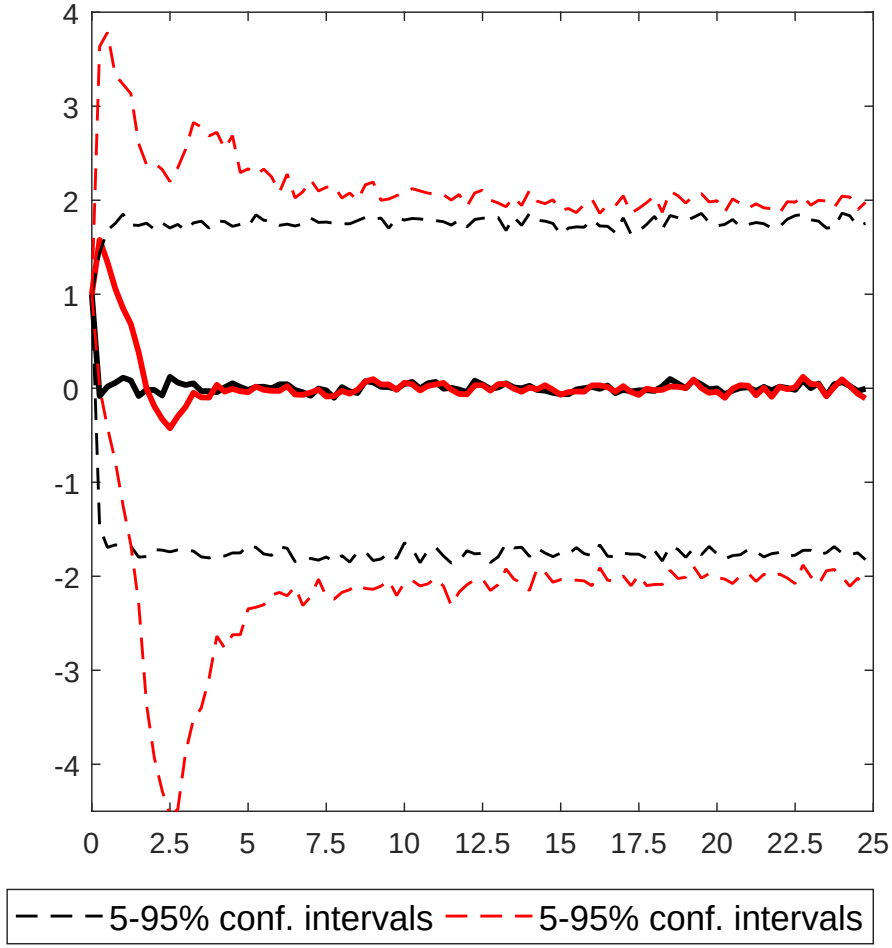
Parameter	Value	Description
β	0.99	Discount factor
ω	2	CRRA coefficient
φ	2	Inverse Frish elasticity
λ	0.25	Openness to trade
θ	1.5	Intratemporal elasticity of substitution
σ	10	Elasticity of substitution between diff products
δ	0.01	Sensitivity of borrowing costs to NFA
α	0.66	Calvo price stickiness parameter

Calibration

Parameter	Value	Description
ϕ_π	1.5	Coefficient on inflation in the SOE Taylor rule
ϕ^*_π	1.5	Coefficient on inflation in the union-wide Taylor rule
std(ε)	0.013	Standard deviation of the technological shock
std(ε)	0.013	Standard deviation of the technological shock
std(m)	0.001	Standard deviation of the monetary policy shock
std(m^*)	0.001	Standard deviation of the monetary policy shock
g	0.025	Gain parameter for the learning algorithm

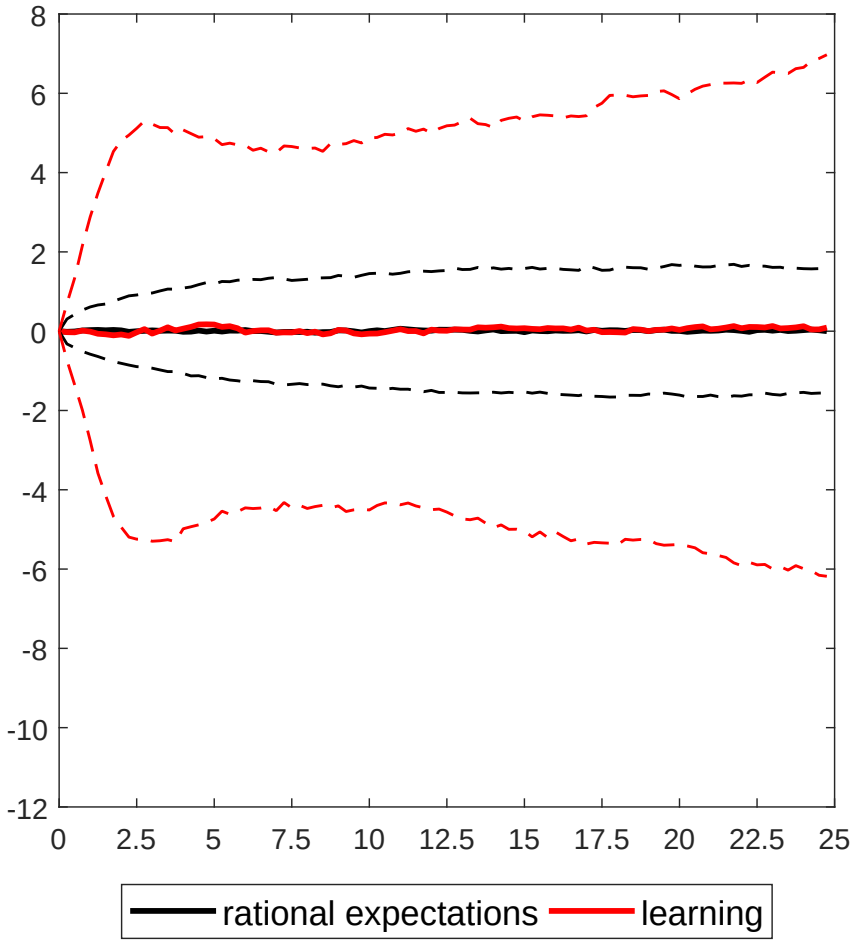
Simulation - Inflation

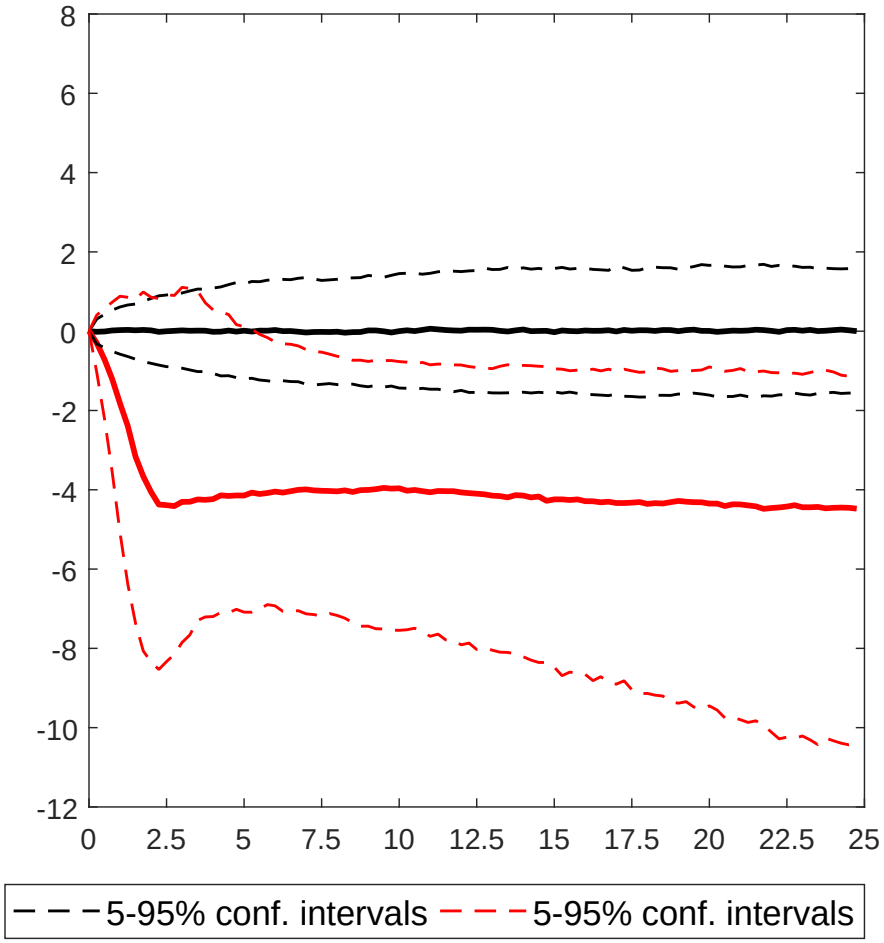




Simulation - Net Foreign Assets

robustness





Simulation - Instability

High inflation SOE after 10 years:

- Probability of negative NFA is 90%.

High inflation SOE after 25 years:

- Probability of negative NFA is 96%,
- Probability of strictly downward path of NFA is 15%

Why care about inflation and inflation expectations?

Why care about inflation and inflation expectations?

May shed some light on the dynamics leading to the Eurozone Crisis

back

Potential causes of the Eurozone Crisis

- Fiscal profligacy (public debt build-up)
- Reckless banks (bank assets relative to GDP)
- Large current account imbalances
- Loss of competitiveness (relative price and wage levels)

Deep causes of the Eurozone Crisis

Public Debt	Budget Deficit	Bank Assets	Δ Bank Assets	Current Account	Excess inflation

Deep causes of the Eurozone Crisis

Public Debt	Budget Deficit	Bank Assets	Δ Bank Assets	Current Account	Excess inflation
GR	GR	LU	IE	PT	IE
IT	PT	IE	AT	GR	GR
BE	FI	FR	FR	ES	ES
PT	IT	BE	ES	IE	PT
EZ	FR	AT	FI	IT	LU
AT	AT	NL	**EZ**	**EZ**	NL
FR	DE	**EZ**	IT	FR	IT
DE	**EZ**	DE	BE	AT	**EZ**
NL	BE	ES	PT	DE	BE
IE	NL	PT	GR	BE	FR
ES	ES	IT	DE	NL	AT
FI	IE	FI	NL	FI	DE
LU	LU	GR	LU	LU	FI

Deep causes of the Eurozone Crisis series

Public Debt	Budget Deficit	Bank Assets	Δ Bank Assets	Current Account	Excess inflation
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IT	PT	IE	AT	GR	GR
BE	FI	FR	FR	ES	ES
PT	IT	BE	ES	IE	PT
EZ	FR	AT	FI	IT	LU
AT	AT	NL	**EZ**	**EZ**	NL
FR	DE	**EZ**	IT	FR	IT
DE	**EZ**	DE	BE	AT	**EZ**
NL	BE	ES	PT	DE	BE
IE	NL	PT	GR	BE	FR
ES	ES	IT	DE	NL	AT
FI	IE	FI	NL	FI	DE
LU	LU	GR	LU	LU	FI

Policy implications

- Lack of pre-EMU convergence may cause instability
- Need for better Convergence Criteria
- Potentially: role for stabilizing fiscal policy

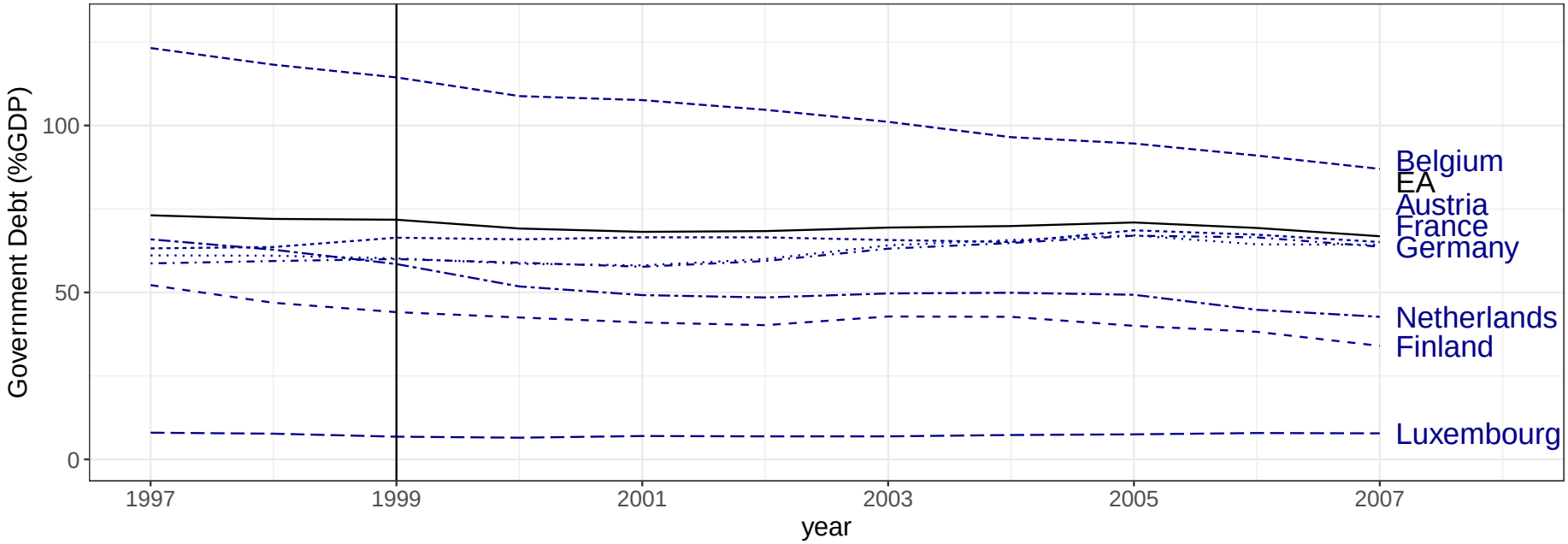
data

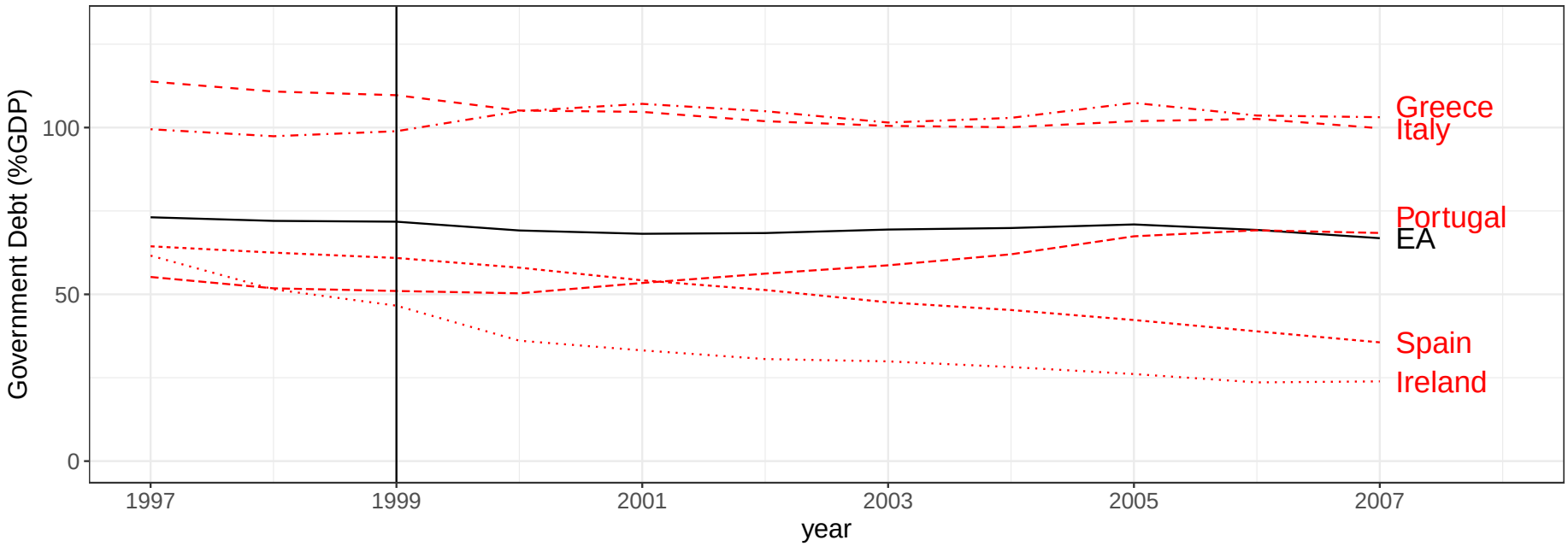
Conclusions

- Inflation differences important for Eurozone Crisis
- Role of inflation expectations
- Structural change requires learning
- Simulation replicates (patterns of) key macro variables for Eurozone imbalances
- Generalization: currency pegs require credibility and change of expectations

Appendix

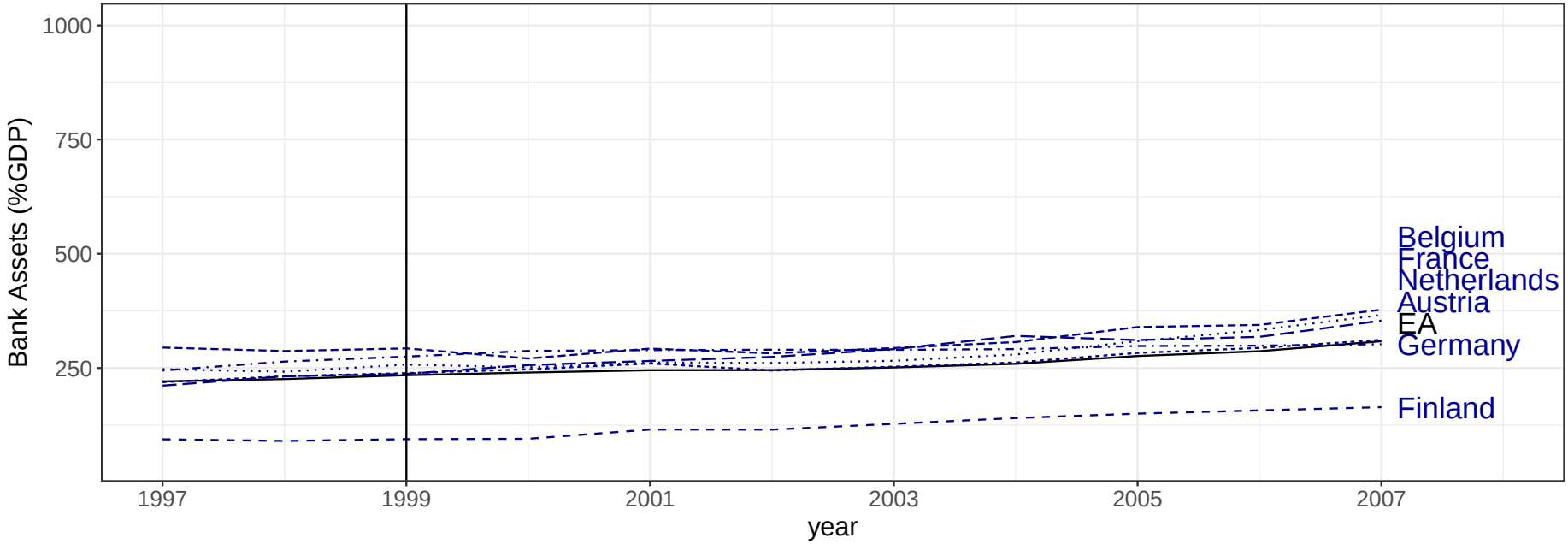
Fiscal Profligacy? back

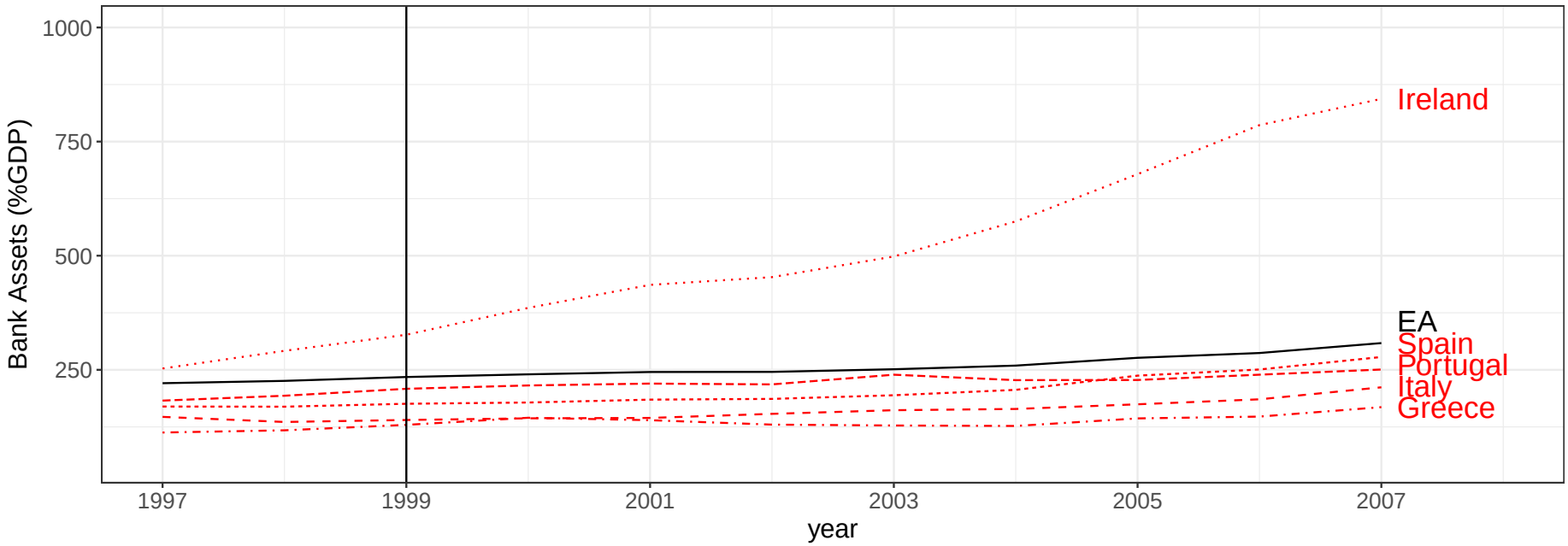




Reckless Banking Sector?

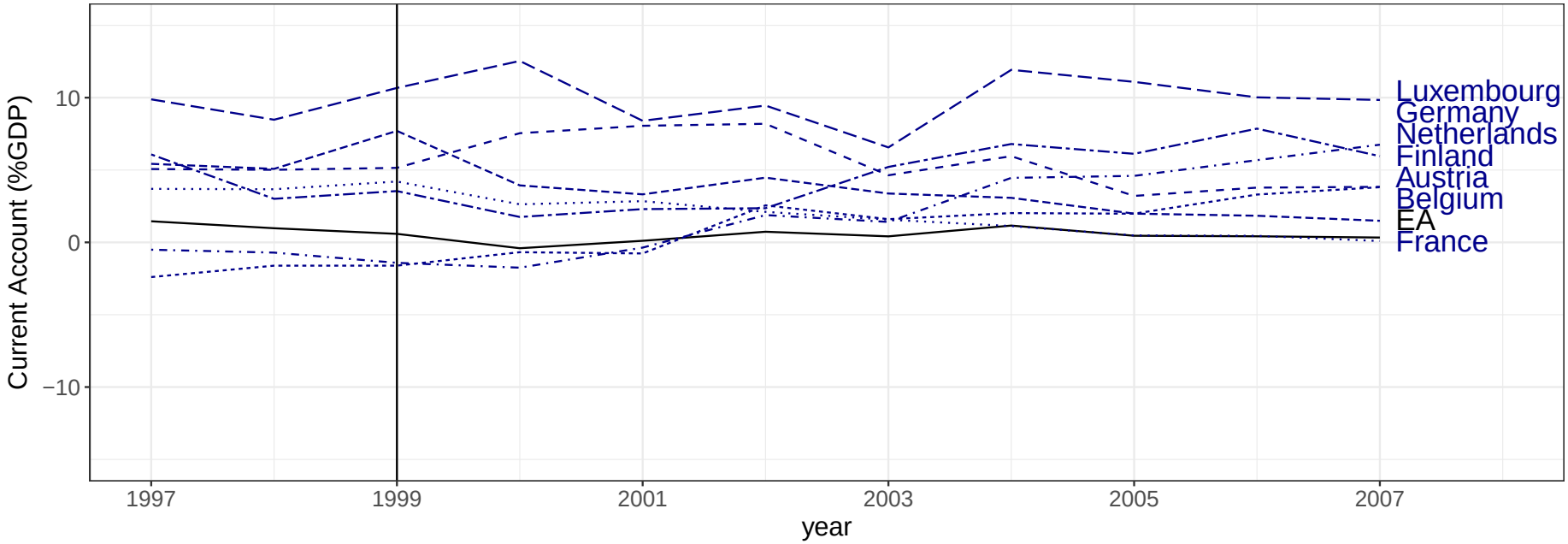
back

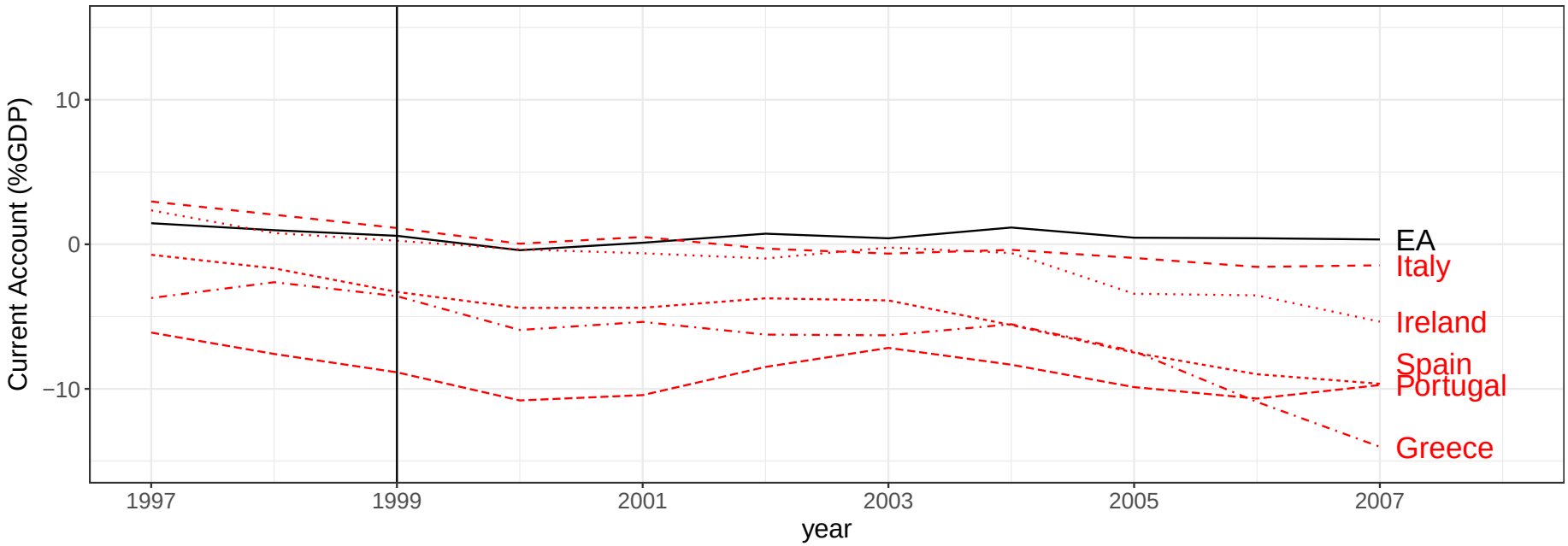




Current Account Imbalances

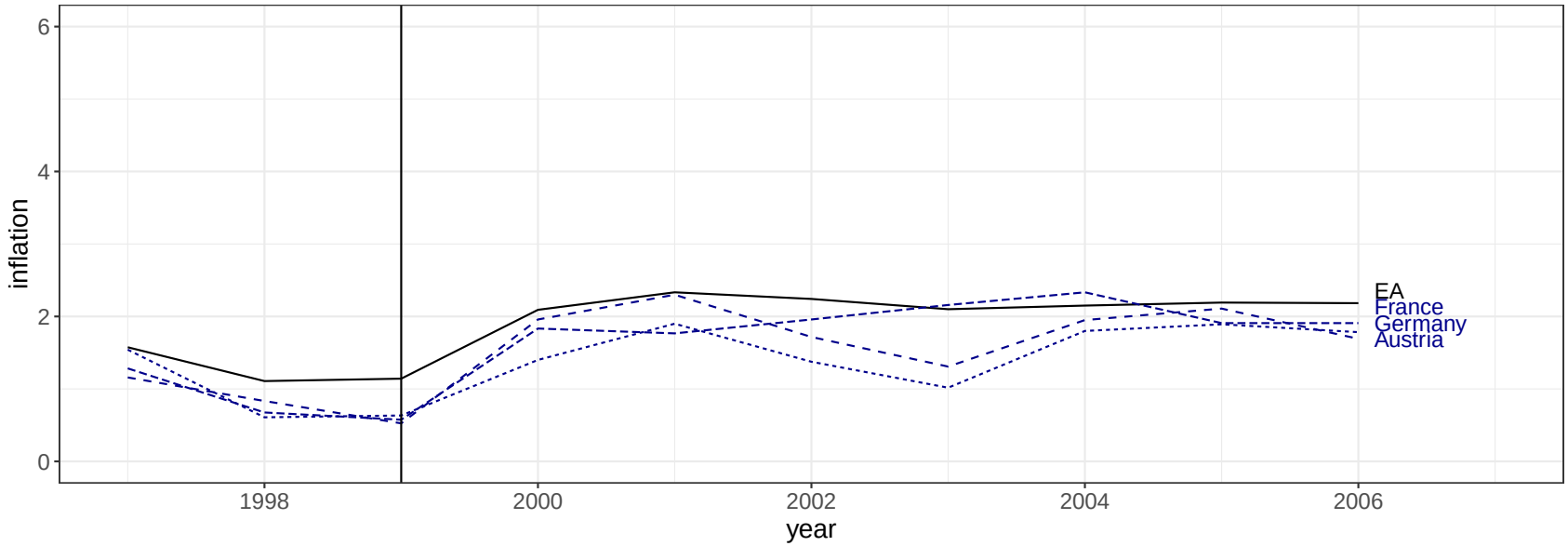
back

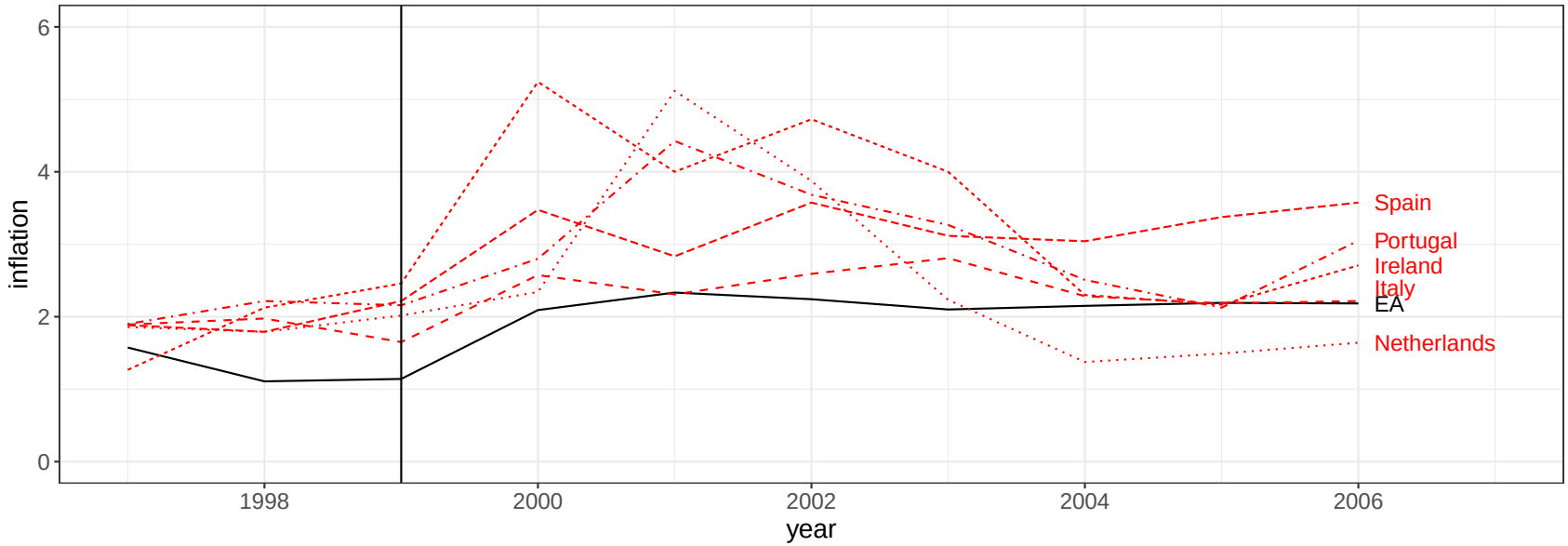




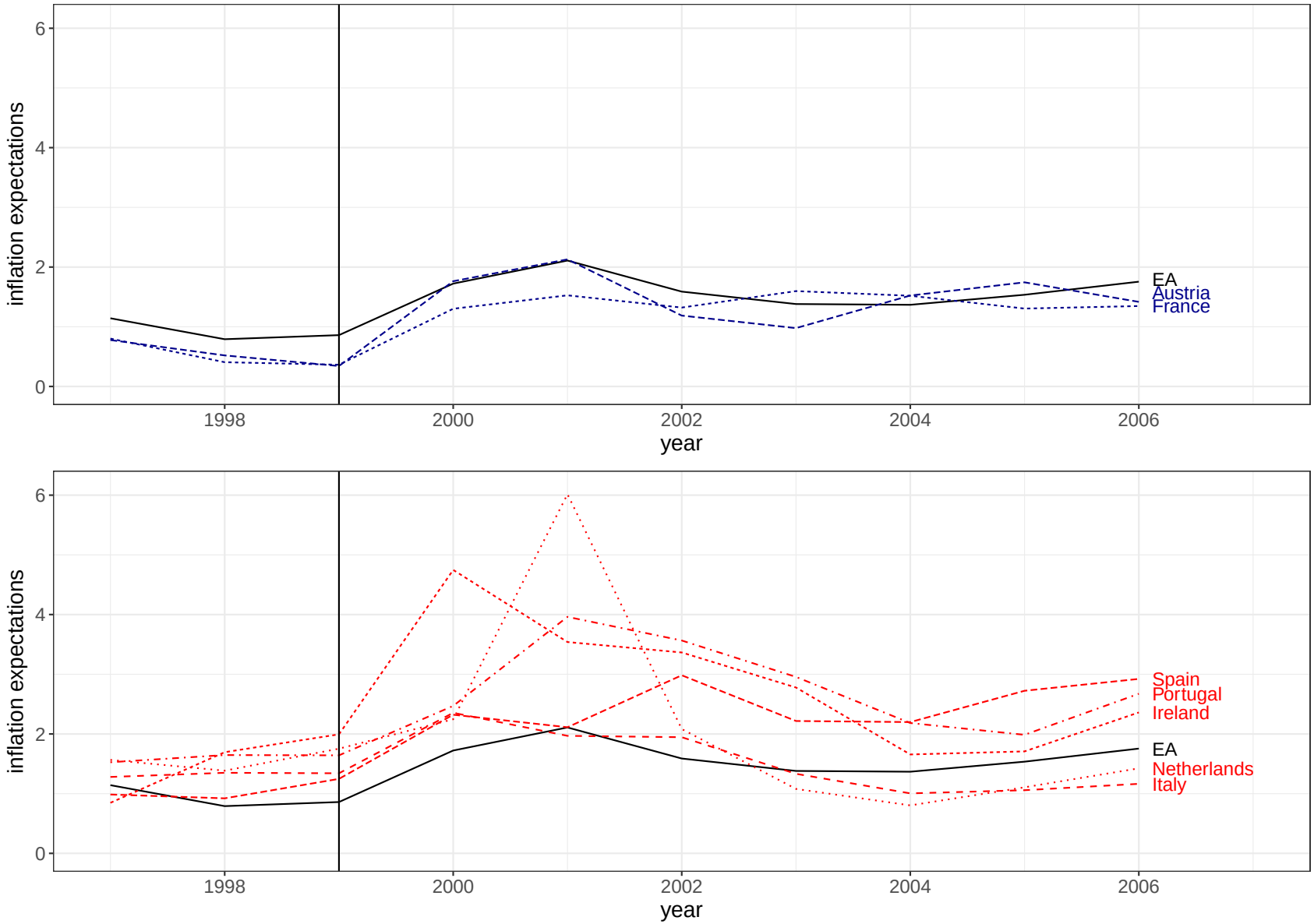
Pre- and Post-Euro Introduction Inflation Rates

back





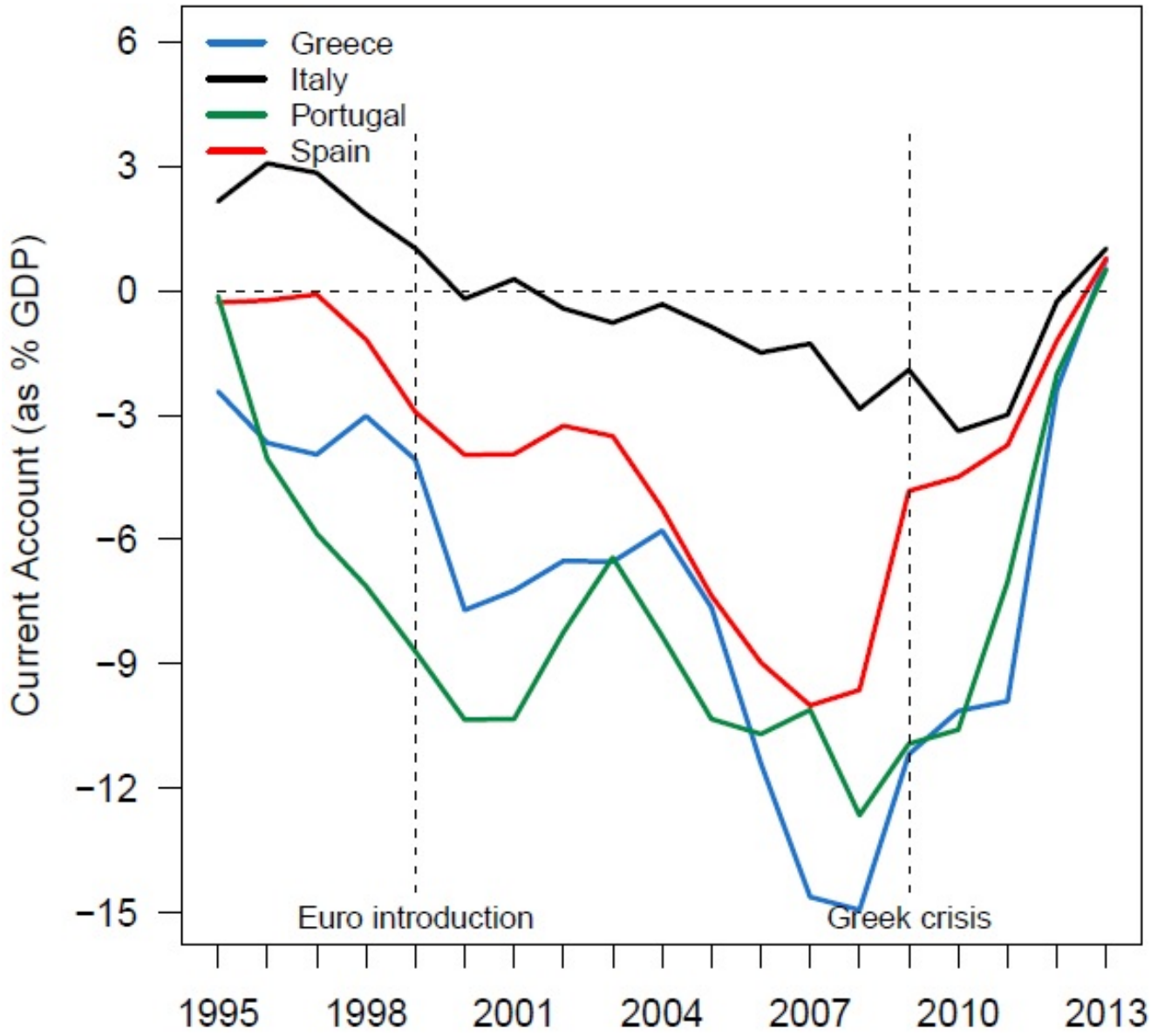
Inflation Expectations (Survey Data) back



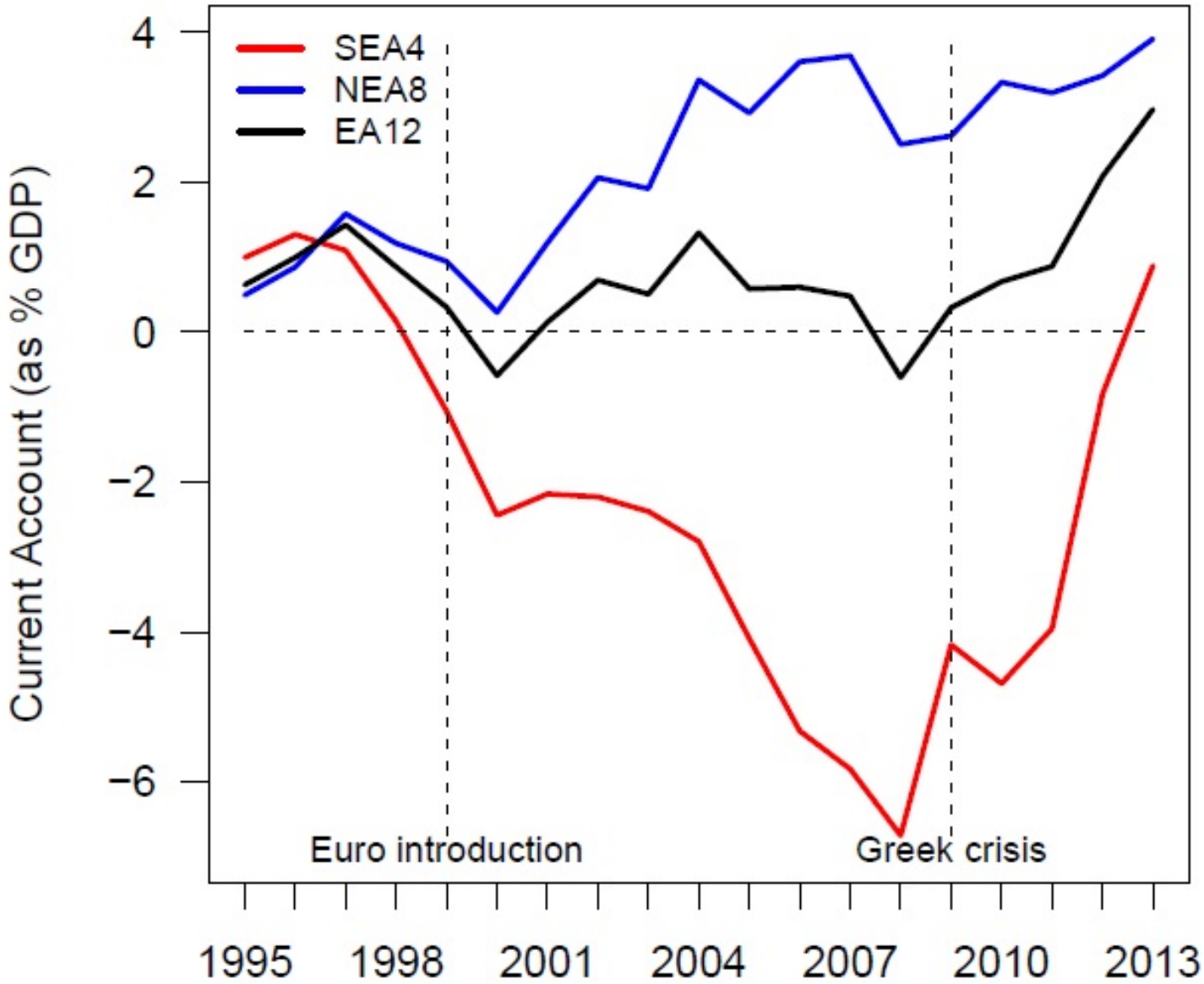
Inflation Expectations - IMF forecasts

IMF forecasts figure

Current Account back



Current Account back



Monetary Union - Foreign Region

1. NK SOE Philips curve

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa_1^* \hat{y}_t - \kappa_2^* \varepsilon_t$$

2. NK SOE IS curve

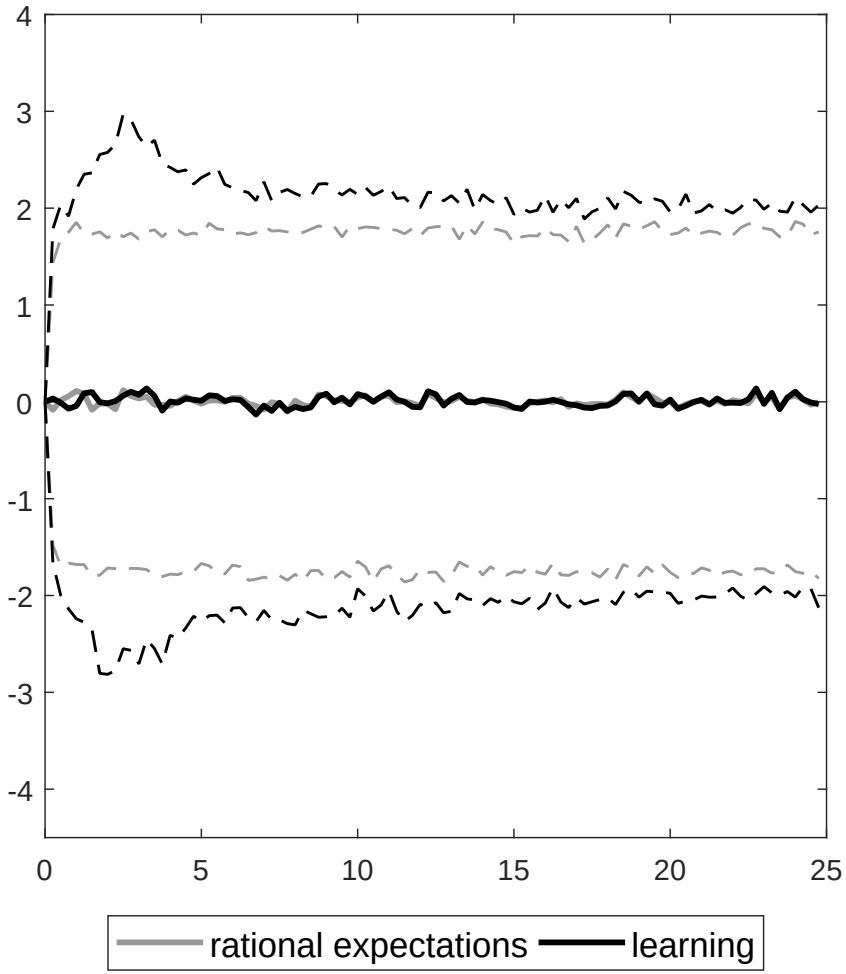
$$E_t \Delta \hat{y}_{t+1}^* = \frac{1}{\sigma} \left[\hat{\imath}_t^* - E_t \hat{\pi}_{t+1}^* \right]$$

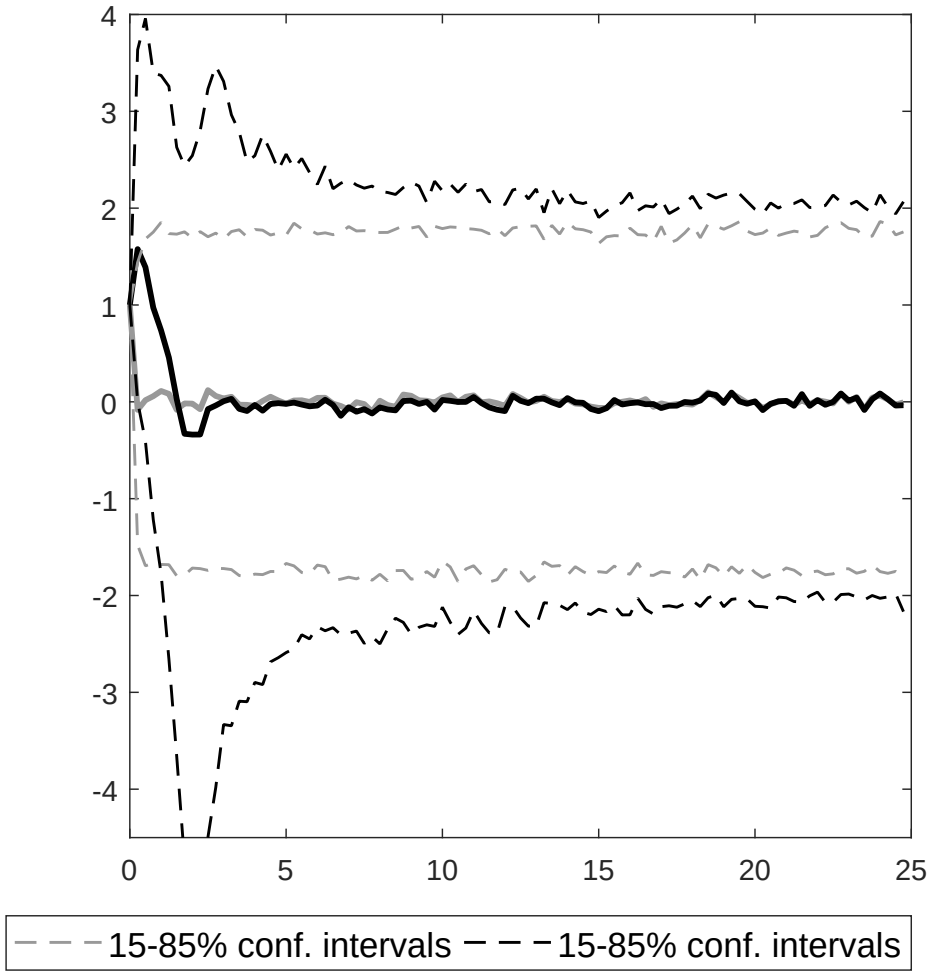
3. No arbitrage condition

$$\hat{\imath}_t^* = \phi_\pi^* \hat{\pi}_t^* + m_t^*$$

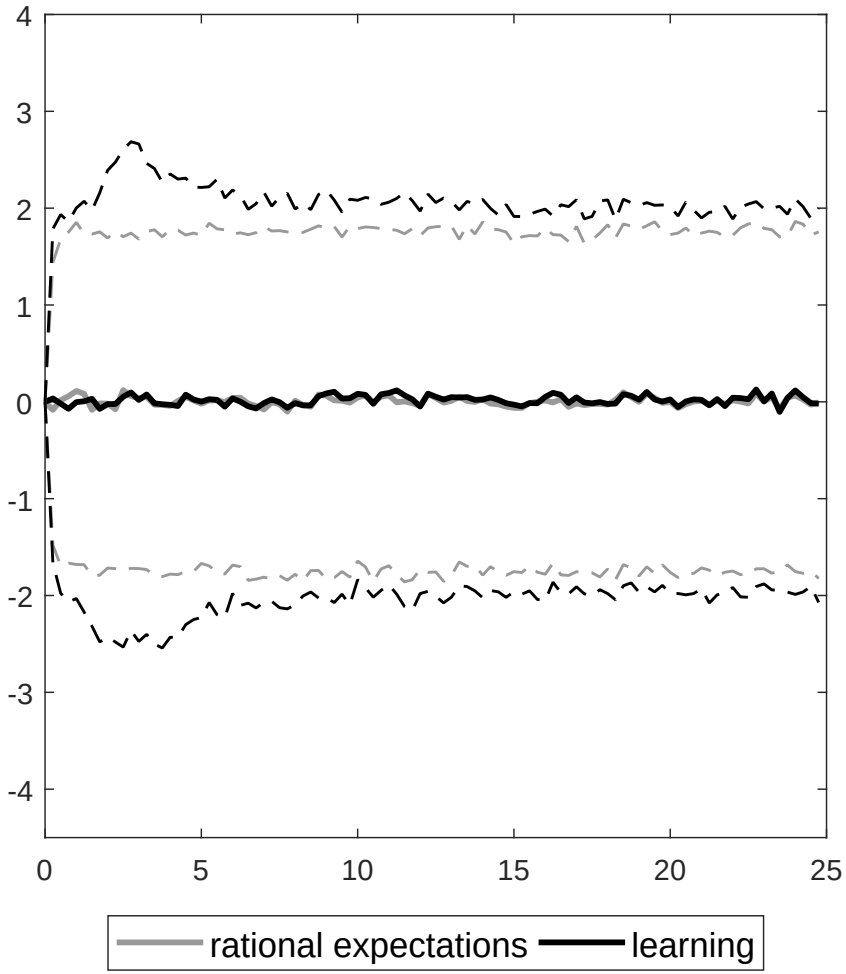
back

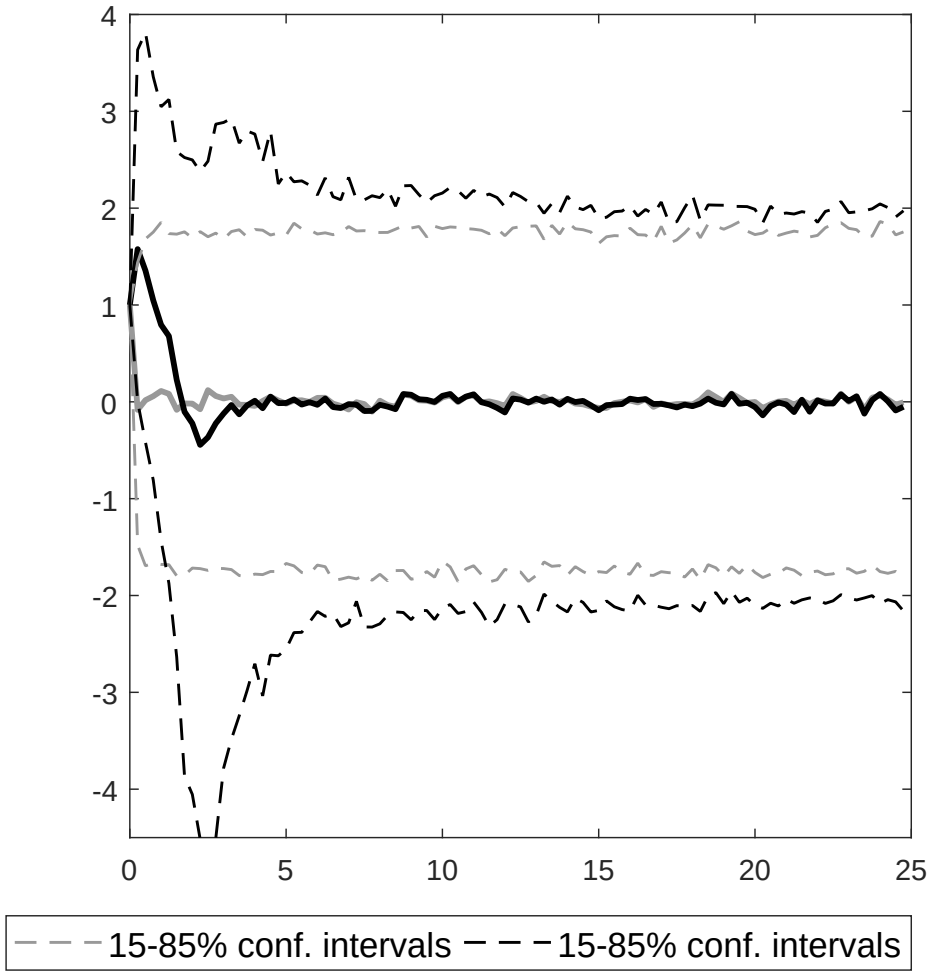
Simulation - Inflation ($g = 0.05$) back



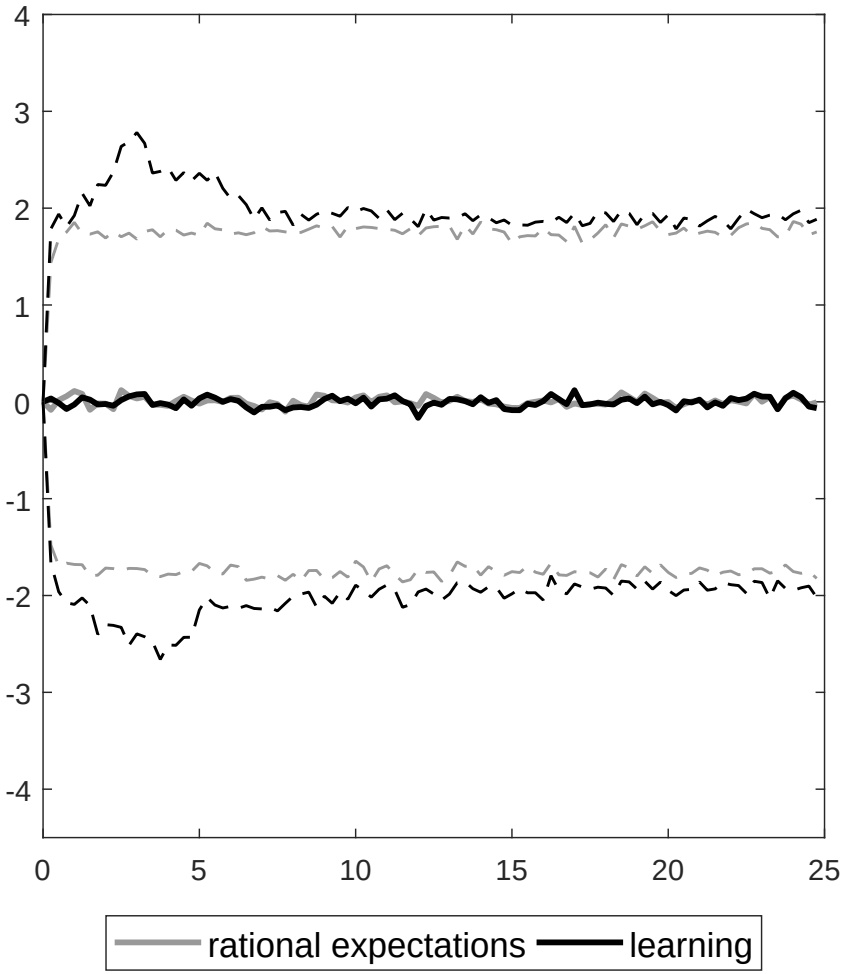


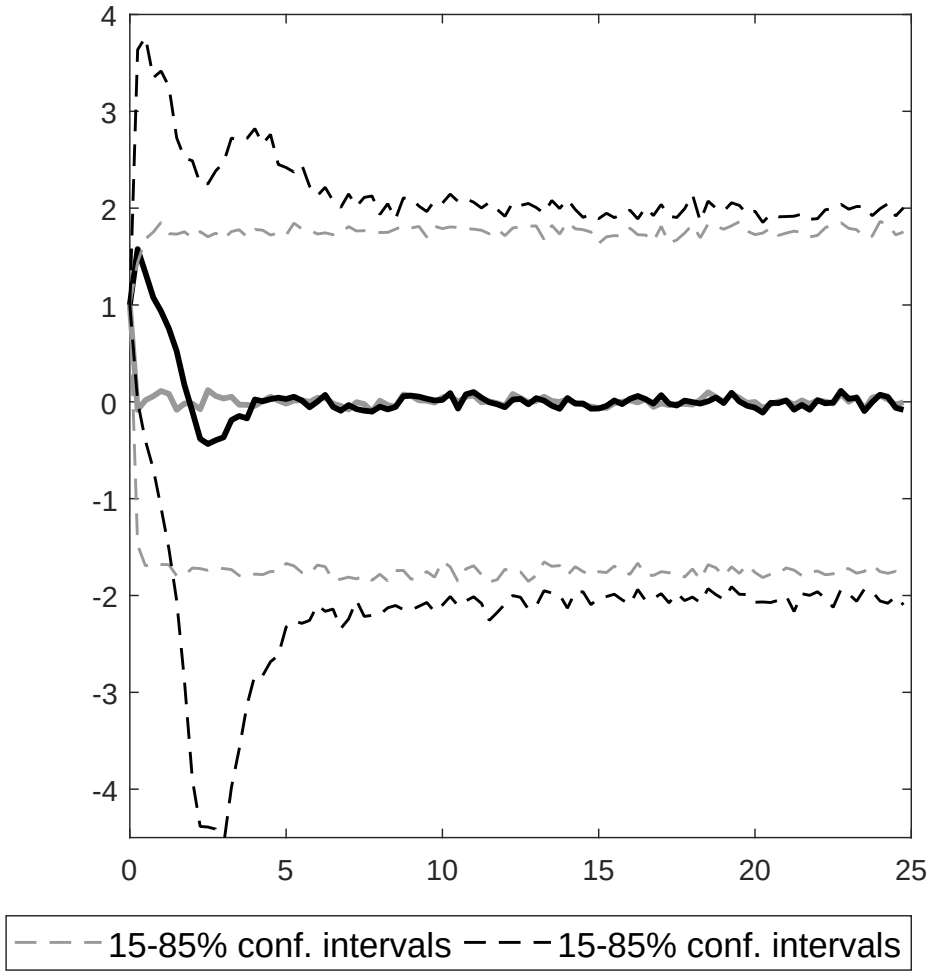
Simulation - Inflation ($g = 0.02$) back



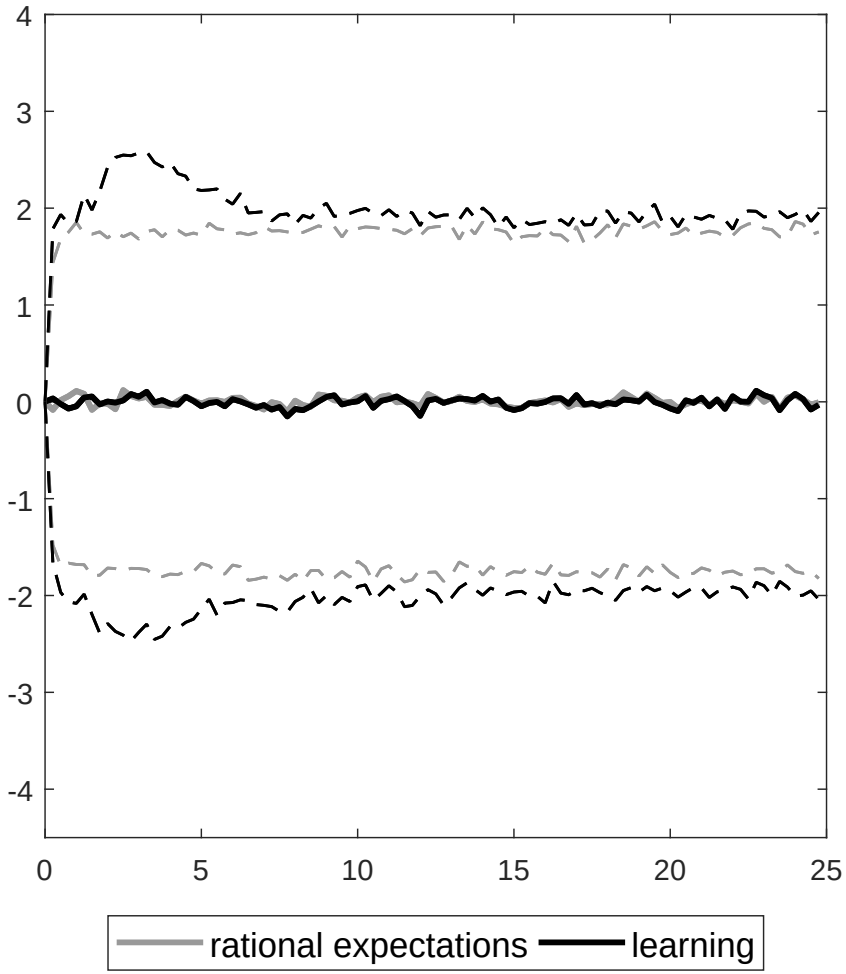


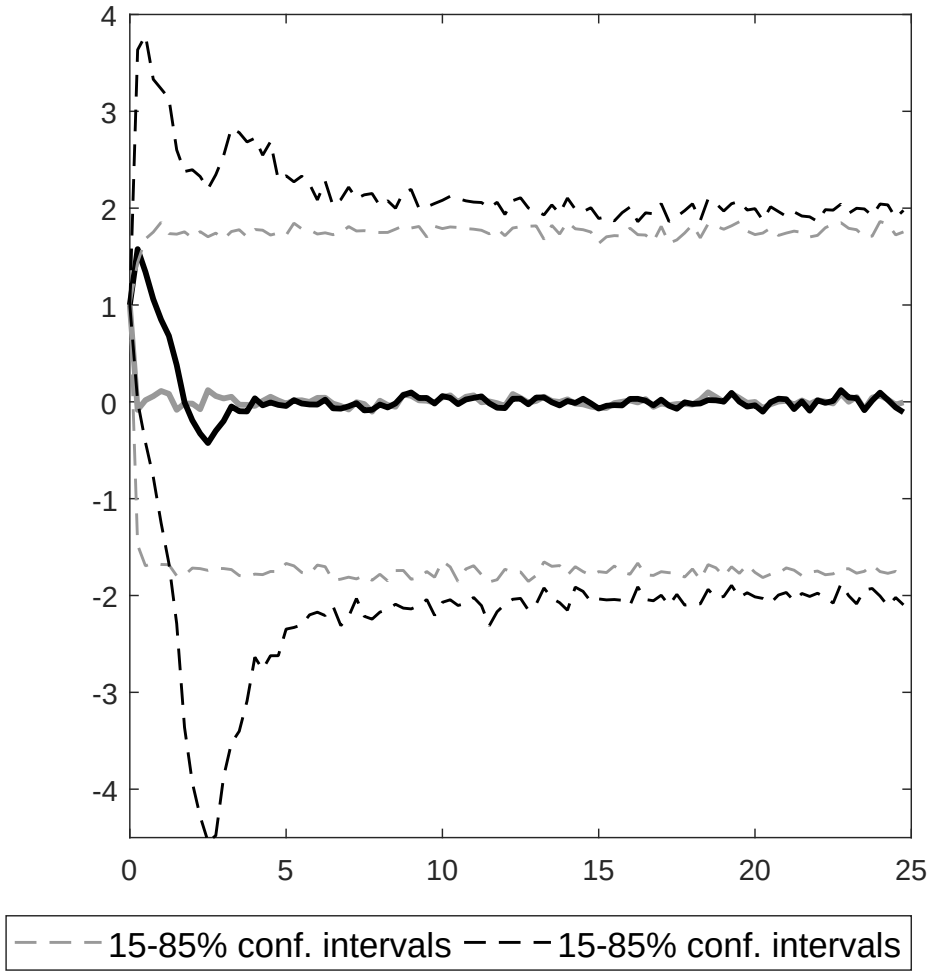
Simulation - Inflation ($g = 0.01$) back



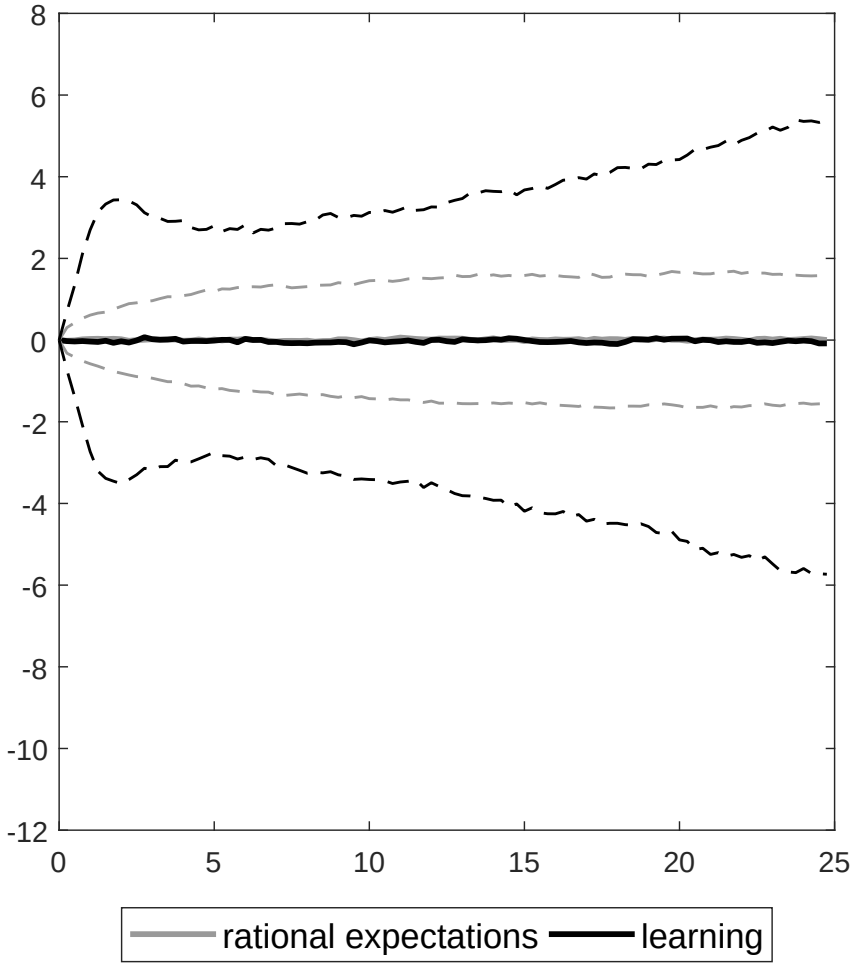


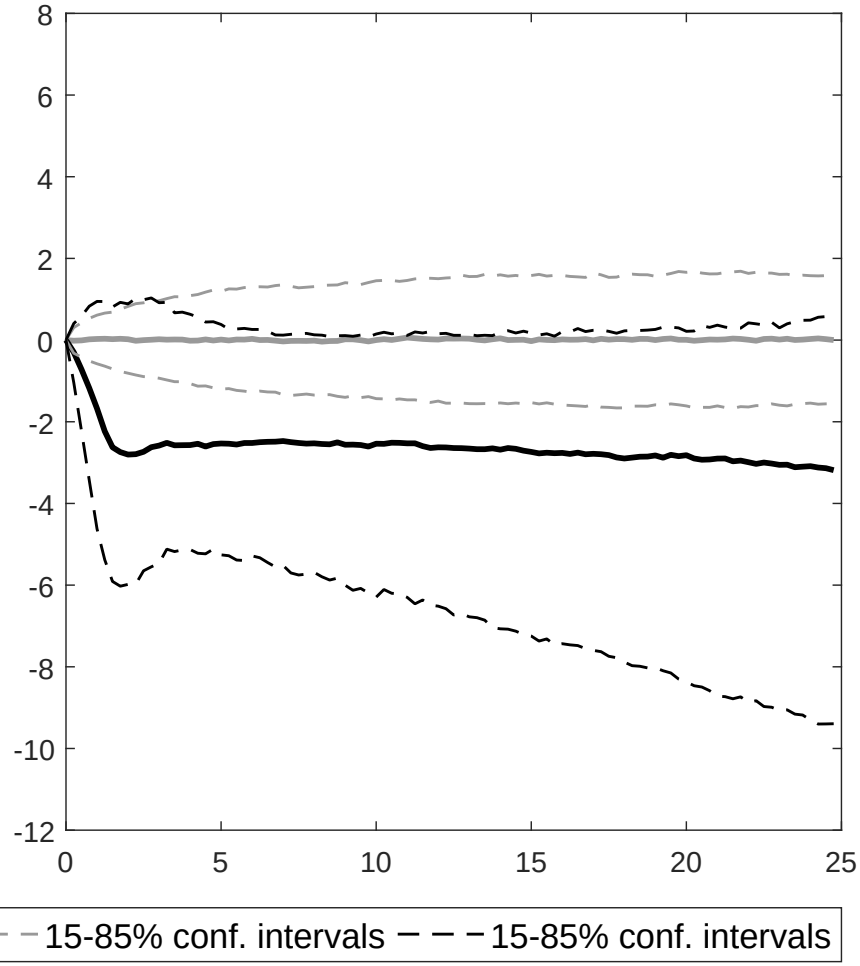
Simulation - Inflation (RLS) back



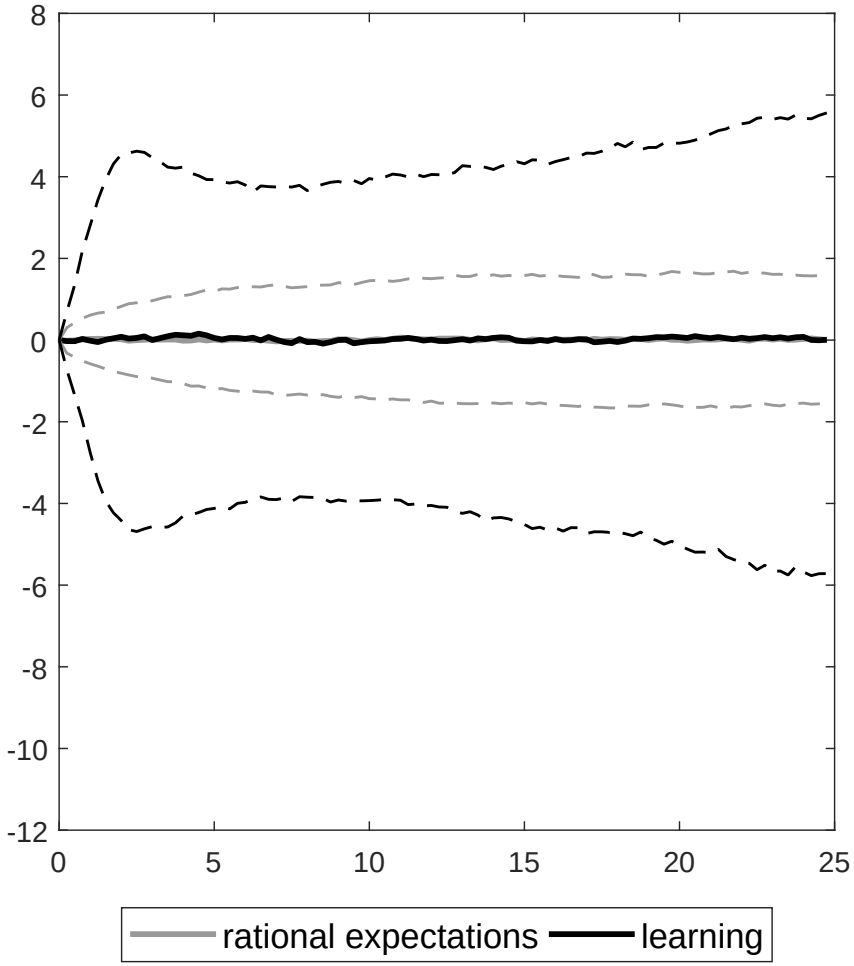


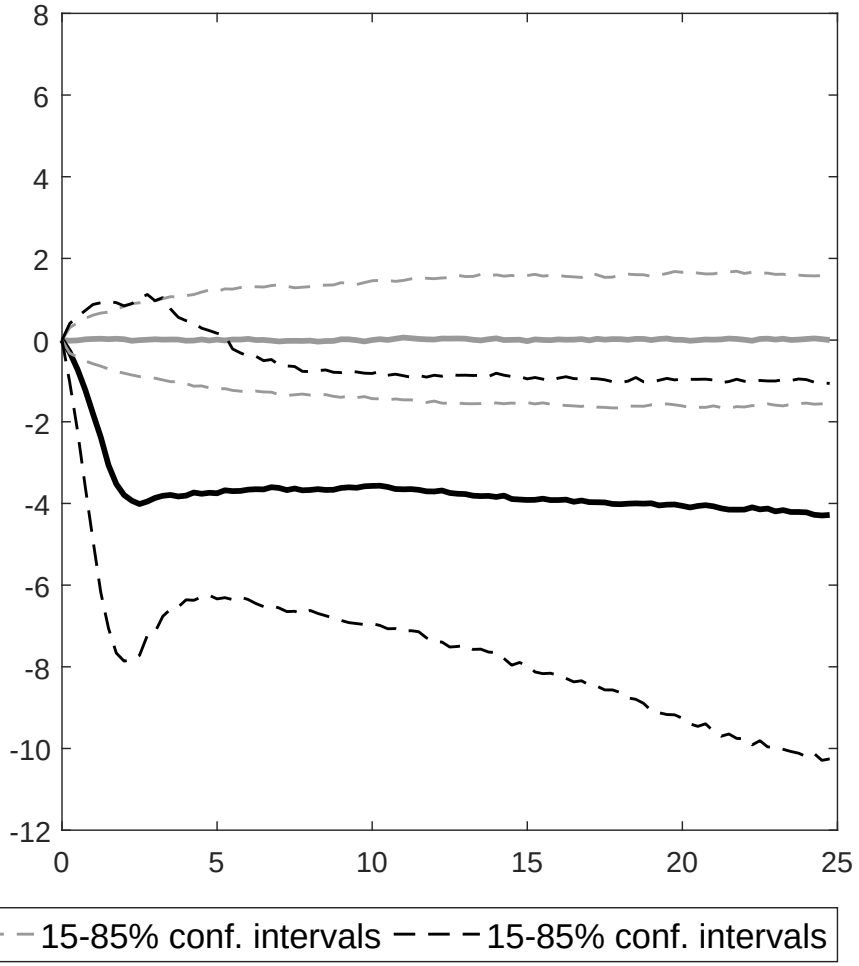
Simulation - Net Foreign Assets ($g = 0.05$) back



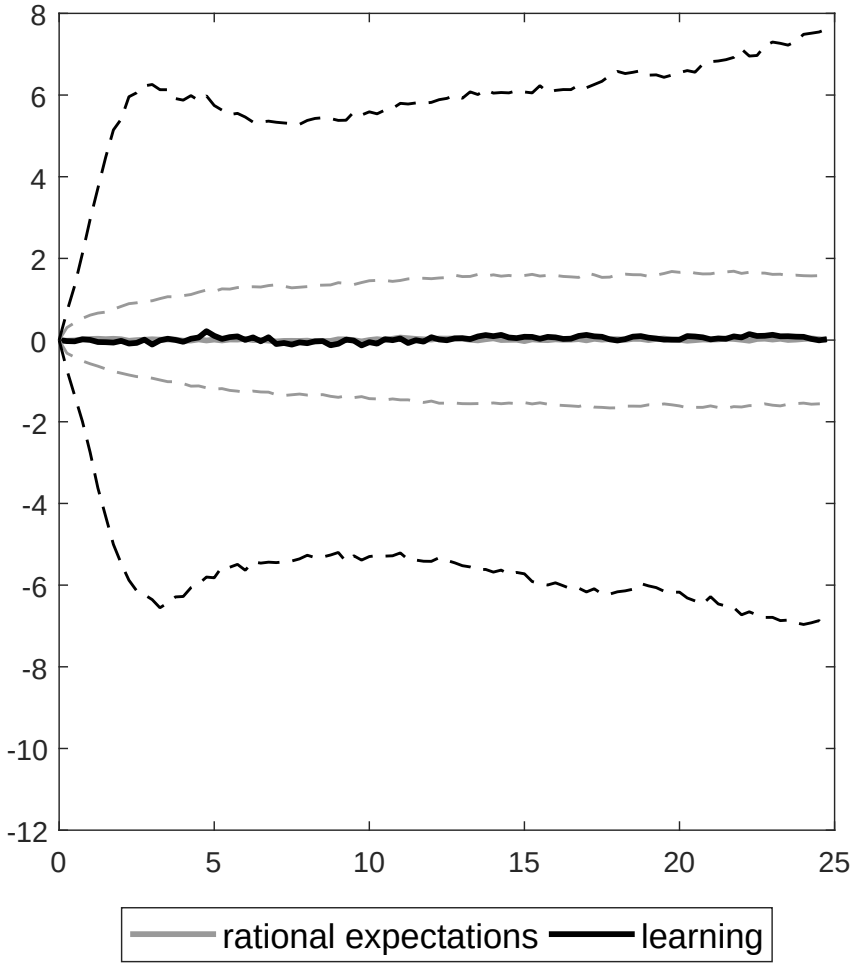


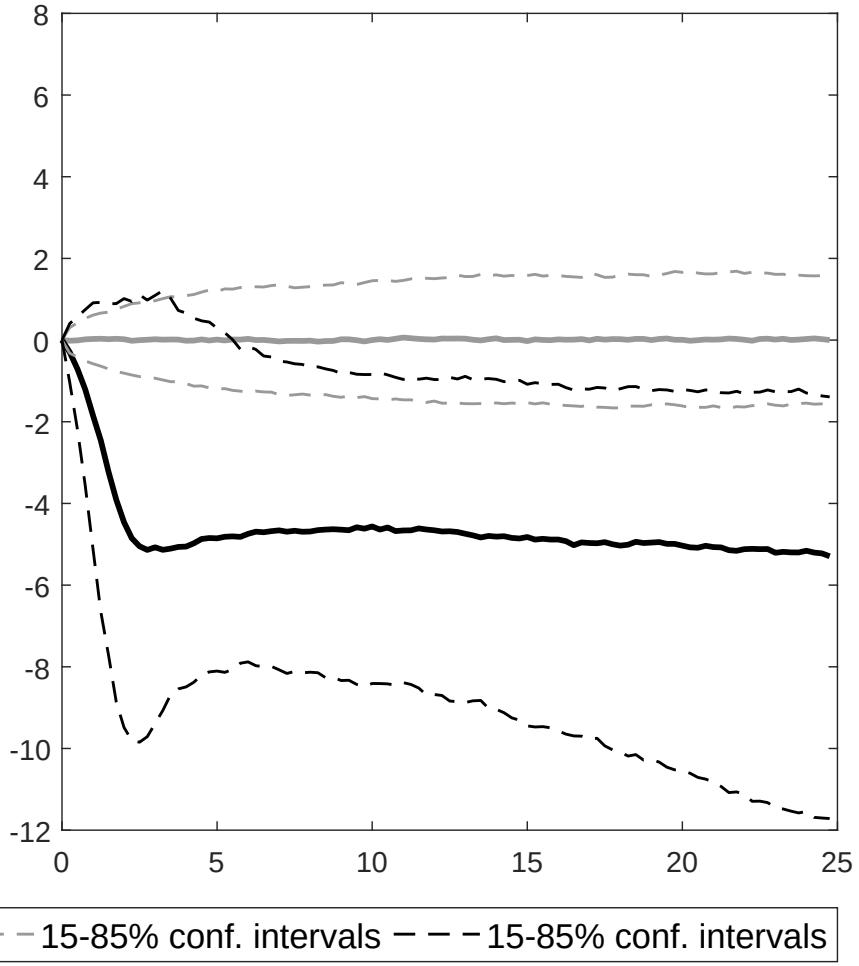
Simulation - Net Foreign Assets ($g = 0.02$) back





Simulation - Net Foreign Assets ($g = 0.01$) back





Simulation - Net Foreign Assets (RLS) back