Sticky prices and the transmission mechanism of monetary policy: A minimal test of New Keynesian models

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- We propose a **simple and minimal** test for the validity of the NK propagation mechanism
- We check **two central implications** of NK models
- ...if we live in a NK world with **some state-dependent prices**

Two Implications of a NK world

If we live in a NK world with **some state-dependent prices:**

First Testable Implication

The impulse response functions of inflation and output to a monetary policy shock should depend on the size of the shock.

The economy should exhibit more **price-flexibility** after **large monetary shocks**
(Alvarez and Lippi, 2014, Alvarez, Lippi and Passadore, 2017, Costain and Nakov, 2011, 2018)

First Testable Implication

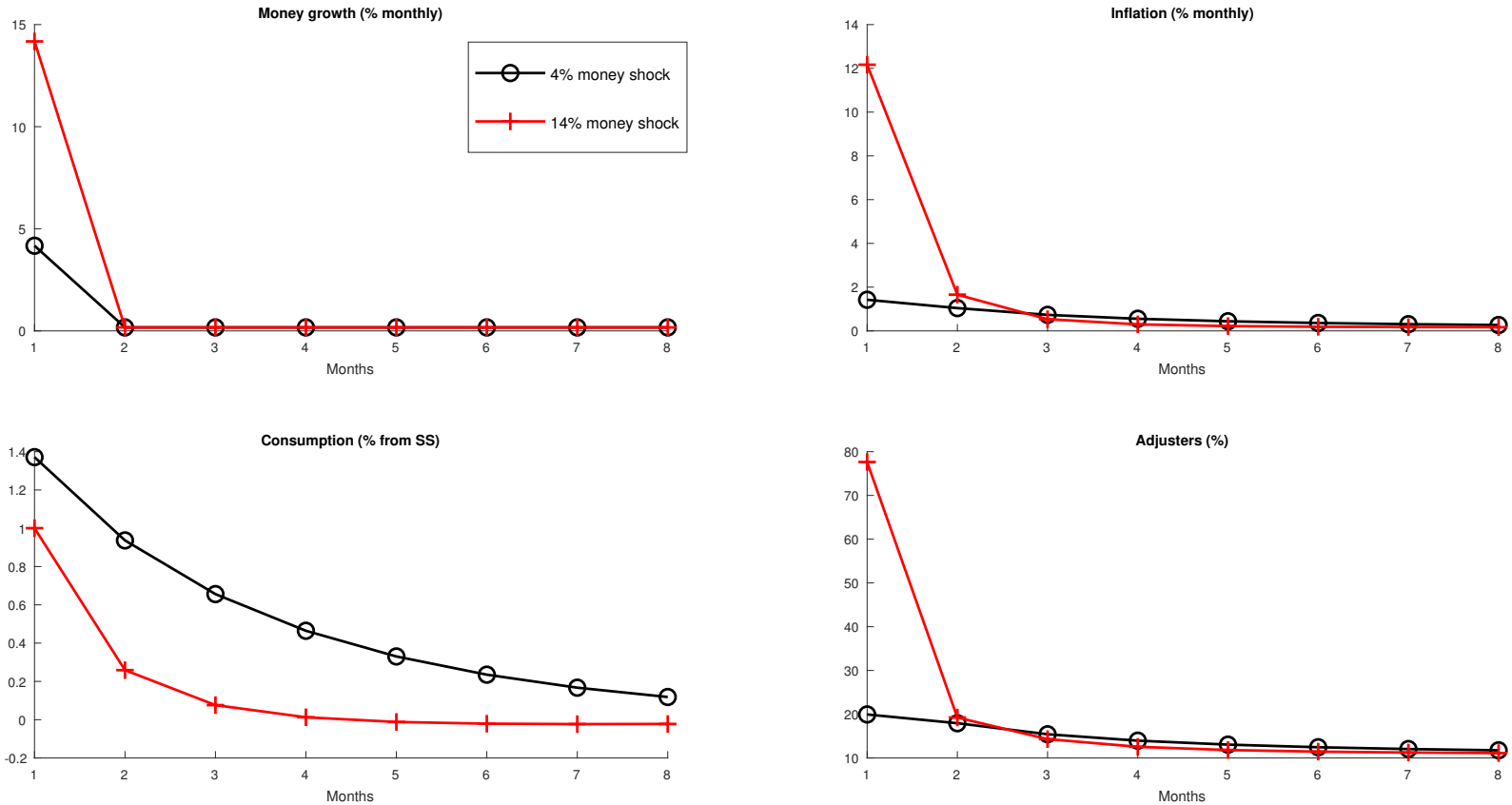

Figure: Impulse response functions to two monetary policy shocks of different size in the model in Costain and Nakov (2018)

Two Implications of a NK world

Second Testable Implication

The impulse response functions of inflation and output to a monetary policy shock should depend on the average level of inflation.

The economy should exhibit more **price-flexibility** in a **high inflation regime**
(Alvarez et al. 2018, Costain and Nakov, 2011, 2018)

Second Testable Implication

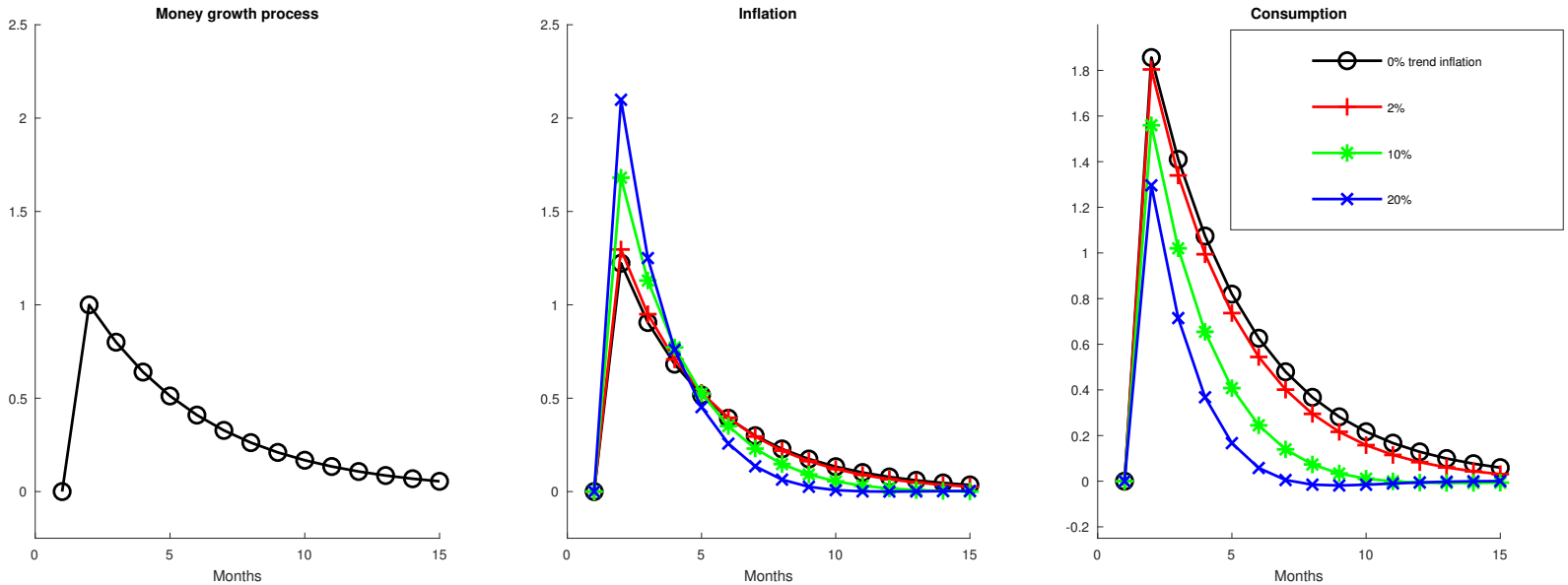

Figure: Impulse response functions to a monetary policy shock as trend inflation varies in the model in Costain and Nakov (2018)

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1. **Large shocks have greater effects** on prices at small horizons and are less persistent
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- Evidence **in favour** of sticky prices in aggregate data

Outline

Literature

- **NK Theory:** Caplin and Spulber (1987), Dotsey, King and Wolman (1999), Golosov and Lucas (2007), Levin and Yun (2007), Alvarez and Lippi (2014), Alvarez, Le Bihan and Lippi (2016), Alvarez, Lippi and Passadore (2017), Costain and Nakov (2011, 2018), Costain, Nakov and Petit (2018)
- **Micro-evidence:** Bils and Klenow (2004), Kehoe and Midrigan (2015), Nakamura and Steinsson (2008), Eichenbaum, Jaimovich and Rebelo (2011)
- **Local projections:** Auerbach and Gorodnichenko (2012), Granger and Teräsvirta (1993), Jordà (2005), Ramey (2016), *Tenreyro and Thwaites (2016)*

Data

- **Shocks:** Extended Romer and Romer (2004) narrative shocks

⏩ Graph

- **Response variables:** PCE Inflation, Industrial Production and the Federal Funds rate
- **Sample:** Monthly, runs from 1969m3 to 2007m12

Local projections

- We use local projections (Jorda, 2005)
- Suppose structural shock ϵ_t has been identified. Then the impulse response of y after a unitary shock at horizon h is β_h in:

$$y_{t+h} = \beta_h \epsilon_t + controls_t + u_{t+h}$$

- **Advantage:** Easy to incorporate non-linearities
- **Disadvantage:** More erratic than VAR IRFs
- Correct for erratic responses with a MA smoothing matrix
- Use heteroskedasticity and autocorrelation robust standard errors
- Use Driscoll and Kraay (1998) method to adjust standard errors for the possibility of correlation in the residuals across dates t and horizons h together[1]

[1] see Tenreyo and Thwaites (2016) or Ramey and Zubairy (2014)

Specification for Test 1

- To test for non-linearity we estimate the following local projection:

$$y_{t+h} = \alpha_h + \tau_h t + \beta_h \epsilon_t + \zeta_h(\epsilon_t \cdot |\epsilon_t|) + \sum_{k=1}^{K} \gamma_{h,k} w_{t,k} + v_{t+h}$$

- Non-linear IRF of variable y at horizon h after shock of size δ is:

$$\Theta_y(\delta, h) = \beta_h \delta + \zeta_h(\delta \cdot |\delta|)$$

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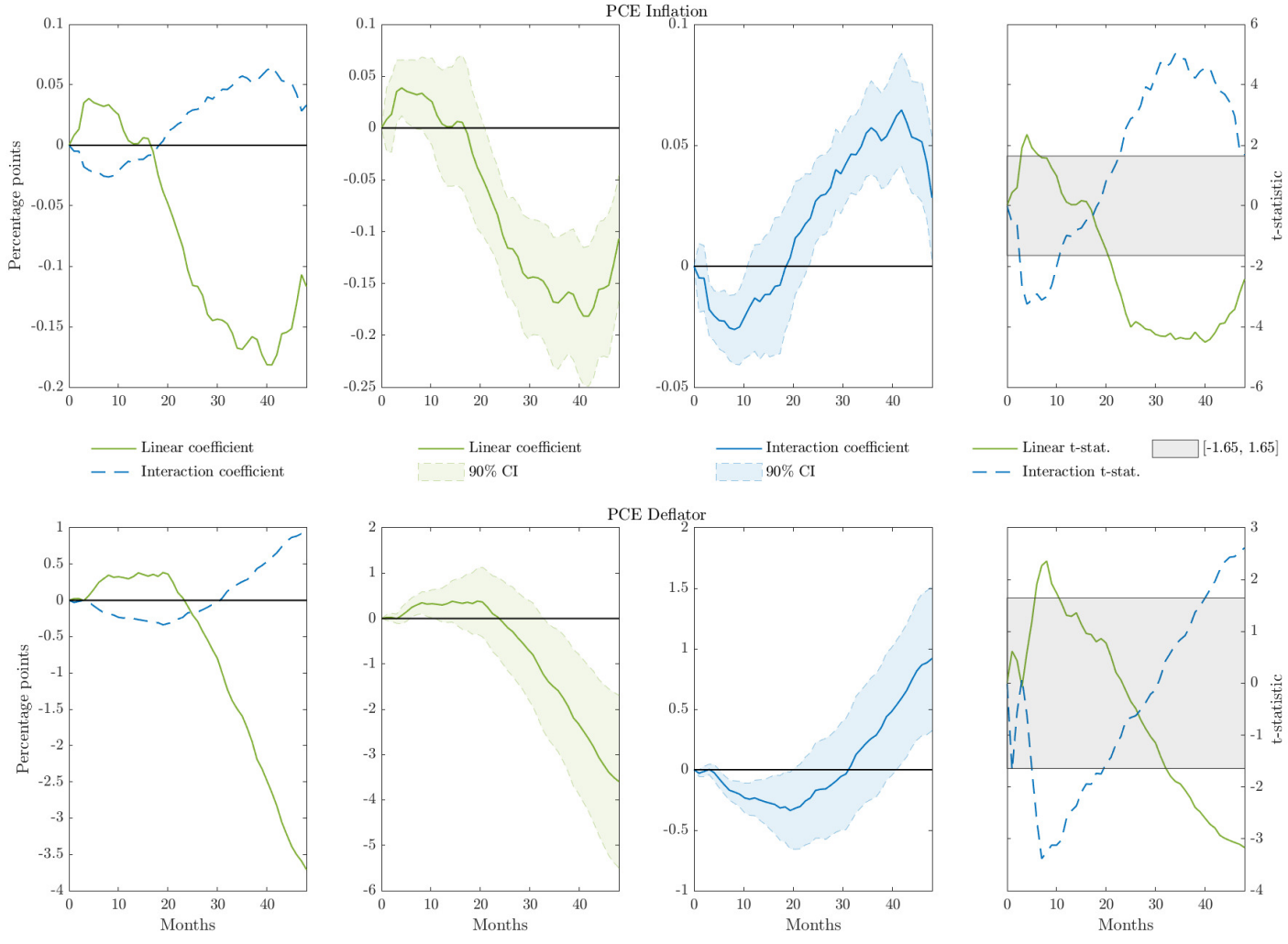
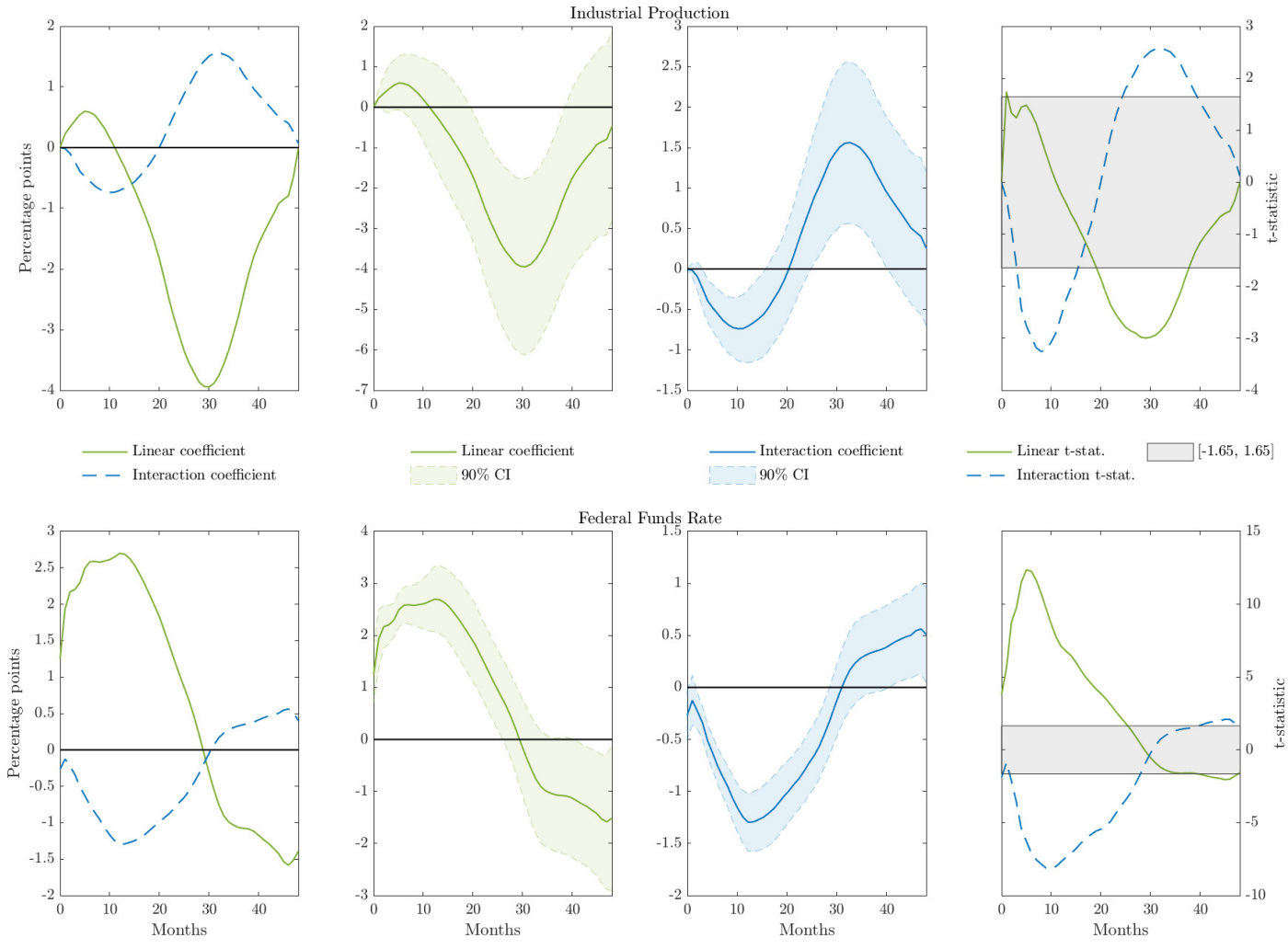
- β_h measures the linear component
- ζ_h: measures the absolute value interaction component, i.e. **size dependence**
- **Non-linear coefficient with same sign as the linear coefficient** $\rightarrow$ non-linear effect **amplifies** the linear effect , otherwise counteract

Test 1 - PCE Inflation and Price Level



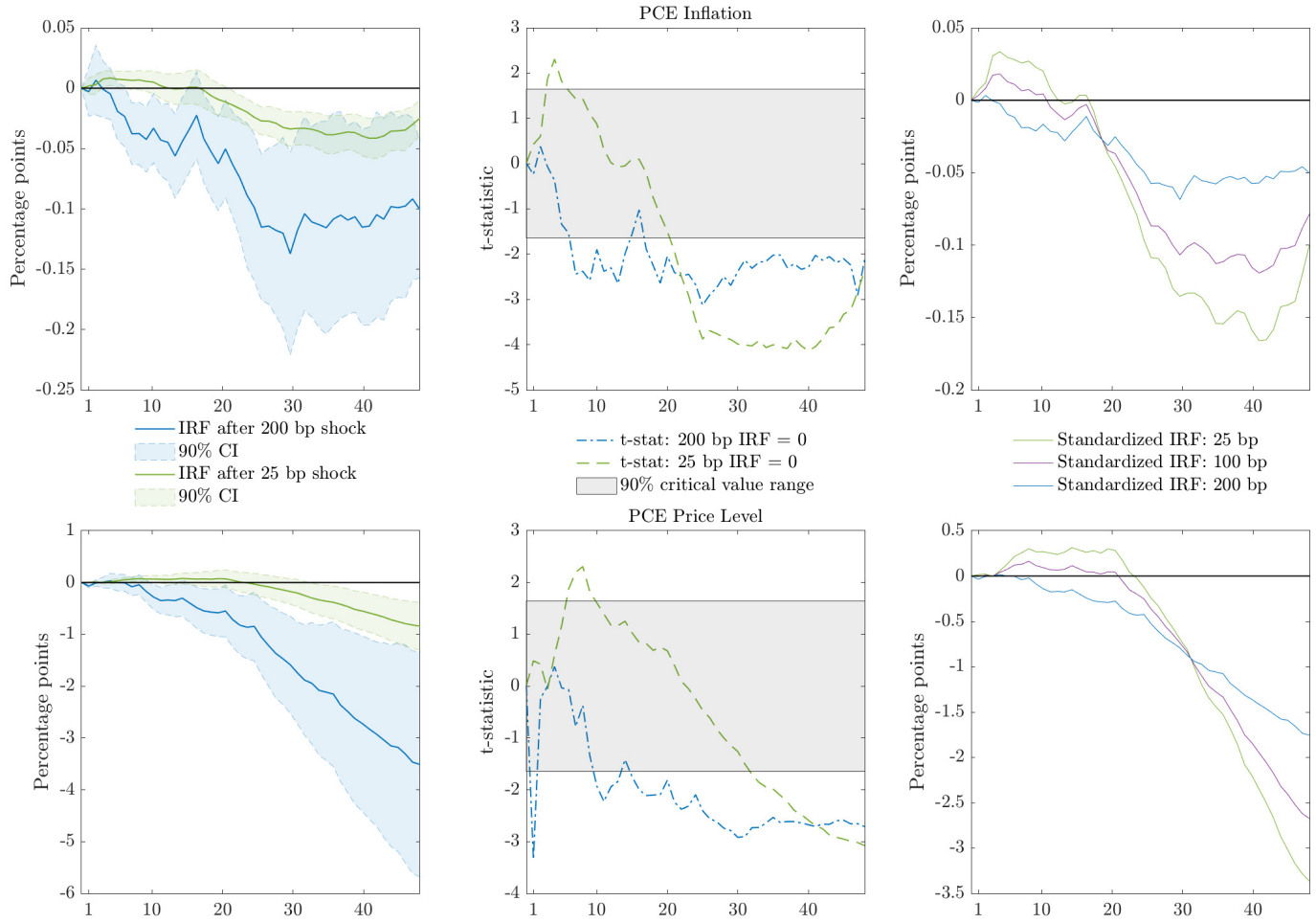
◂ Specification

Test 1 - Industrial Production and FFR

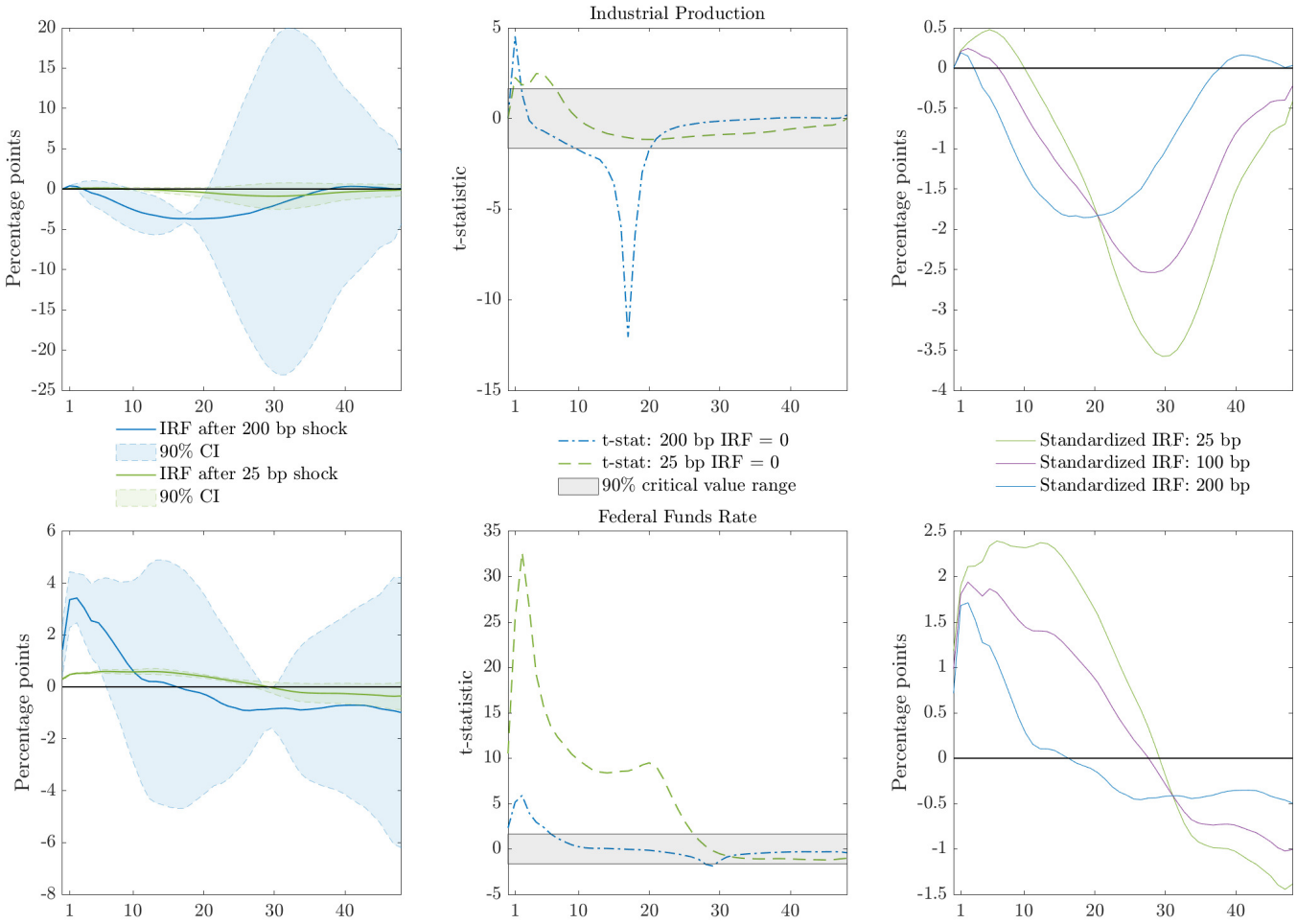


◂ Specification

Test 1 - Shock simulations (PCE Inf. and Def.)



Test 1 - Shock Simulation (FFR and Output)



Specification for Test 2

- To test for regime dependency we estimate smooth transition local projections:

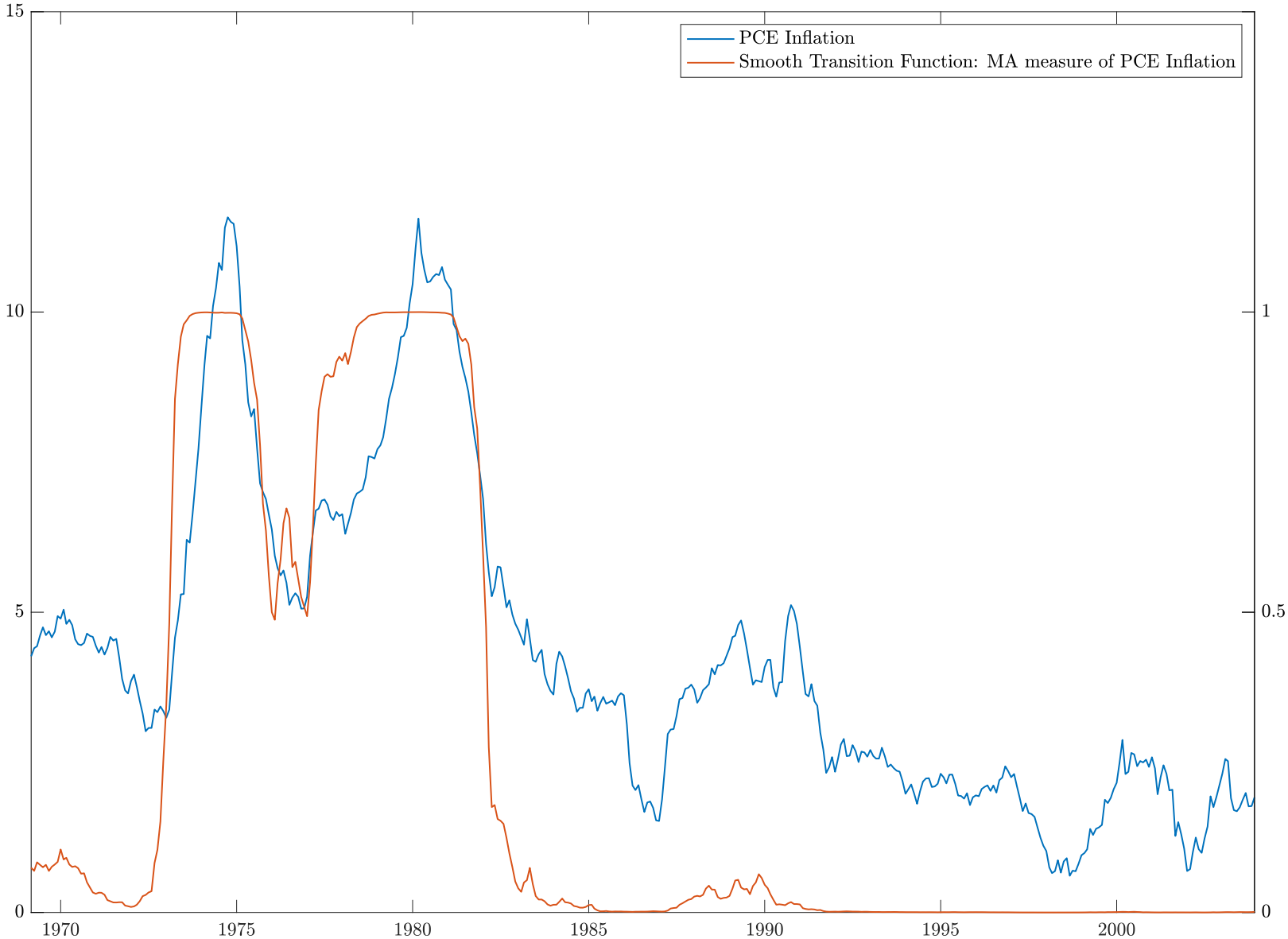
$$y_{t+h} = \tau_h t + F(z_t)(\alpha_h^{HI} + \beta_h^{HI}\epsilon_{j,t} + \sum_{k=1}^{K}\gamma_{h,k}^{HI} w_{t,k})$$
$$+(1 - F(z_t))(\alpha_h^{LO} + \beta_h^{LO}\epsilon_{j,t} + \sum_{k=1}^{K}\gamma_{i,h,k}^{LO} w_{t,k}) + u_{t+h}$$

- Smooth transition function is a logistic function:

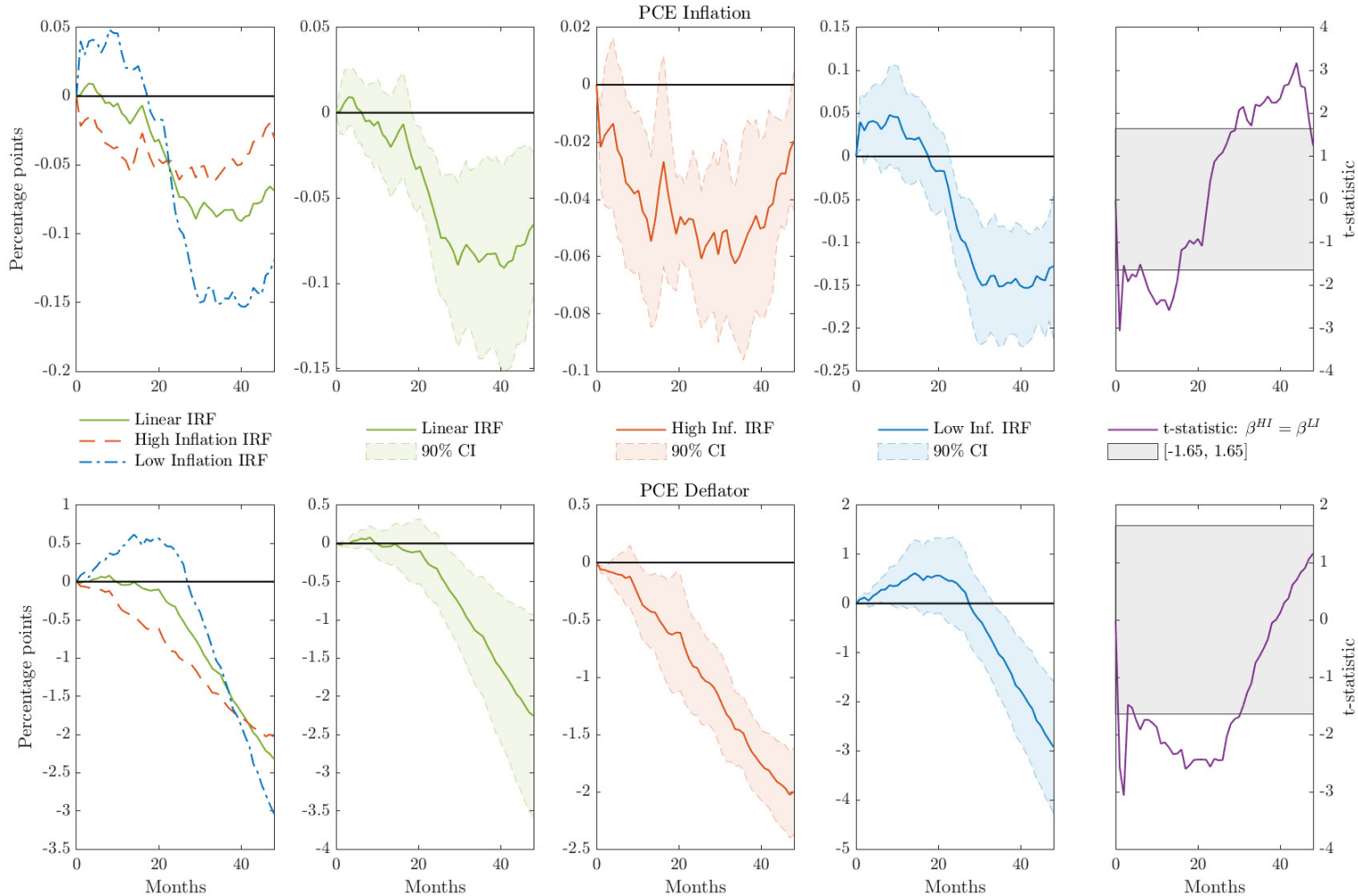
$$F(z_t) = \frac{\exp(\gamma\frac{z_t - c}{\sigma_z})}{1 - \exp(\gamma\frac{z_t - c}{\sigma_z})} \in [0, 1]$$

- z_t: 24 month centred moving average of PCE inflation
- Calibrate c and γ so that $\approx 30\%$ of sample is in high trend inflation
- If $\beta_h^{HI} \neq \beta_h^{LO}$: **regime dependency** of impulse responses

State Variable and PCE Inflation



Test 2 - PCE Inflation and Price Level



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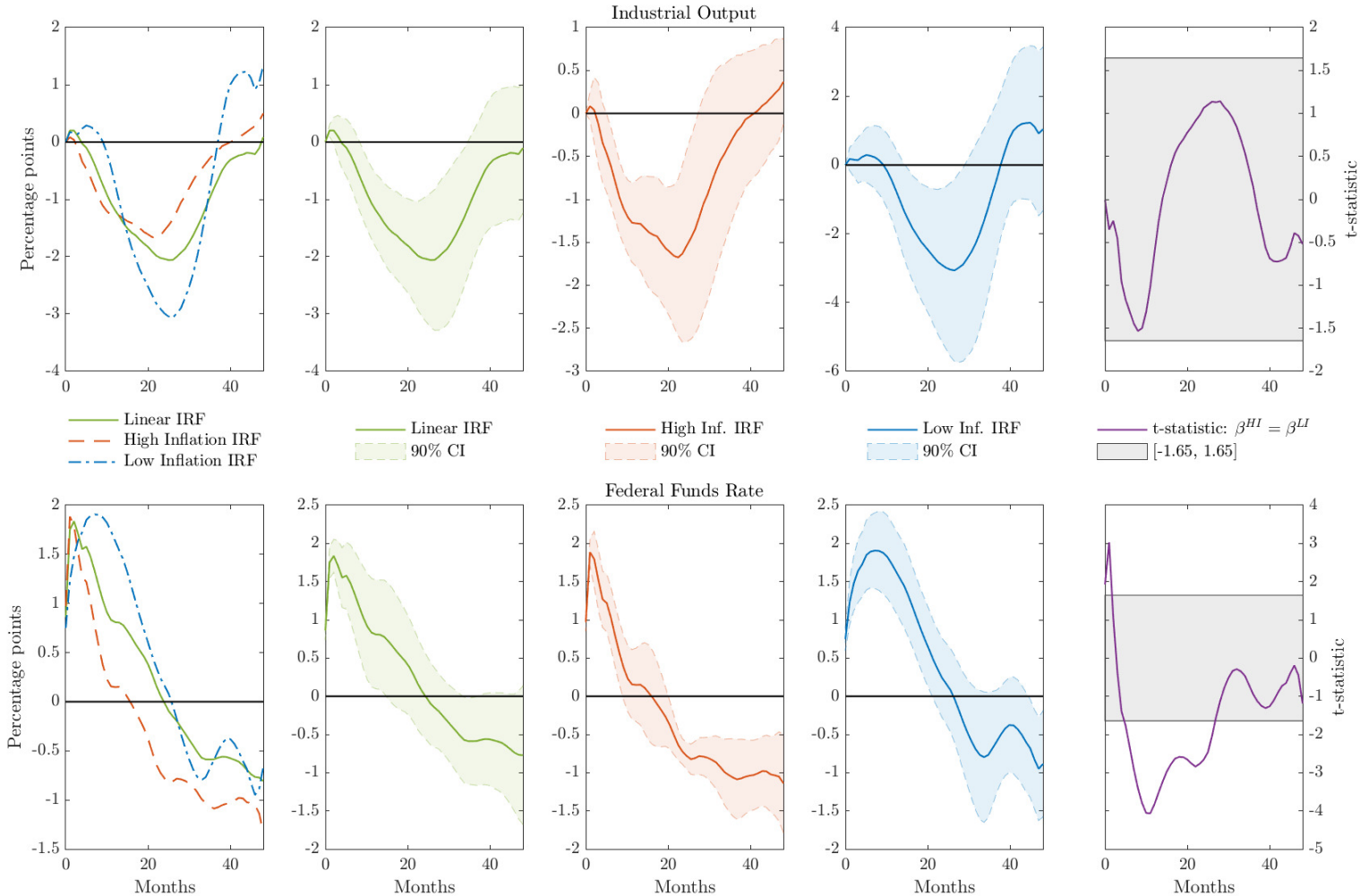


◂ Specification

Robustness tests

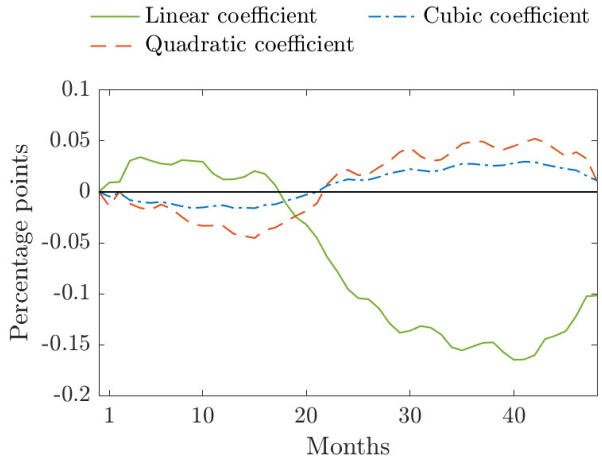
- Quadratic and cubic shock terms (Test 1) ⏩ Link
- Excluding the NBR targeting period (Test 1) ⏩ Link
- Varying γ and c (Test 2) ⏩ Link
- Alternative state variable: HP Filter (Test 2) ⏩ Link
- Alternative price measure: CPI (both) ⏩ Link
- Alternative shock: Smooth Transition VAR (both) ⏩ Link

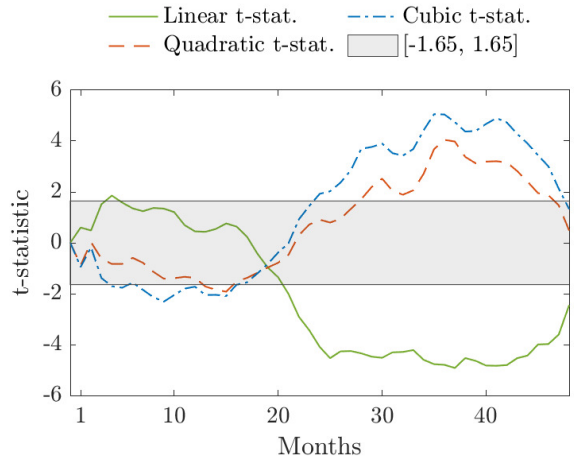
  ⏩ Time series of shocks
- Controlling for financial frictions (both) ⏩ Link
- Controlling for oil crises using the PCOM (both) ⏩ Link
- Non-linear Romer and Romer regression (both) ⏩ Link
- Including lags of shock measure (both) ⏩ Link
- Including leads of shock measure (both) ⏩ Link

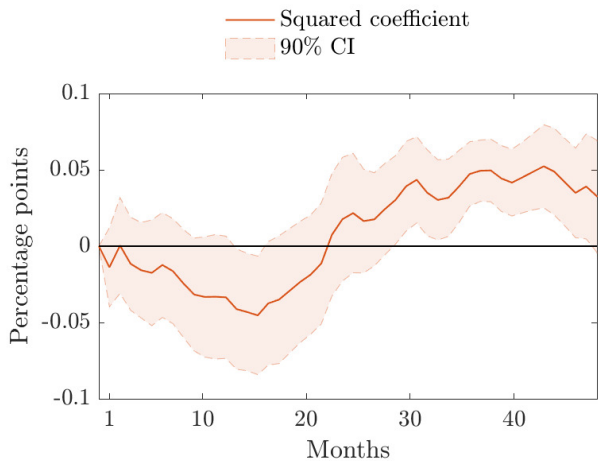
Summary

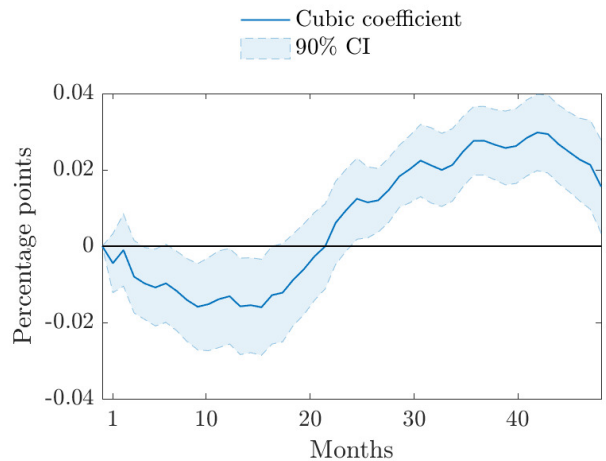
- **Aim:** Test two central predictions of a NK world
- **Method:** Non-linear and smooth transition local projections
- **Size- and state-dependencies** are important
- NK propagation mechanism exists in the **aggregate**
- **Outlook:** Further research into the relative contribution of other propagation mechanisms (financial frictions, networks etc.)

Quadratic and cubic terms (Test 1, PCE Inf.)









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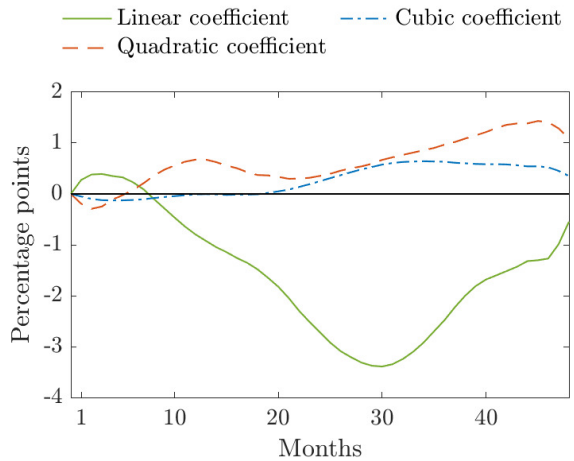
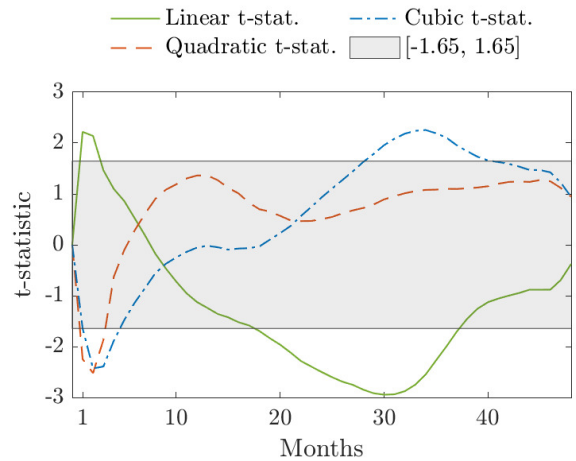
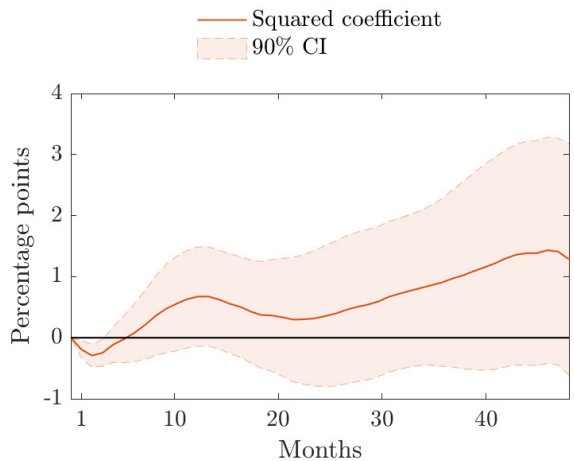
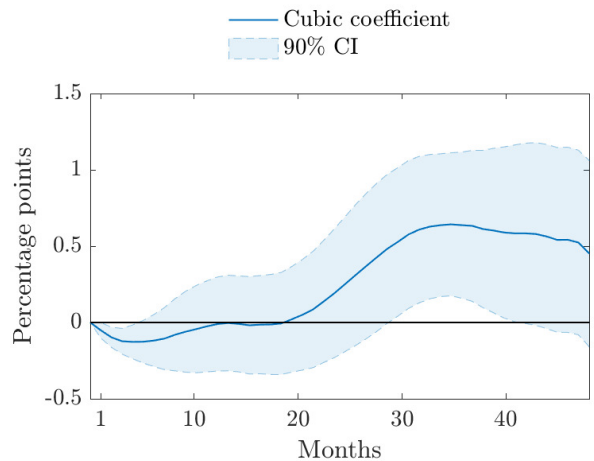
Quadratic and cubic terms (Test 1, IP)









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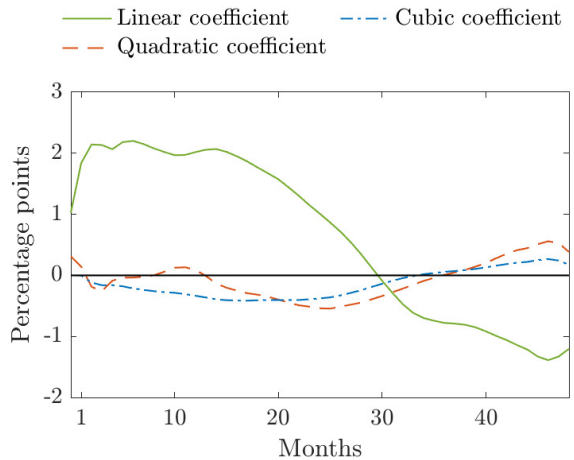

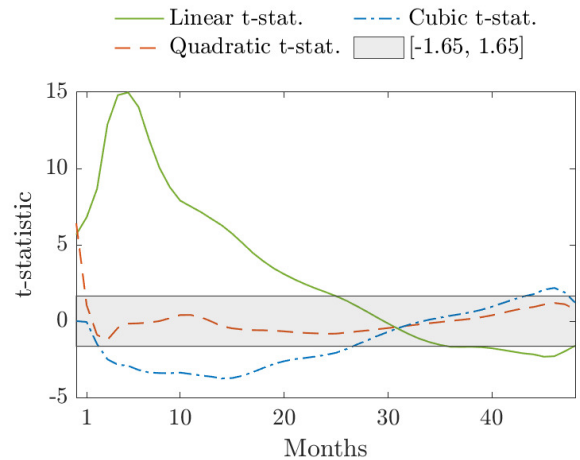

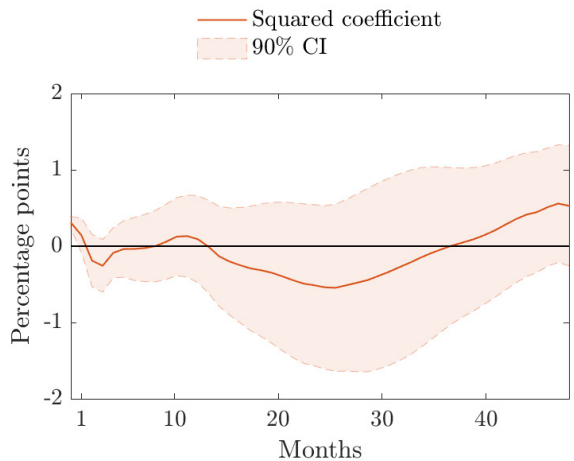

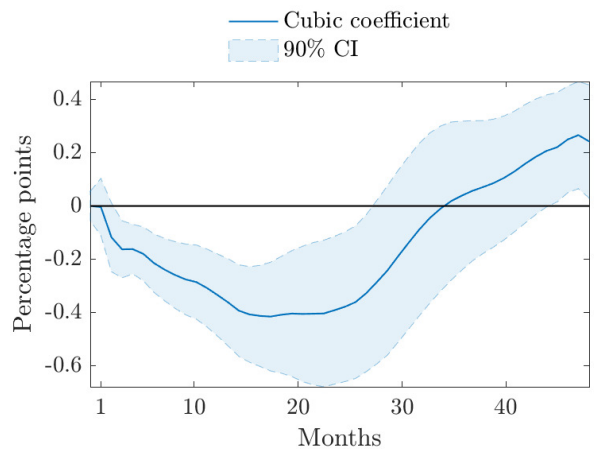

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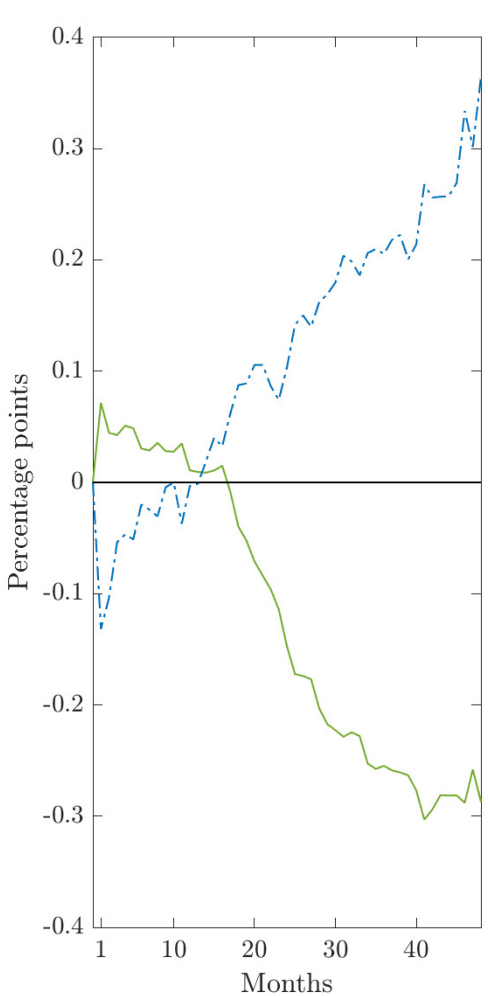
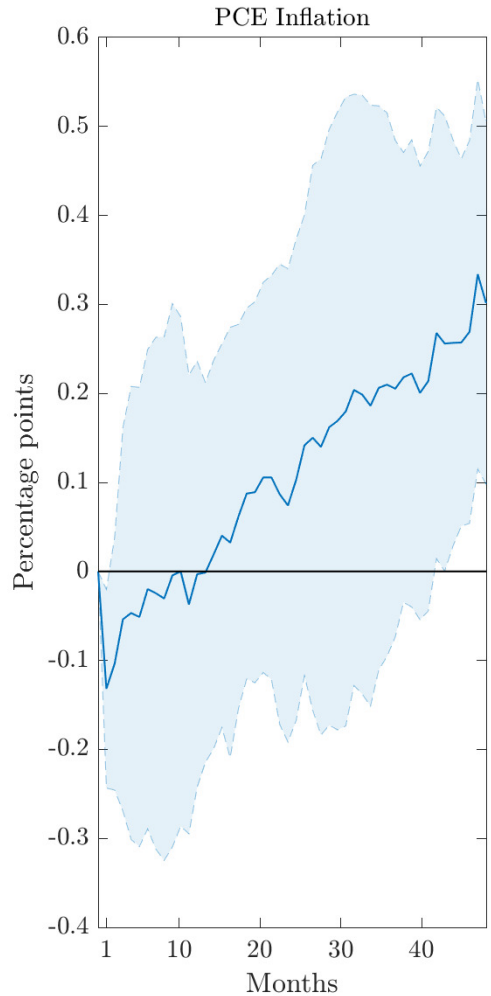
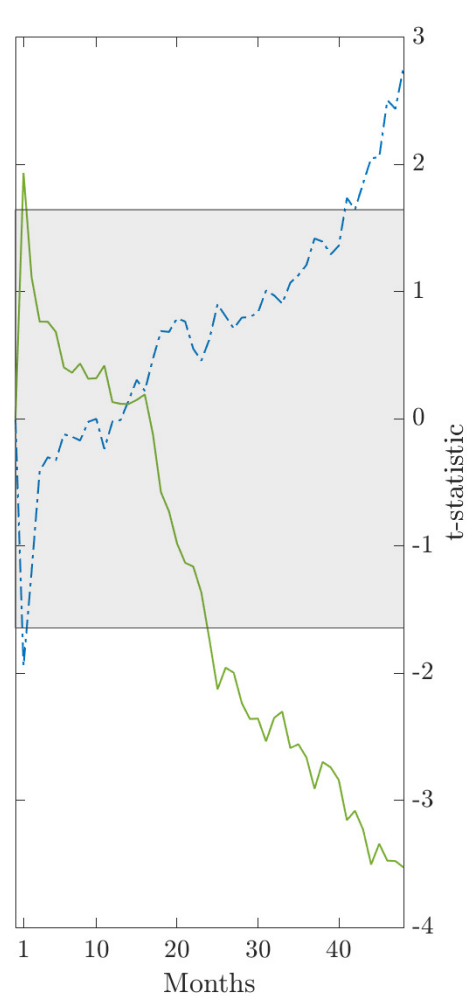
Excluding the NBR Targeting Period (Test 1, PCE Inf.)







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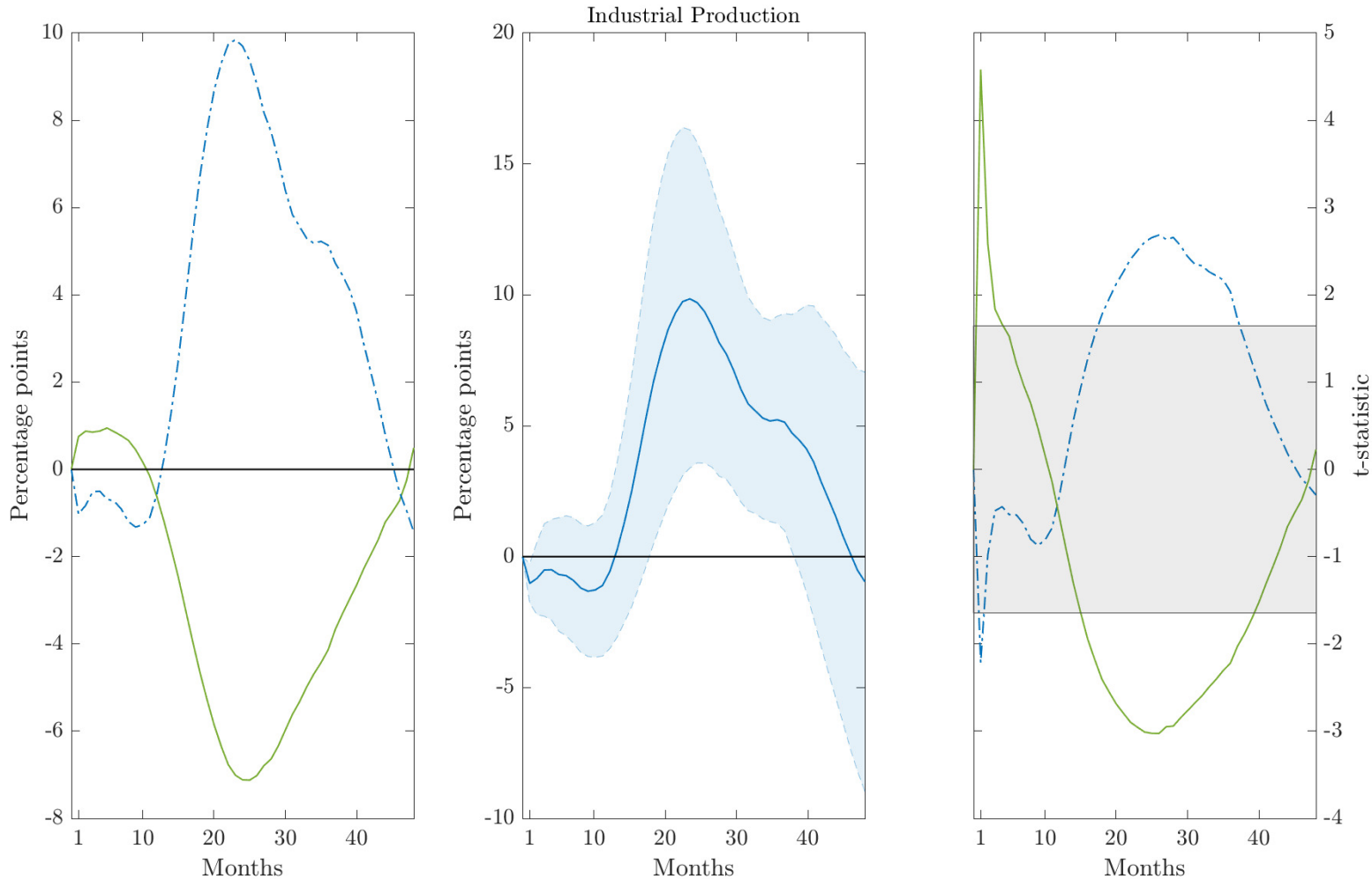
Excluding the NBR Targeting Period (Test 1, IP)



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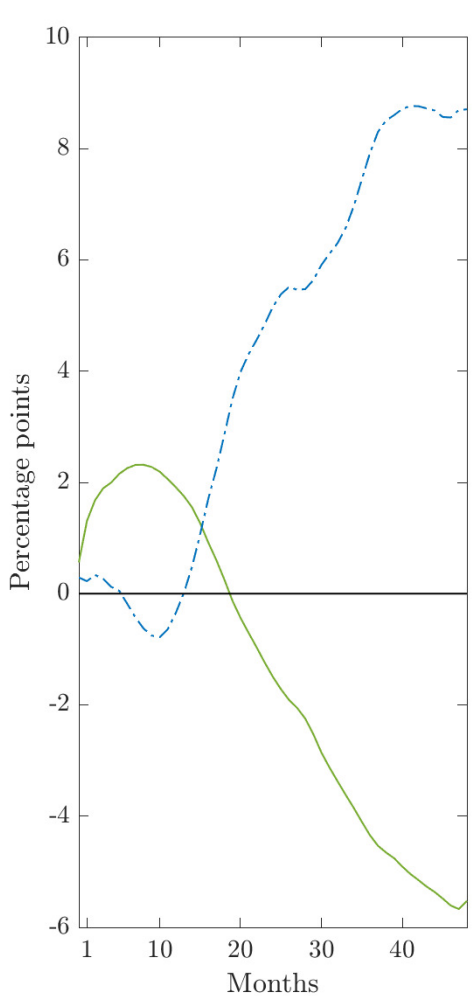

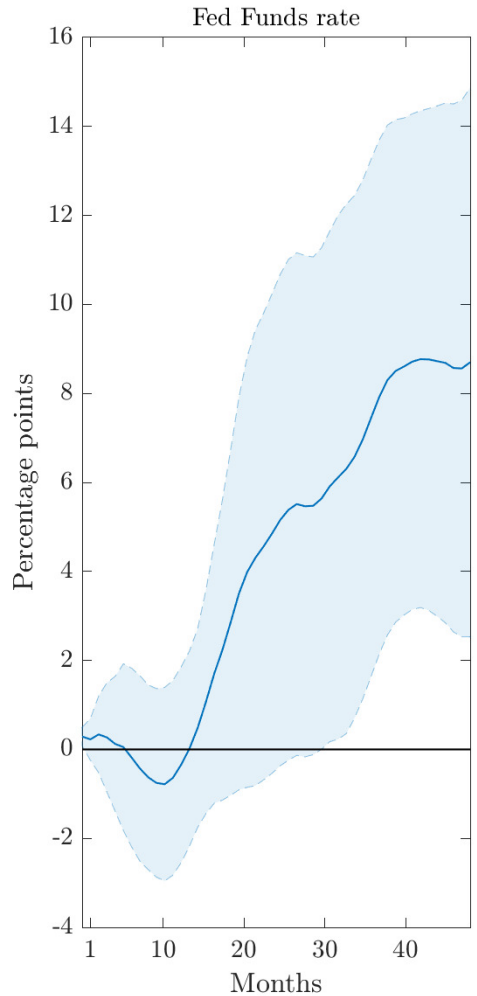

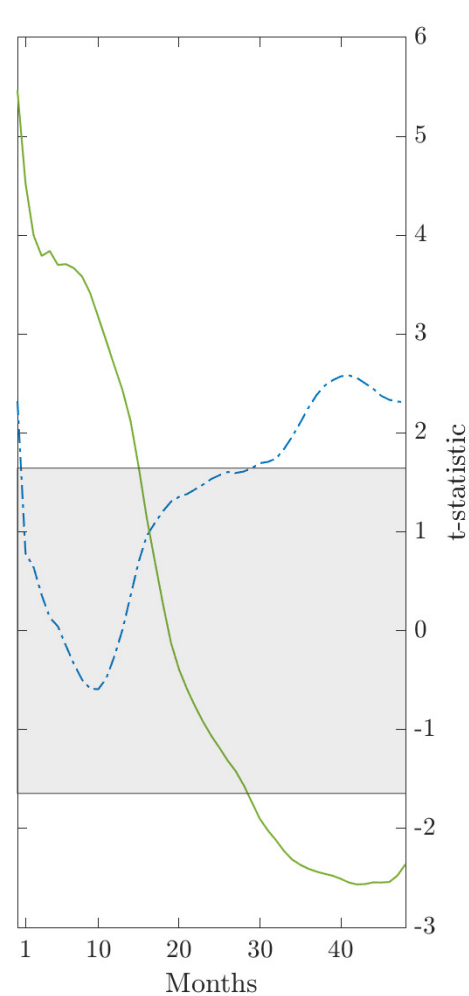

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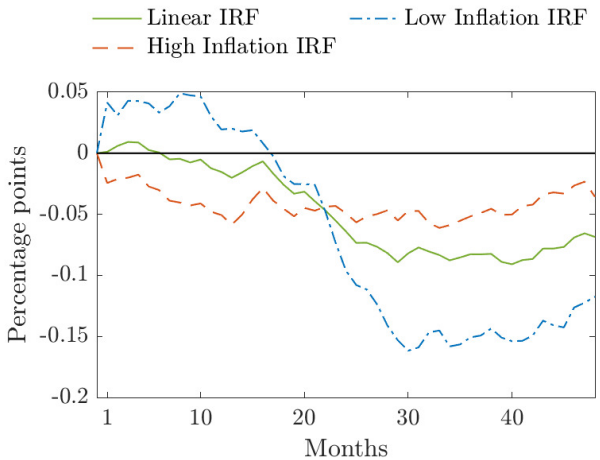
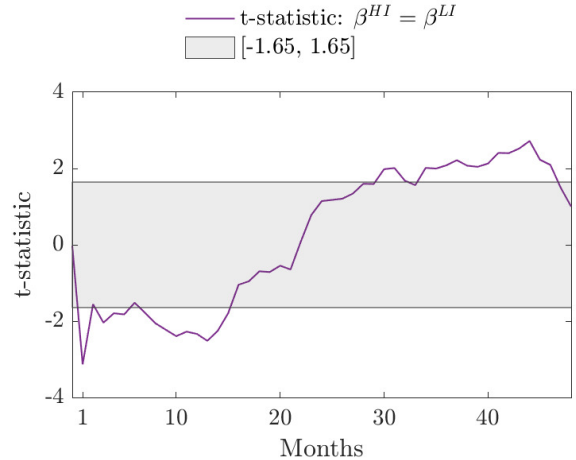
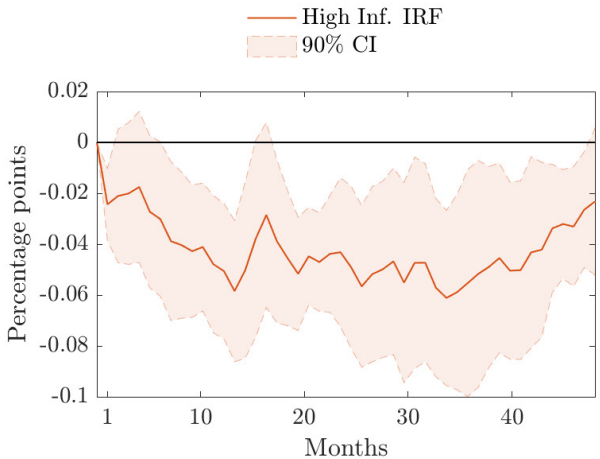
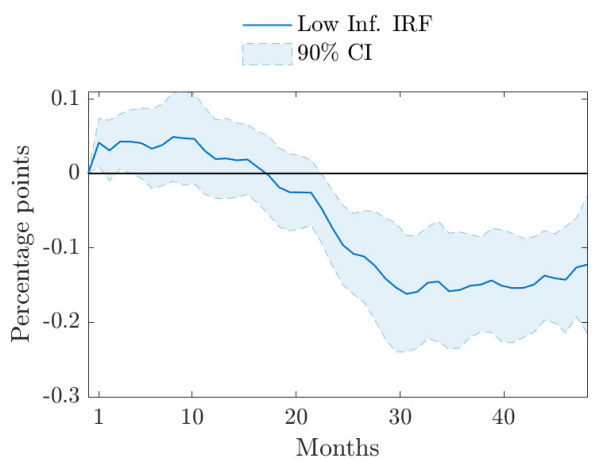
Low γ, (Test 2, PCE Inf.)









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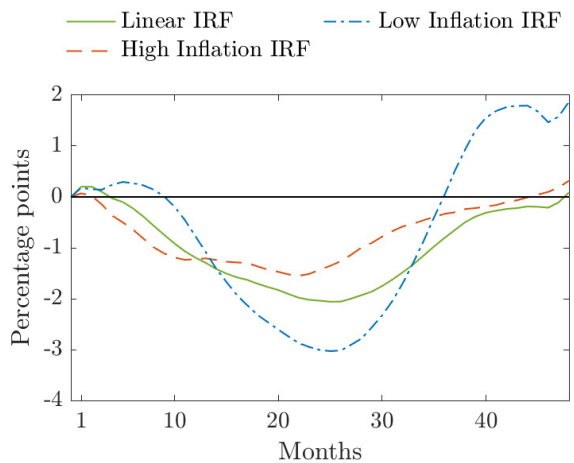

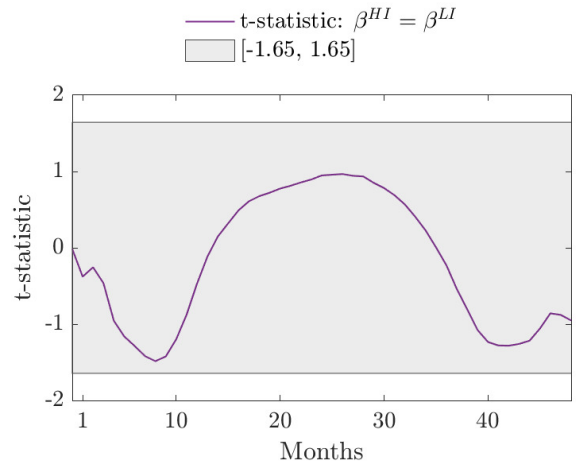

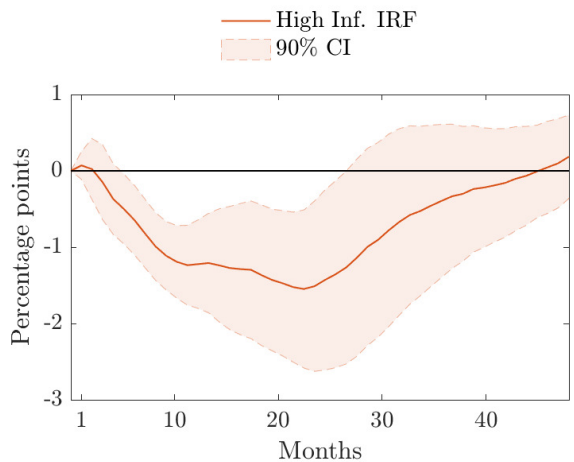

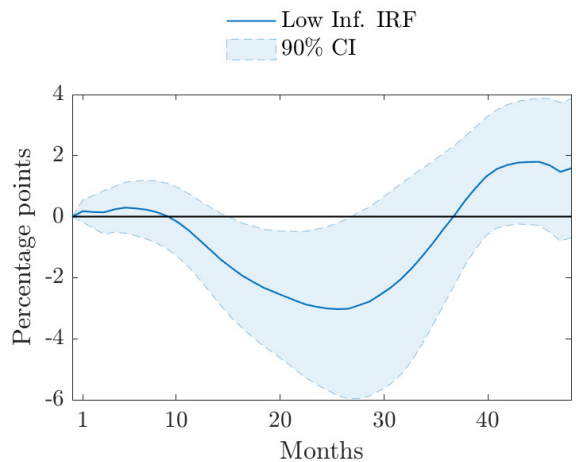

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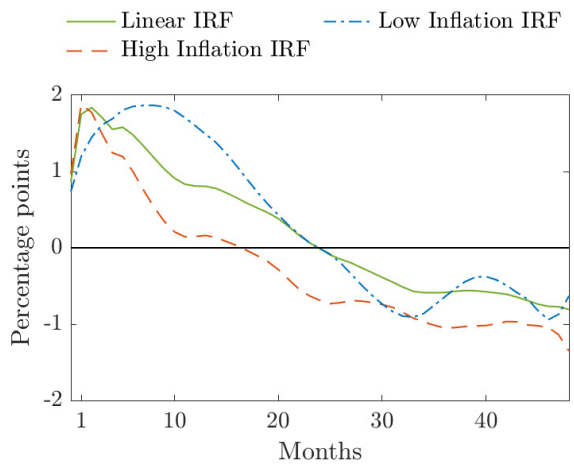
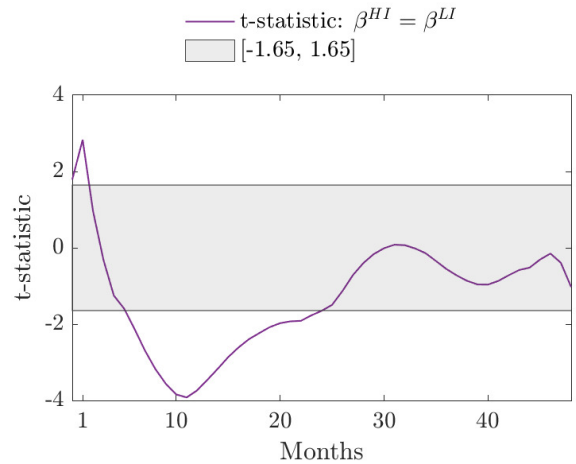
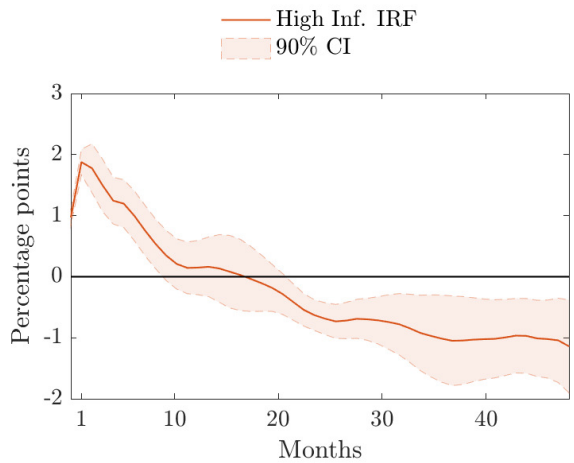
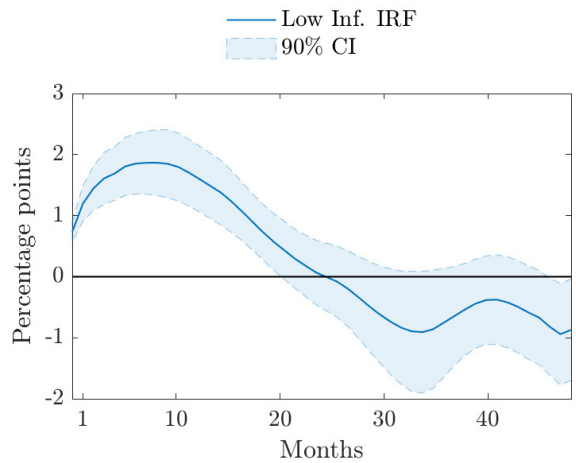


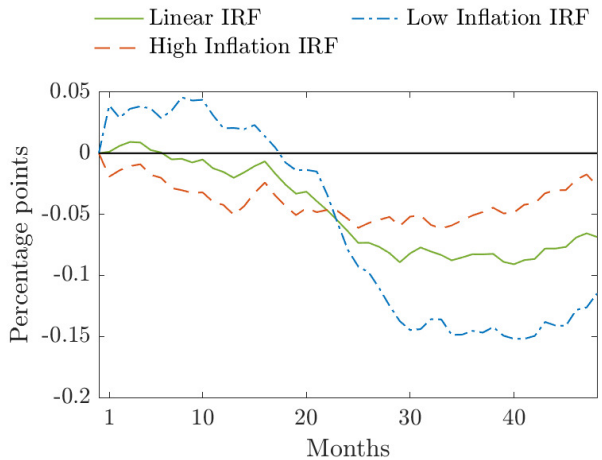


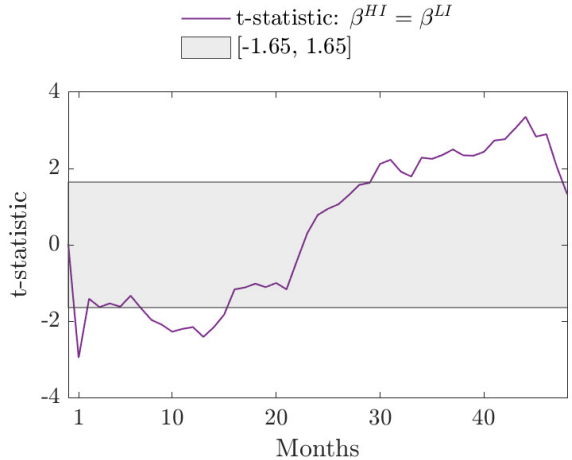


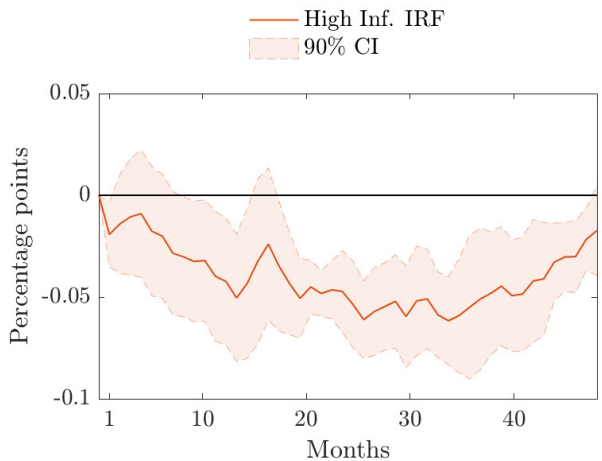


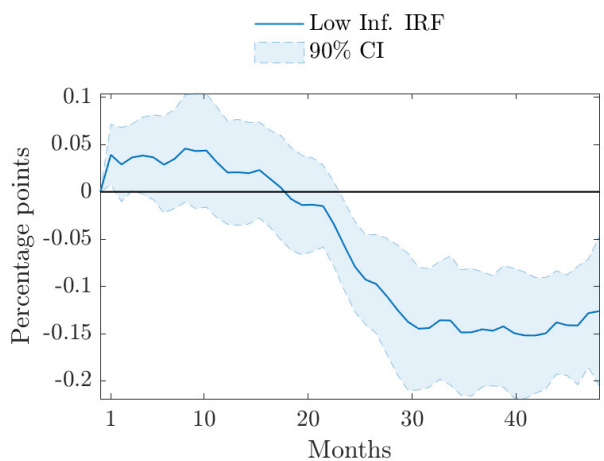
back

High γ, (Test 2, PCE Inf.)



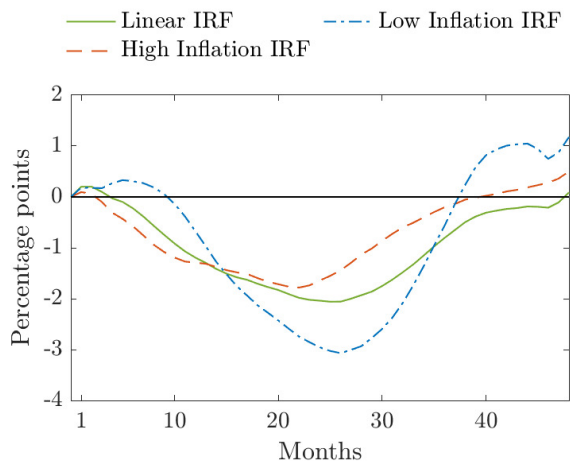


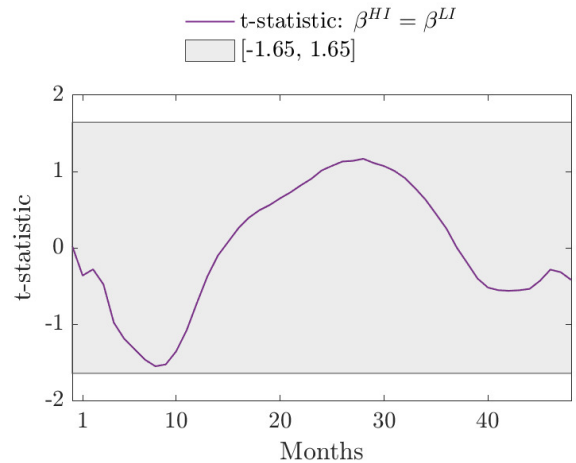


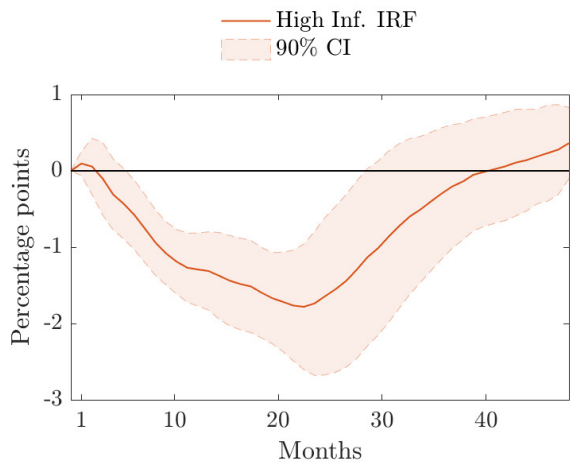


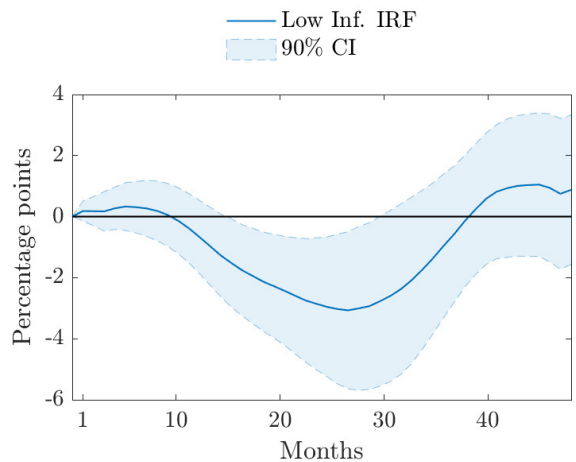
back

High γ, (Test 2, IP)



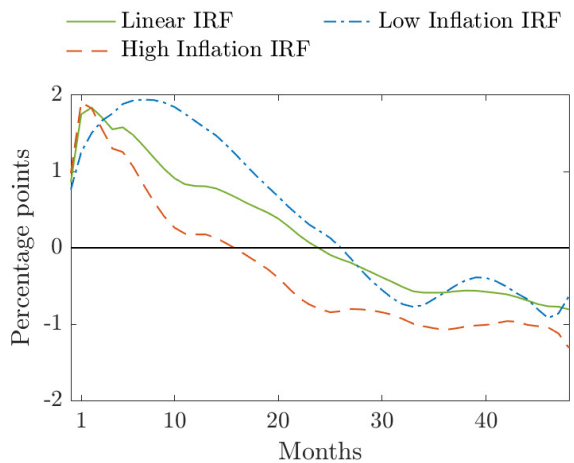


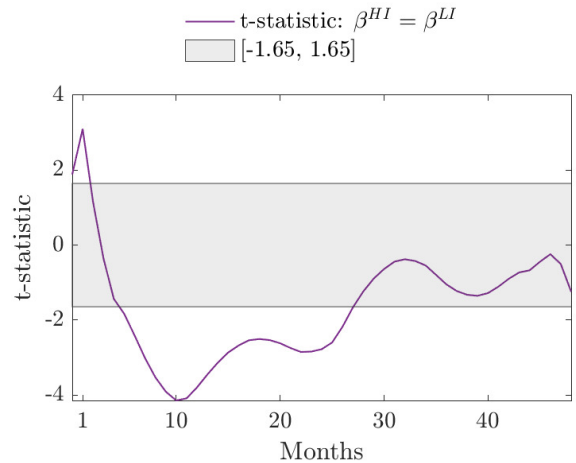


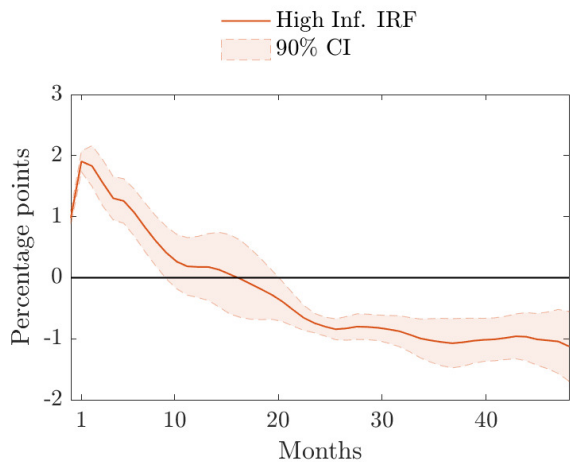


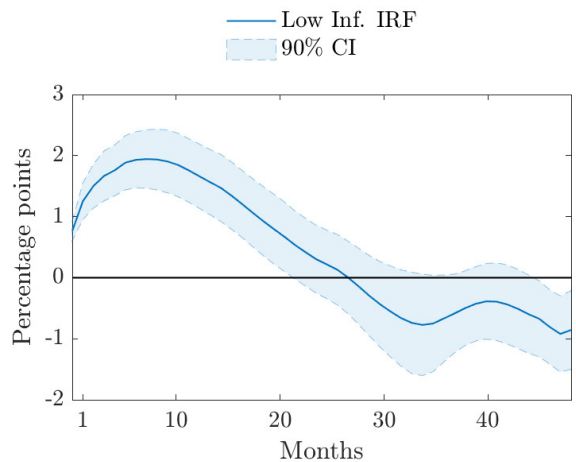
back

High γ, (Test 2, FFR)



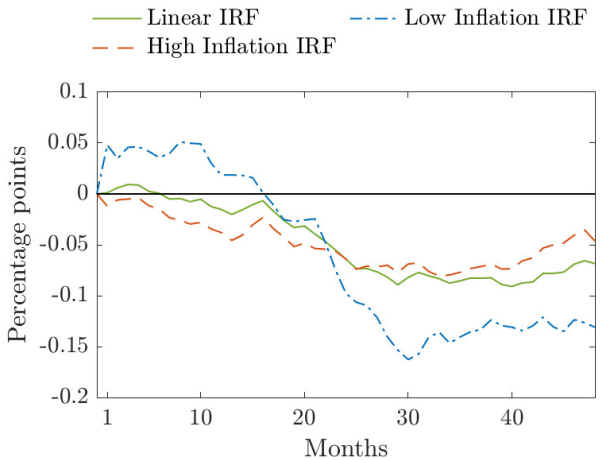


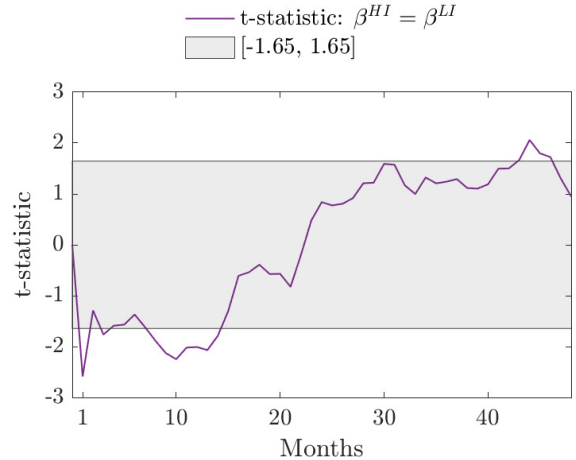


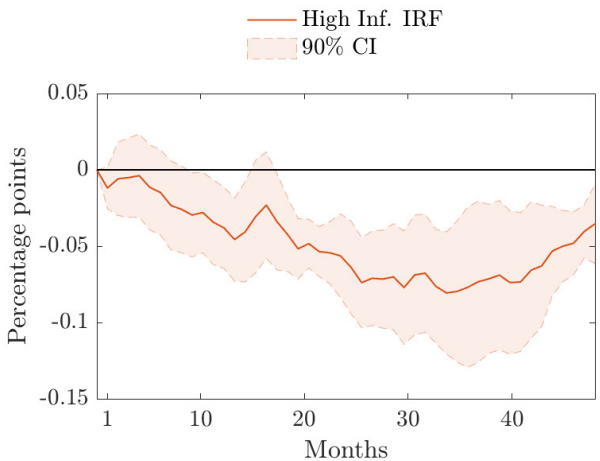


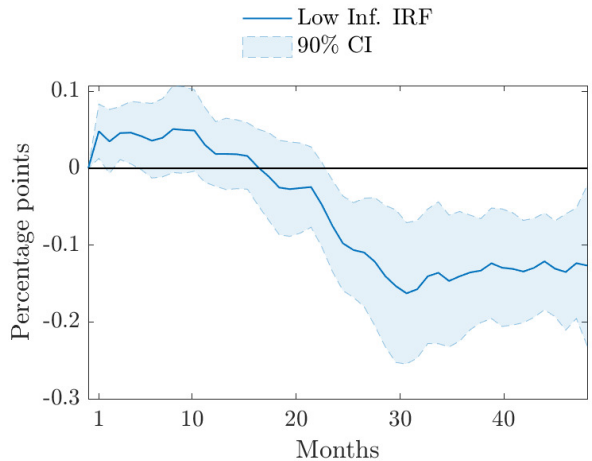
back

Low c, (Test 2, PCE Inf.)



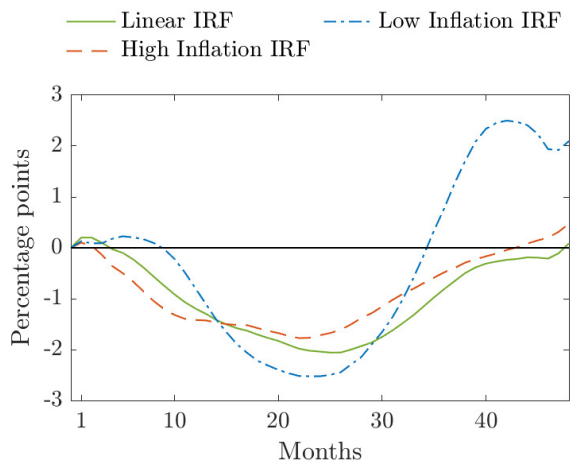


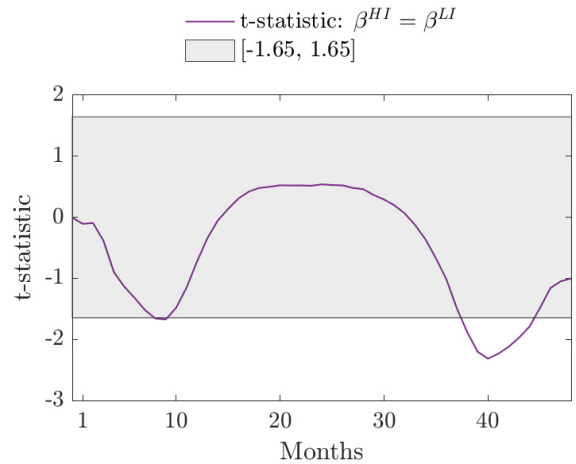


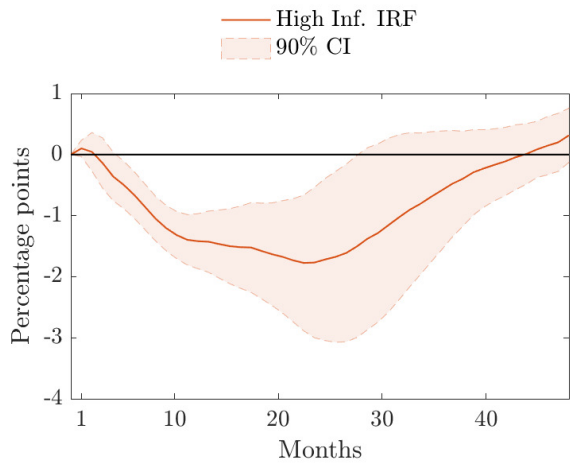


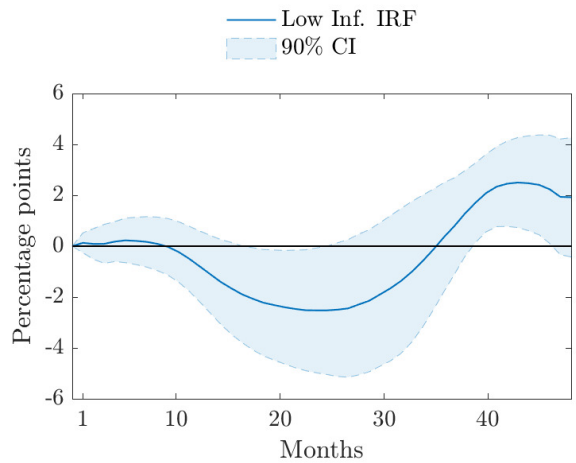
back

Low c, (Test 2, IP)



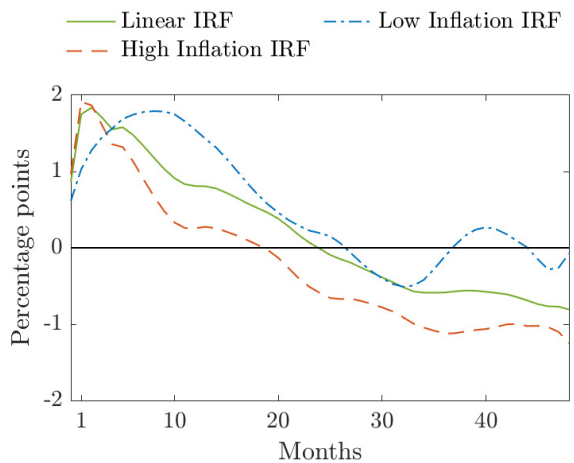


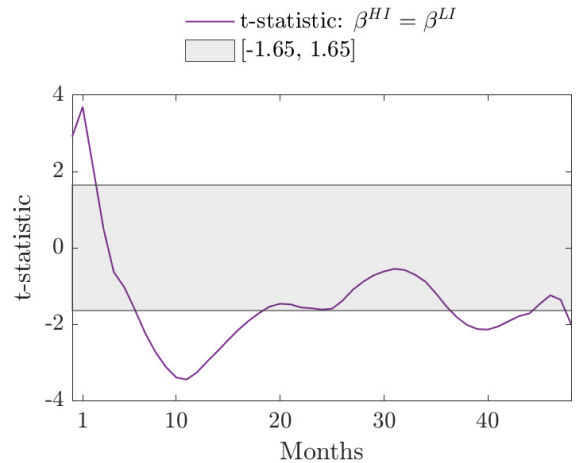


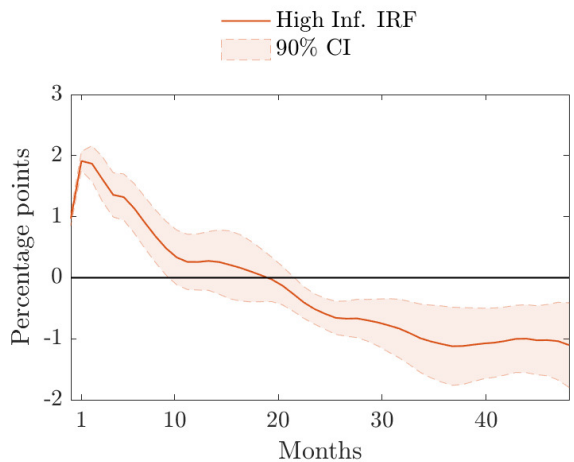


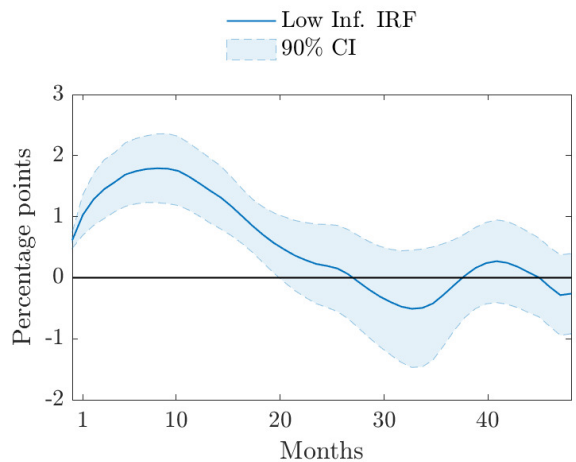
back

Low c, (Test 2, FFR)



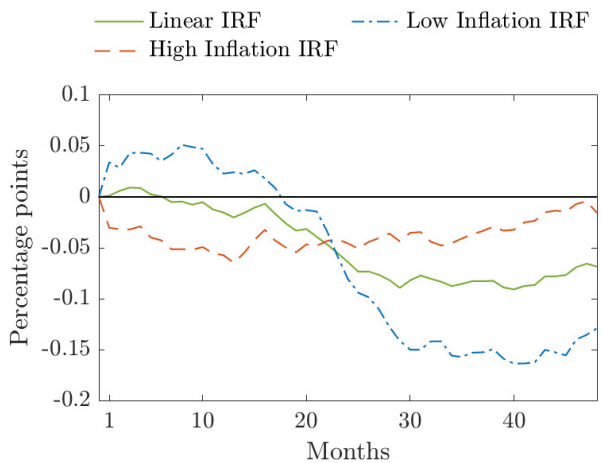


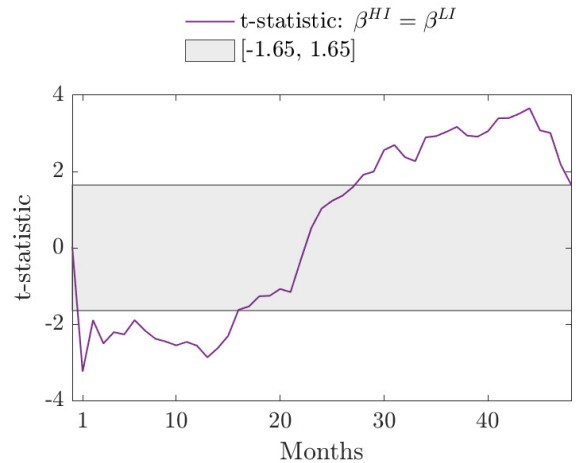


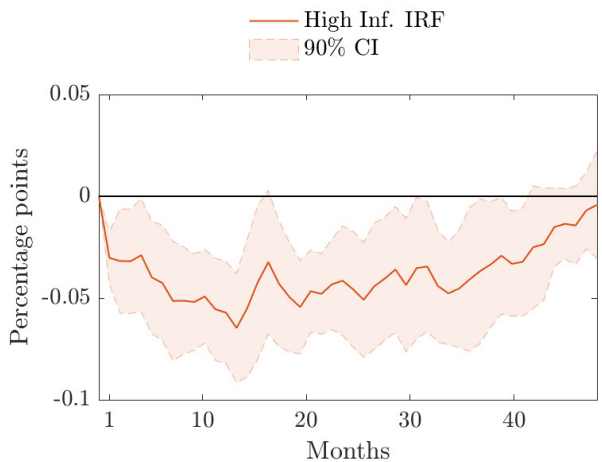


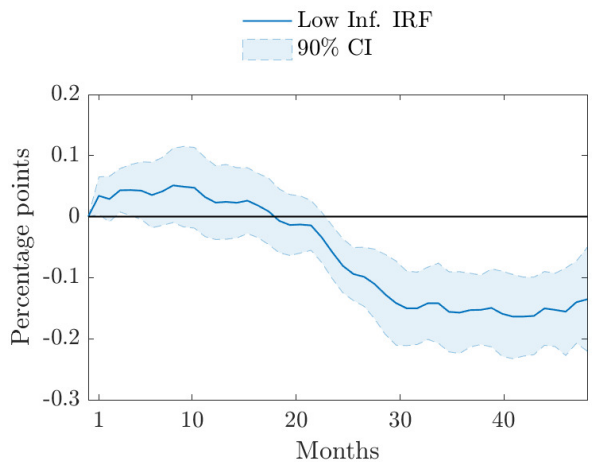
back

High c, (Test 2, PCE Inf.)



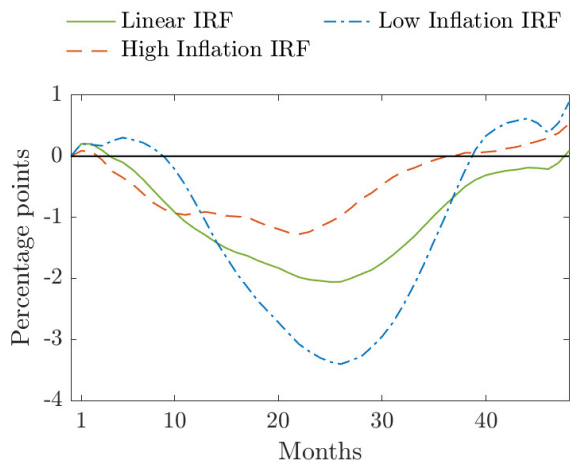


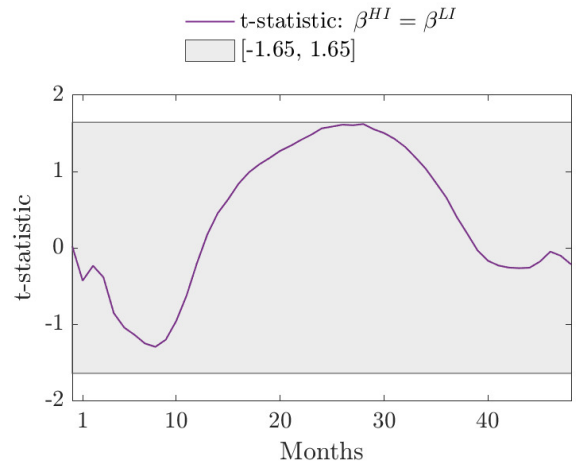


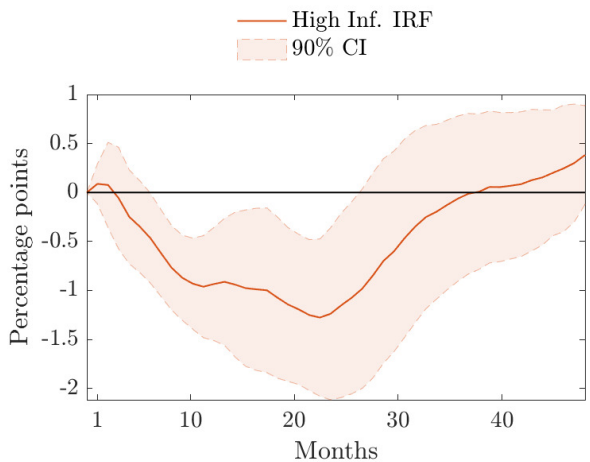


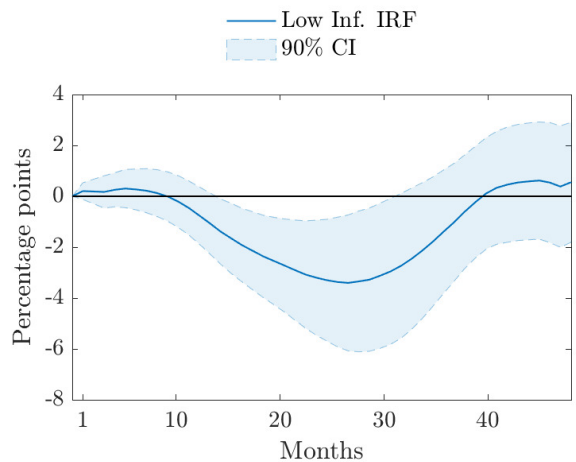
back

High c, (Test 2, IP)



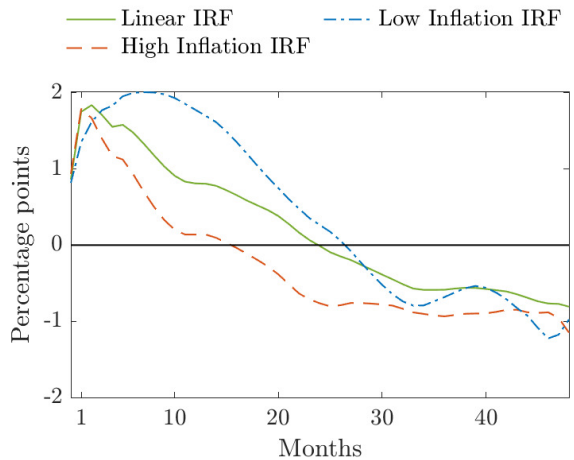


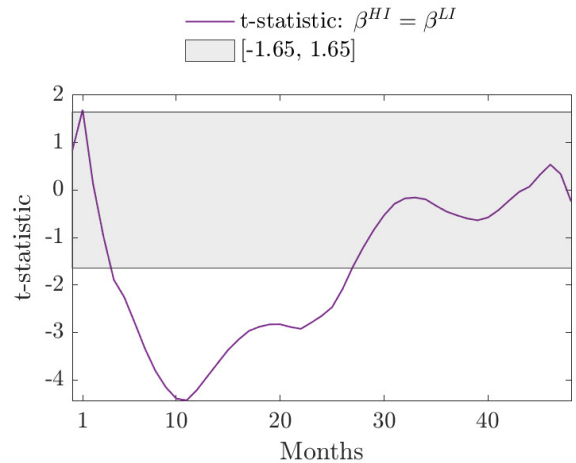


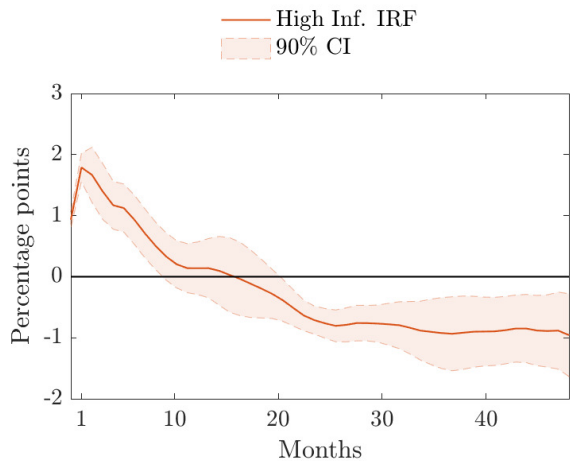


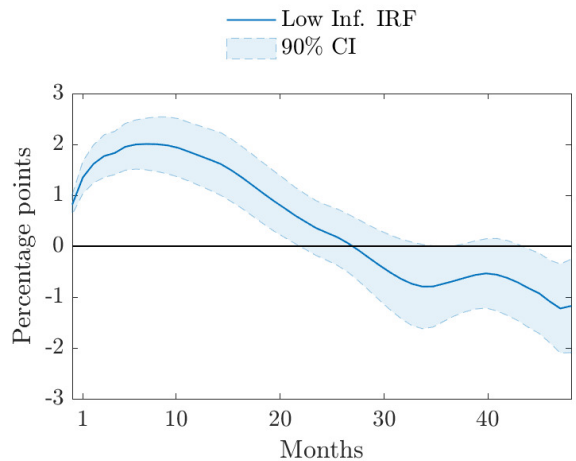
back

High c, (Test 2, FFR)



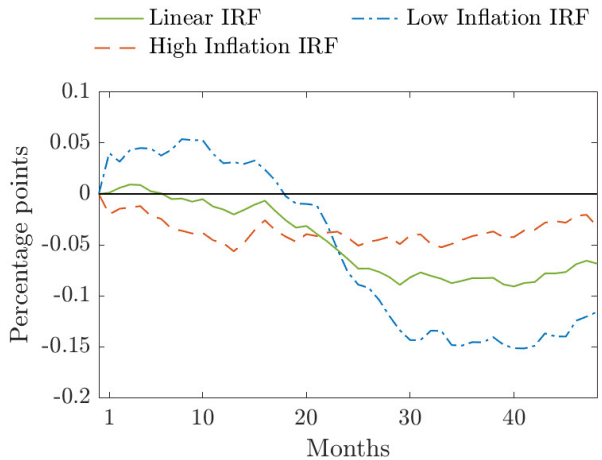


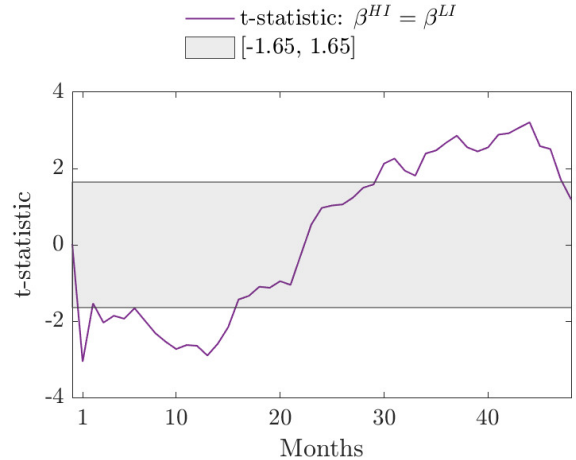


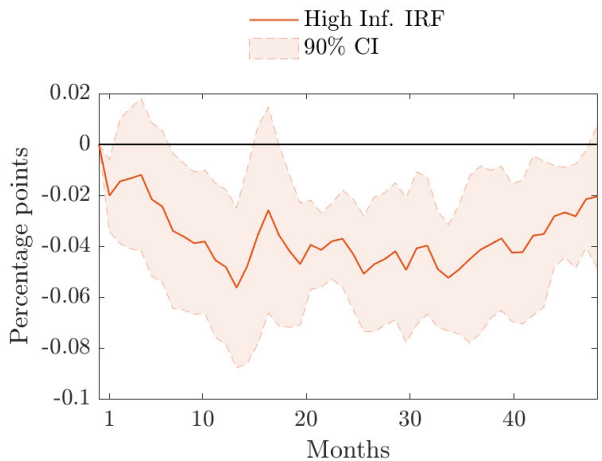


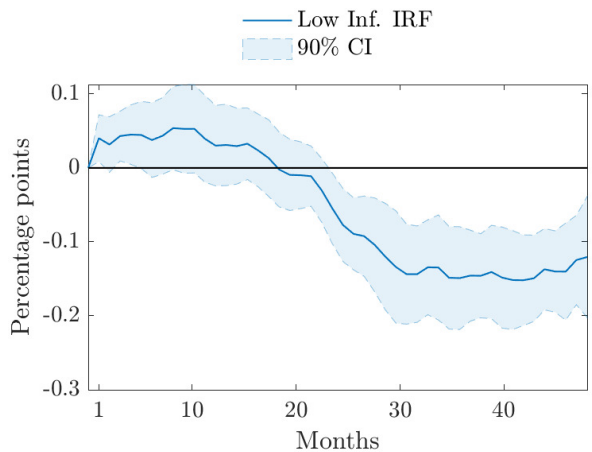
back

State: HP Filtered Inflation (Test 2, PCE Inf.)



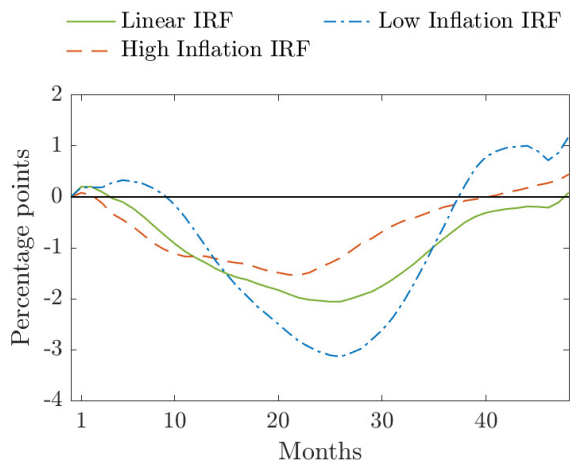


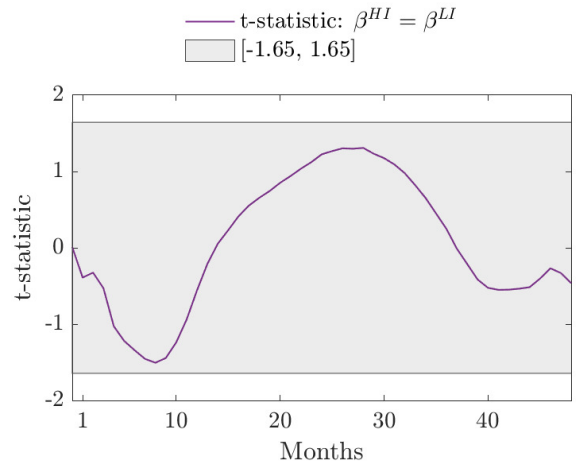


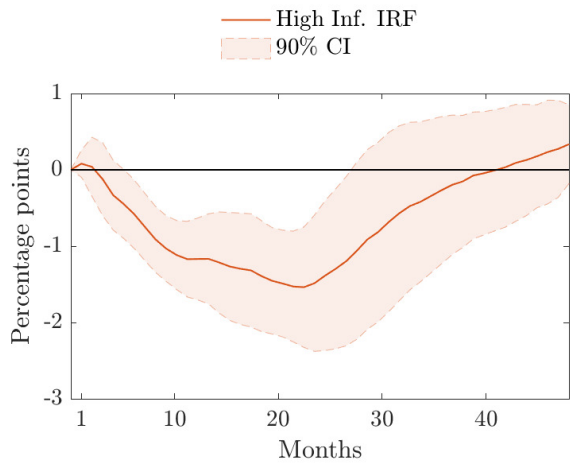


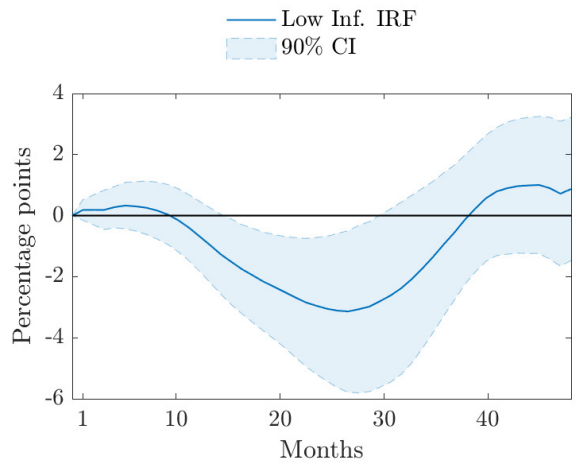
back

State: HP Filtered Inflation (Test 2, IP)



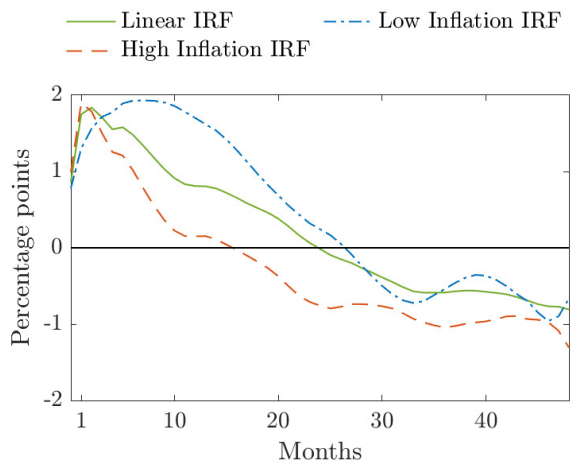


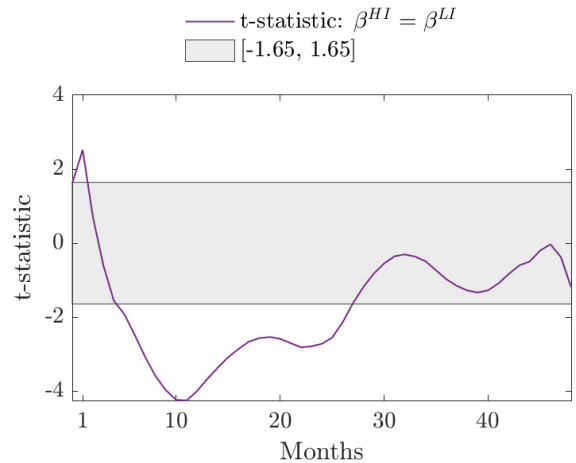


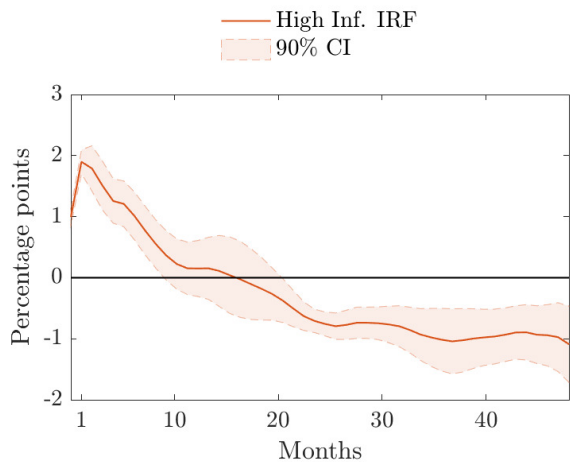


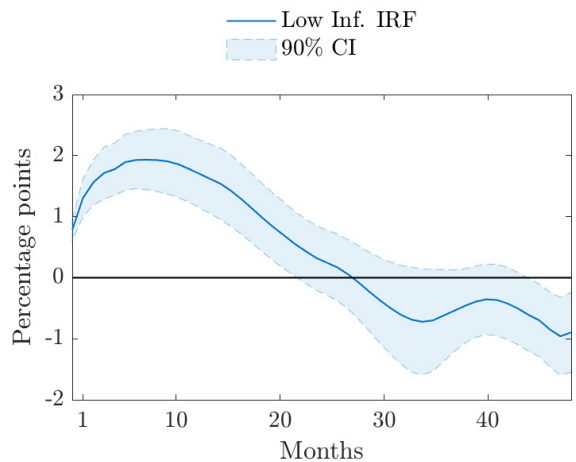
back

State: HP Filtered Inflation (Test 2, FFR)



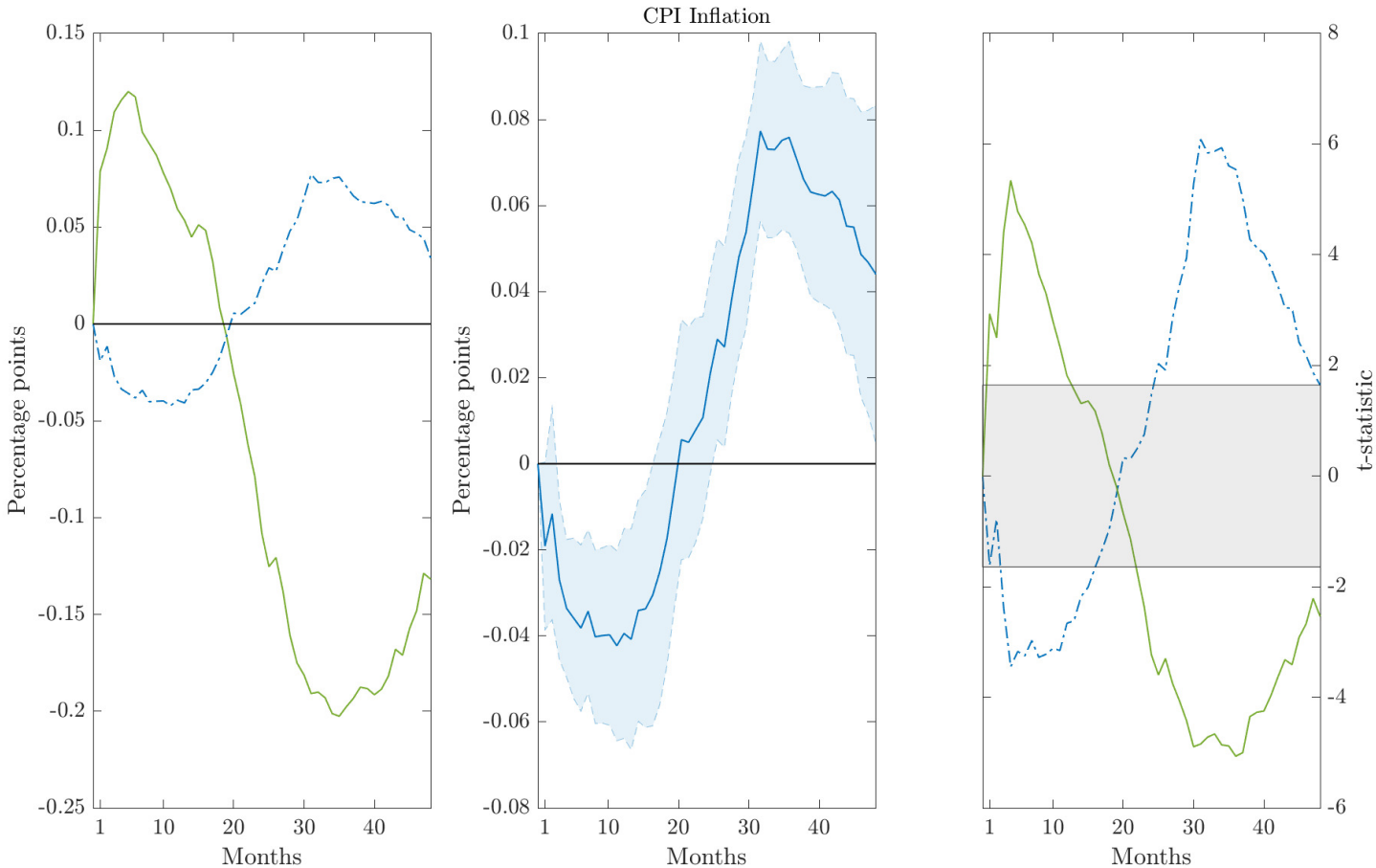






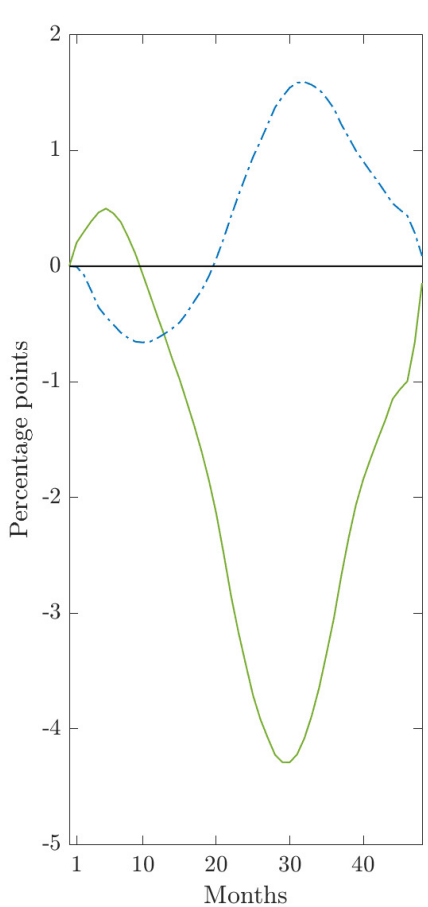
back

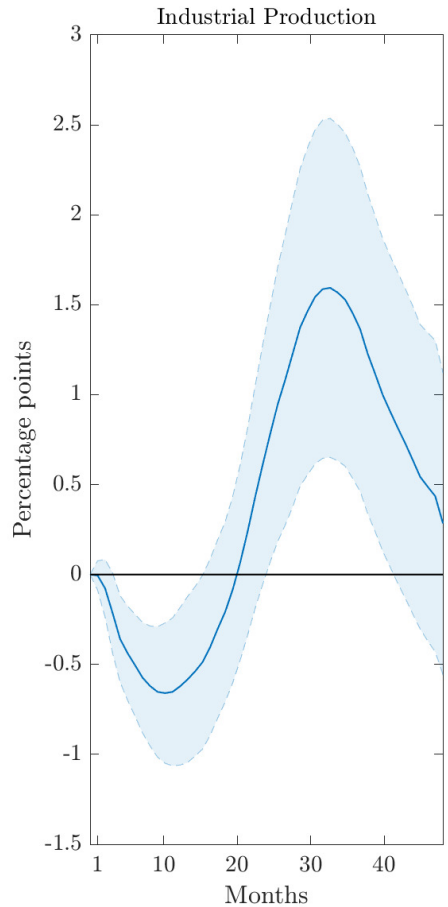
CPI Price results (Test 1, CPI Inf.)

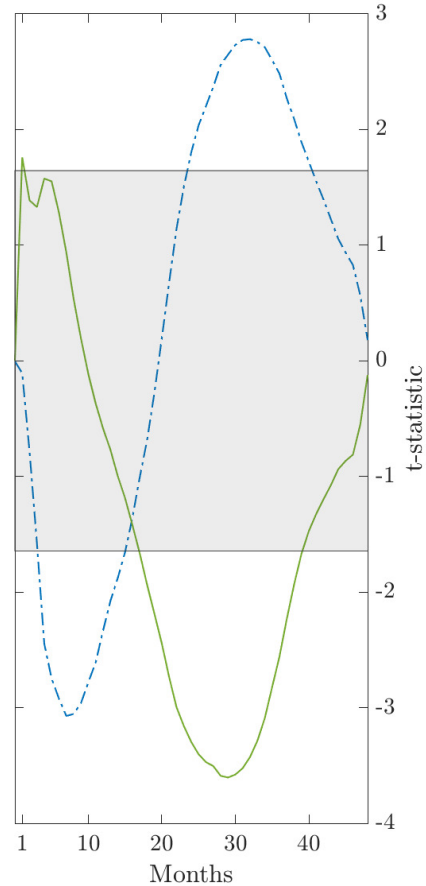


back

CPI Price results (Test 1, IP)

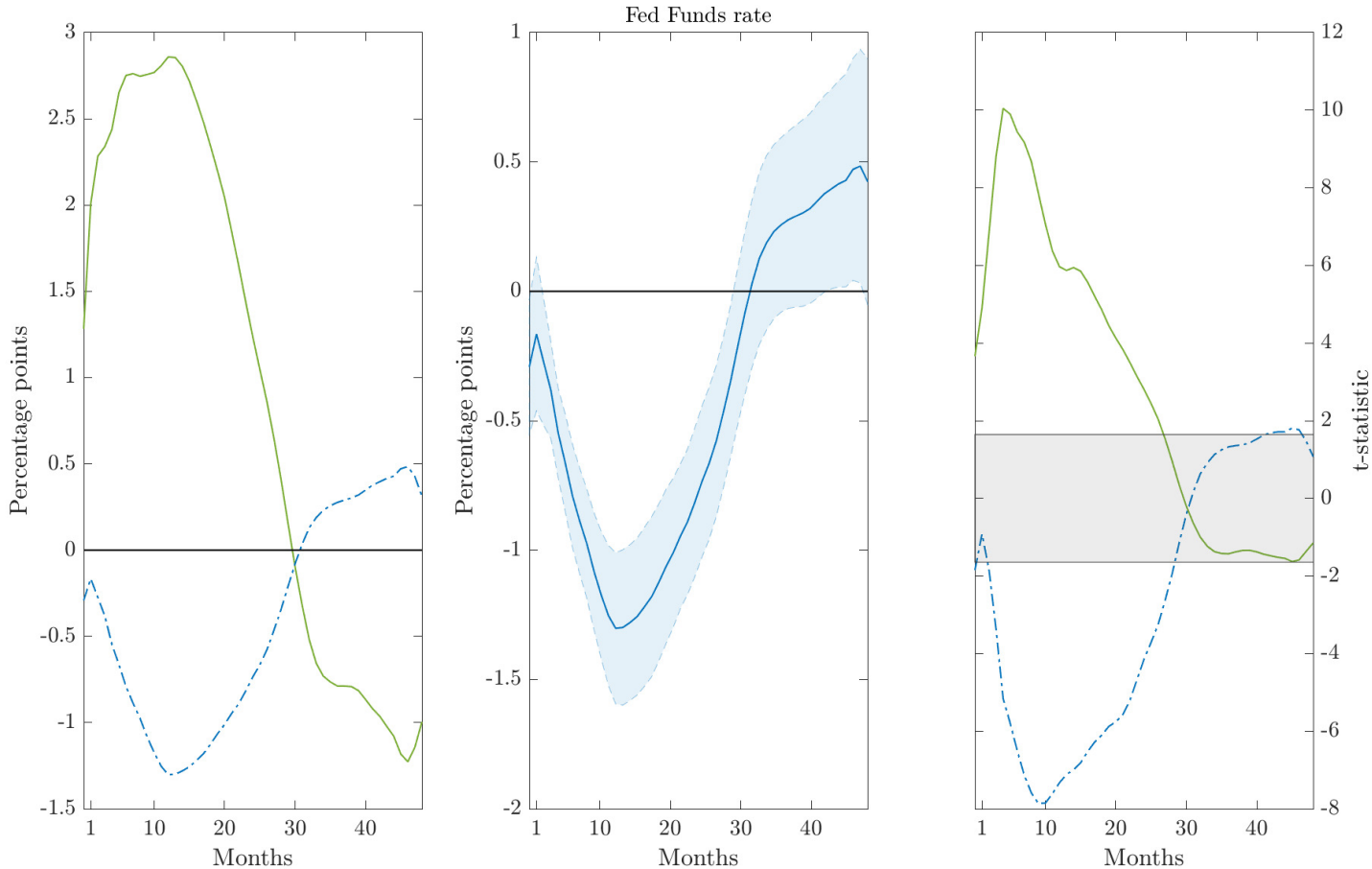






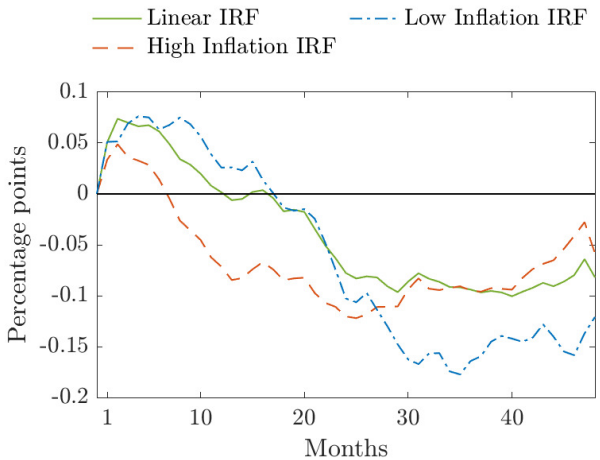
back

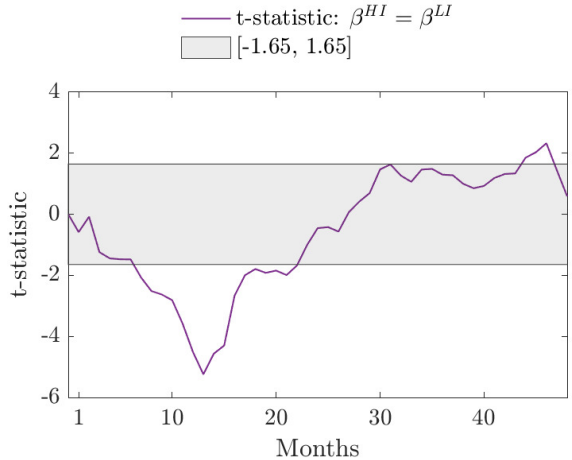
CPI Price results (Test 1, FFR)

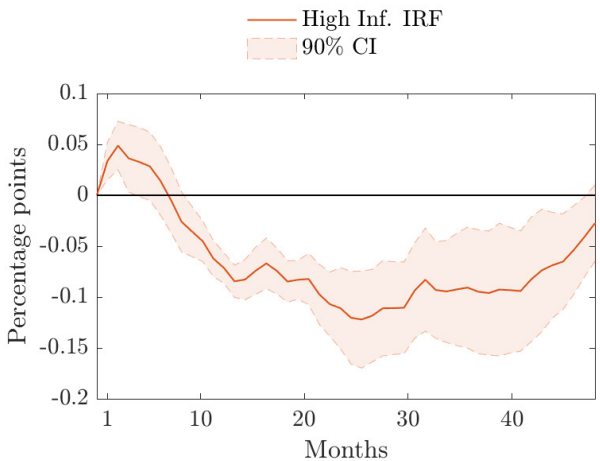


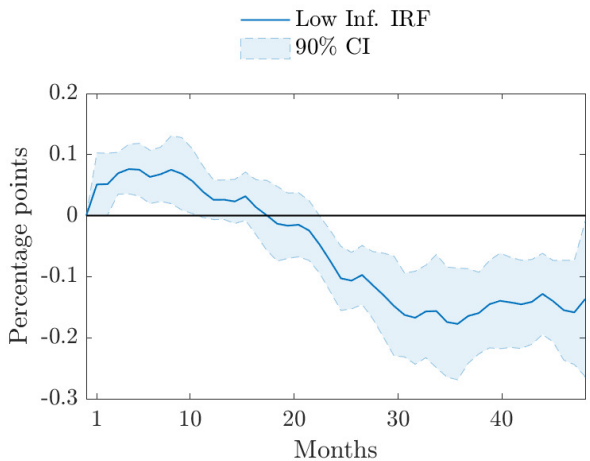
back

CPI results (Test 2, CPI Inf.)



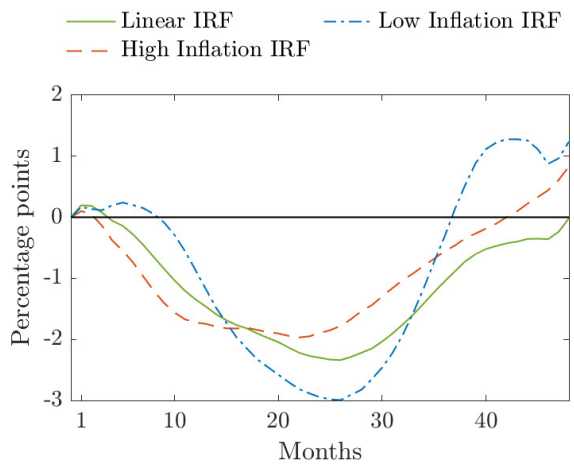


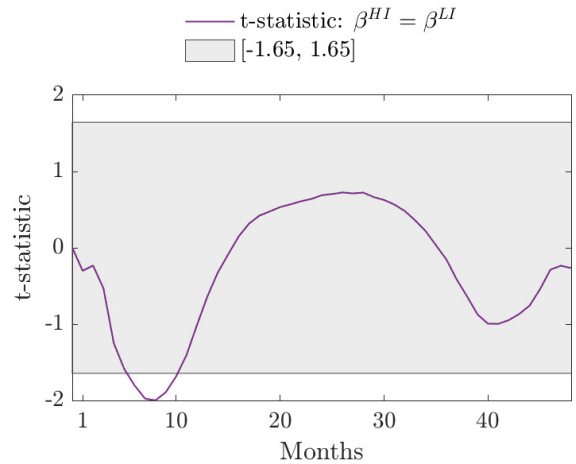


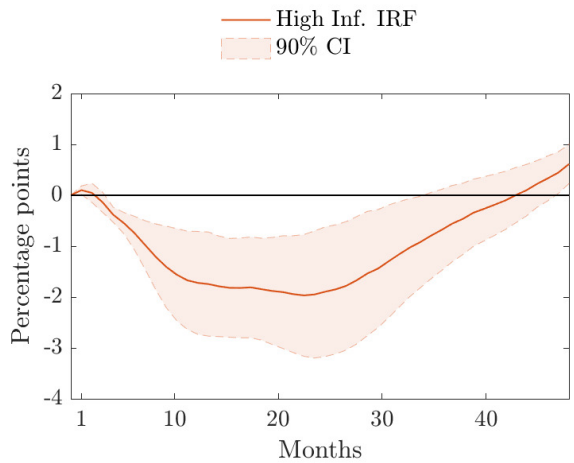


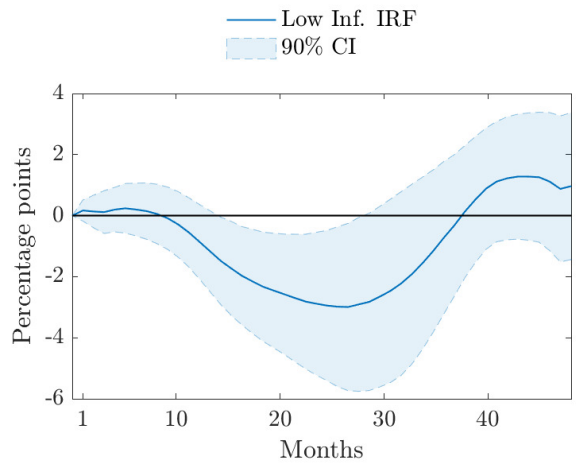
back

CPI results (Test 2, IP)









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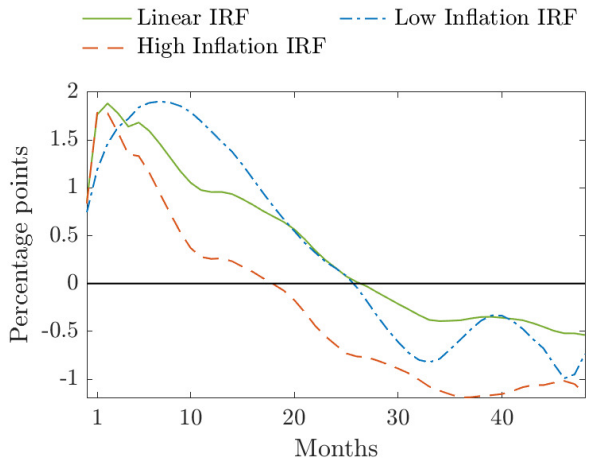
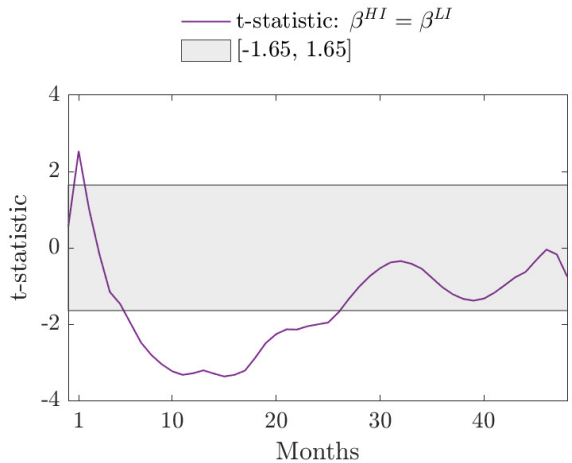
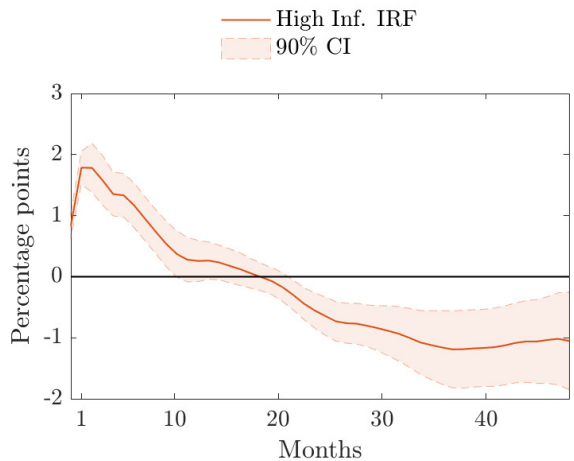
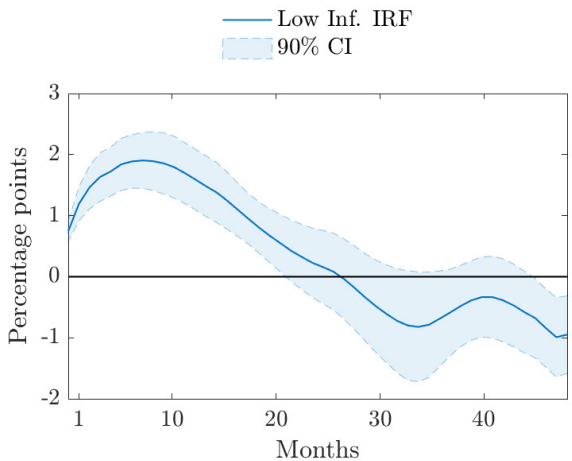
CPI results (Test 2, FFR)









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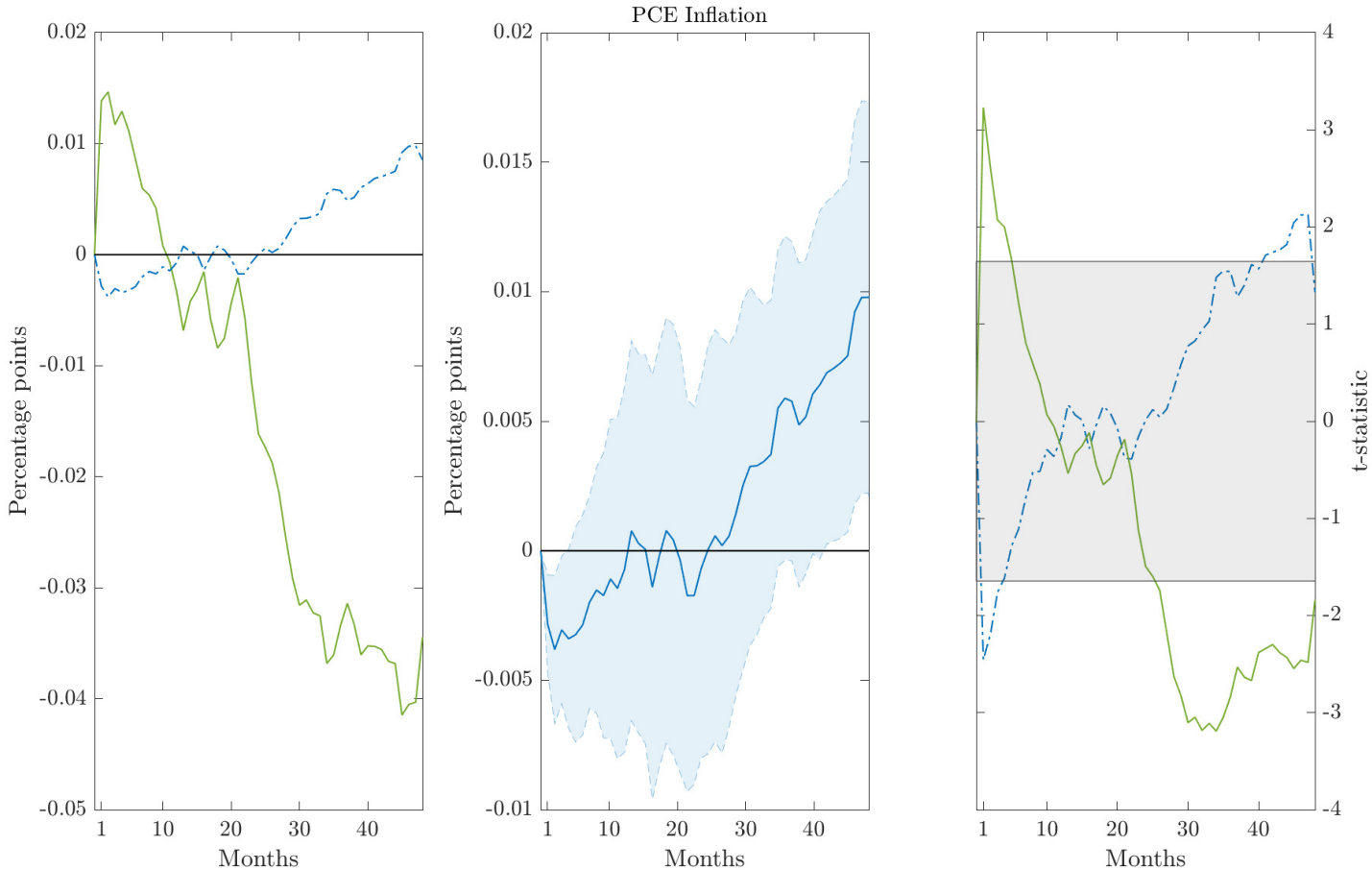
Shocks from STVAR (Test 1, PCE Inf.)



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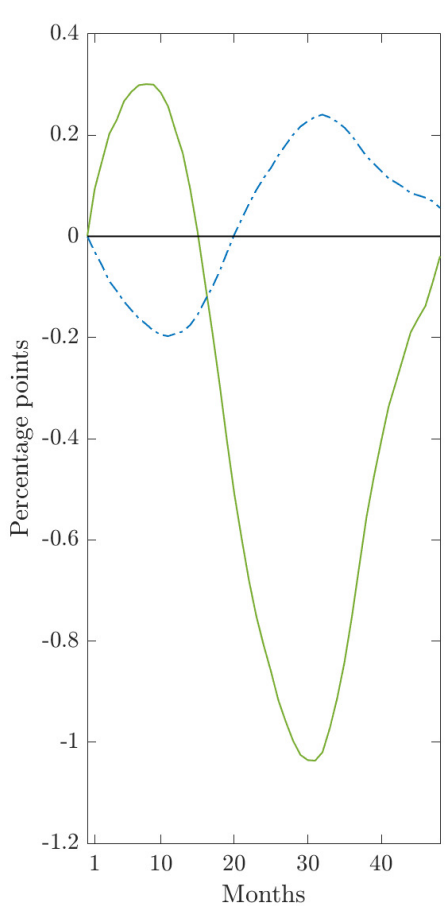
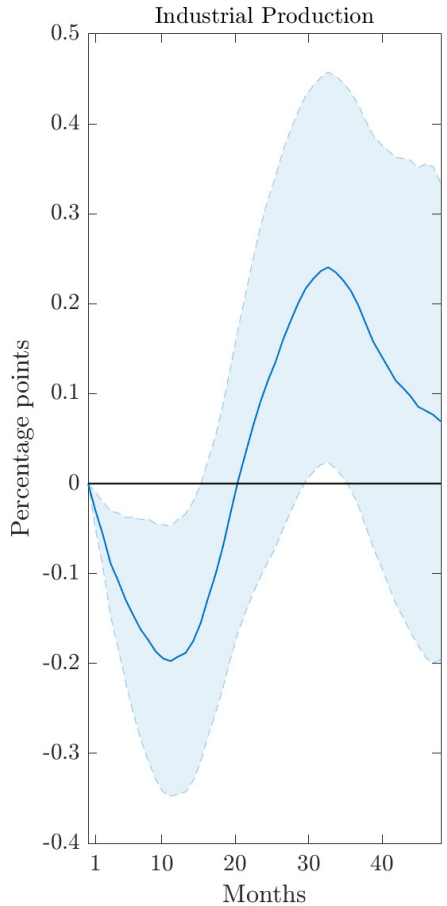
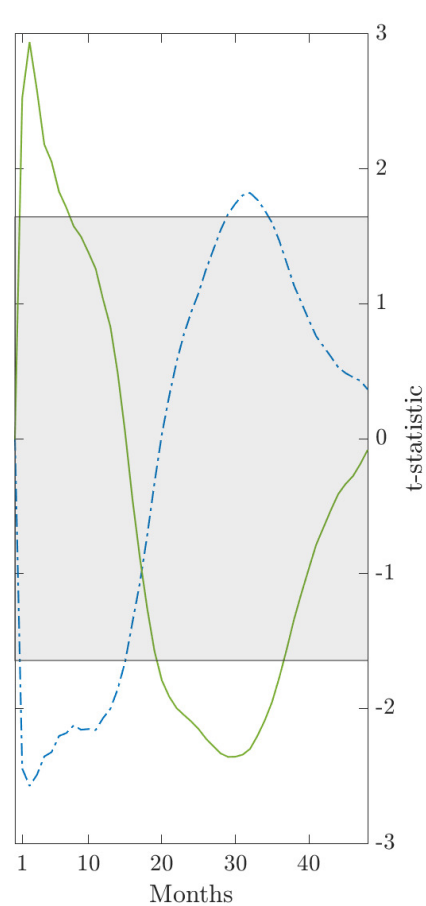
Shocks from STVAR (Test 1, IP)







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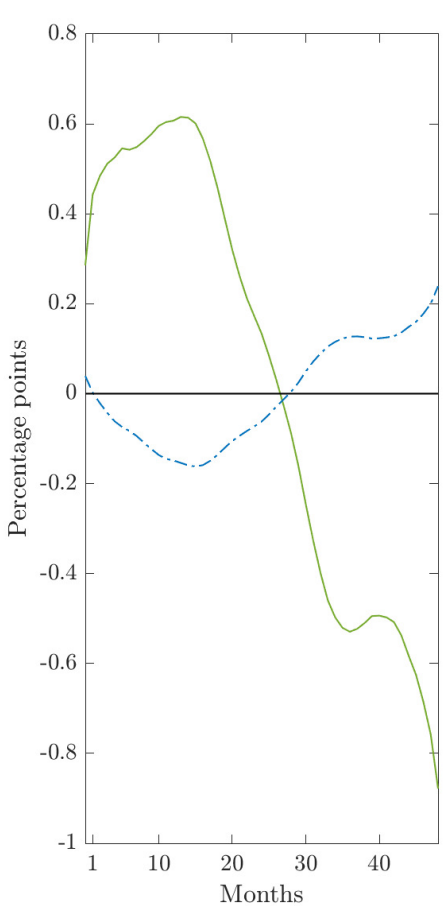
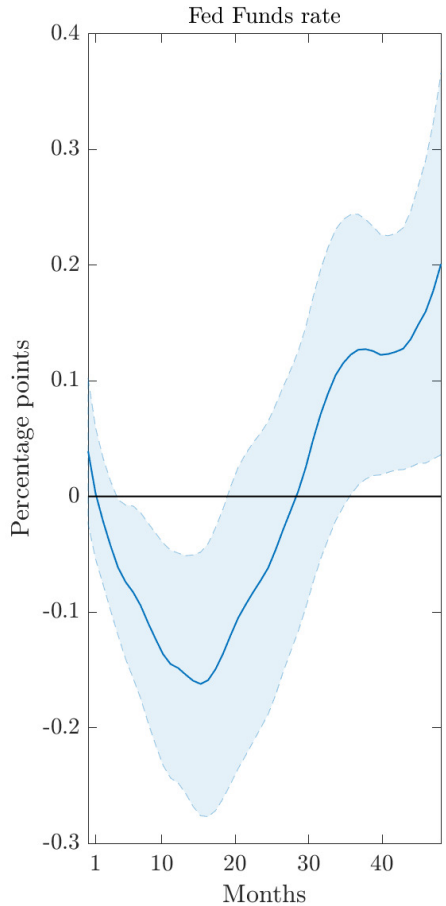
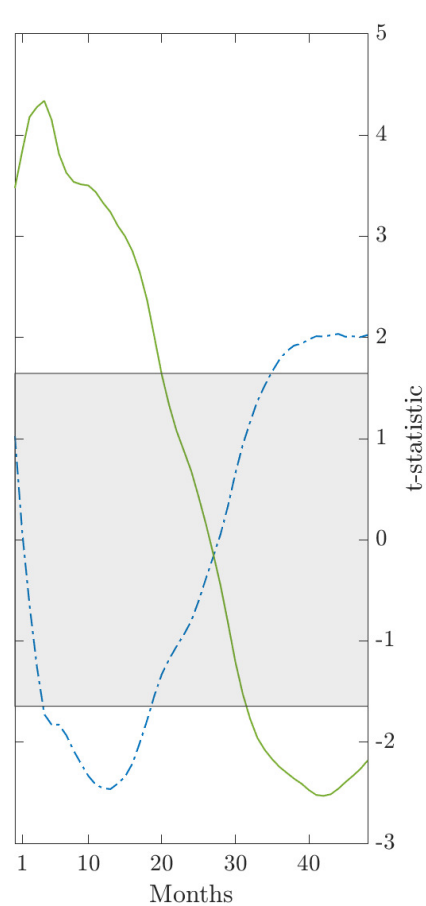
Shocks from STVAR (Test 1, FFR)







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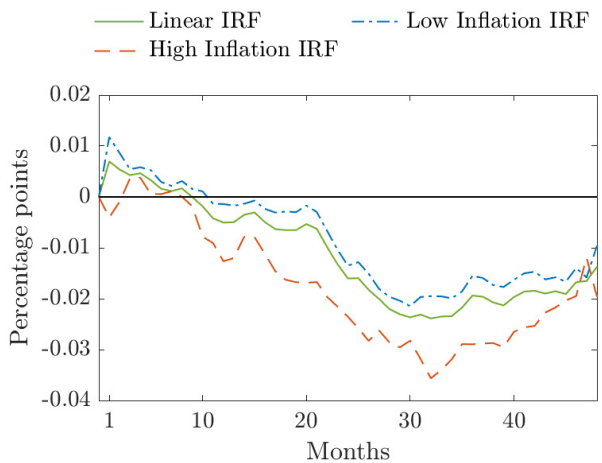
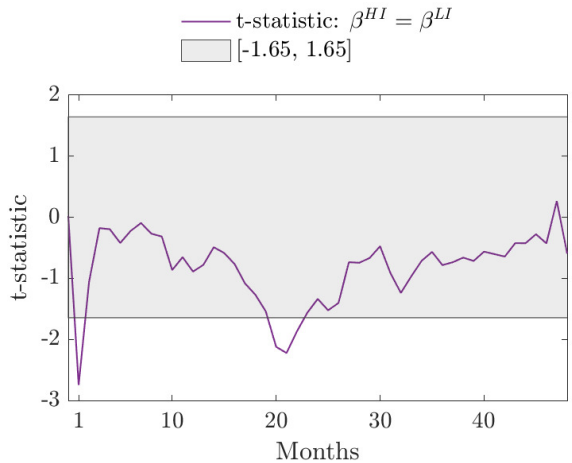
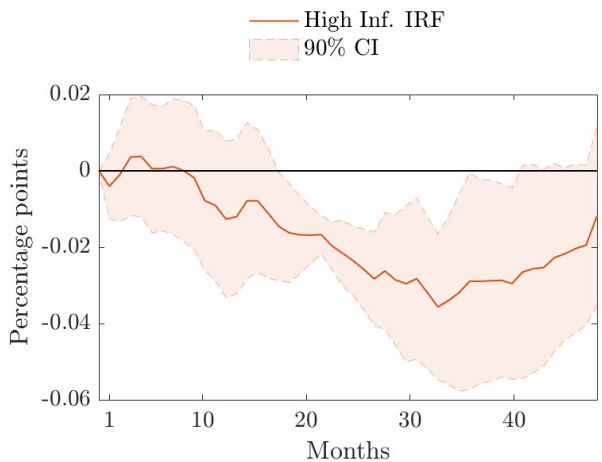
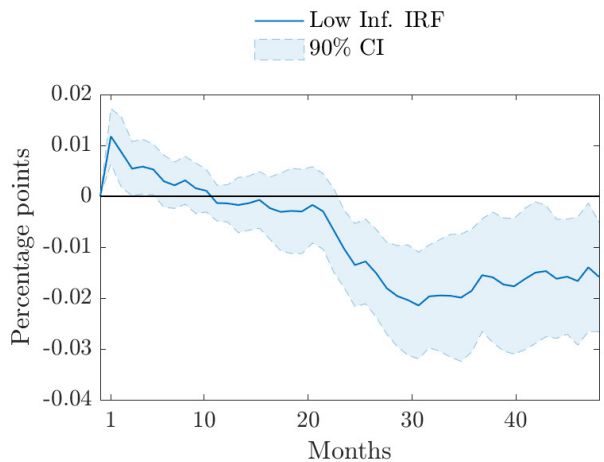
Shocks from STVAR (Test 2, PCE Inf.)









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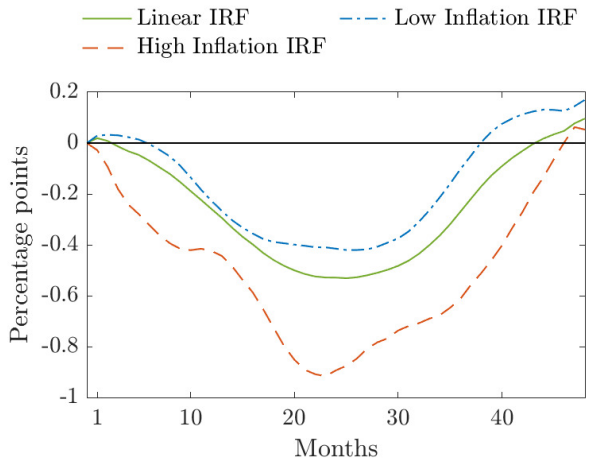
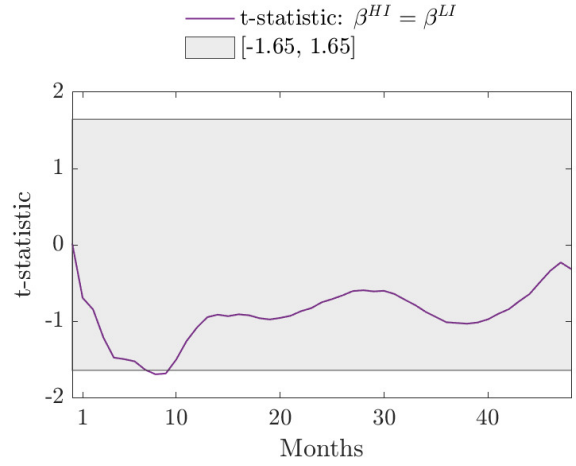
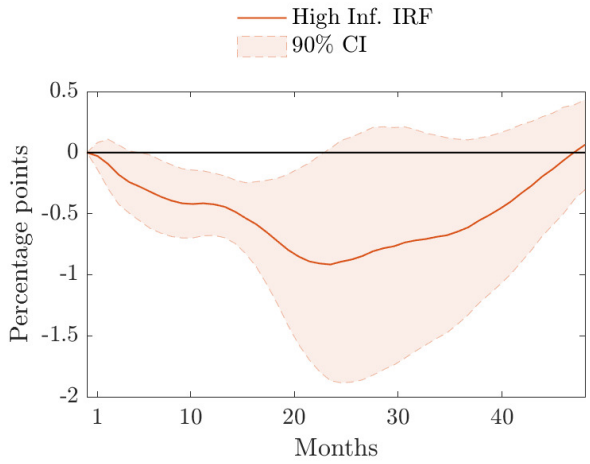
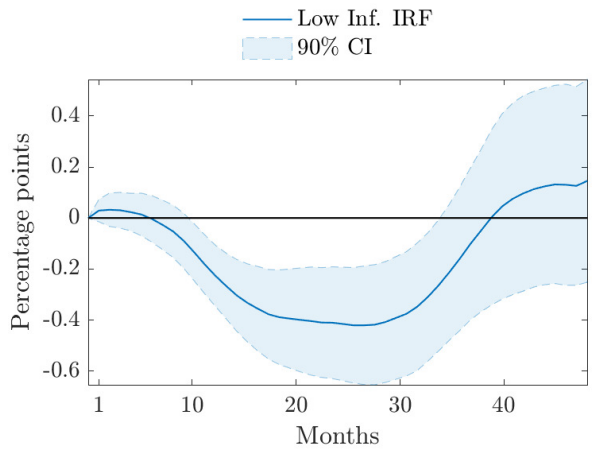
Shocks from STVAR (Test 2, IP)









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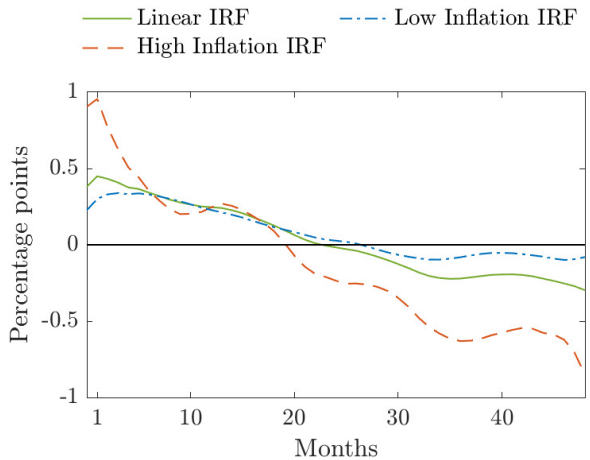
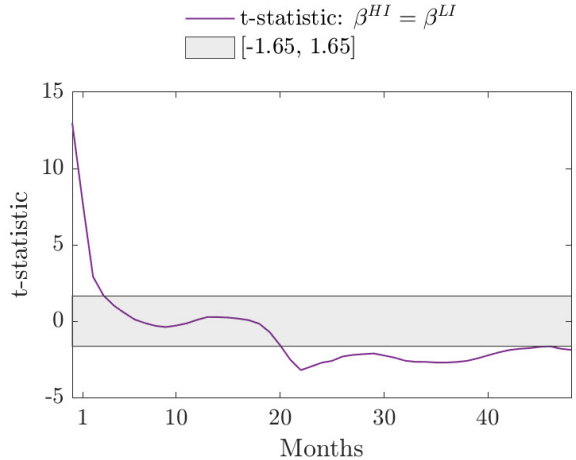
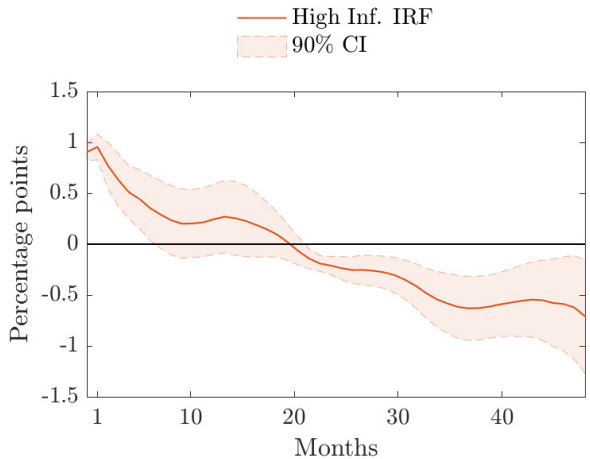
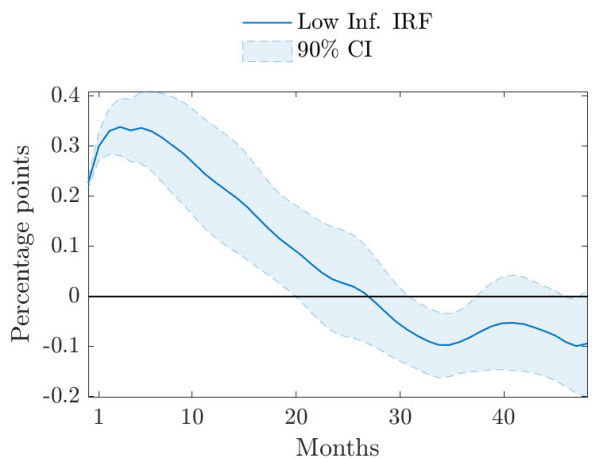
Shocks from STVAR (Test 2, FFR)









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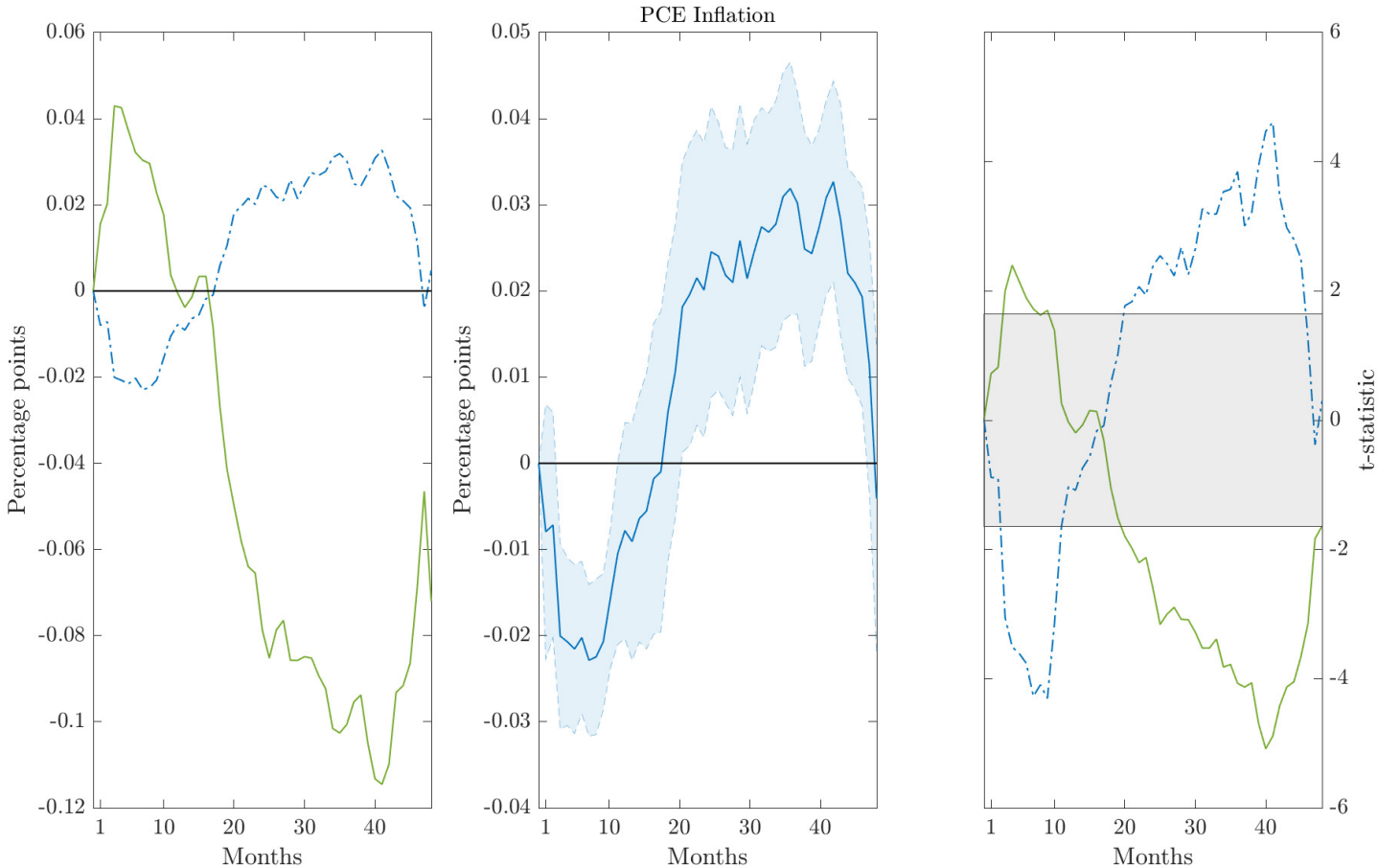
Controlling for GZ Spread (Test 1, PCE Inf.)



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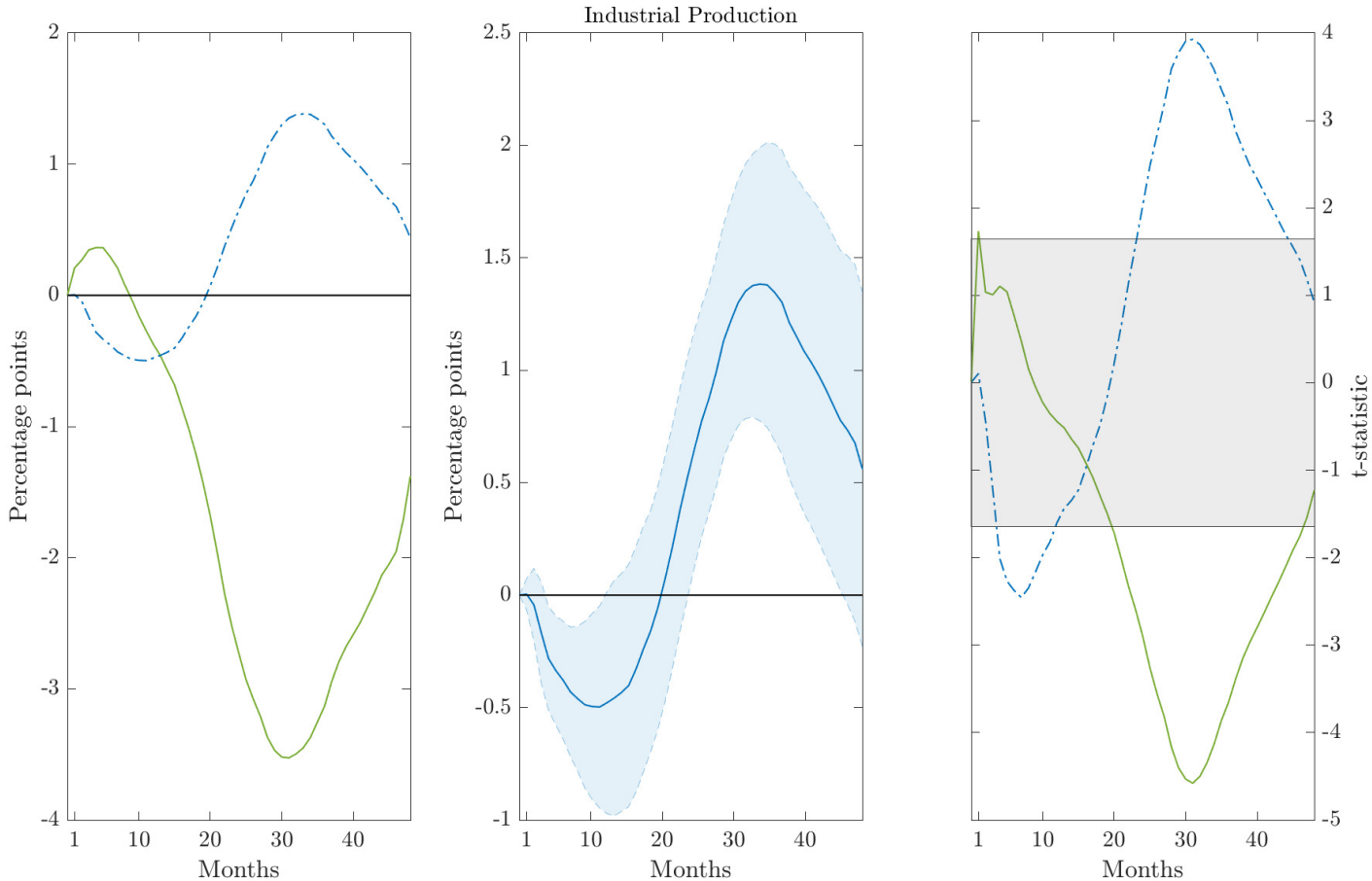
Controlling for GZ Spread (Test 1, IP)



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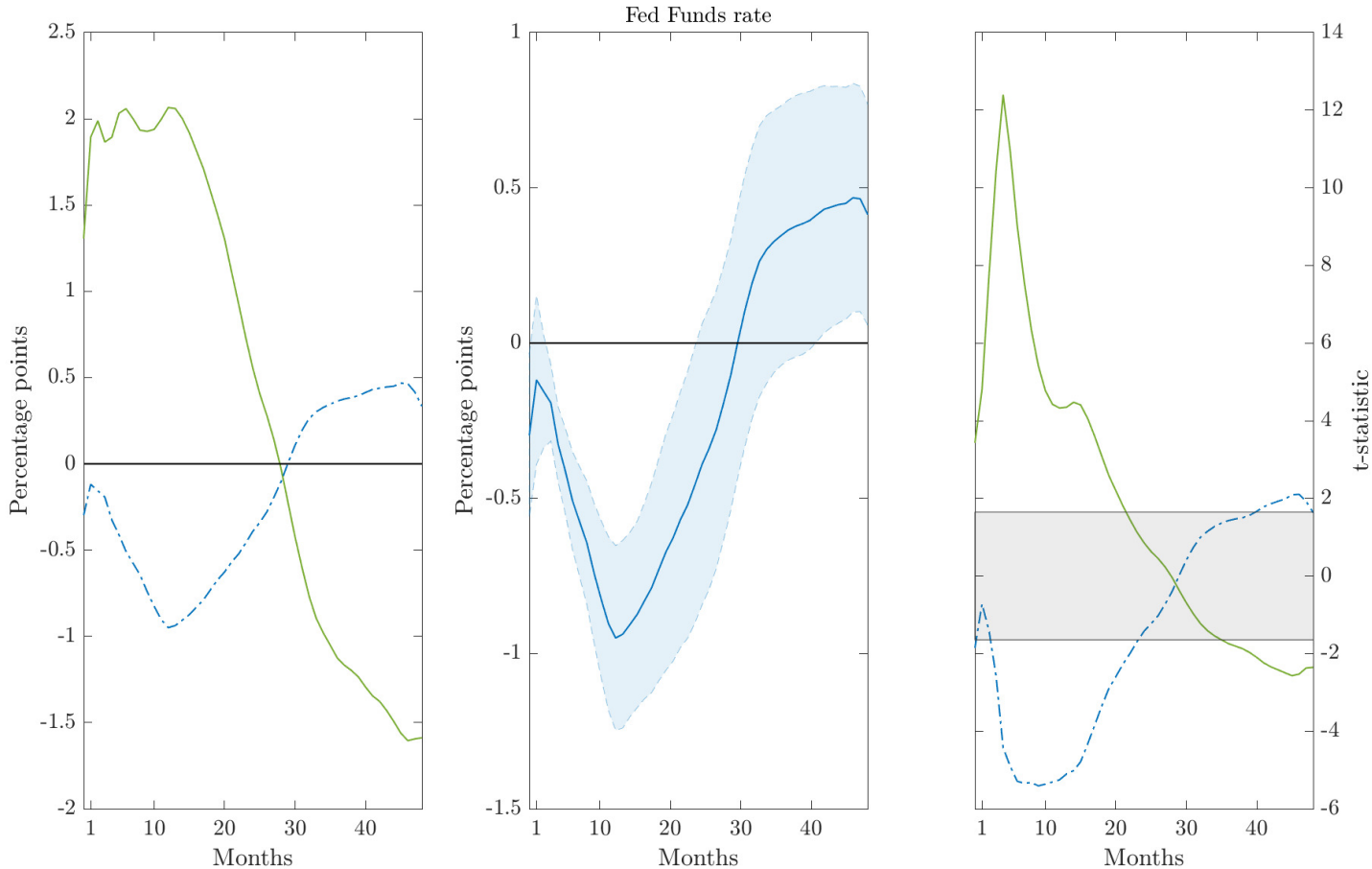
Controlling for GZ Spread (Test 1, FFR)



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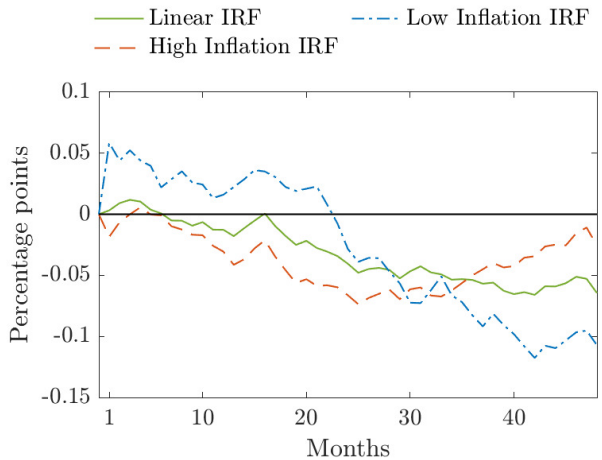
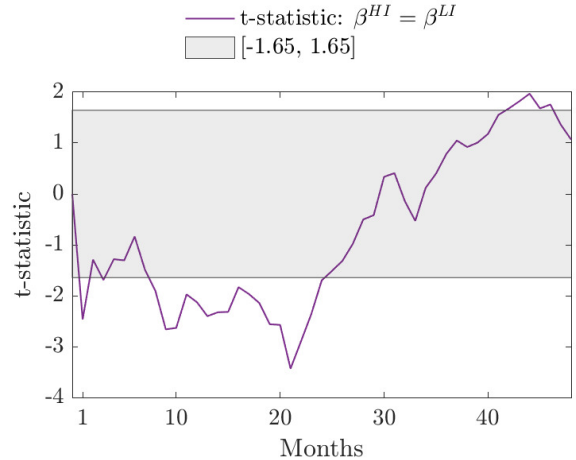
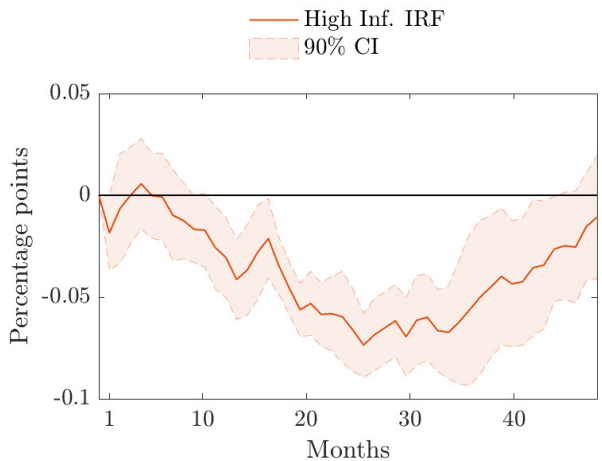
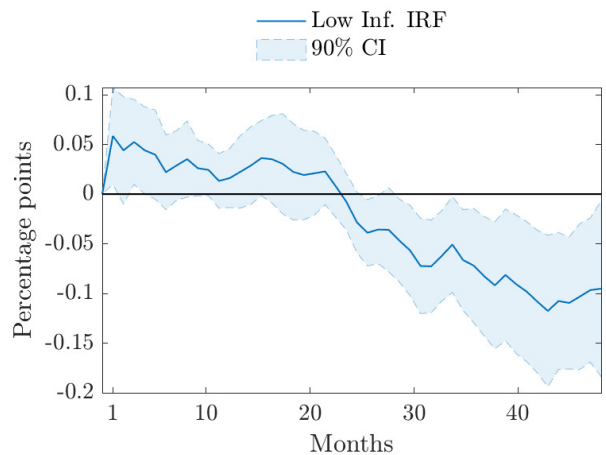
Controlling for GZ Spread (Test 2, PCE Inf.)









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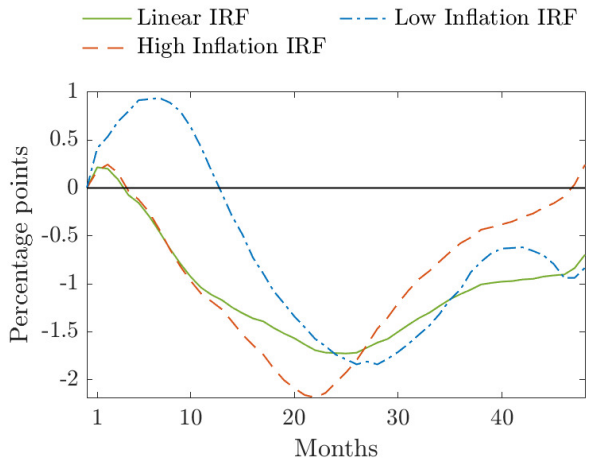
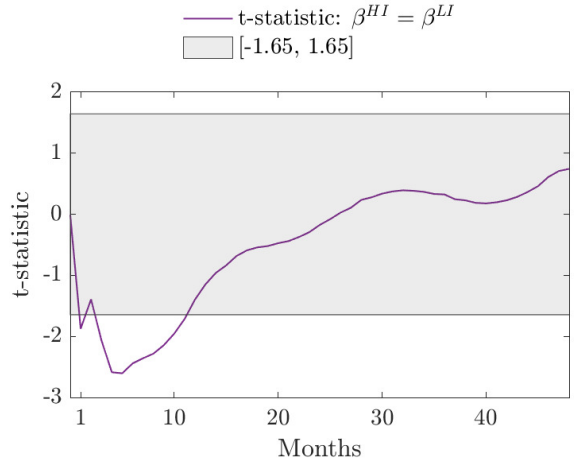
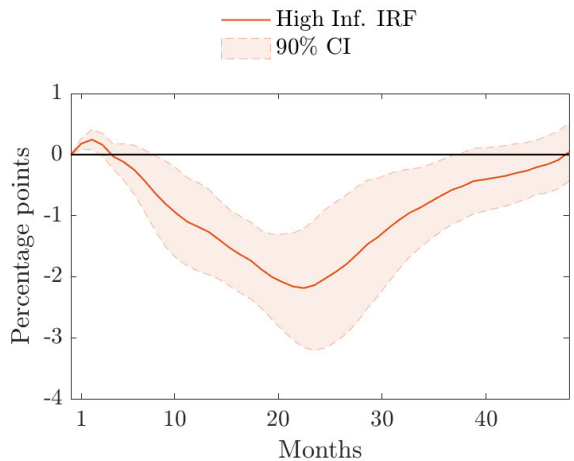
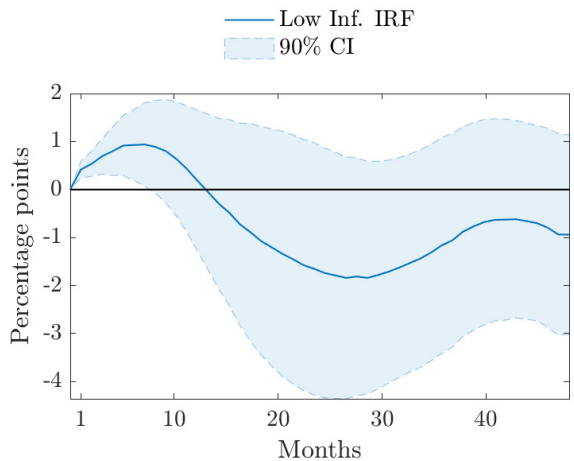
Controlling for GZ Spread (Test 2, IP)









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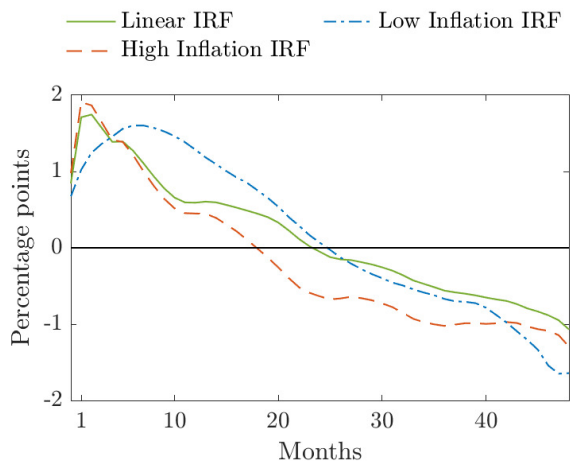
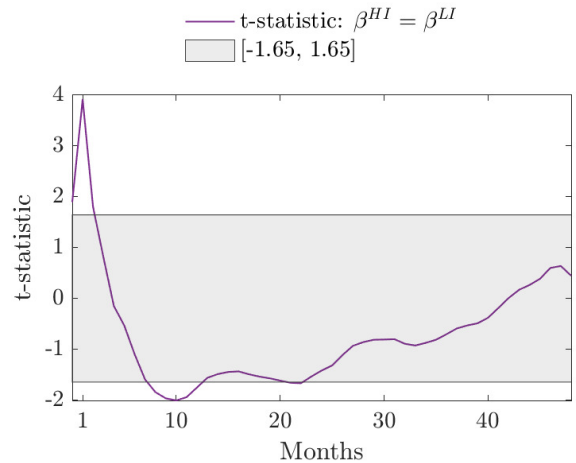
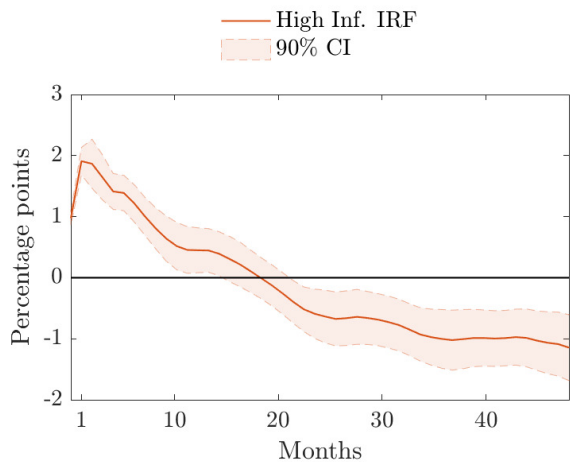
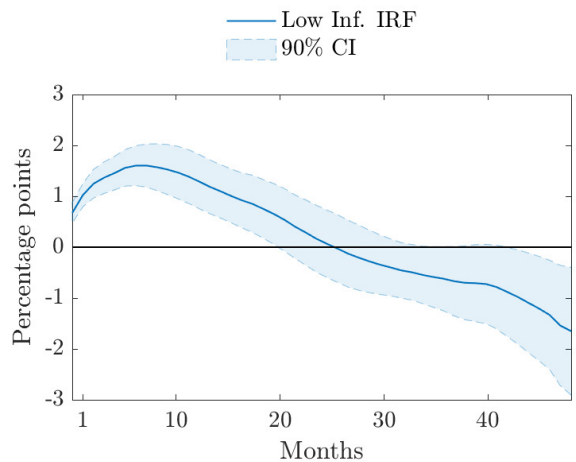
Controlling for GZ Spread (Test 2, FFR)









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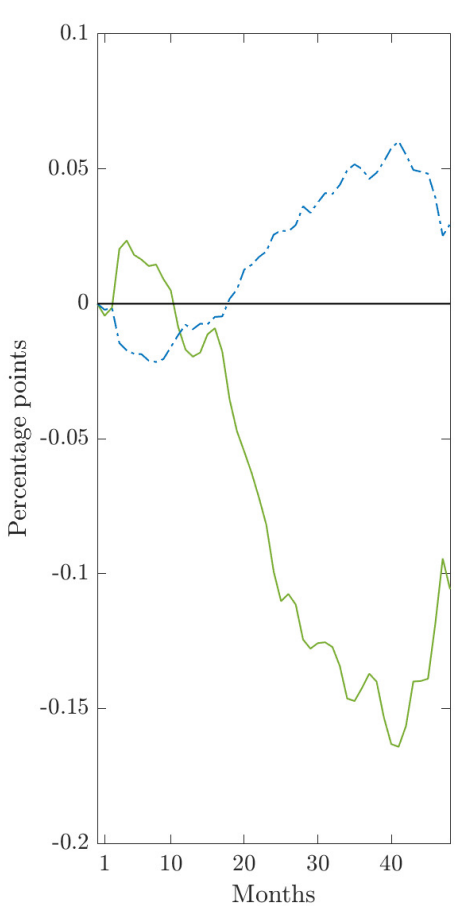
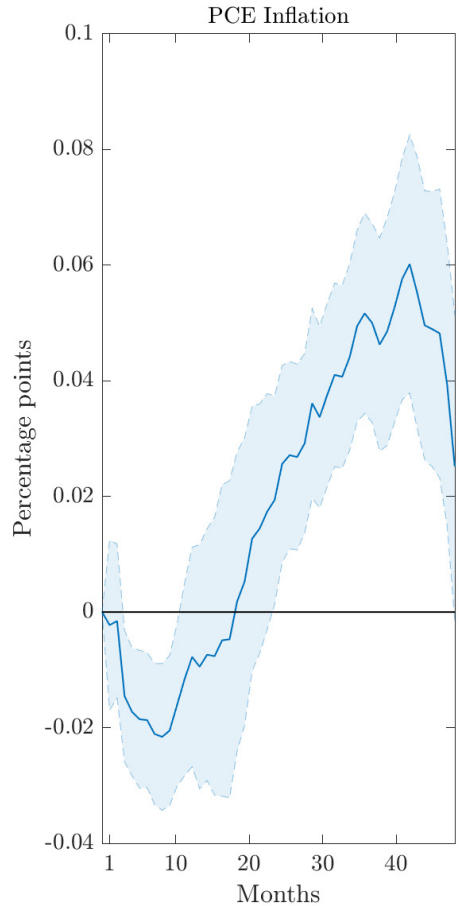
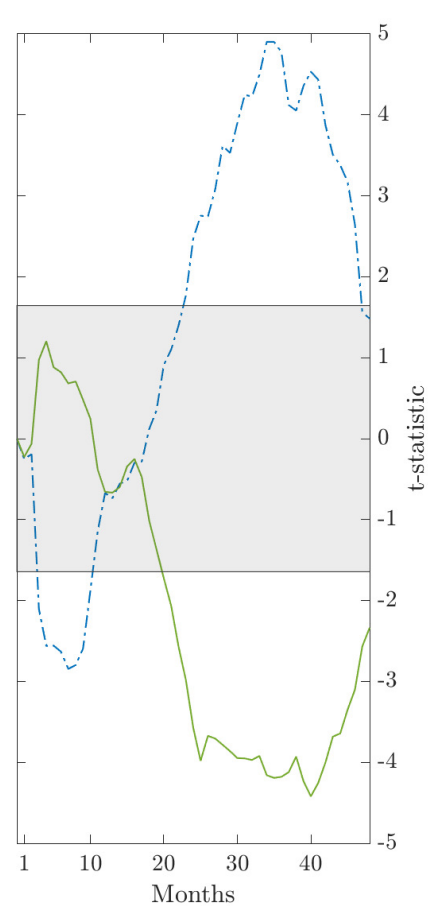
Controlling for PCOM (Test 1, PCE Inf.)







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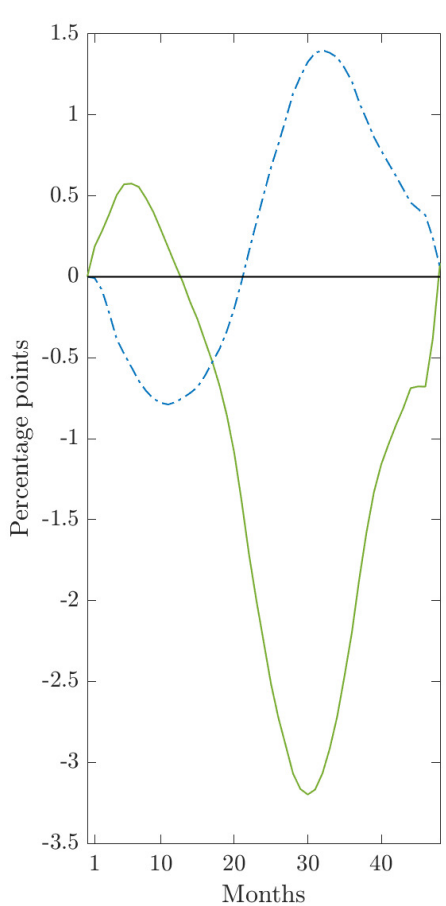
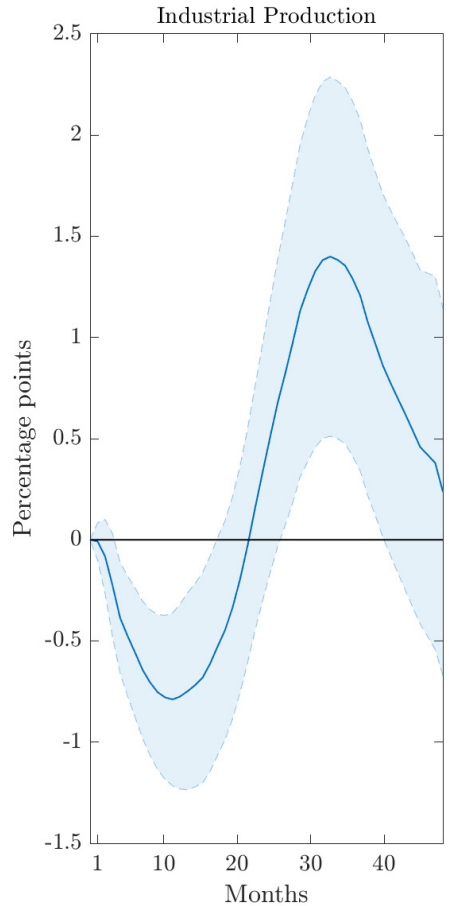
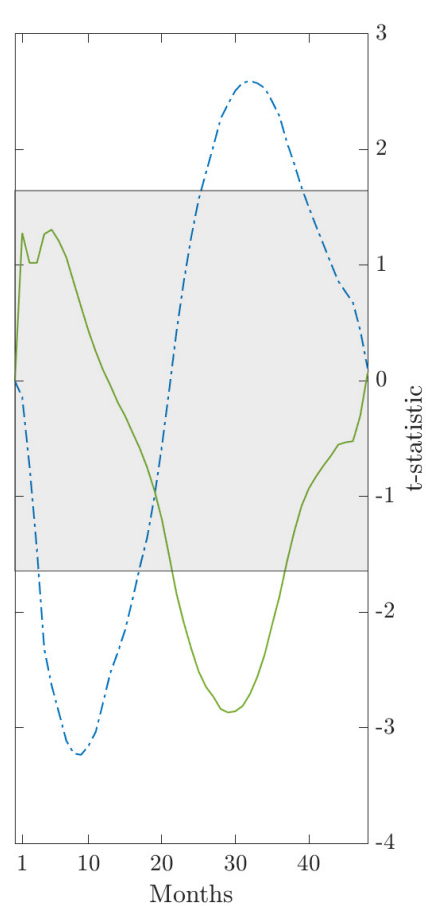
Controlling for PCOM (Test 1, IP)

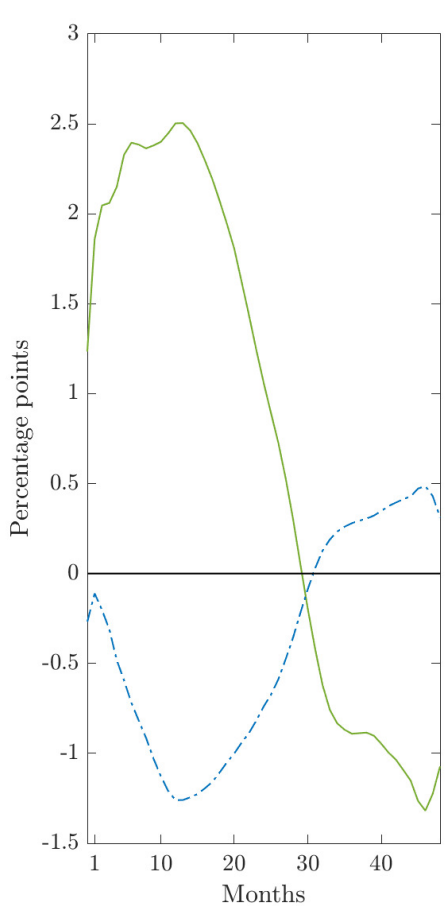


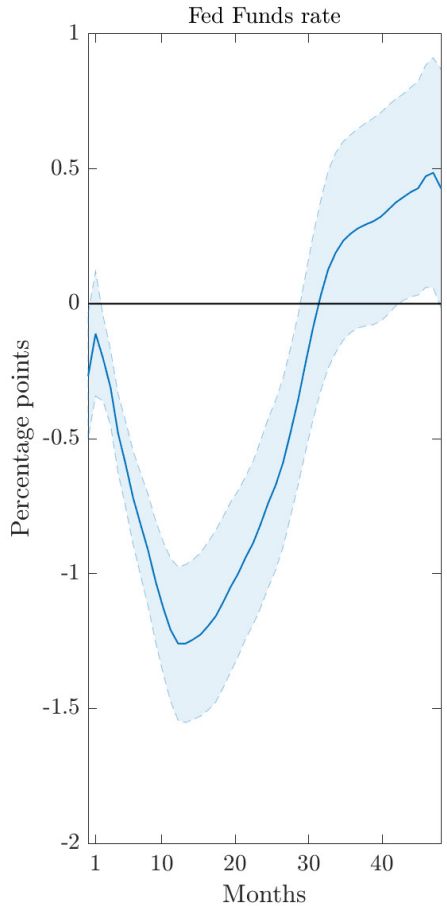


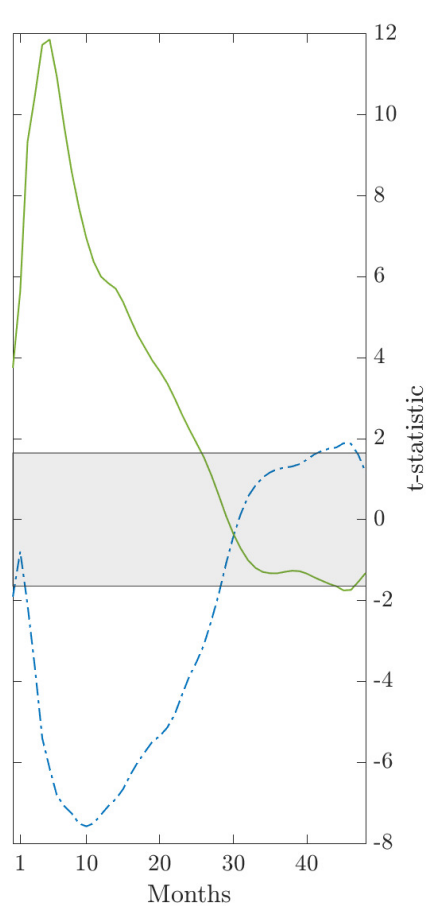


back

Controlling for PCOM (Test 1, FFR)

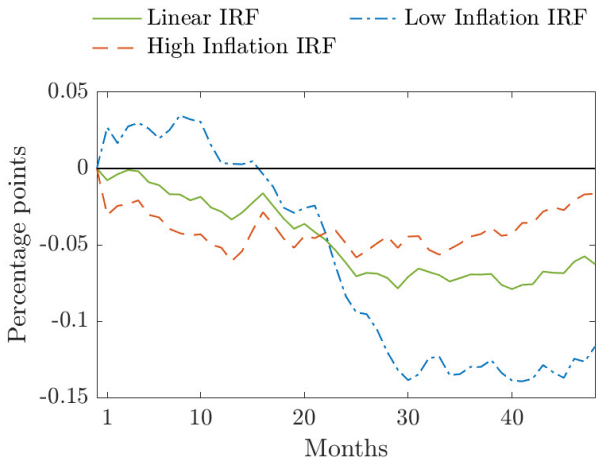


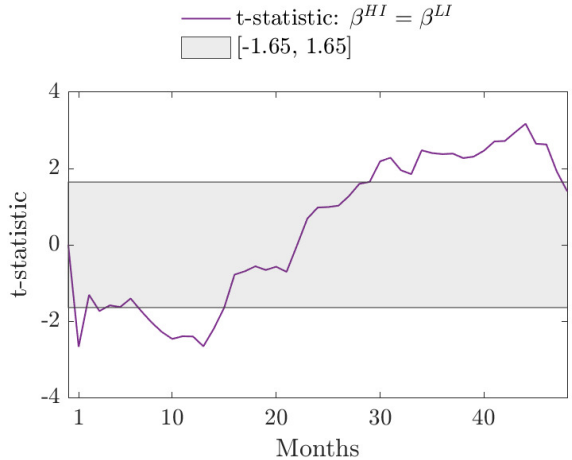


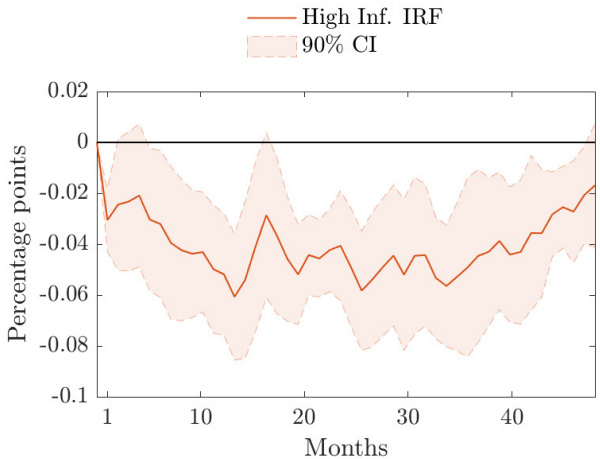


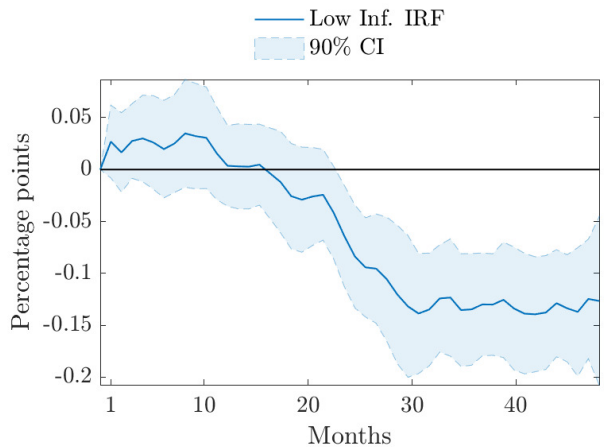
back

Controlling for PCOM (Test 2, PCE Inf.)



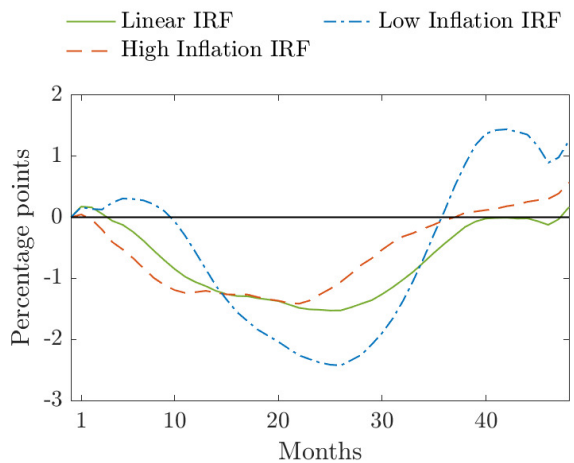


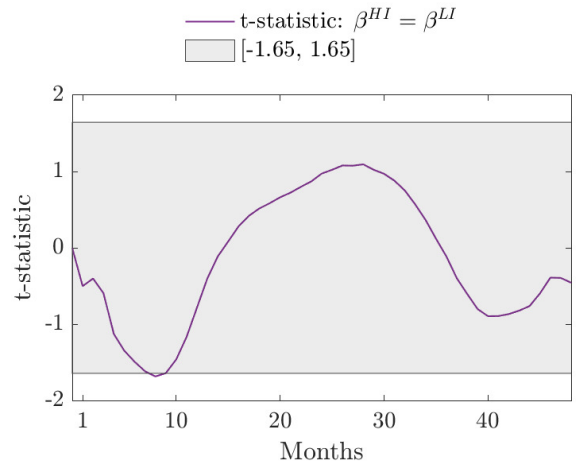


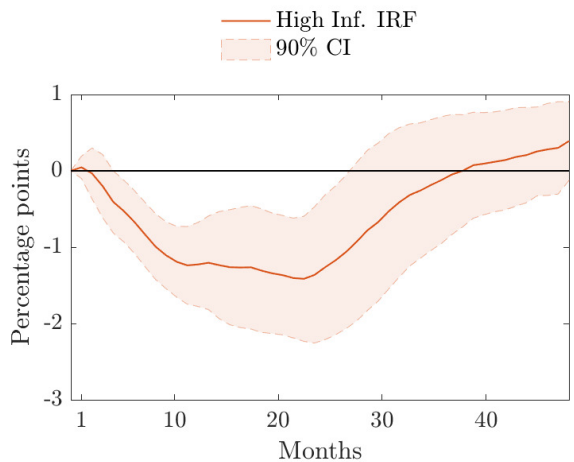


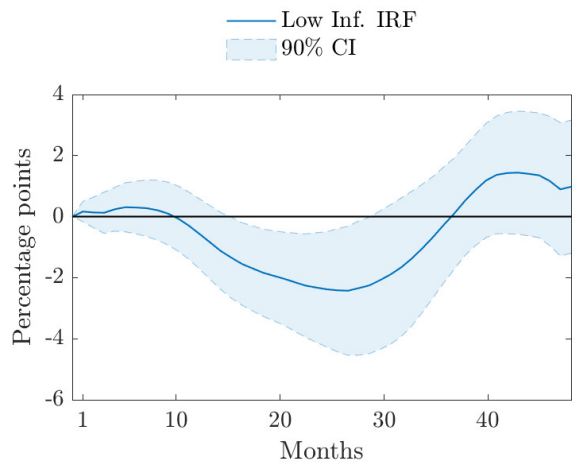
back

Controlling for PCOM (Test 2, IP)









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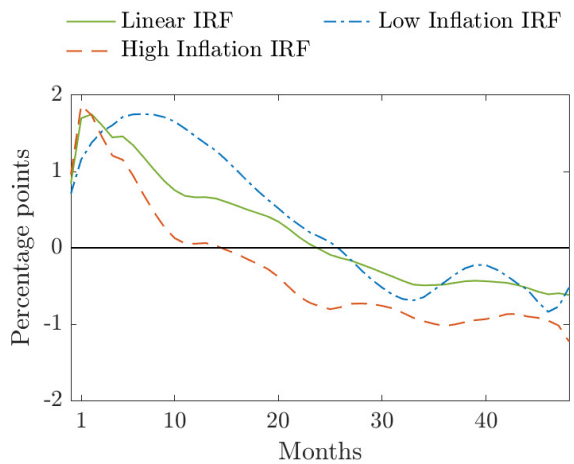
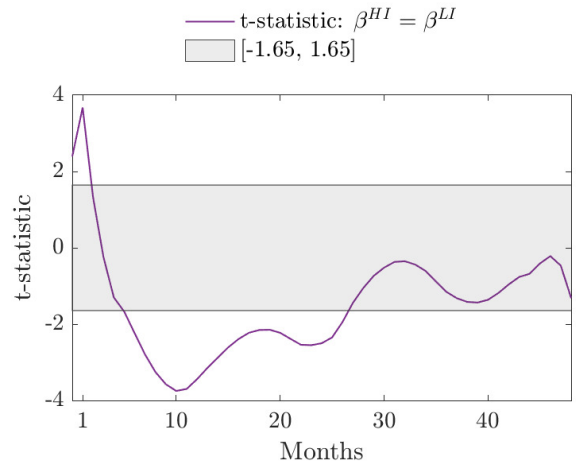
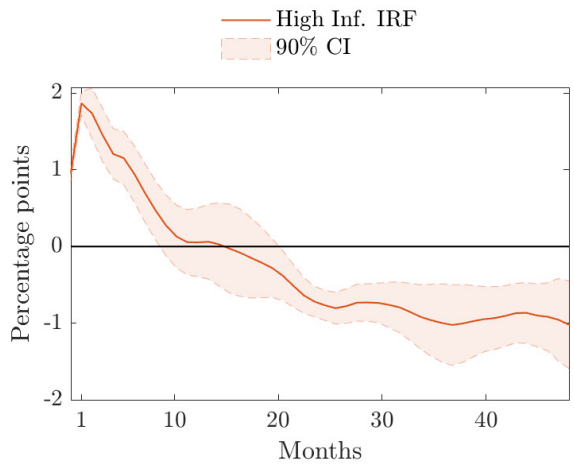
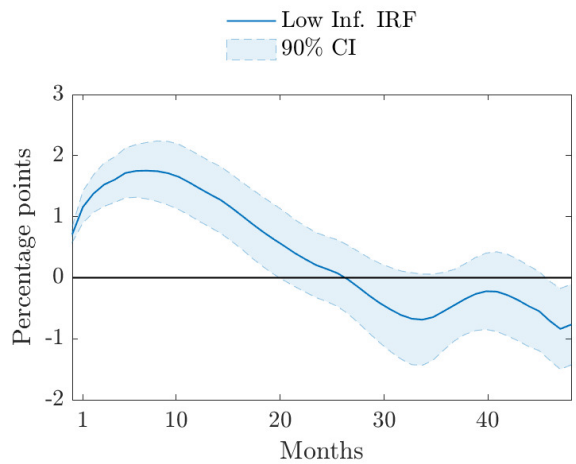
Controlling for PCOM (Test 2, FFR)



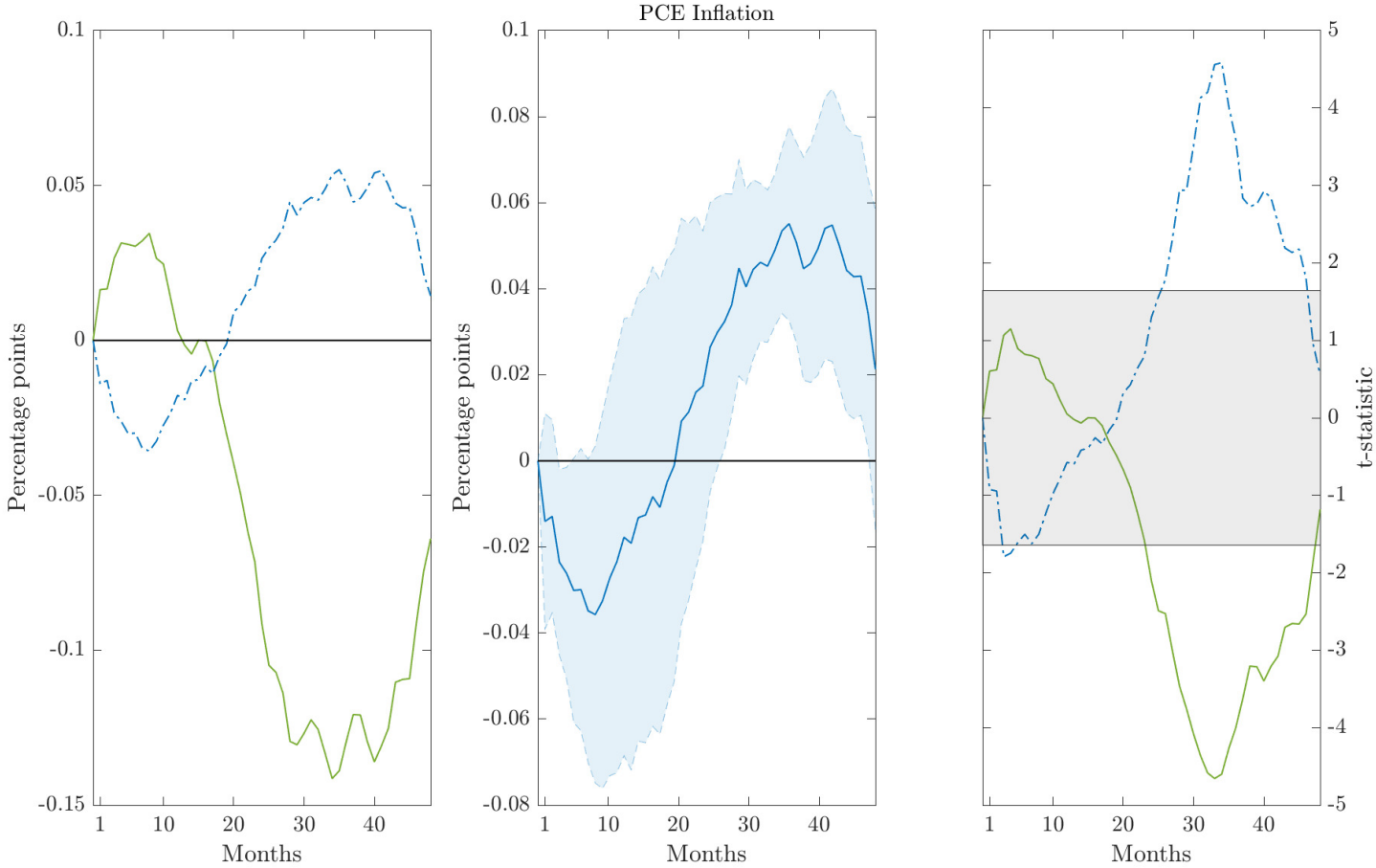






back

State-dependent Romer and Romer Shocks (Test 1, PCE Inf.)



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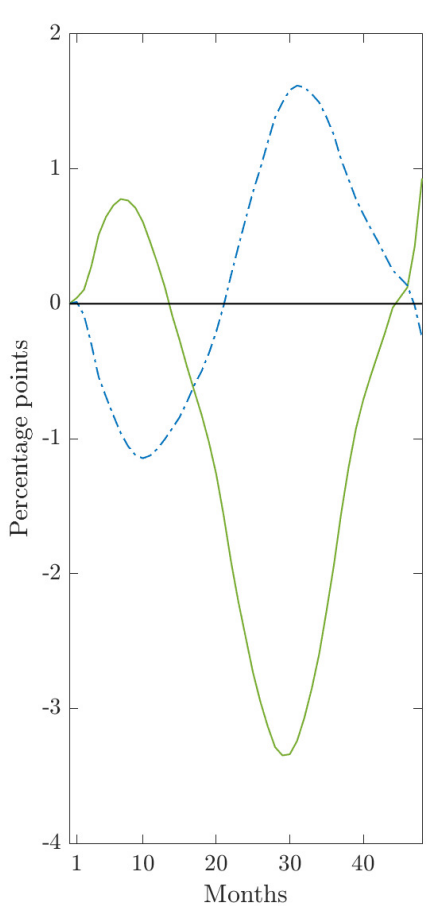
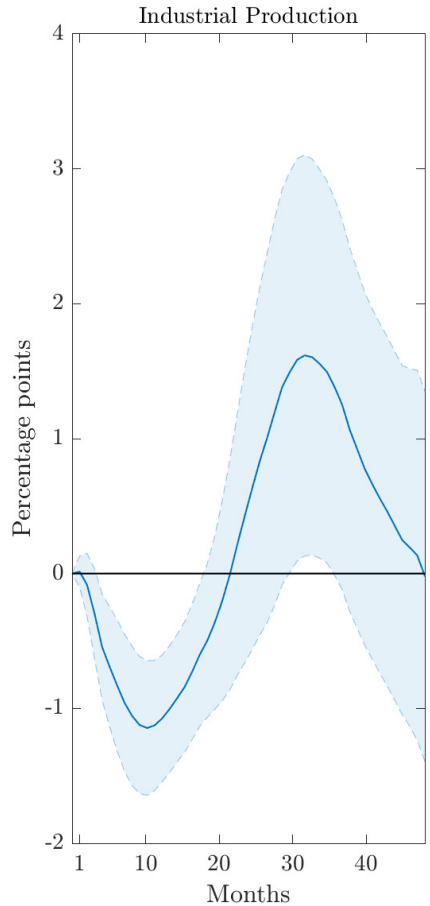
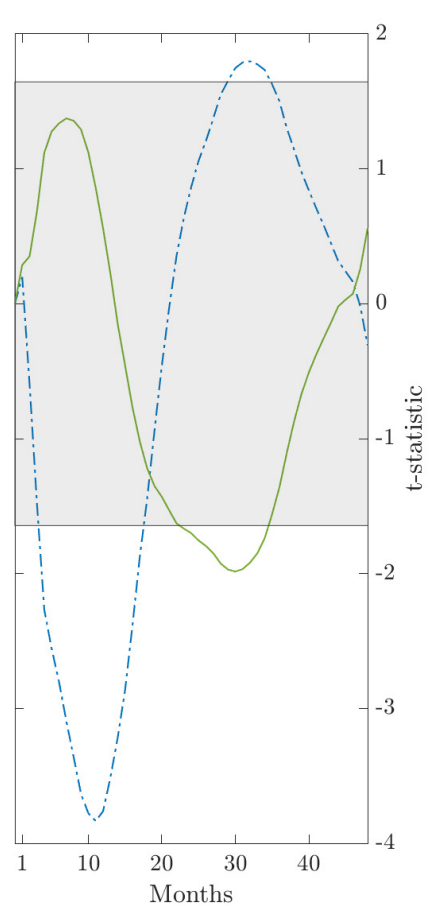
State-dependent Romer and Romer Shocks (Test 1, IP)







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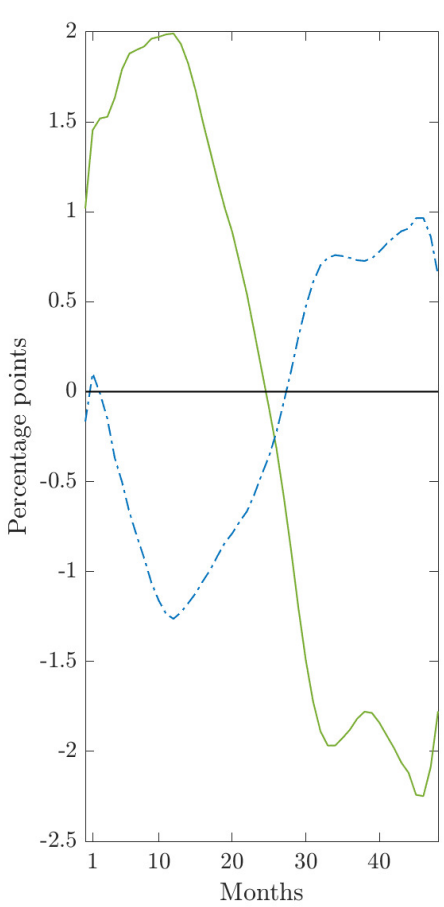
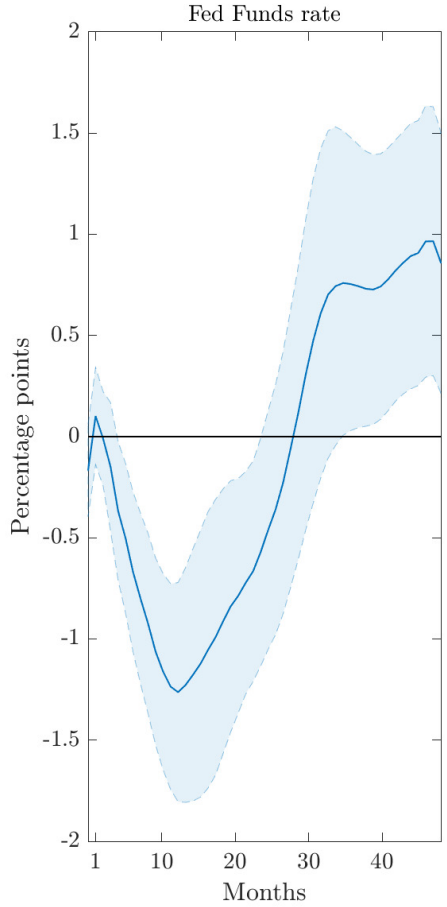
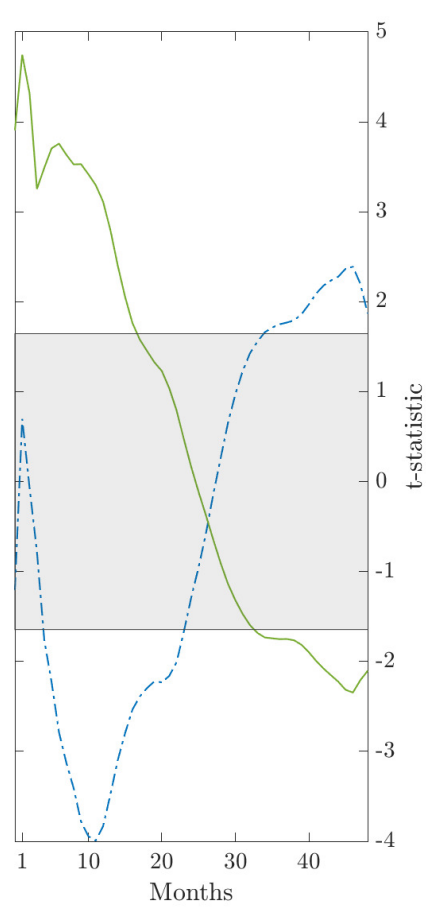
State-dependent Romer and Romer Shocks (Test 1, FFR)

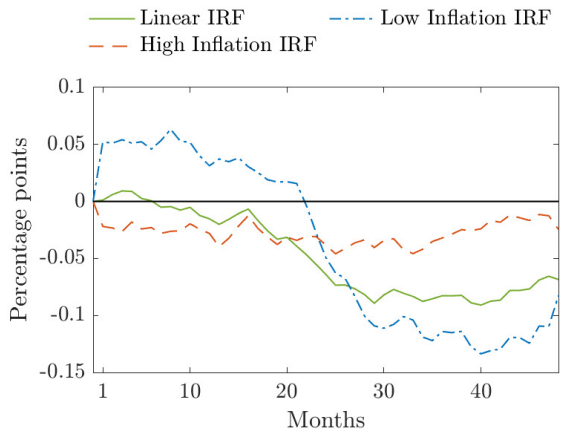


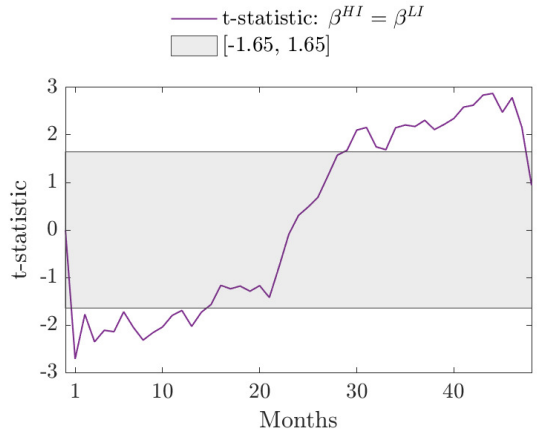


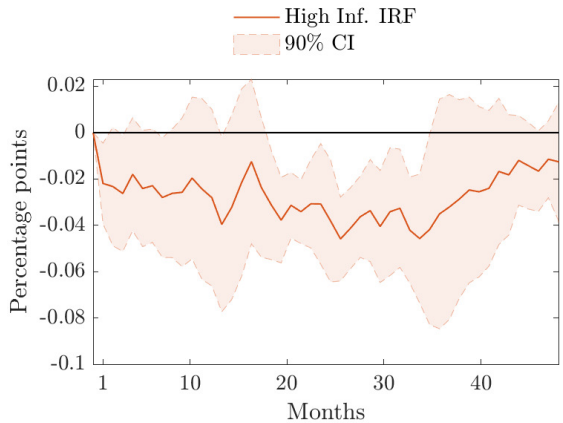


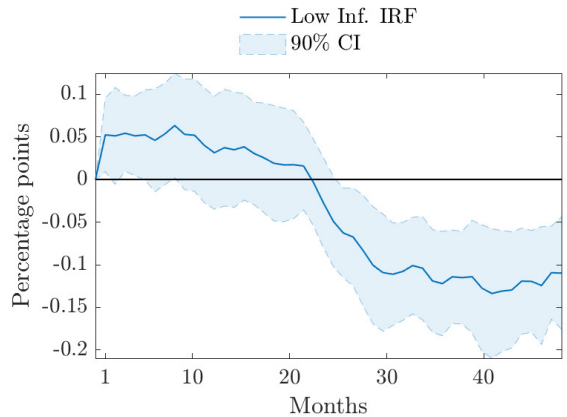
◂ back

State-dependent Romer and Romer Shocks (Test 2, PCE Inf.)









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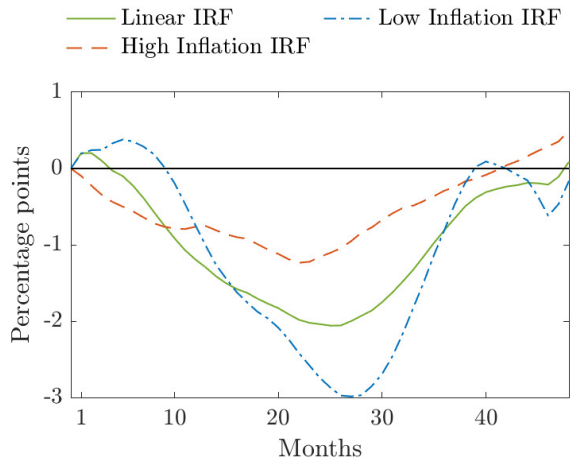
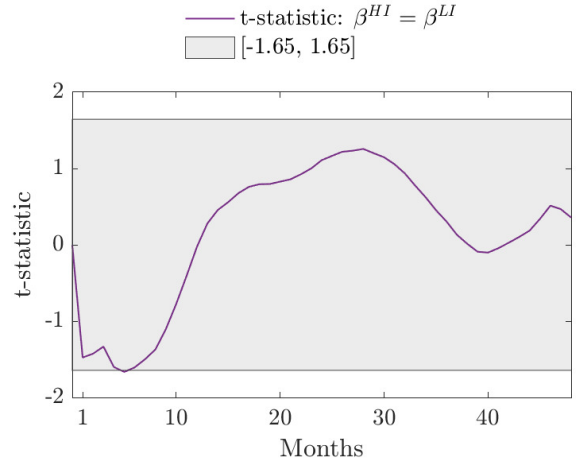
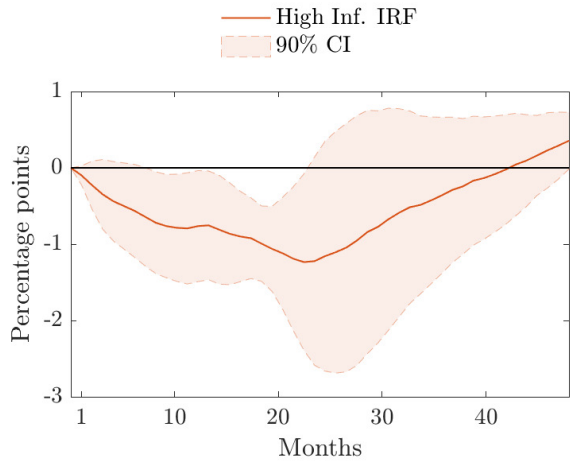
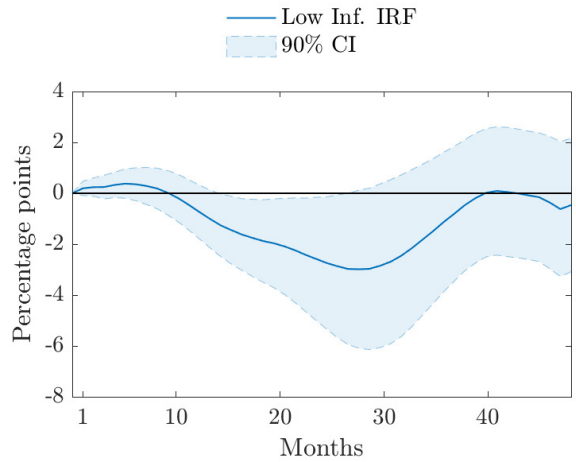
State-dependent Romer and Romer Shocks (Test 2, IP)









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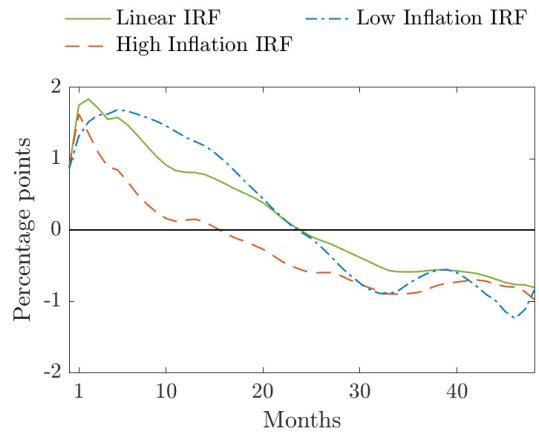
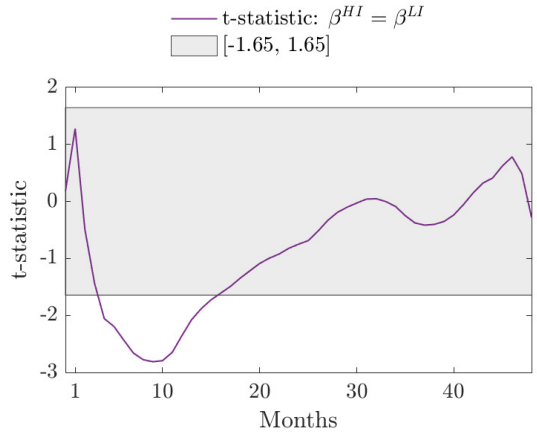
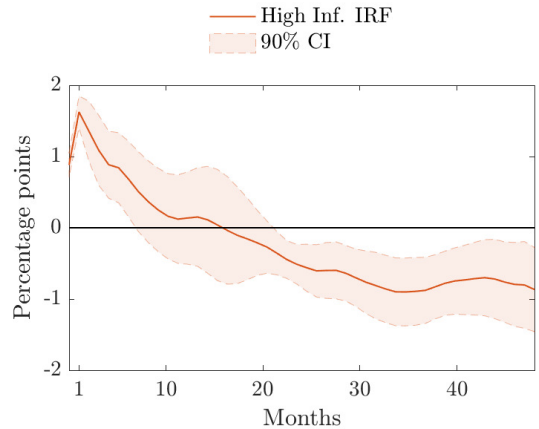
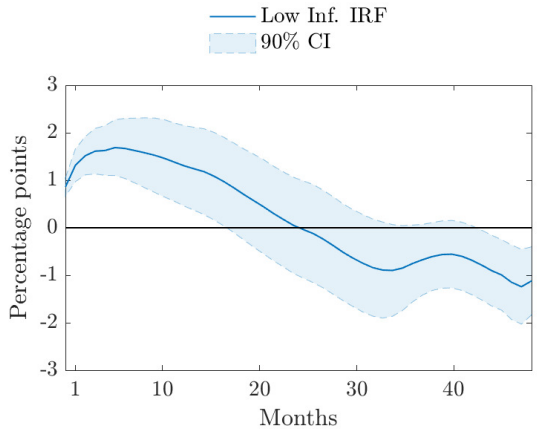
State-dependent Romer and Romer Shocks (Test 2, FFR)



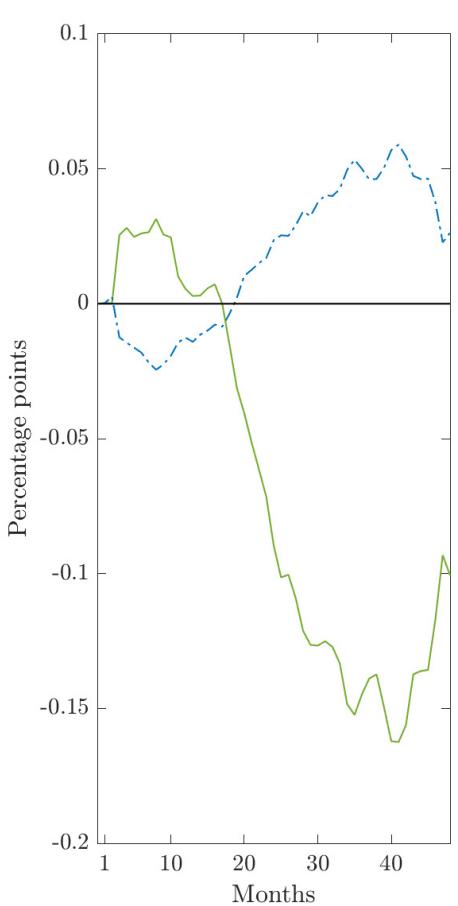


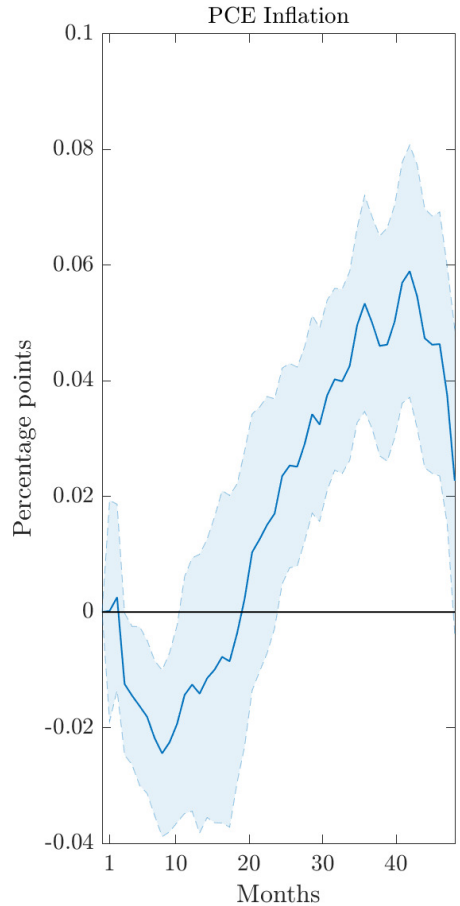


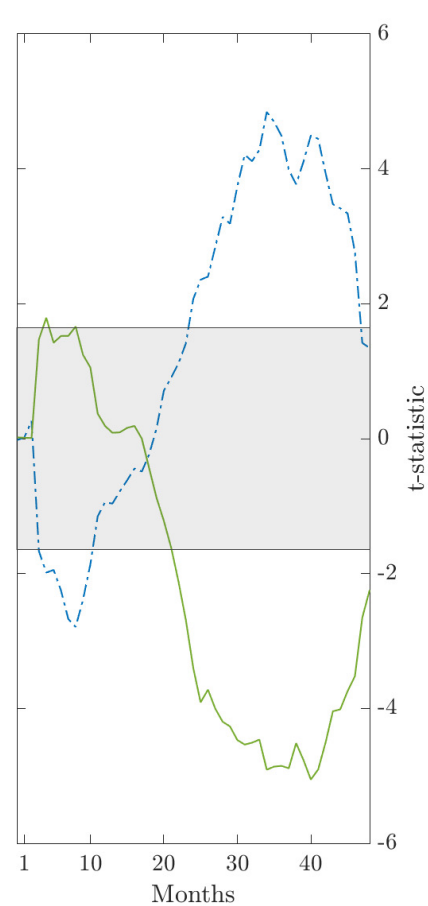


back

Inclusion of two lags of shocks (Test 1, PCE Inf.)

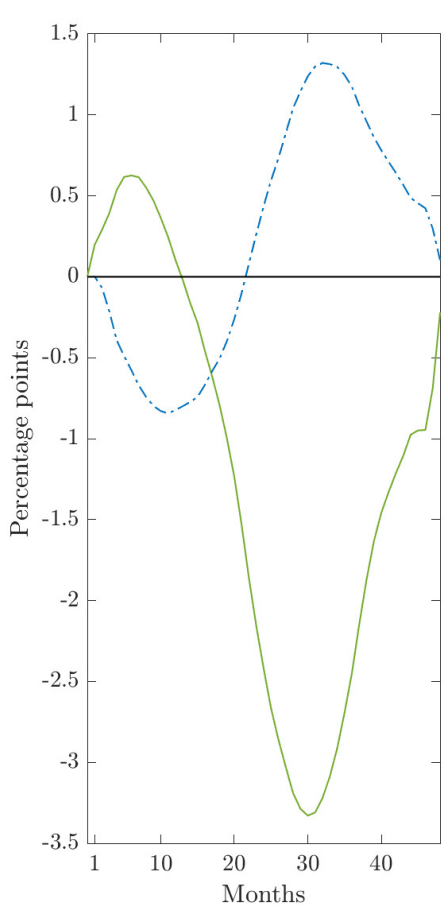


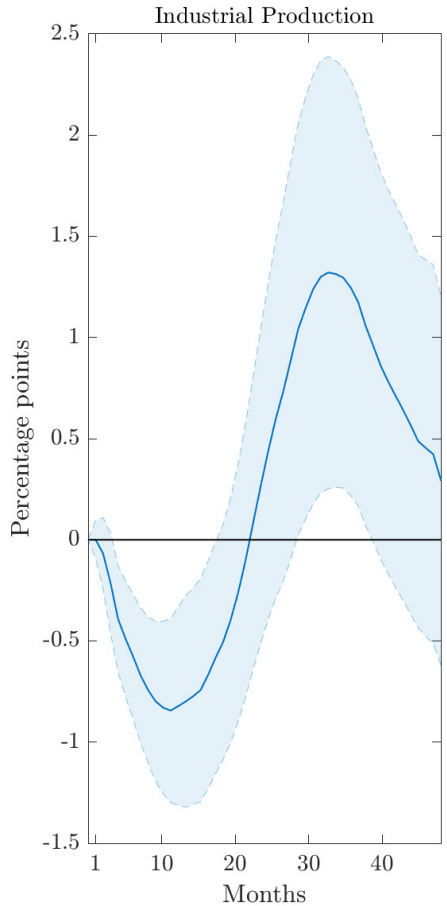


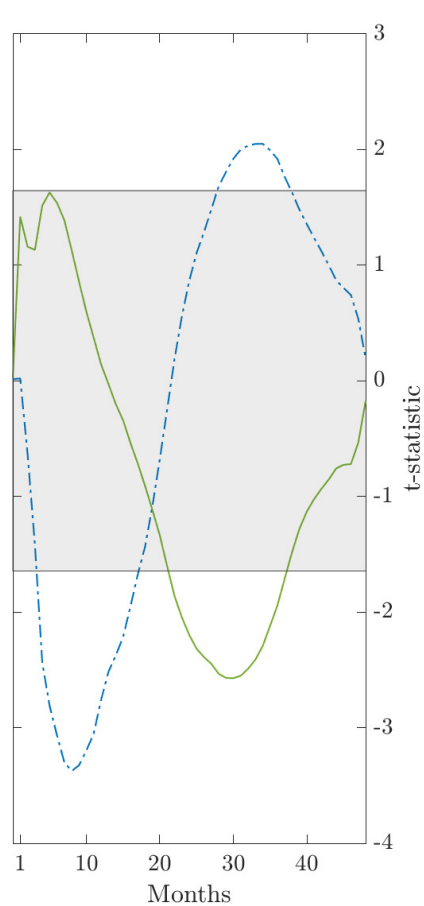


◂ back

Inclusion of two lags of shocks(Test 1, IP)







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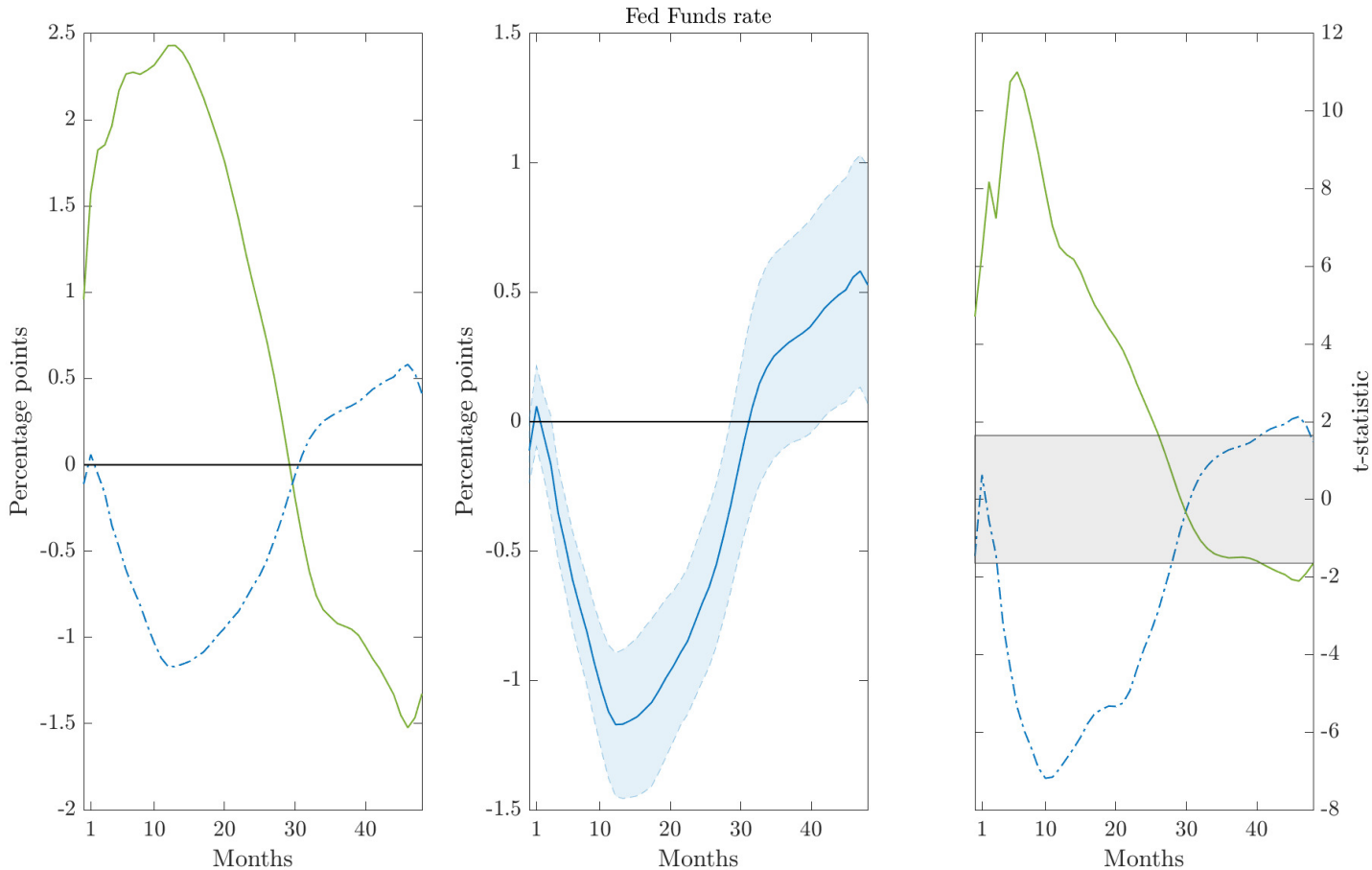
Inclusion of two lags of shocks (Test 1, FFR)



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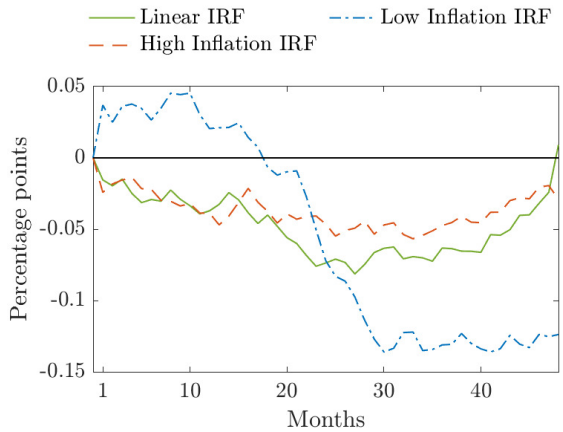
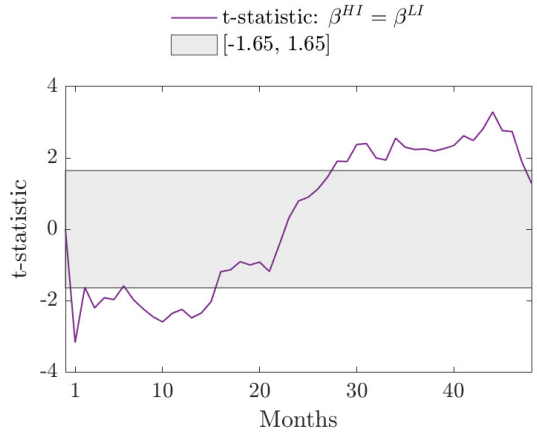
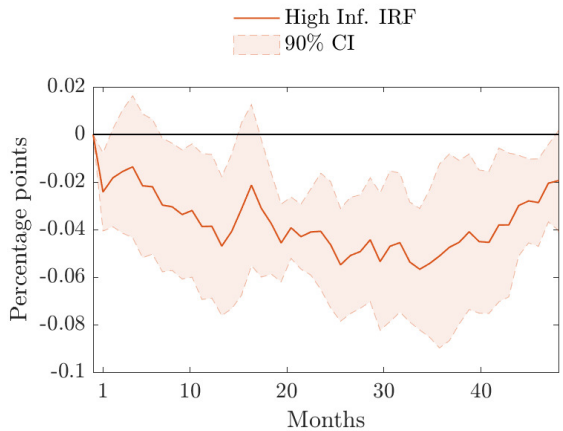
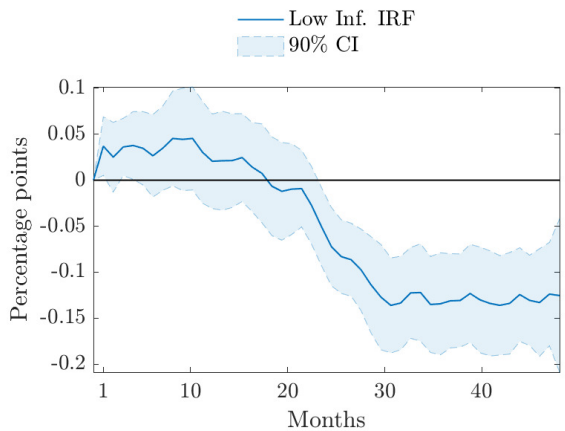
Inclusion of two lags of shocks (Test 2, PCE Inf.)



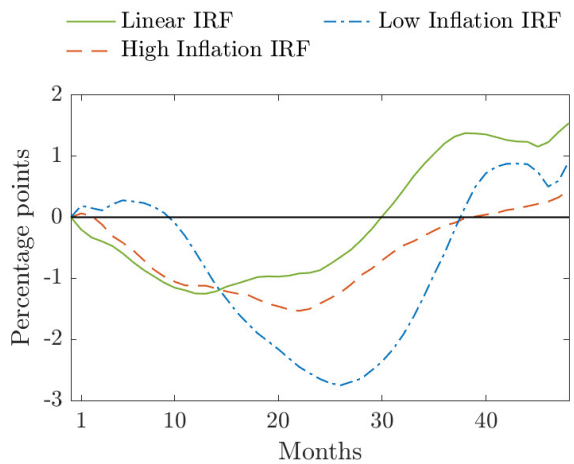


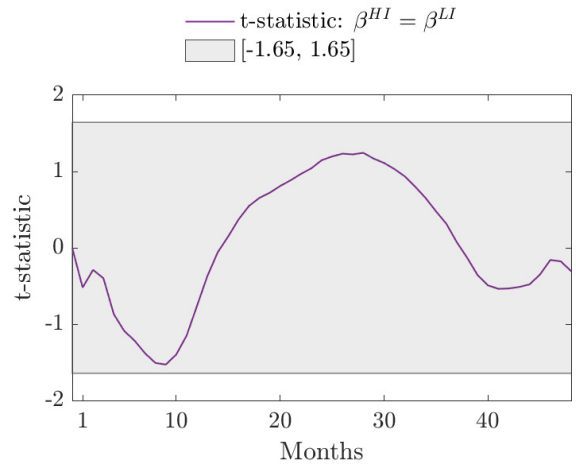


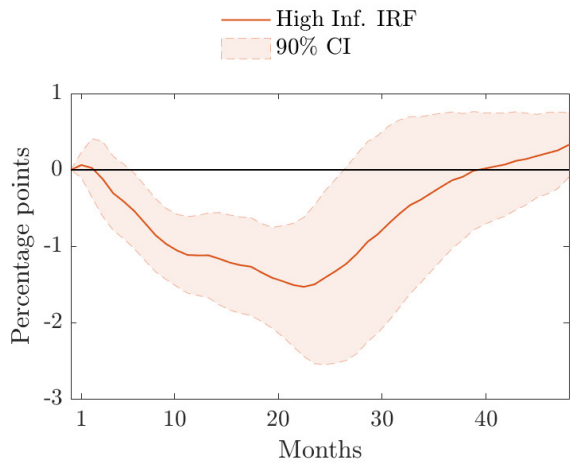


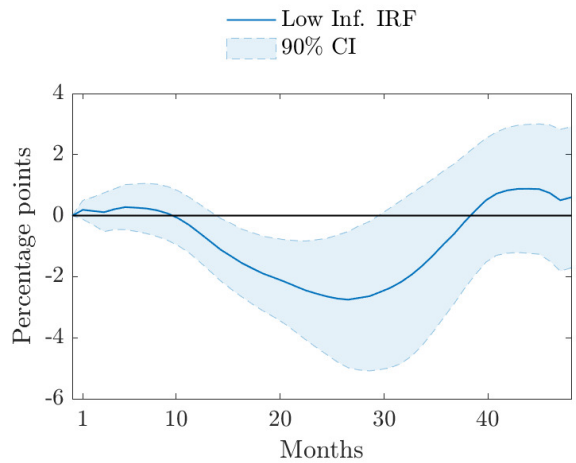
◂ back

Inclusion of two lags of shocks (Test 2, IP)



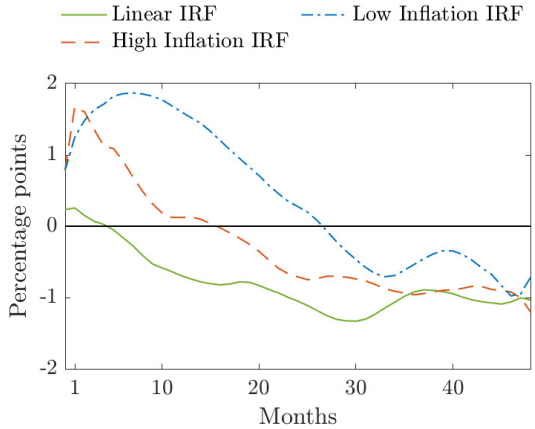


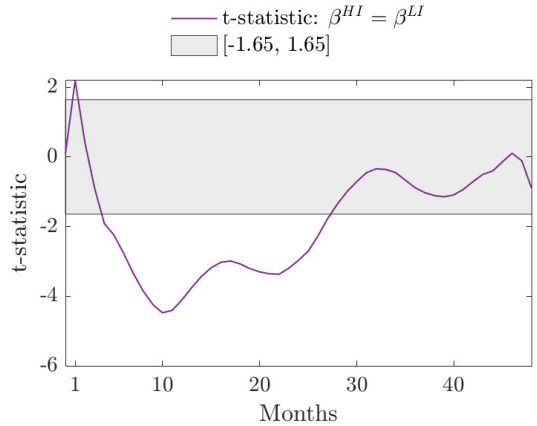


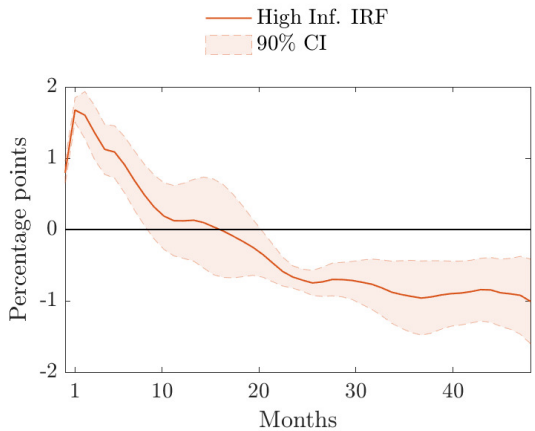


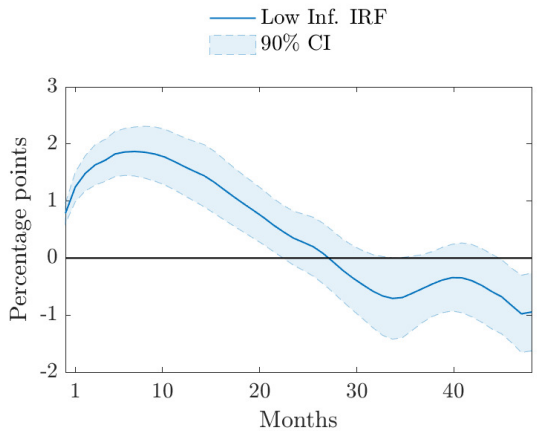
back

Inclusion of two lags of shocks (Test 2, FFR)



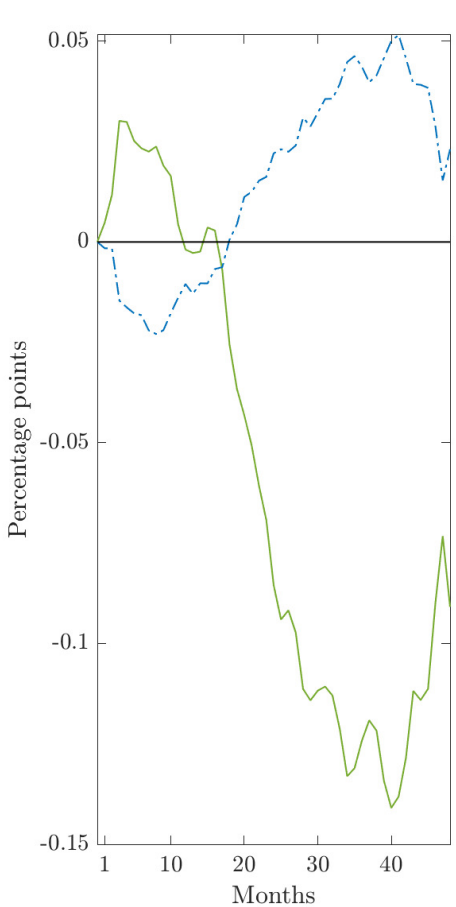


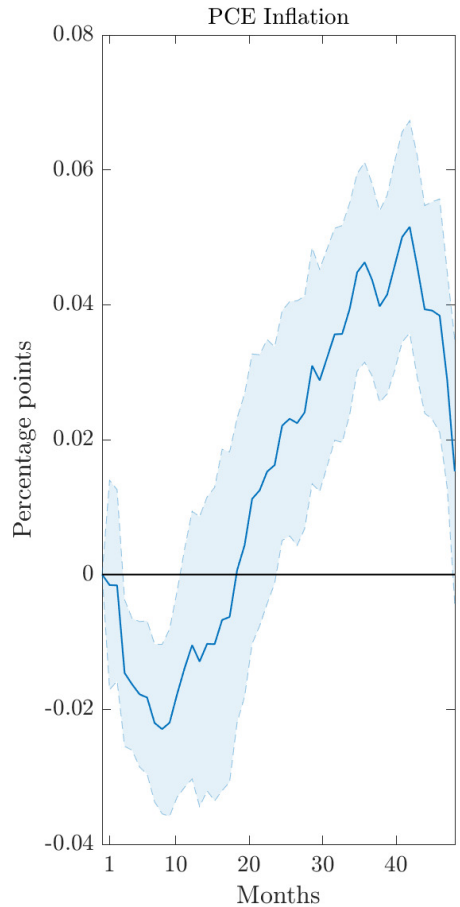


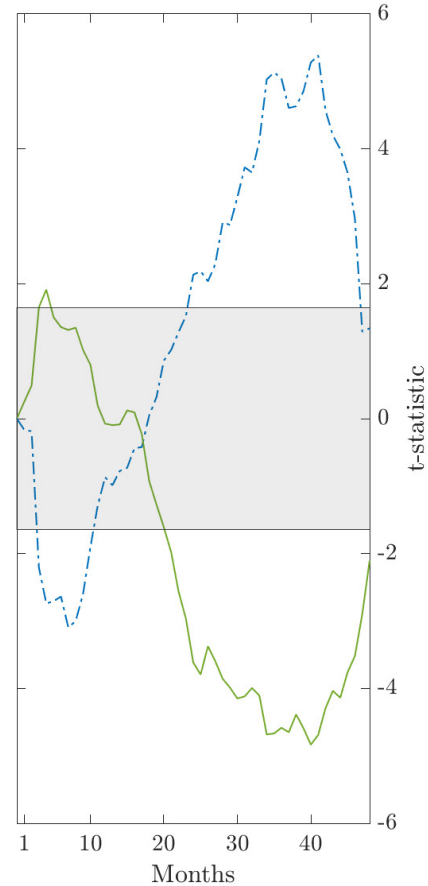


◂ back

Inclusion of two leads of shocks (Test 1, PCE Inf.)

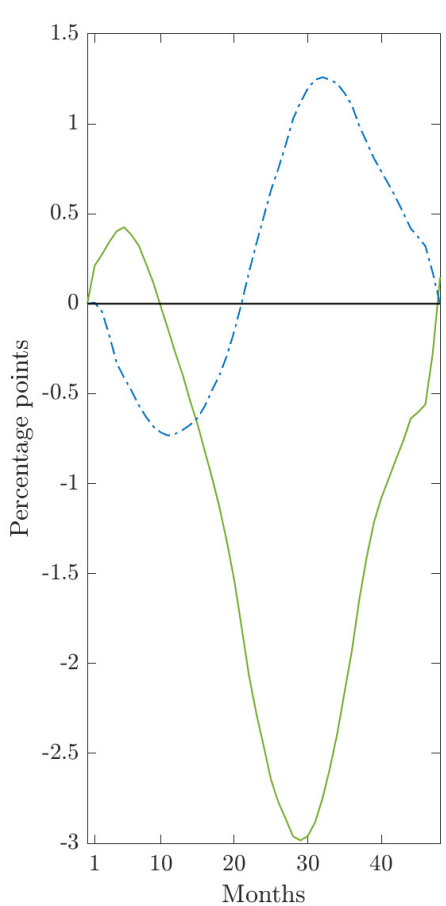


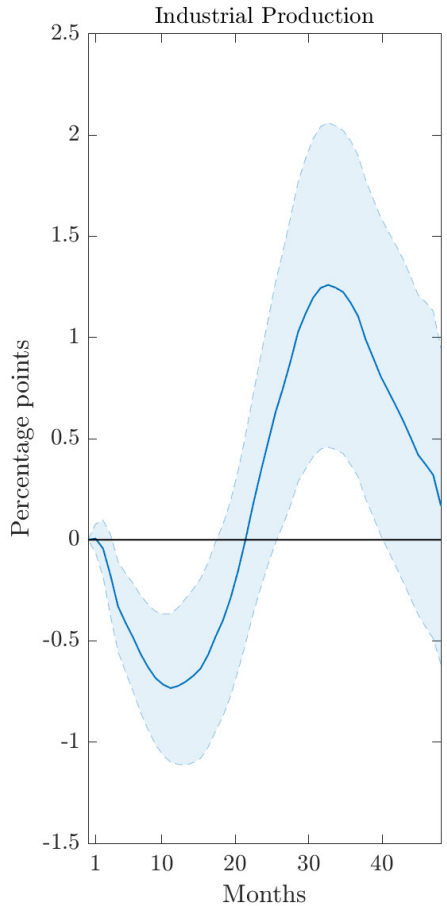


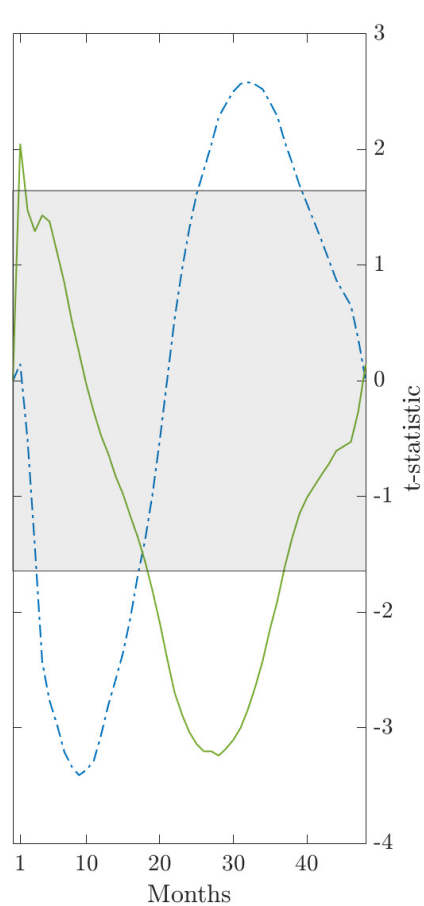


◂ back

Inclusion of two leads of shocks(Test 1, IP)

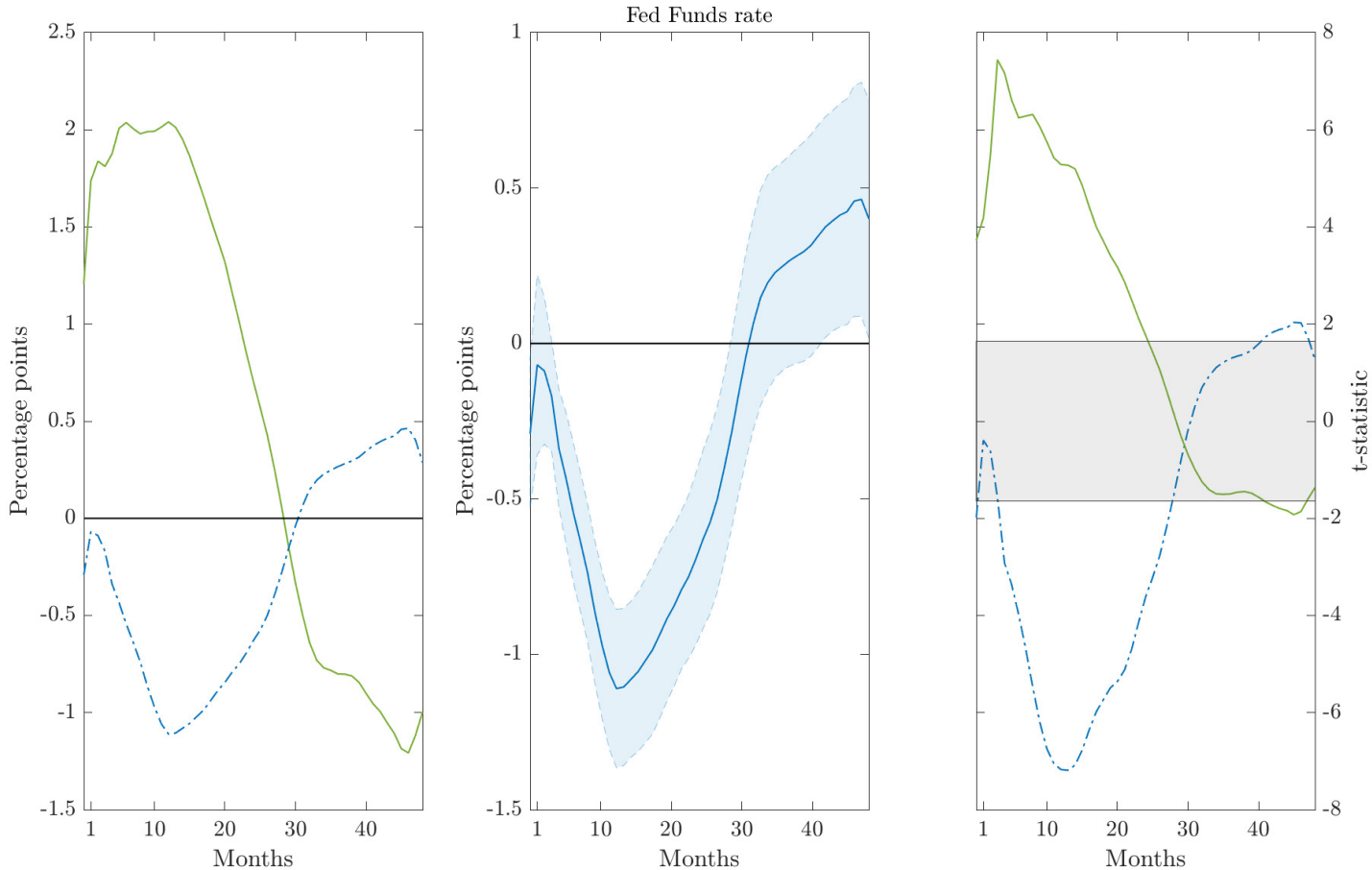






back

Inclusion of two leads of shocks (Test 1, FFR)



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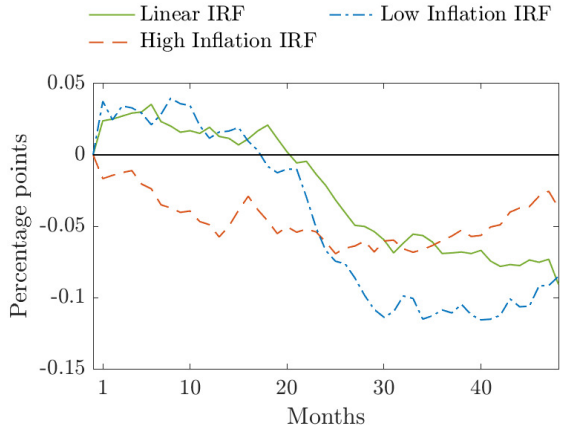
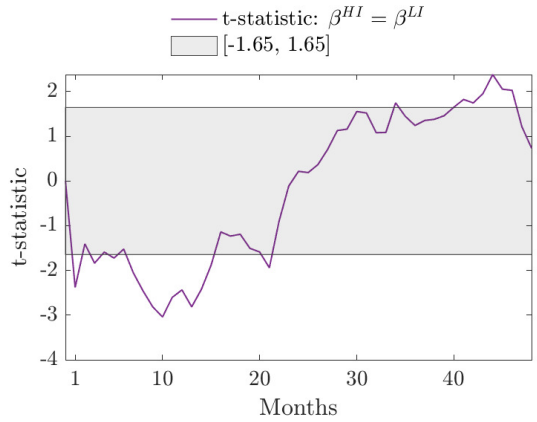
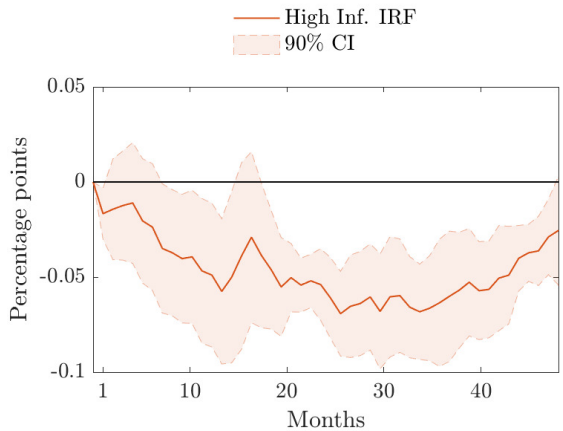
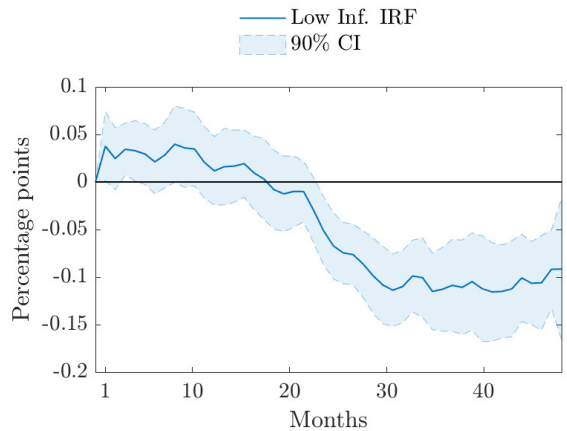
Inclusion of two leads of shocks (Test 2, PCE Inf.)



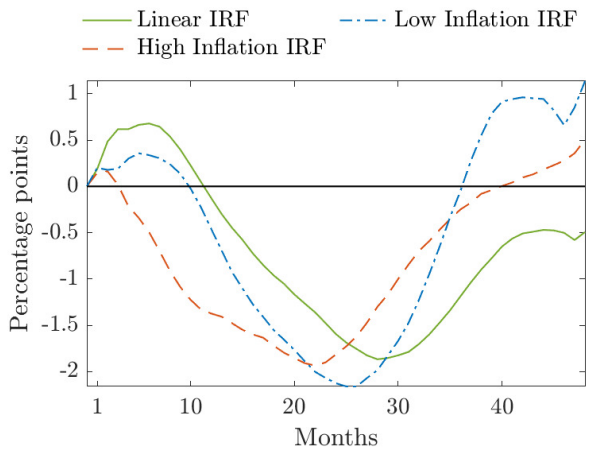


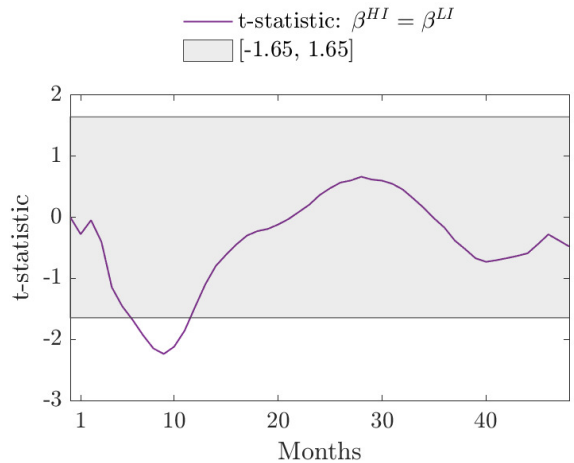


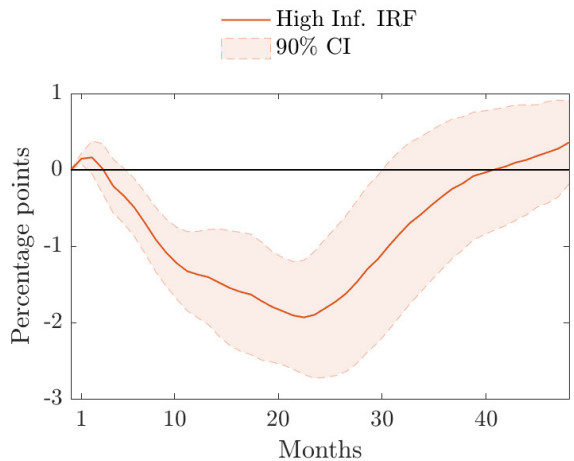


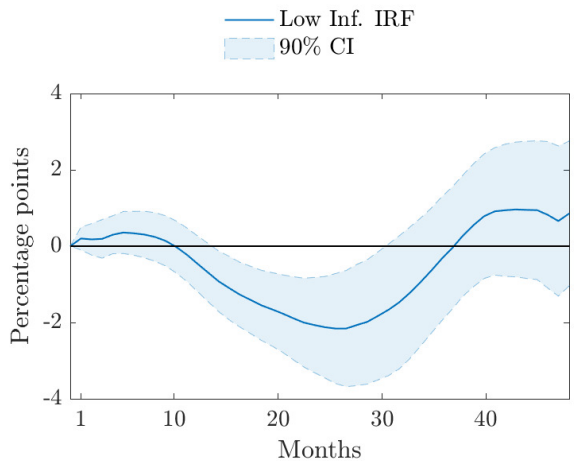
◂ back

Inclusion of two leads of shocks (Test 2, IP)



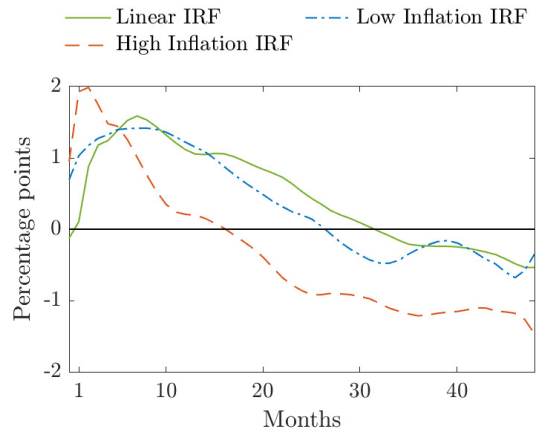


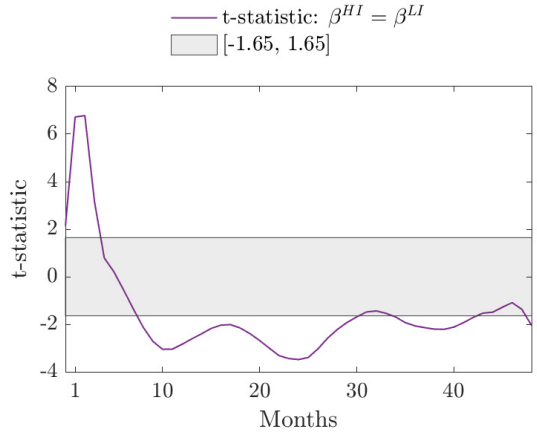


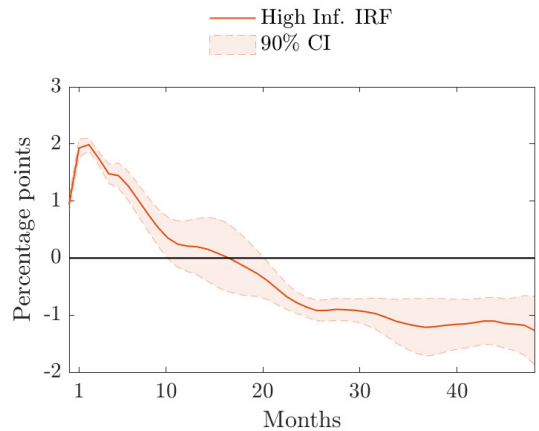


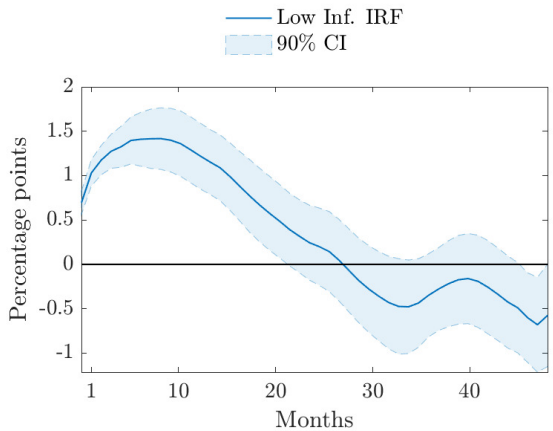
back

Inclusion of two leads of shocks (Test 2, FFR)





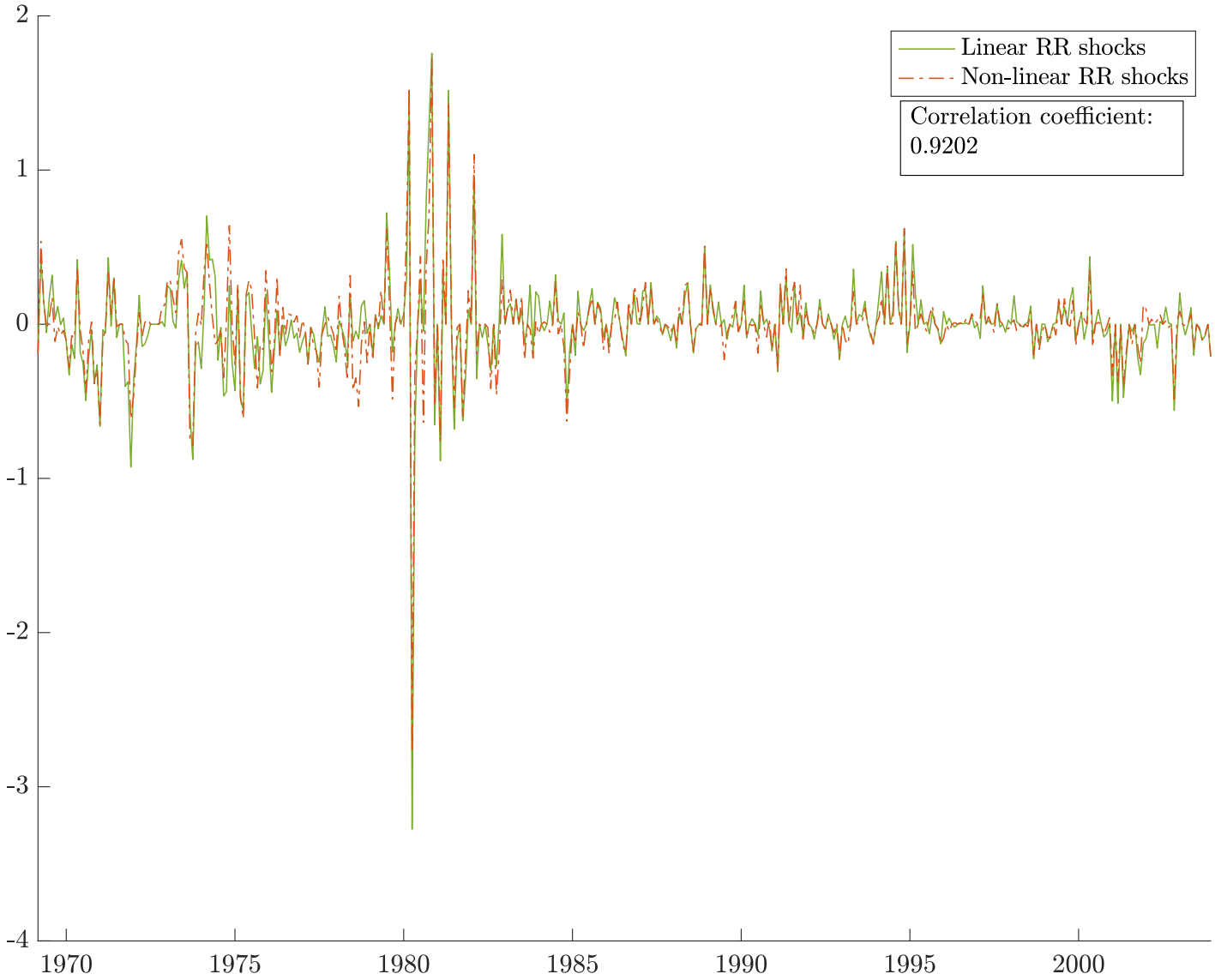




◂ back

Linear and Non-linear RR Shocks

back



Linear and STVAR Shocks

back