The Expected Sensitivity of the Long-term Yield to Macroeconomic Conditions

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Long-term yields matter

- Facing the ELB of short-term interest rates, central banks have attempted to control inflation and economic activity mainly through long-term yields
  - Asset purchases and forward guidance
  - The BoJ statements from Dec. 2016 to Mar. 2023: “The Bank will continue with “QQE with YCC," aiming to achieve the price stability target of 2%, as long as it is necessary for maintaining that target in a stable manner”
- This is the case even under conventional MP regimes
  - QT
  - Implicit commitment of UMP under worse situations
  - Communication (Gürkaynak et al. 2005)
- The sensitivity of yields to macroeconomic conditions, not their levels, matters for forward guidance, fiscal policy, and asset prices (Swanson and Williams 2014)

Preview

- What I do:
  - I use individual professional forecasts each month since April 2004
  - I estimate the expected sensitivity of the 10Y yield to inflation and economic slack
- What I find:
  - The expected sensitivities have varied substantially
  - This is not only due to the level of the yield
  - The response of the yen/dollar rate to US MP shocks is more muted when the expected sensitivity to inflation is higher

The literature

- Swanson and Williams (2014); Fatum, Hara, and Yamamoto (2023)
  - Estimate the sensitivity of long-term yields to macroeconomic news
- Nakazono and Ueda (2013); Fujiwara, Nakazono, and Ueda (2015)
  - Use Japanese survey data (the QSS) to document that the expected sensitivity of the interest rate to inflation declined
- Bauer, Pflueger, and Sunderam (2024)
  - Use panel data of 1 to 5-quarter-ahead forecasts each month
  - Estimate the perceived monetary policy rule using professional forecasts
  - Find that the perceived rule matters for responses of asset prices to macroeconomic news and MP shocks
- Shambaugh (2004); Rey (2015), among others
  - Examine US MP spillovers and their relationship with FX regime

Outline

1. Introduction
2. Data
3. The regression model
4. Results of sensitivities
5. Exchange rate responses to US MP shocks
6. Conclusion

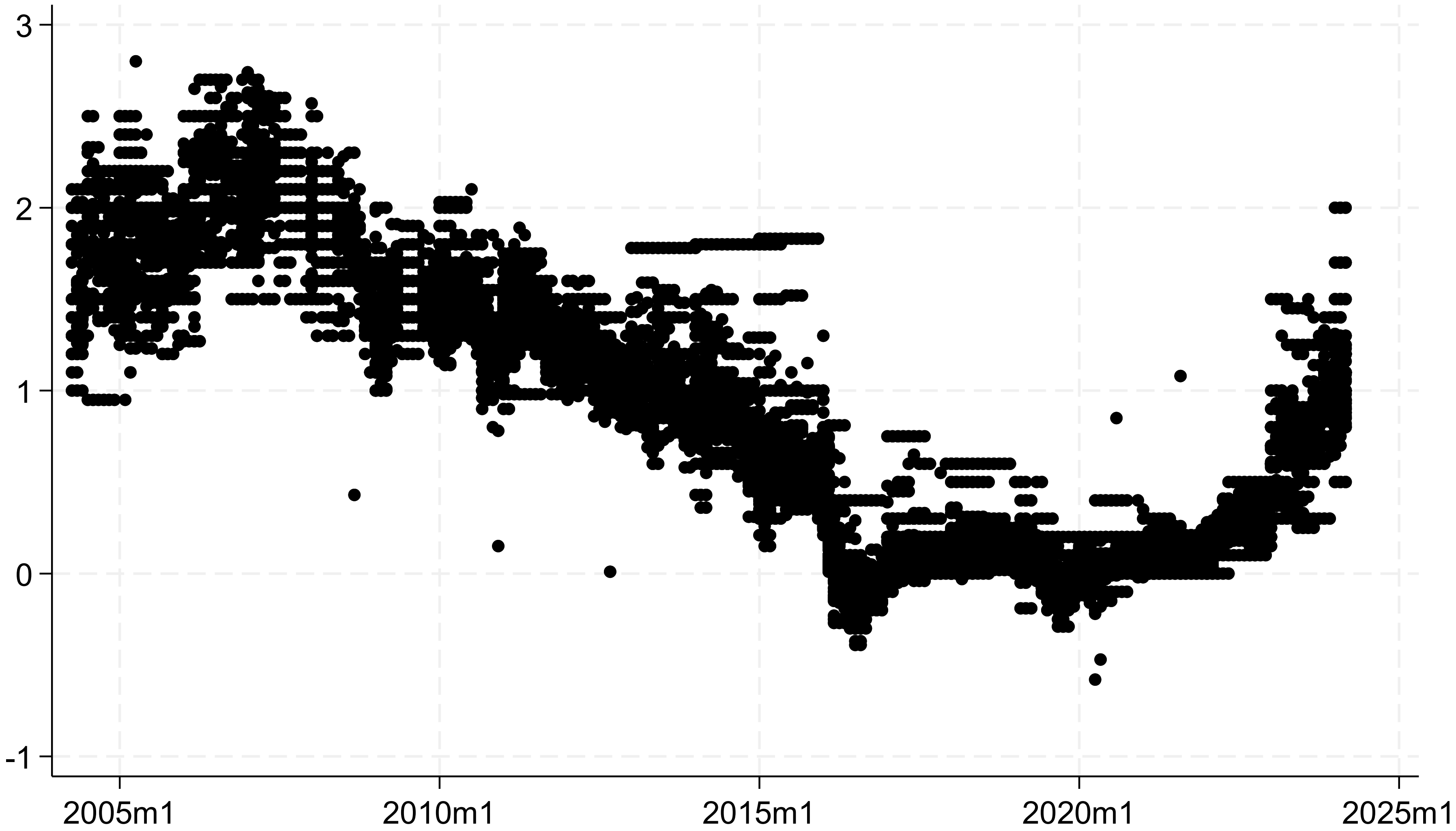
ESP forecasts

- Institution-level professional forecasts from April 2004 to March 2024
- Quarterly-horizon forecasts are available only for fewer variables
- E.g., the 10Y JGB yield in FY 2006 (April 2006-March 2007) was forecasted from January 2005 to March 2007

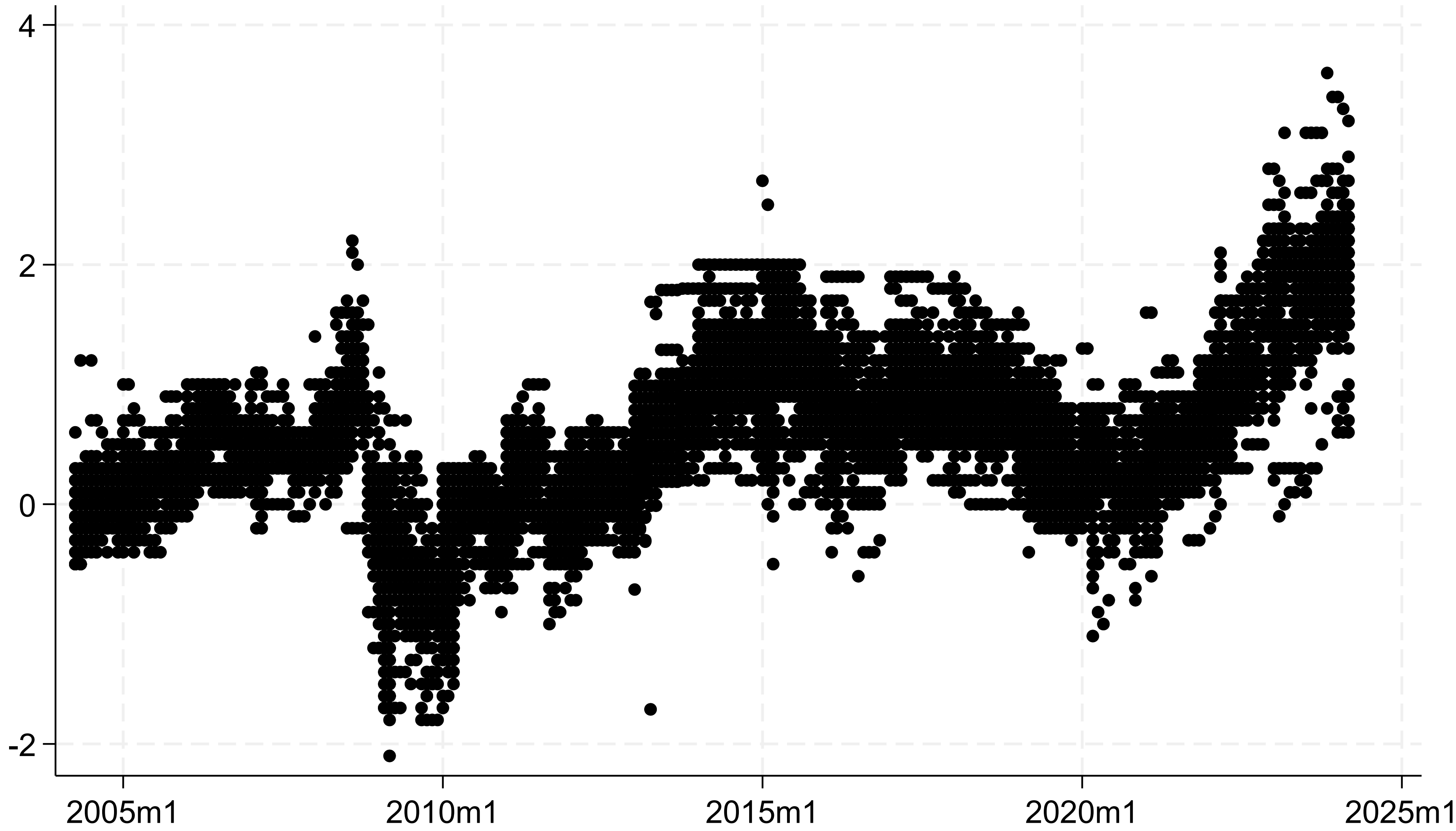
Data

- This study mainly uses monthly forecasts of the yield, CPI inflation (excluding the effect of consumption tax), and cumulative log GDP growth (the GDP gap) in FY f from January in year $f-1$ to March in year f
  - For FY 2014 forecasts of inflation from January to September in 2013, the average difference between the forecasts of inflation excluding and not excluding the effect of consumption tax for six months up to March 2014, 2.01%, is subtracted
  - Cumulative growth is calculated by cumulating all growth forecasts up to FY f
  - Robust to using the unemployment rate instead of cumulative GDP growth
- The baseline sample covers 10,287 forecasts by 67 institutions (26-42 per month)
  - 475-565 for each of forecasted FY 2005-2024 and 92 for FY 2025
- All variables are winsorized at the 1 and 99% levels for each forecasted FY (except for FY 2025)

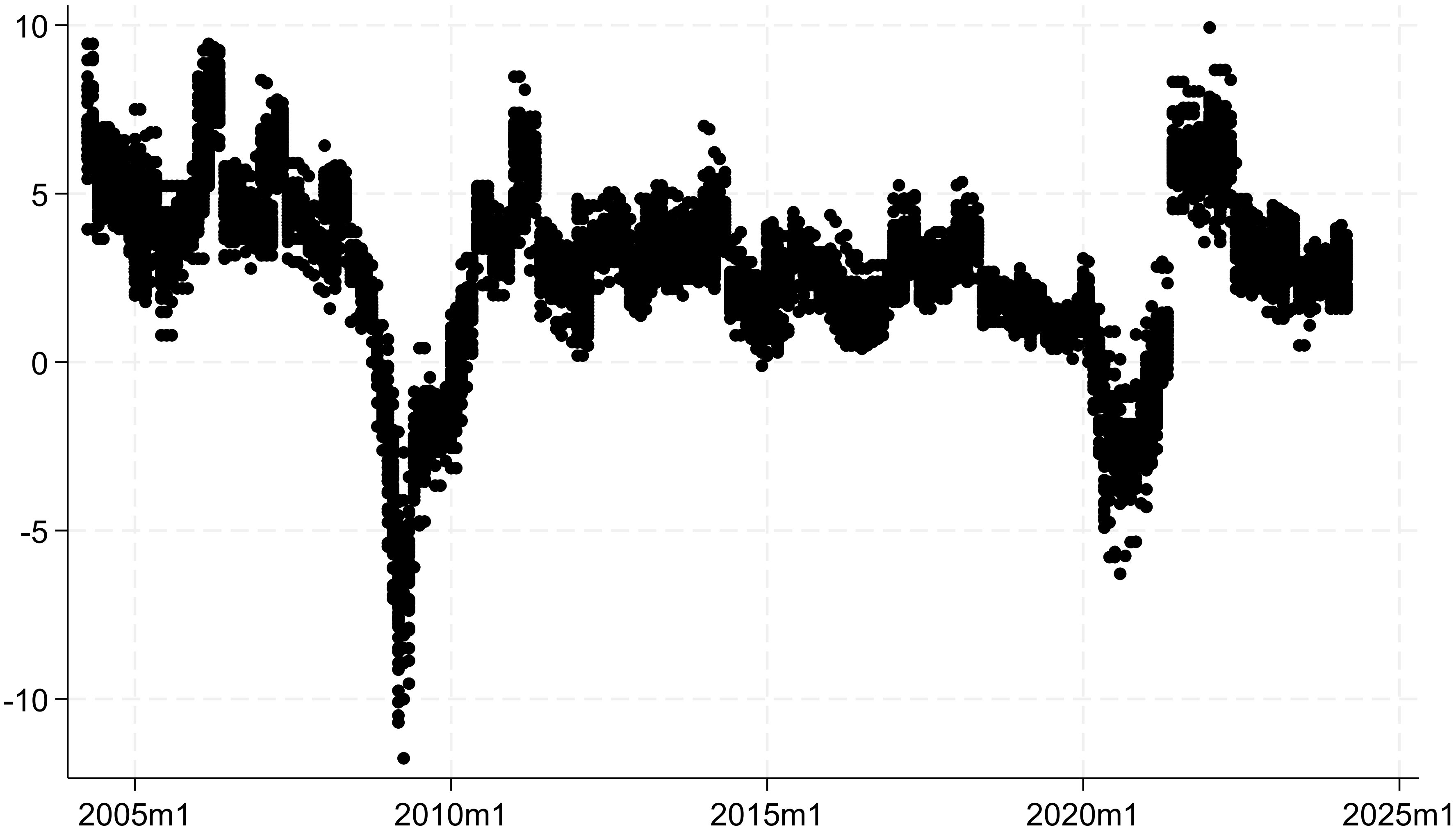
Forecasts of the Yield (%)



Forecasts of inflation (%)



Forecasts of cumulative GDP growth (%)



Model

- A Taylor rule-like relationship between the long-term yield and macro variables:

$$i_t = r_t^* + \pi_t^* + \phi(\pi_t - \pi_t^*) + \psi\,(y_t - y_t^*) + \epsilon_t$$

- Considering heterogeneous expectations and time-varying sensitivities:

$$i_{j,t,f}^e = r_{j,t,f}^{*,e} + \pi_{j,t,f}^{*,e} + \phi_{j,t,f}^e\left(\pi_{j,t,f}^e - \pi_{j,t,f}^{*,e}\right) + \psi_{j,t,f}^e\left(y_{j,t,f}^e - y_{j,t,f}^{*,e}\right) + \xi_{j,t,f}^e$$

- The regression model:

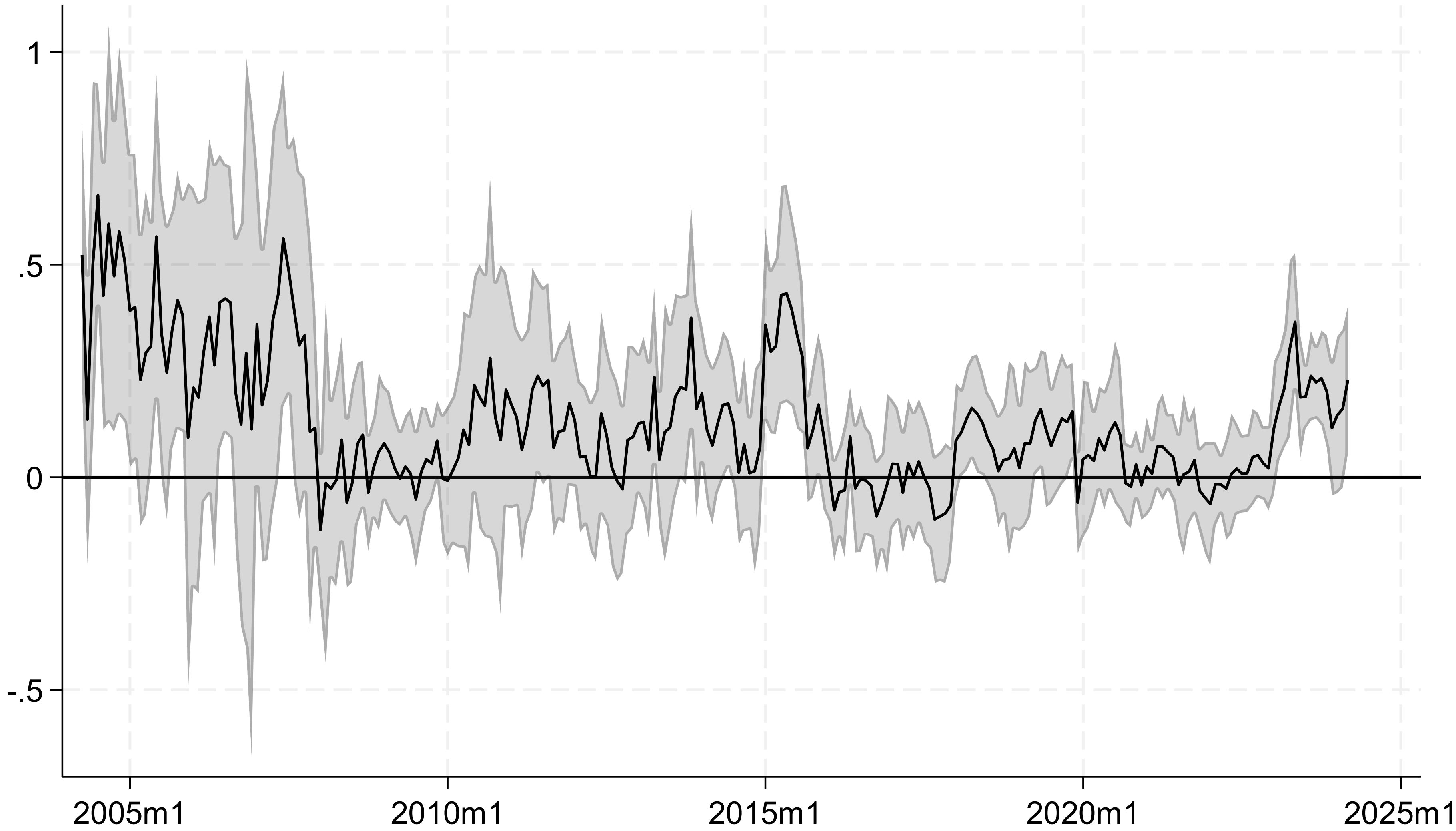
$$i_{j,t,f}^e = \alpha_j + \tau_t + \zeta_f + \phi_t^e \pi_{j,t,f}^e + \psi_t^e (y_{j,t,f}^e - y_{t,f-}) + \omega_{j,t,f}$$

- Note that $\alpha_j + \tau_t + \zeta_f + \omega_{j,t,f}$ represents

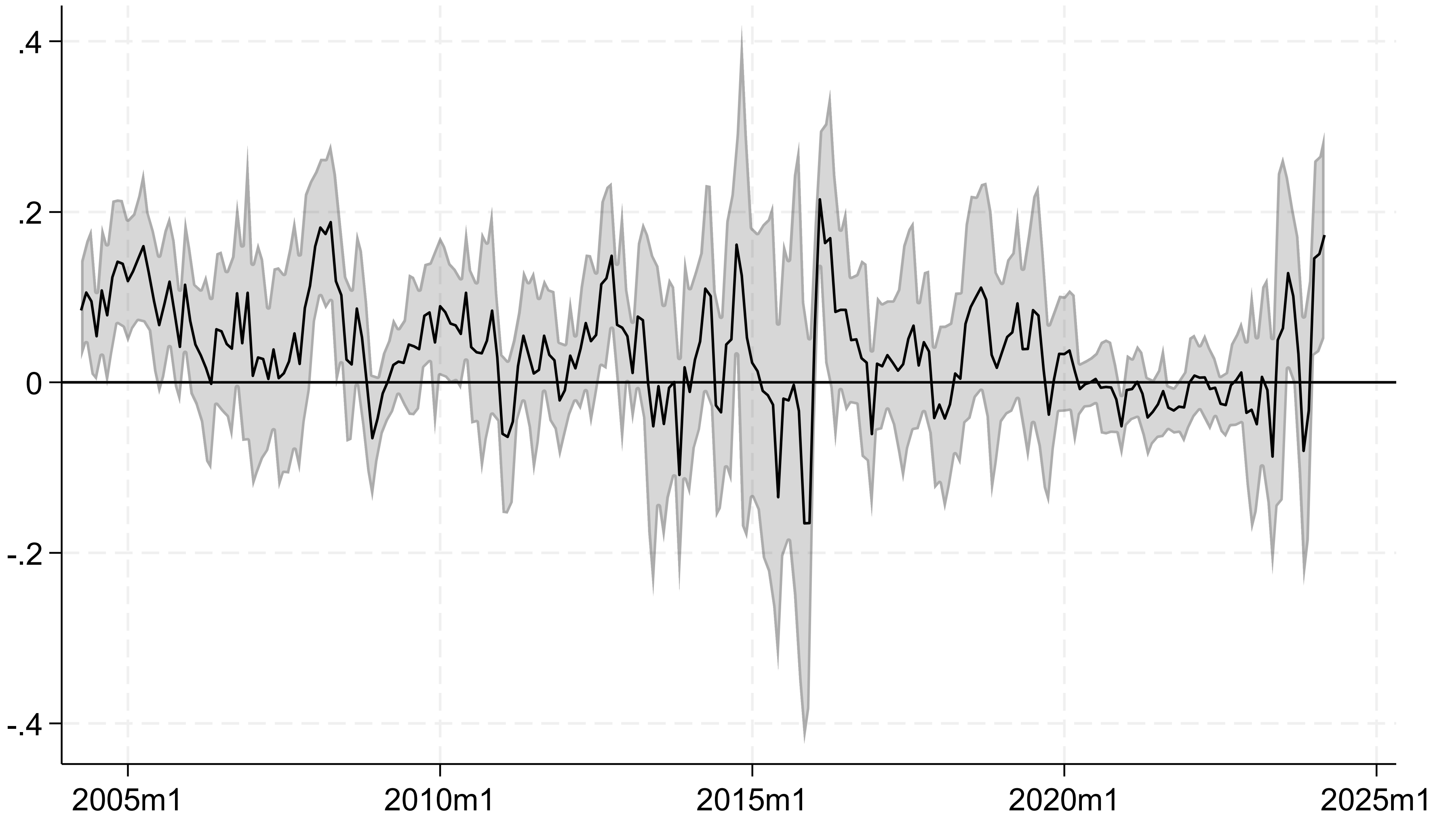
$$r_{j,t,f}^{*,e} + \pi_{j,t,f}^{*,e} + \left(\phi_{j,t,f}^e - \phi_t^e\right)\left(\pi_{j,t,f}^e - \pi_{j,t,f}^{*,e}\right) - \phi_t^e \pi_{j,t,f}^{*,e}$$
$$+\left(\psi_{j,t,f}^e - \psi_t^e\right)\left(y_{t,t,f}^e - y_{j,t,f}^{*,e}\right) - \psi_t^e\left(y_{j,t,f}^{*,e} - y_{t,f-}\right) + \xi_{j,t,f}^e$$

- Standard errors are clustered at the institution, time, and forecasted FY levels

Sensitivity to inflation with 95% CI



Sensitivity to the GDP gap with 95% CI



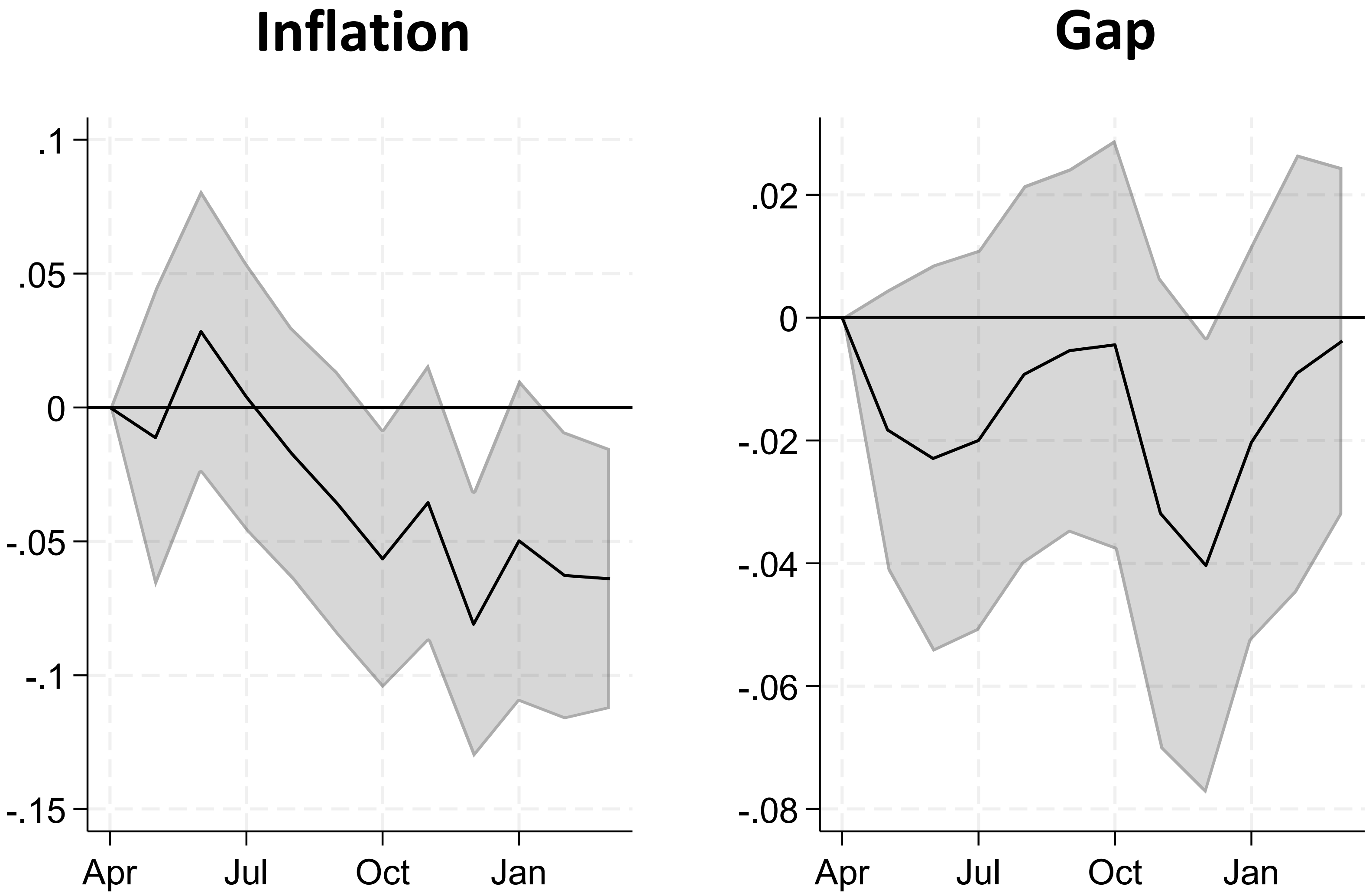
Why can the sensitivity be zero when the yield is far from zero?

- Investors usually require premia to hold a large amount of long-term bonds (Vayanos and Vila 2021)
- Premia could decline if the central bank purchases a large mount of bonds
- Premia could be sensitive to macroeconomic conditions, if investors expect the central bank to purchase a large amount of bonds as the situation worsens
- In early 2008, most central banks did not purchase large mount of bonds and were not expected to do so
- Once the expected component hits the ELB, long-term yields could be far from zero and not be sensitive to macroeconomic conditions

Bias from short forecast horizons

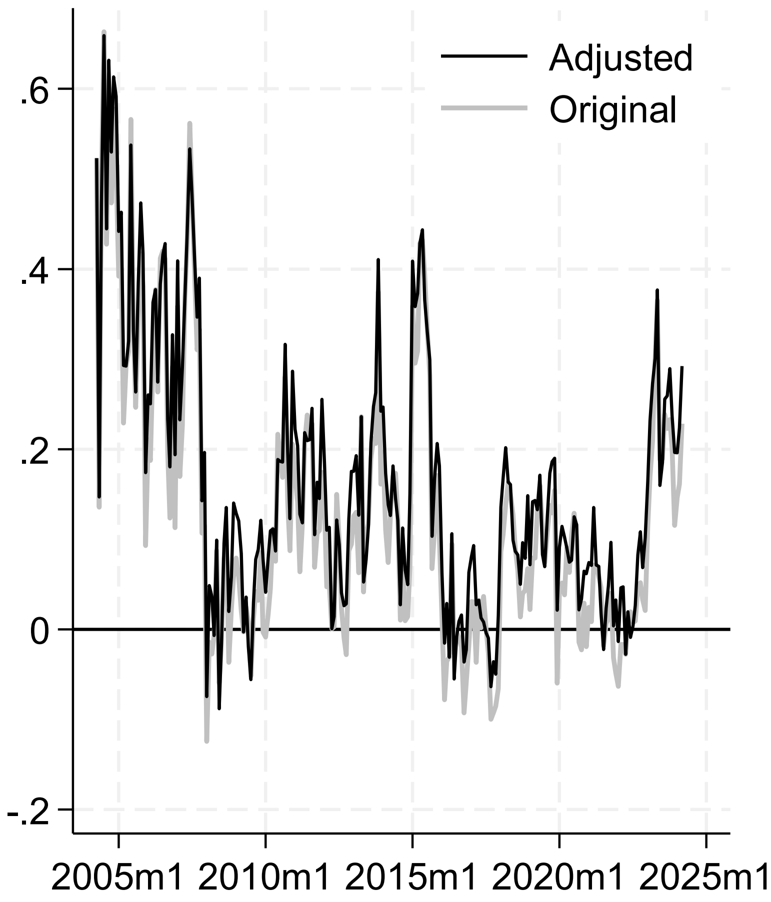
- The estimated sensitivities may vary by month
  - The yield may be estimated to be less sensitive due to realized shocks to the yield, which mask the relationship between the yield and macroeconomic conditions, when the forecast horizon is shorter and the shocks are more persistent
- To check this possibility, the estimated sensitivities are regressed on month dummies
  - Forecasted FY dummies are controlled for
  - Newey and West (1987) with 3 lags
  - April is used as the reference group

Estimated bias with 95% CI

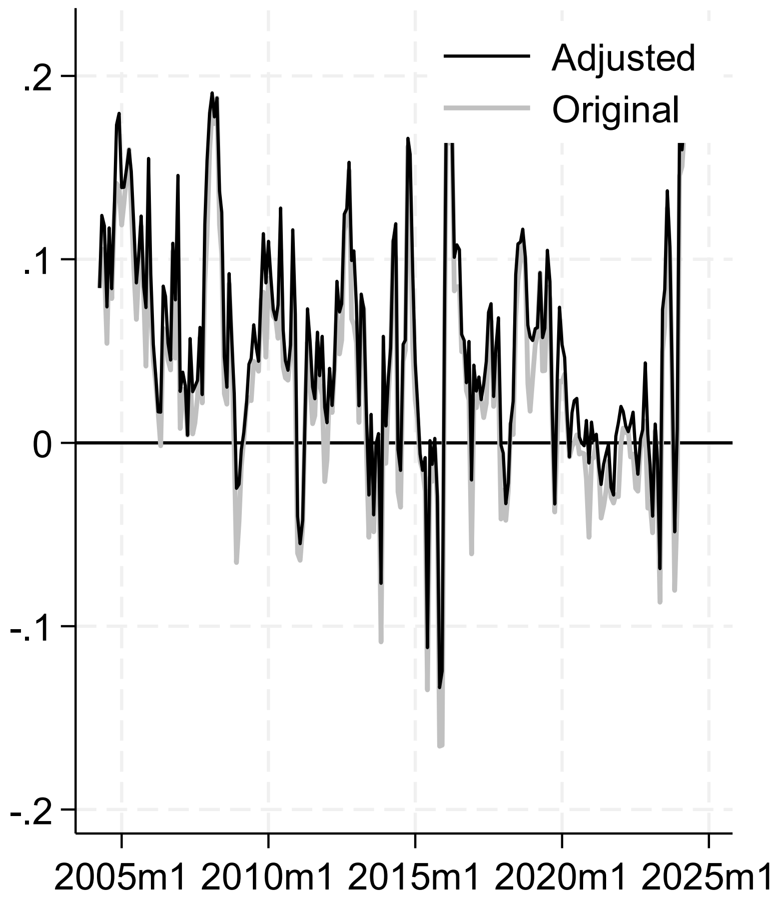


Bias-adjusted sensitivities

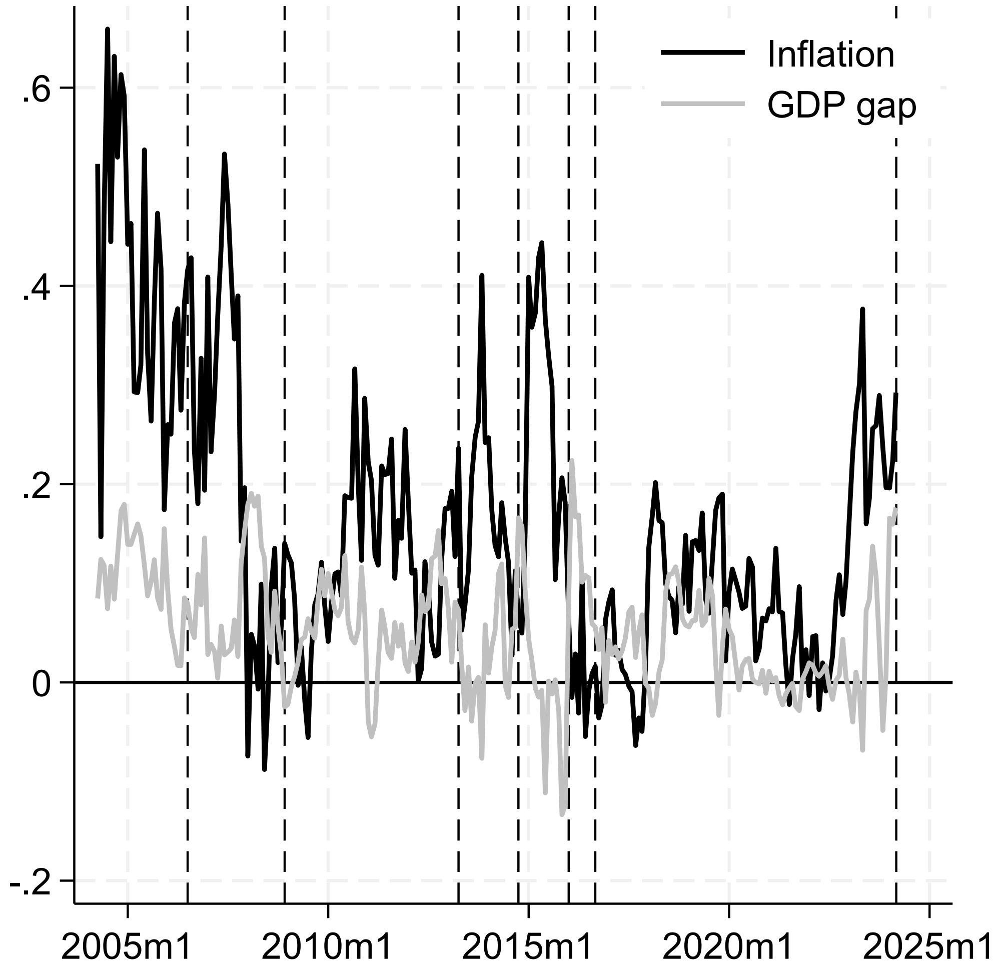
Inflation



Gap



Sensitivities and events



Date	Event
Jul. 2006	0% to 0.25%
Dec. 2008	0.3% to 0.1%
Apr. 2013	QQE
Oct. 2014	Expansion of QQE
Jan. 2016	Negative interest rate
Sep. 2016	YCC
Mar. 2024	End of YCC

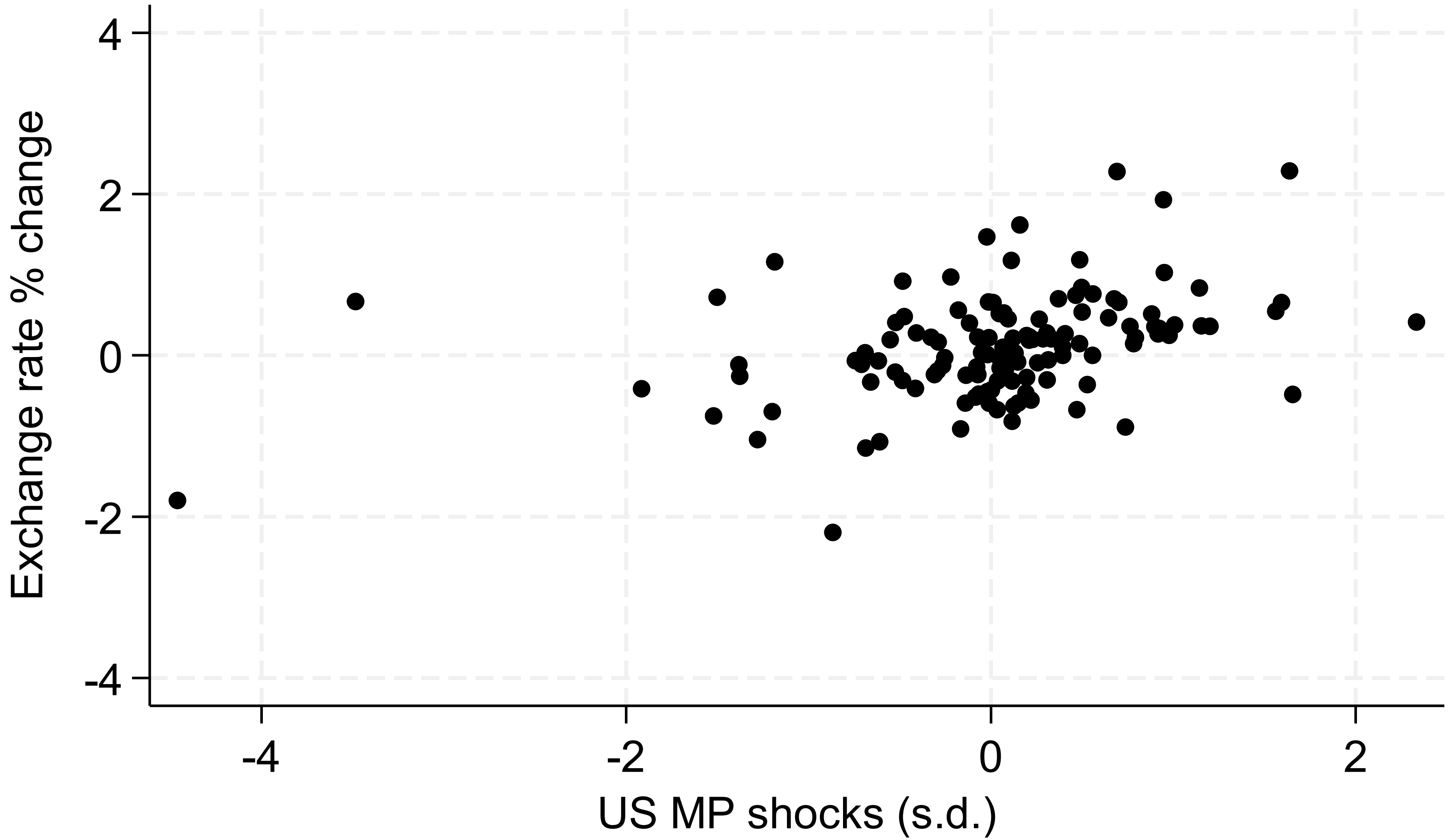
US MP shocks and FX rates

- This study examines yen/dollar rate responses to US MP shocks using time-series regressions such as:

$$\Delta x_t = \alpha + \beta s_t + \gamma_\phi \hat{\phi}^e_{t-} s_t + \gamma_\psi \hat{\psi}^e_{t-} s_t + \delta_\phi \hat{\phi}^e_{t-} + \delta_\psi \hat{\psi}^e_{t-} + \upsilon_t$$

- Δx_t is the percent change of the exchange rate from JST 17:00 at day t to JST 9:00 at day $t+1$ (excluding Fridays and national holidays)
- s_t is Nakamura and Steinsson's (2018) MP shock at day t in the US, updated until July 2022 and standardized by Acosta (2023)
- $\hat{\phi}^e_{t-}$ and $\hat{\psi}^e_{t-}$ are the 3M-moving averages of the estimated sensitivities of the yield to inflation and the GDP gap in the previous month

The FX rate vs. US MP shocks



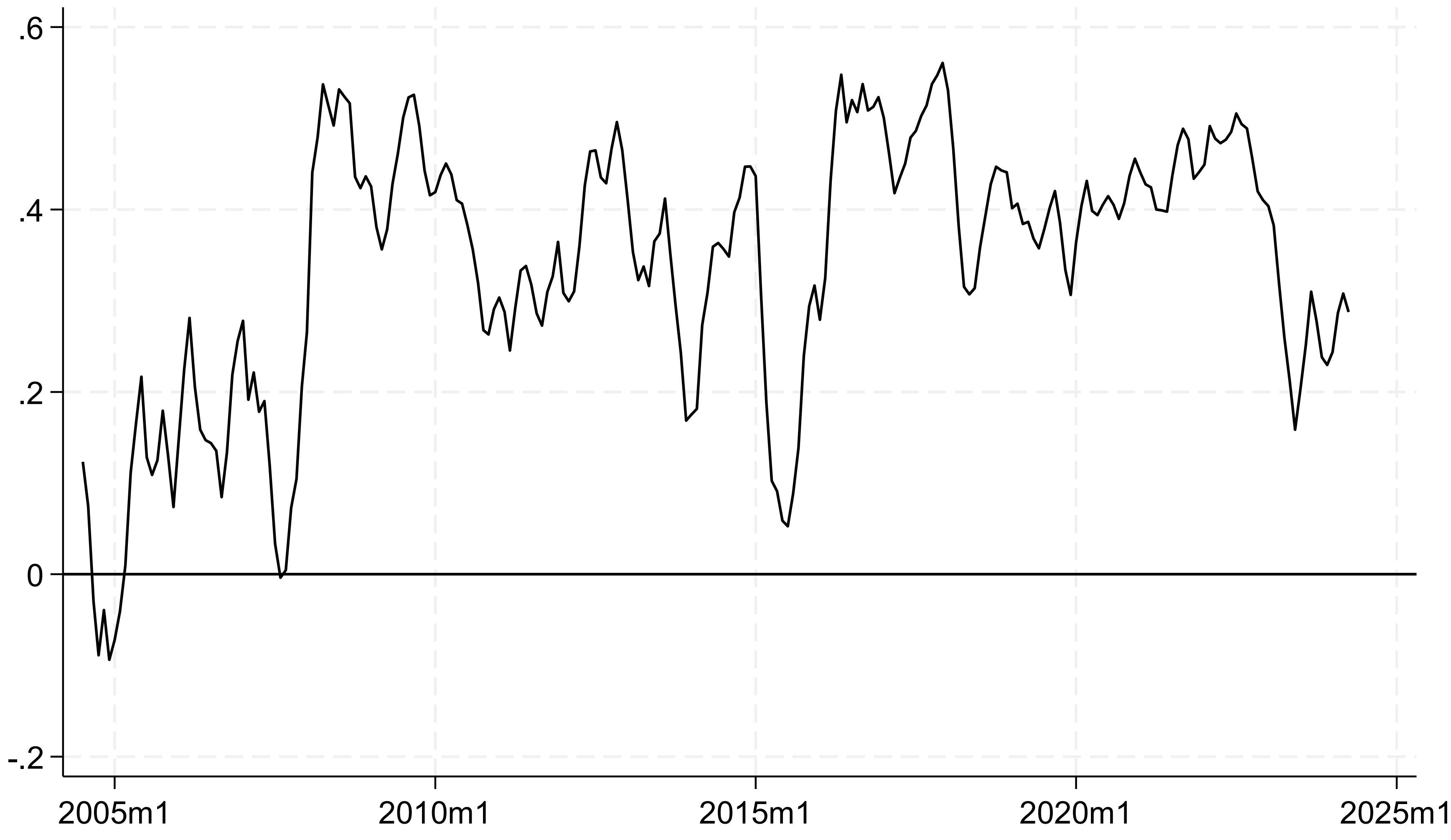
Results

	(1)	(2)	(3)	(4)
US MP shock	0.31***	0.50***	0.47***	0.49***
US MP shock × Inflation sensitivity		-1.05***	-1.26***	-1.10***
US MP shock × Gap sensitivity		0.24	0.30	0.59
US MP shock × JGB yield			0.067	
US MP shock × ELB dummy				0.0012
Observations	123	123	123	123
Adjusted R-squared	0.145	0.188	0.213	0.210

*** p<0.01, ** p<0.05, * p<0.1

Note: ELB dummy = 1 if the JGB yield < 0.25%

The model (2)- implied sensitivity of the FX rate to US MP shocks



Robustness

- Bauer and Swanson’s (2023) MP shocks, available until December 2019
  - They compute the orthogonalized MP shocks as the residuals from regressing the original shocks on the six macro and financial variables
- The unemployment rate
- No moving average
- Winsorizing US MP shocks at the 1 and 99% levels (5 and 95% levels)
- No bias adjustment

Results of robustness checks

	(1) Baseline	(2) BS shock	(3) Unemp.	(4) No MV	(5) Win 1%	(6) No adj.
US MP shock	0.50***	13.2***	0.44***	0.52***	0.58***	0.48***
US MP shock × Inflation sensitivity	-1.05***	-29.4***	-1.16***	-0.88**	-1.22***	-1.02***
US MP shock × Gap sensitivity	0.24	-19.9	-0.68*	-0.79	-0.088	-0.20
Observations	123	111	123	124	123	123
Adjusted R-squared	0.188	0.237	0.197	0.157	0.195	0.191

*** p<0.01, ** p<0.05, * p<0.1

Effects on JGB future returns

	(1)	(2)	(3)	(4)
US MP shock	-0.038**	-0.0077	0.026	-0.0054
US MP shock × Inflation sensitivity		0.10	0.21*	0.097
US MP shock × Gap sensitivity		-0.88**	-0.73*	-0.90**
US MP shock × JGB yield			-0.060*	
US MP shock × ELB dummy				-0.0053
Observations	123	123	123	123
Adjusted R-squared	0.026	0.052	0.078	0.036

*** p<0.01, ** p<0.05, * p<0.1

Results of robustness checks for JGB future returns

	(1) Baseline	(2) BS shock	(3) Unemp.	(4) No MV	(5) Win 1%	(6) No adj.
US MP shock	-0.0077	-2.28***	-0.011	-0.024	-0.012	-0.023
US MP shock × Inflation sensitivity	0.10	6.31***	0.17	-0.0064	0.11	0.093
US MP shock × Gap sensitivity	-0.88**	-4.59	0.36***	-0.22	-0.88**	-0.75*
Observations	123	111	123	124	123	123
Adjusted R-squared	0.052	0.183	0.095	0.011	0.052	0.044

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Discussion

- For yen/dollar rate responses to US MP shocks, the expected sensitivity of the yield to inflation matters
  - Not the yield level and whether it is close to zero
  - Not for JGB future returns
- UIP suggests that the FX rate is determined by the interest rate differential and the expected FX rate

$$x_t = (r_{\mathrm{US},t,10\mathrm{Y}} - r_{\mathrm{JP},t,10\mathrm{Y}}) \times 10 + x^e_{t,10\mathrm{Y}}$$

- If the central bank is expected to raise interest rates in response to inflation caused by a weak FX rate in the future, the FX rate may be less responsive to US MP shocks

$$\begin{aligned} x_t &= r_{\mathrm{US},t,1\mathrm{Y}} - r_{\mathrm{JP},t,1\mathrm{Y}} + x^e_{t,1\mathrm{Y}} \\ &= r_{\mathrm{US},t,1\mathrm{Y}} - r_{\mathrm{JP},t,1\mathrm{Y}} + \left(r^e_{\mathrm{US},t+1,10\mathrm{Y}} - r^e_{\mathrm{JP},t+1,10\mathrm{Y}}\right) \times 10 + x^e_{t,11\mathrm{Y}} \end{aligned}$$

Conclusion

- Findings:
  - The expected sensitivity of the yield to inflation and economic activity has varied substantially
  - This is not only due to the level of the yield
  - The response of the yen/dollar rate to US MP shocks is more muted when the expected sensitivity to inflation is higher
- If the central bank is expected to raise interest rates in response to inflation caused by a weak FX rate, the FX rate may be less responsive to shocks

Potential future work

- Extension of the sample of MP shocks
- Responses of other asset prices (e.g., stock indexes) to other shocks (e.g., macroeconomic indicator surprises)
- Fiscal policy shocks (Miyamoto et al., 2018)
- Correction of endogenous bias

Endogeneity bias

- Suppose that forecasts of a macroeconomic variable (y_j^e) and the yield (i_j^e) are determined by two equations (like the IS curve and the policy rule):

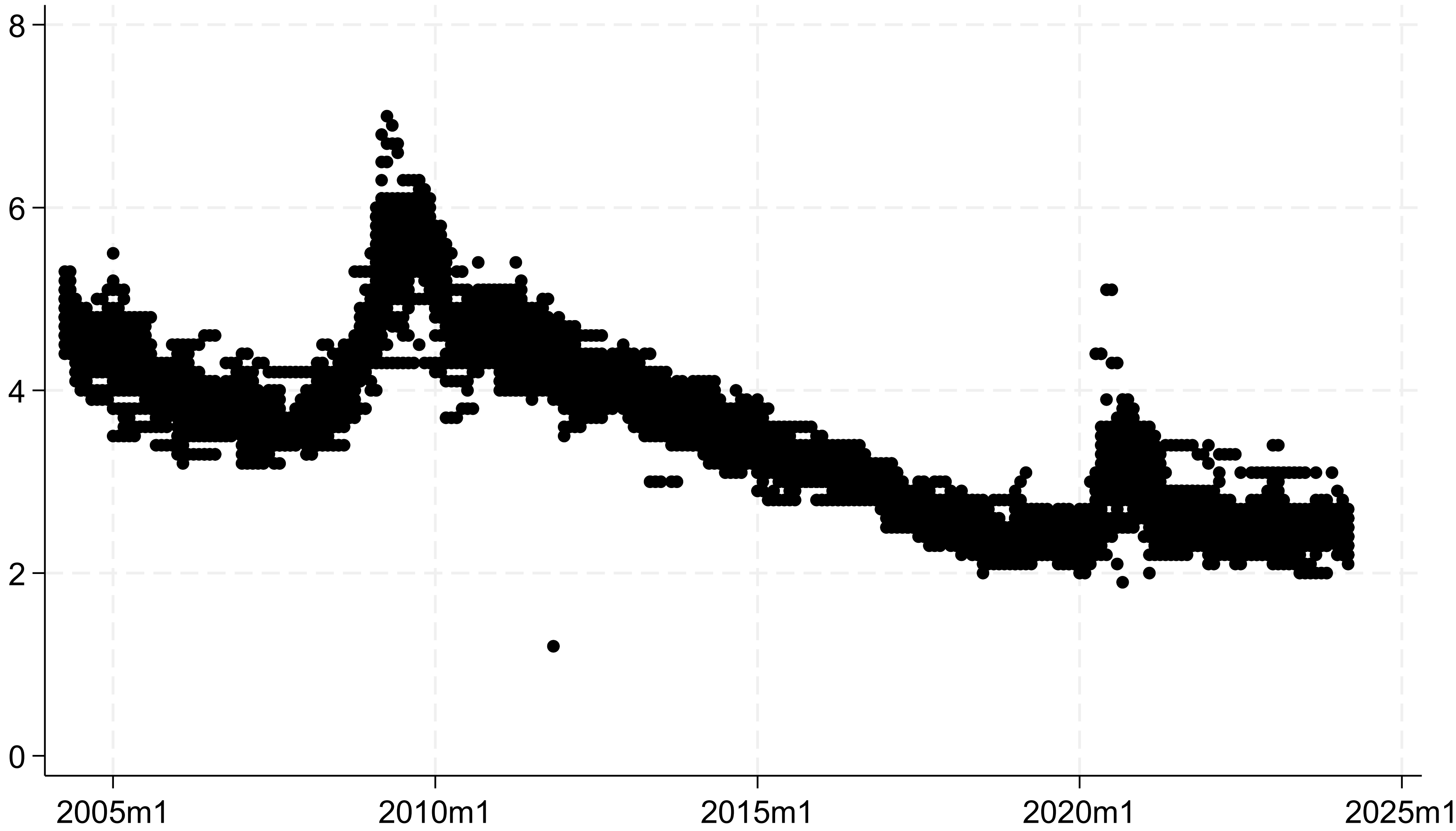
$$y_j^e = -\gamma^e i_j^e + \eta_j^e$$
$$i_j^e = \phi^e y_j^e + \epsilon_j^e$$

- Here, $\eta_j \sim N(0, \sigma_\eta^2)$ and $\epsilon_j \sim N(0, \sigma_\epsilon^2)$ can be called the IS shock and the MP shock, respectively
- The slope coefficient estimated by an OLS regression of the policy rule:

$$\hat{\phi}^e = \frac{\phi^e - \gamma^e \sigma_\epsilon^2 / \sigma_\eta^2}{1 + (\gamma^e)^2 \sigma_\epsilon^2 / \sigma_\eta^2}$$

- The coefficient is more under-biased as$\gamma^e \sigma_\epsilon^2 / \sigma_\eta^2$ is higher
- Fujiwara et al. (2015) and Carvalho et al. (2021) focus on time-series analysis and find that the bias is small since the MP shock is relatively small
- What about the dispersion of forecasts of shocks?

Forecasts of the unemployment rate (%)



Model for the unemployment rate

- A Taylor rule-like relationship between the long-term yield and macro variables:

$$i_t = r_t^* + \pi_t^* + \phi(\pi_t - \pi_t^*) + \psi\,(u_t - u_t^*) + \epsilon_t$$

- Considering heterogeneous expectations and time-varying sensitivities:

$$i_{j,t,f}^e = r_{j,t,f}^{*,e} + \pi_{j,t,f}^{*,e} + \phi_{j,t,f}^e\left(\pi_{j,t,f}^e - \pi_{j,t,f}^{*,e}\right) + \psi_{j,t,f}^e\left(u_{j,t,f}^e - u_{j,t,f}^{*,e}\right) + \xi_{j,t,f}^e$$

- The regression model:

$$i_{j,t,f}^e = \alpha_j + \tau_t + \zeta_f + \phi_t^e \pi_{j,t,f}^e + \psi_t^e u_{j,t,f}^e + \omega_{j,t,f}$$

- Note that $\alpha_j + \tau_t + \zeta_f + \omega_{j,t,f}$ represents

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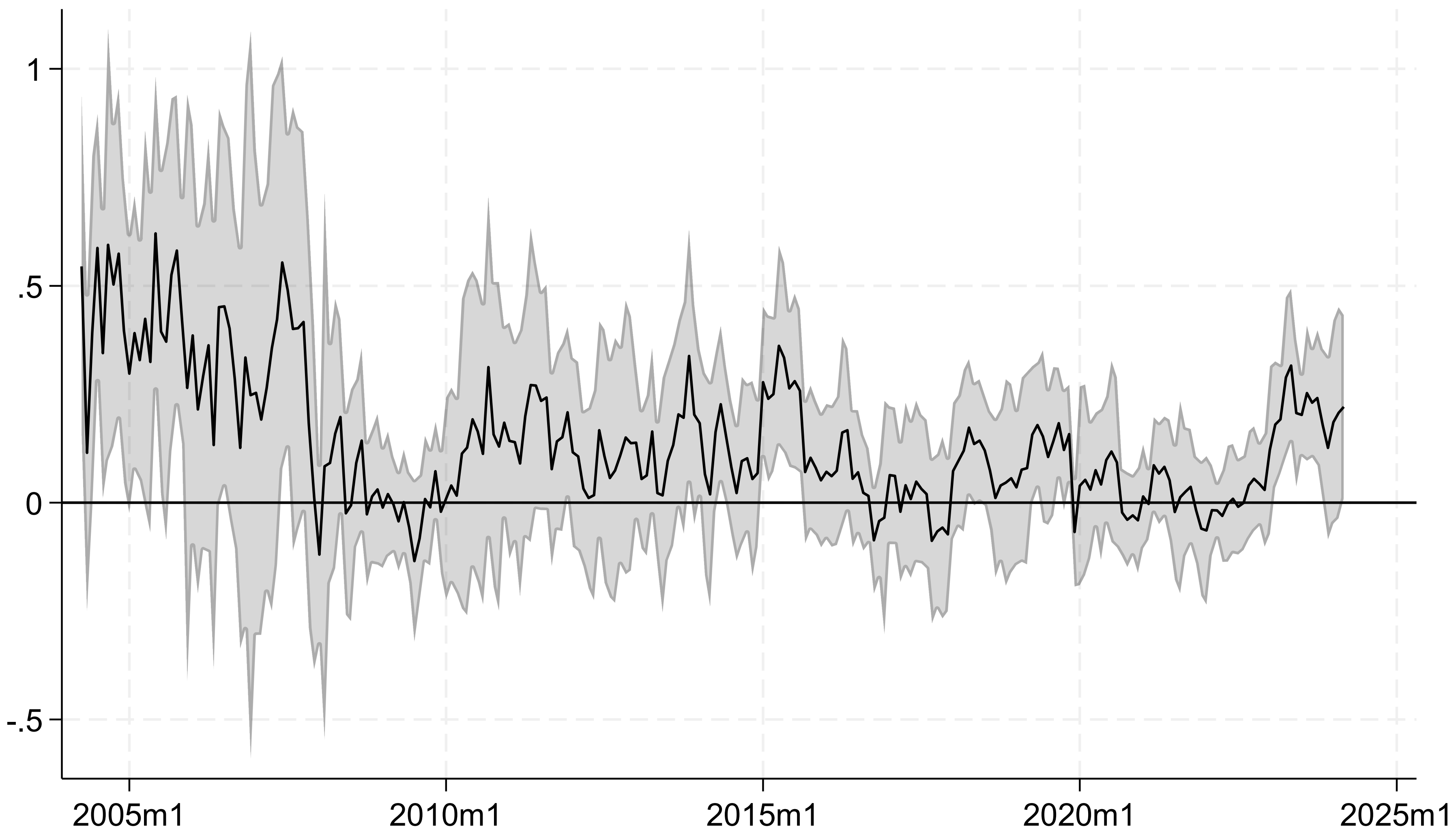
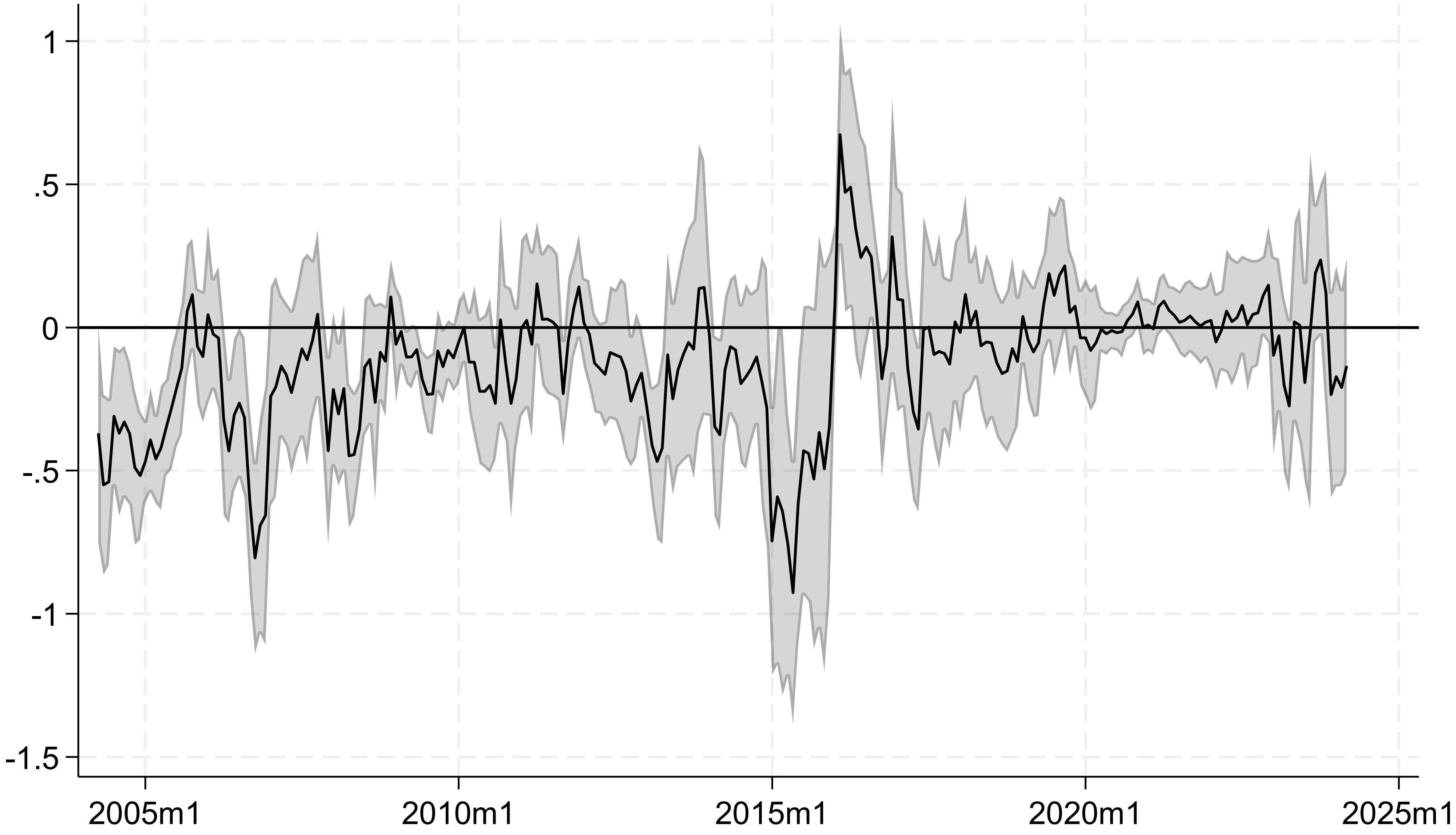
$$+\left(\psi_{j,t,f}^e - \psi_t^e\right)\left(u_{t,t,f}^e - u_{j,t,f}^{*,e}\right) - \psi_t^e u_{j,t,f}^{*,e} + \xi_{j,t,f}$$

- Standard errors are clustered at the institution, time, and forecasted FY levels

Sensitivity to inflation with 95% CI

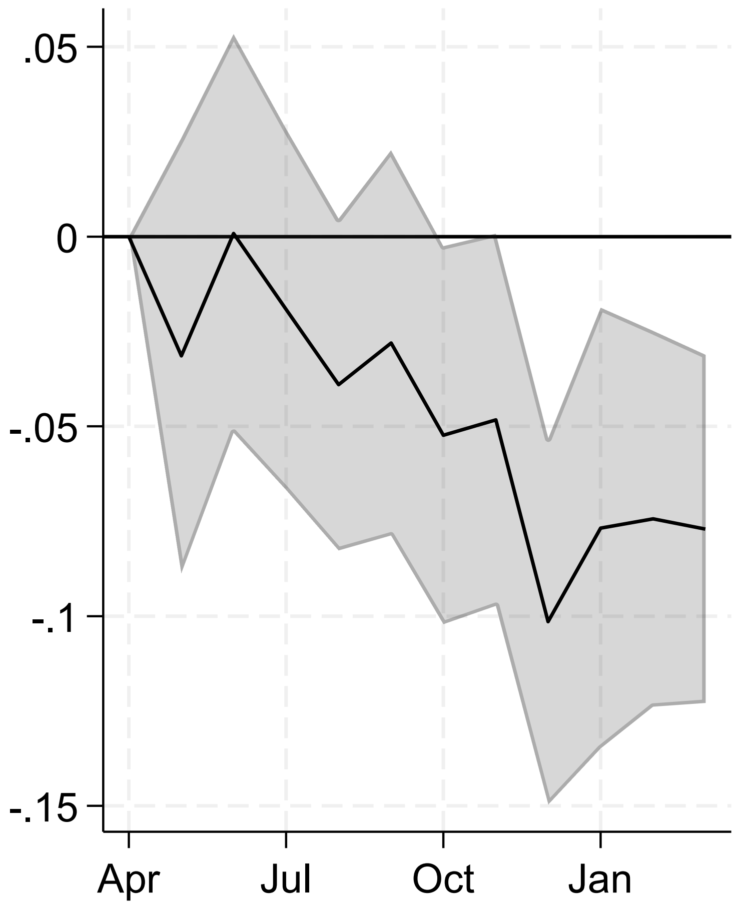


Sensitivity to the unemployment rate with 95% CI

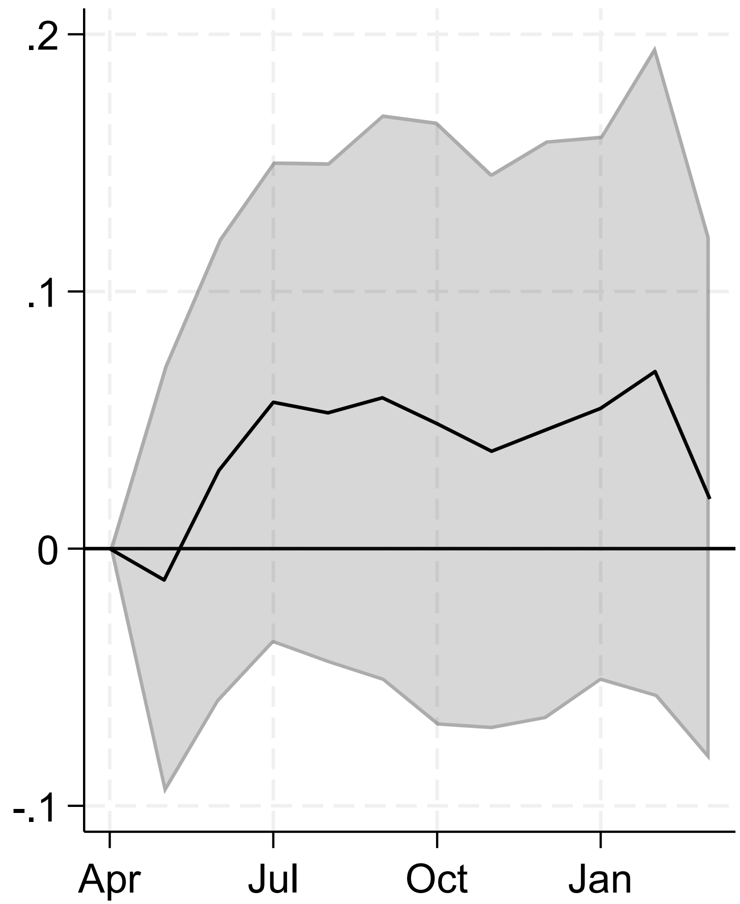


Estimated bias with 95% CI

Inflation

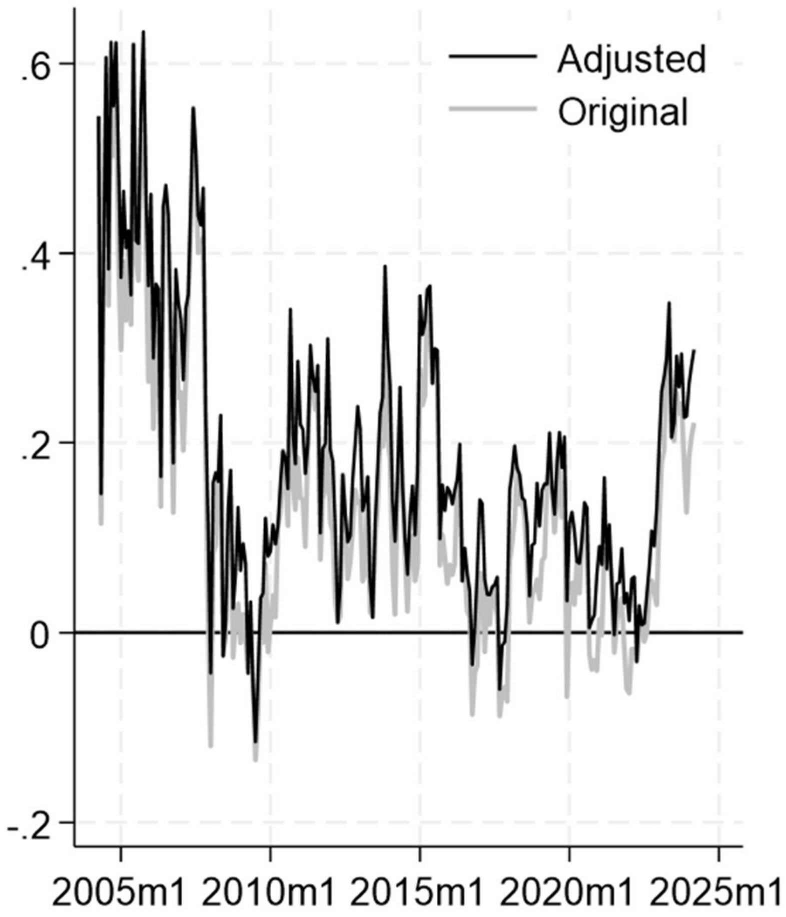


Unemployment rate

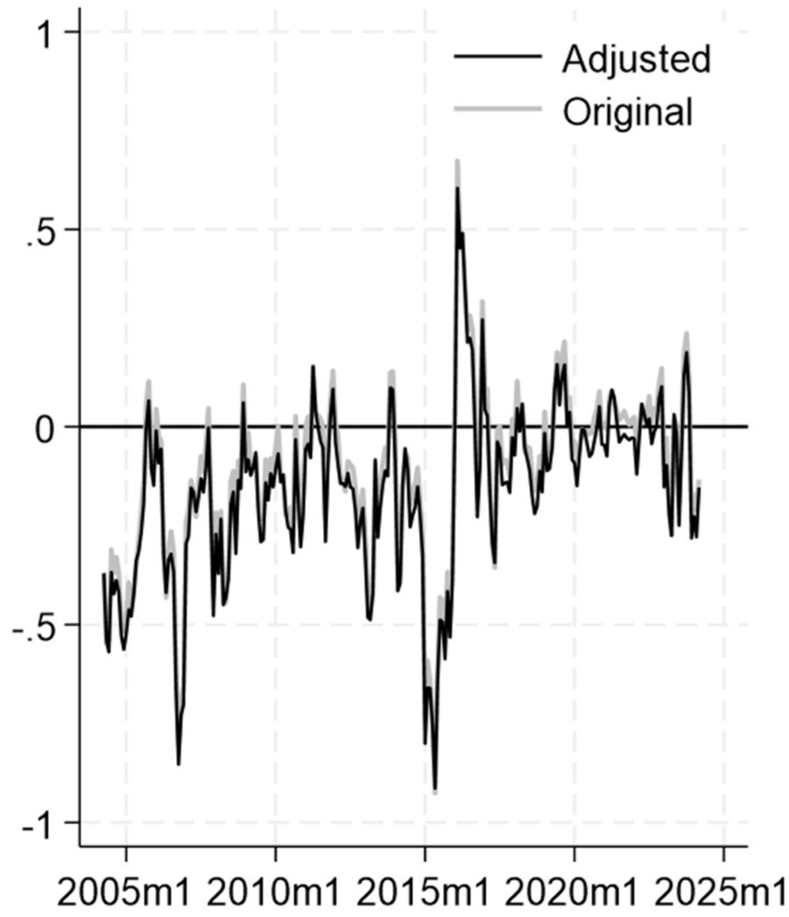


Bias-adjusted sensitivities

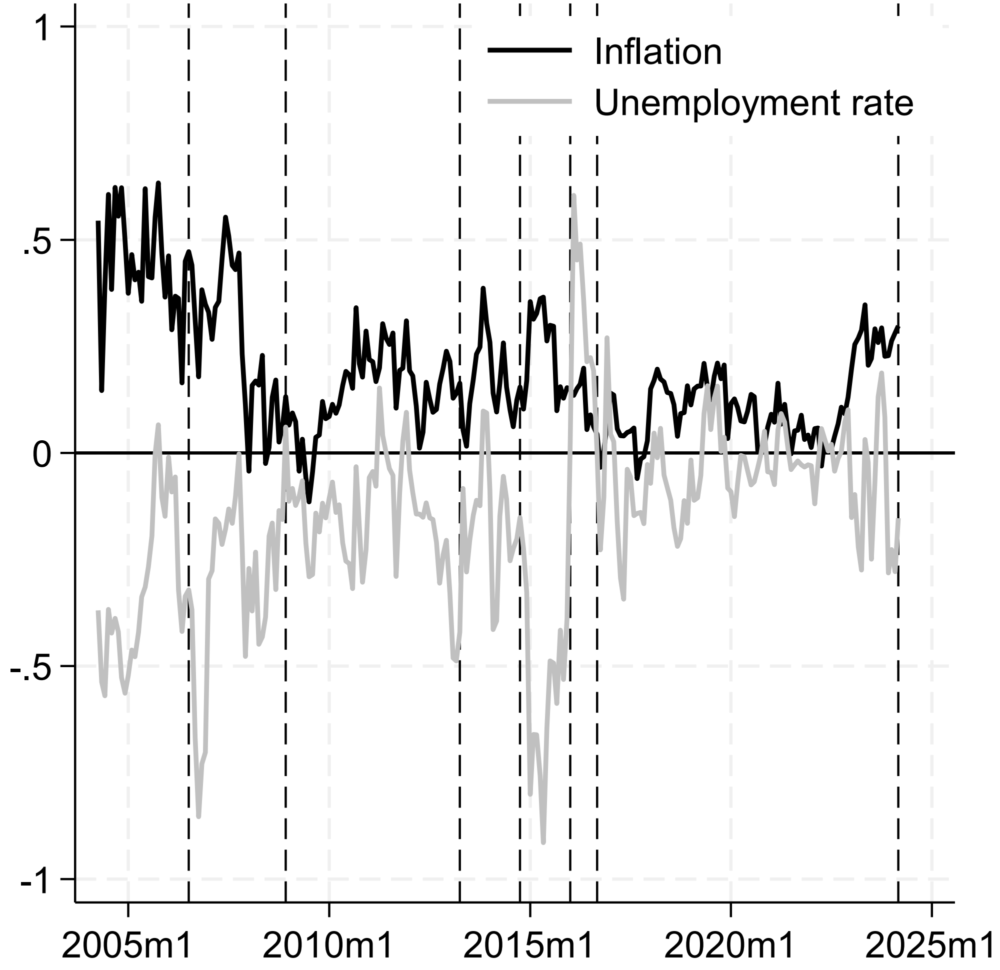
Inflation



Unemployment rate



Sensitivities and events



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Oct. 2014	Expansion of QQE
Jan. 2016	Negative interest rate
Sep. 2016	YCC
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