A Comprehensive Look at the Empirical Performance of Forecast Error Prediction

Kenneth Eva and Fabian Winkler

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  - Most models would not have helped a forecaster to improve their forecasts.
  - But there are important exceptions.

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  - But there are important exceptions.

- Most biases are weak at best. Research should focus on those that are strong.

Models of expectations

A person predicts y_{t+h} as $\hat{y}_{t+h|t}$ at time t. Their information set is $\mathcal{F}_t$. Consider:

$$y_{t+h} - \hat{y}_{t+h|t} = \beta x_t + e_{t+h}, \mathbb{E}\left[e_{t+h} \mid \mathcal{F}_t\right] = 0$$

- Rational expectations model: $\beta = 0$ for any x_t in $\mathcal{F}_t$.
- Behavioral models: $\beta \neq 0$ for some x_t in $\mathcal{F}_t$.

Measure of predictive performance

- In-sample (IS) behavioral forecast:

$$\hat{y}^*_{t+h|t,IS} = \hat{y}_{t+h|t} + \hat{\beta}_T x_t$$

- Out-of-sample (OOS) behavioral forecast:

$$\hat{y}^*_{t+h|t,OOS} = \hat{y}_{t+h|t} + \hat{\beta}_t x_t$$

where $\hat{\beta}_t$ is the OLS coefficient estimated with data up to time t.

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Difference in cumulative sum of squared errors (SSE)

$$\Delta_{tj} = \sum_{s=T_0}^{t} \left[\left(y_{t+h} - \hat{y}_{t+h|t,j} \right)^2 - \left(y_{t+h} - \hat{y}^*_{t+h|t,j} \right)^2 \right], \; j = IS, OOS$$

An increase in Δ_{tj} means the behavioral model performs better.

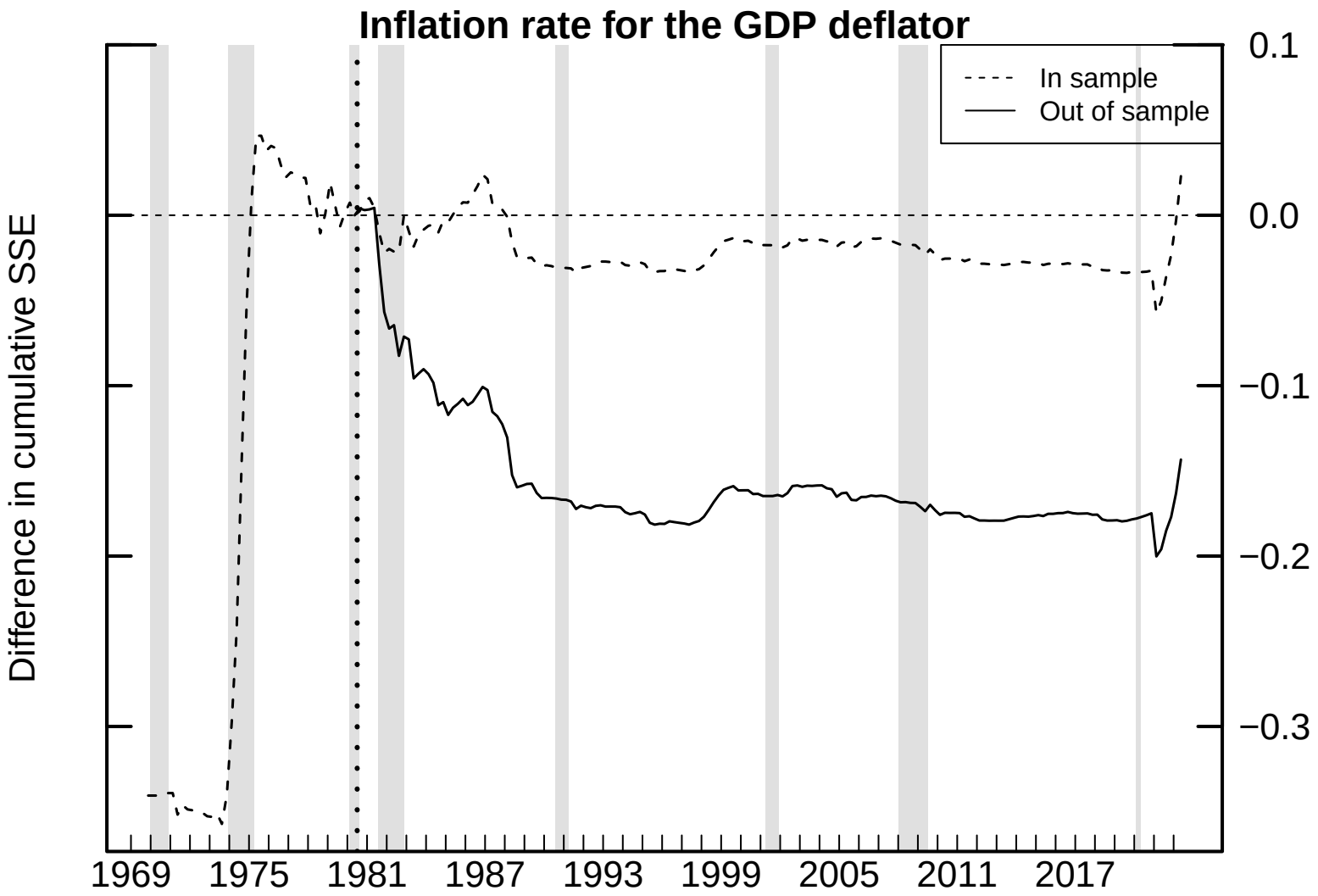
Underreaction of aggregate forecasts

- Coibion and Gorodnichenko (2015, "CG") propose:

$$y_{t+h} - \hat{y}_{t+h|t} = \alpha + \beta \left(\hat{y}_{t+h|t} - \hat{y}_{t+h|t-1} \right) + e_{t+h}$$

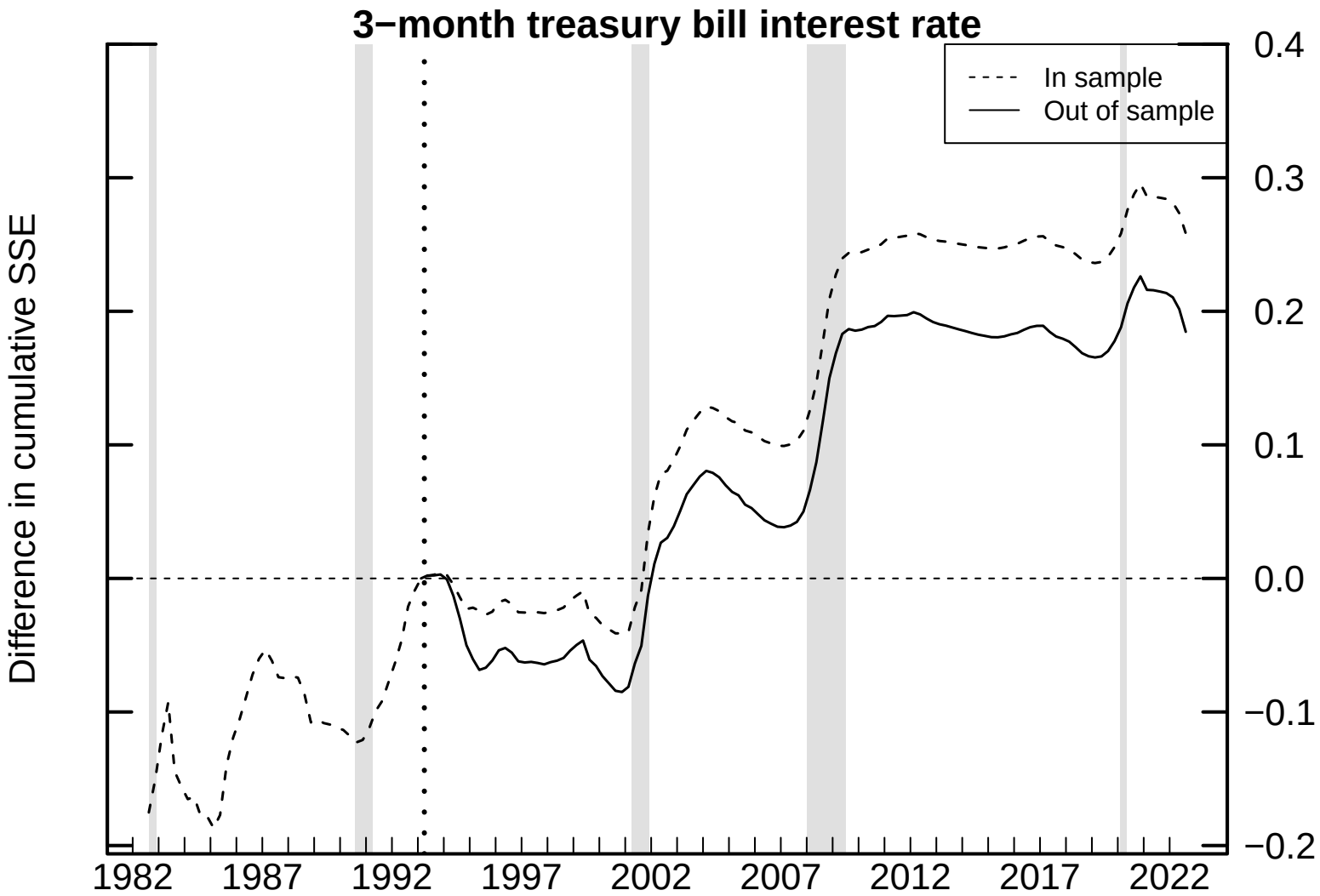
- Evaluate this for all variables in the Survey of Professional Forecasters
- 3-quarter ahead predictions
- Extend their data to 2021Q4

CG: Inflation (GDP deflator)



CG: GDP growth

CG: Short-term interest rate



CG: Across SPF variables, weak predictability on average

	$\Delta_{T,IS}$	$\Delta_{T,OOS}$
Inflation (deflator)	0.023*	-0.143
Inflation (CPI)	-0.008	-0.083
Real GDP	0.003*	-0.145
Industrial Production	0.119**	0.032**
Nominal GDP	0.037*	-0.157
Unemployment rate	0.003	-0.274
Consumption	0.020	-0.049
Non-residential inv.	0.014	-0.125
Residential inv.	0.027	-0.088
Federal govt.	-0.001	-0.075
Non-federal govt.	0.026	-0.134
Housing starts	0.132***	0.021**
3-month yield	0.258***	0.185***
10-year yield	0.450***	0.115**
AAA yield	0.279***	0.220***
Term spread	0.102	0.014
Bond spread	0.022	-0.126

- We bootstrap the distribution of $\Delta_{T,IS}$, $\Delta_{T,OOS}$ under the null of RE for critical values (***, **, *: 1, 5, 10 percent)
- Predictability is weak even in sample
- However, RE is solidly rejected for interest rates
- The results are similar if we regress only on a constant

Overreaction of individual forecasts

- Bordalo et al. (2020, BGMS) apply the CG model to individual forecasts:

$$y_{t+h} - \hat{y}_{t+h|it} = \alpha + \beta \left(\hat{y}_{t+h|it} - \hat{y}_{t+h|it-1} \right) + e_{it+h}$$

- Repeat out-of-sample tests, summing squared errors across individuals
- Results:
  - Still no predictability despite cross-sectional data dimension
  - Interest rates are still the only variables that are OOS-predictable

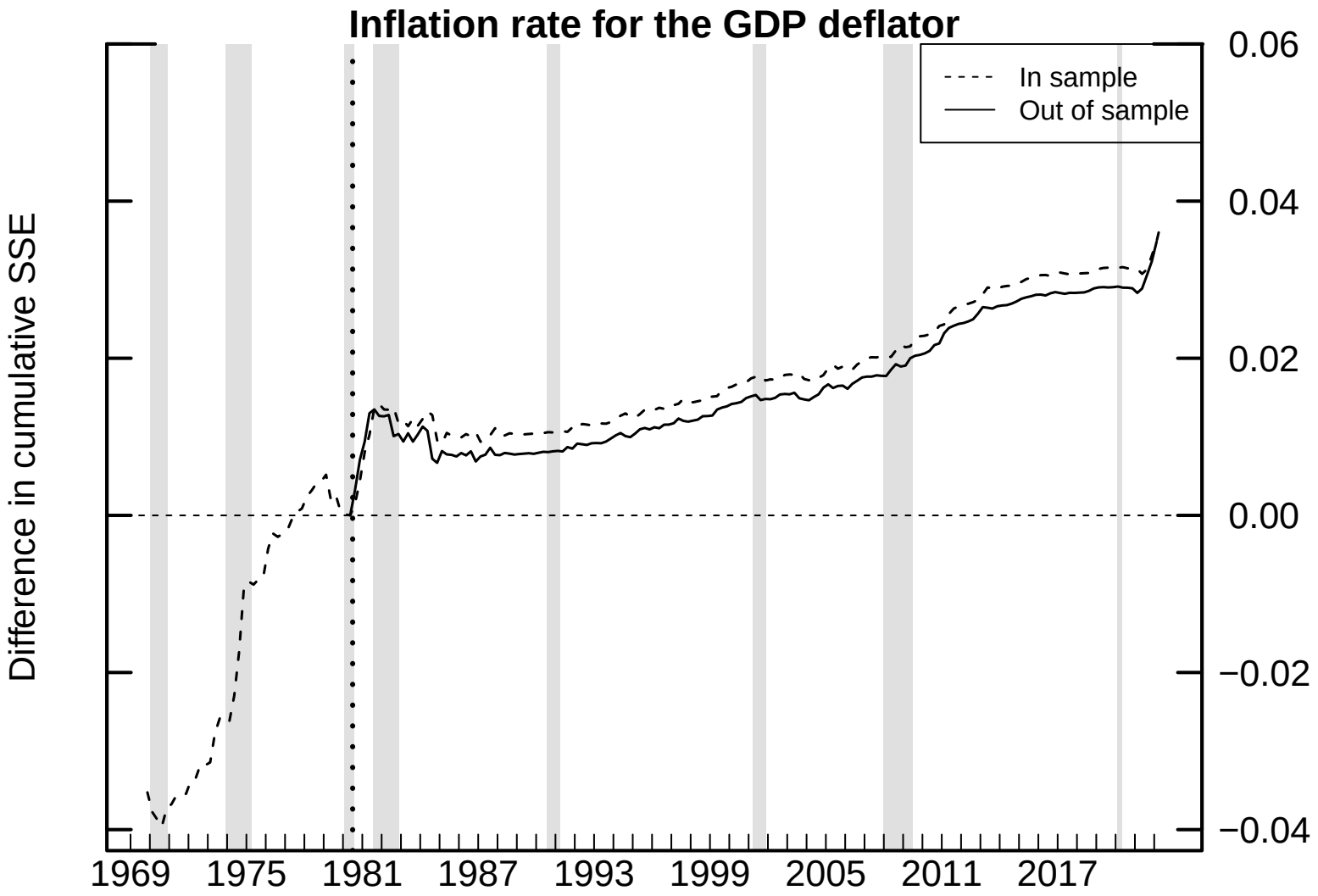
Forecast combination bias

- The advantages of forecast combination are well documented in the forecasting literature (e.g. Timmermann, 2006)
- This implies that forecasters could do better by averaging their forecasts
- Here we propose:

$$y_{t+h} - \hat{y}_{t+h|it} = \beta \left(\bar{y}_{t+h-1|t-1} - \hat{y}_{t+h-1|it-1} \right) + e_{it+h}$$

  - Combination is based only on lagged values, which are known to forecasters in real time

Combination bias: Inflation (GDP deflator)



Forecast combination

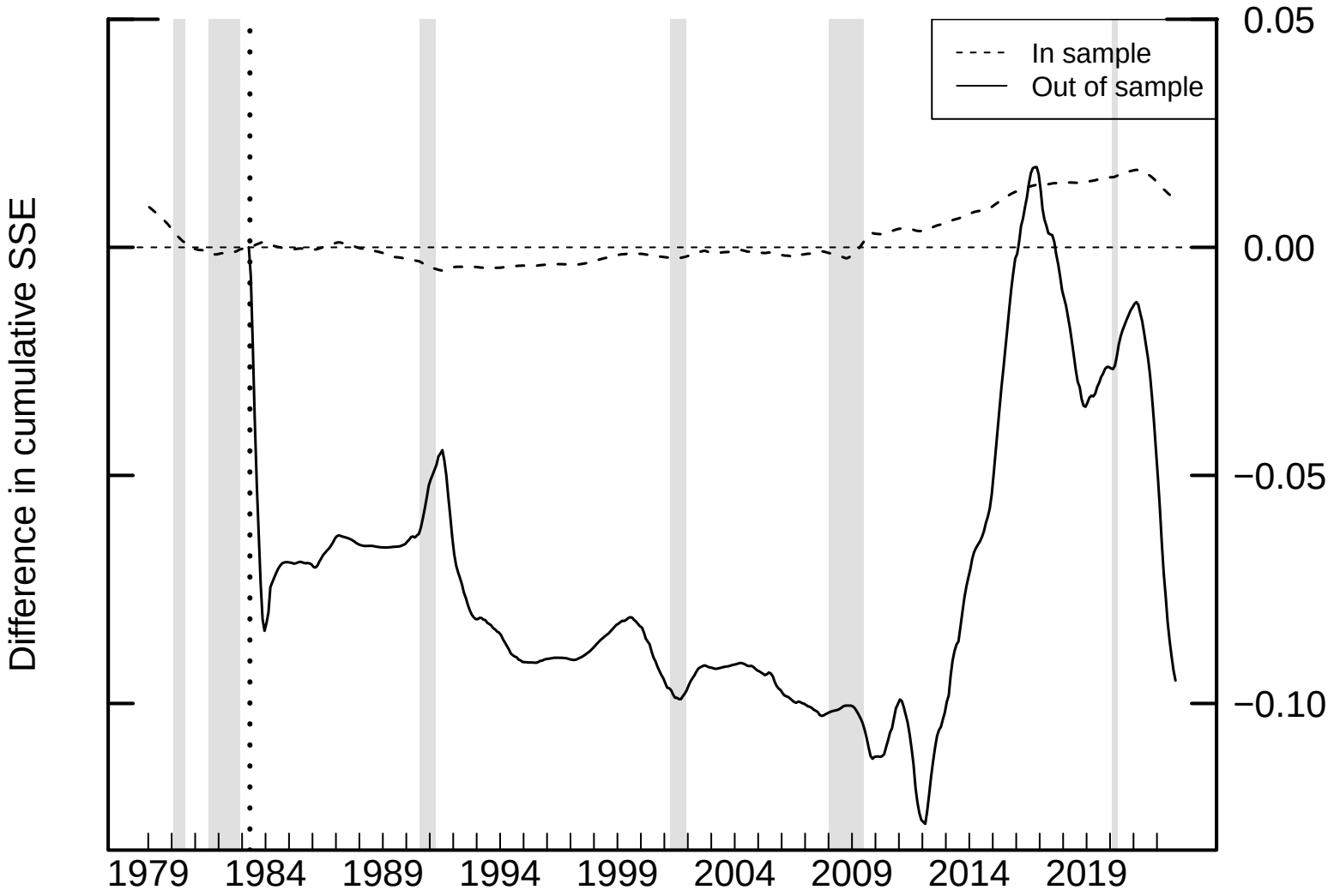
	$\Delta_{T,IS}$	$\Delta_{T,OOS}$
Inflation (deflator)	0.037^{***}	0.035^{***}
Inflation (CPI)	0.014^{***}	0.013^{***}
Real GDP	0.005^{**}	0.005^{***}
Industrial Production	0.011^{***}	0.010^{***}
Nominal GDP	0.006^{*}	0.006^{***}
Unemployment rate	0.018^{***}	0.012^{***}
Consumption	0.002	0.001^{**}
Non-residential inv.	0.023^{***}	0.021^{***}
Residential inv.	0.049^{***}	0.043^{***}
Federal govt.	0.018^{***}	0.011^{***}
Non-federal govt.	0.038^{***}	0.029^{***}
Housing starts	0.105^{***}	0.103^{***}
3-month yield	0.057^{***}	0.056^{***}
10-year yield	0.055^{***}	0.052^{***}
AAA yield	0.102^{***}	0.100^{***}
Term spread	0.058^{***}	0.057^{***}
Bond spread	0.099^{***}	0.091^{***}

- Forecast combination bias is highly significant in and out of sample
- Strategic interactions between forecasters (e.g. Gemmi and Valchev, 2021) could be an explanation

Households

- Households are less sophisticated forecasters, so our OOS tests may reject the null more easily
- Use median inflation expectations in the Michigan survey
- Focus on mean bias (e.g. d'Acunto et al., 2022), rolling window regressions

Mean bias in Michigan inflation expectations



Additional tests

- We examine other tests:
  - Simple mean bias
  - Autocorrelation of forecast errrors
  - Mincer-Zarnovitz
  - Nordhaus
- Our results are robust to different specifications:d
  - Different forecast horizons
  - Rolling-window instead of recursive regressions
  - Data transformations (levels, logs, cumulative or per-period growth rates)
- Using BlueChip data produces similar results.
  - Interest rates across the yield curve show solid mean bias.

Conclusion

- Most documented biases in macroeconomic expectations do not survive OOS tests.
- The models could not have been used to make better predictions.
- But some biases hold up out of sample, in particular:
  - Mean bias in interest rate expectations
  - Forecast combination bias
- Efforts to model expectation formation should focus on the latter biases.