Forecasting Macroeconomic Risks in the UK

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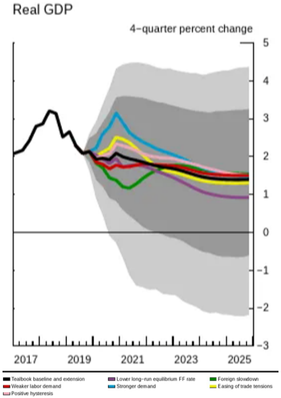
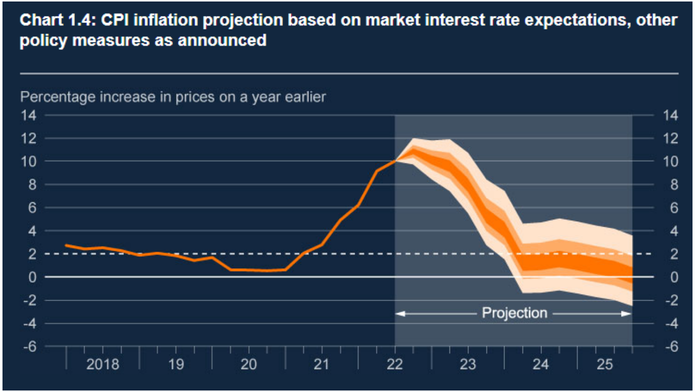
December 2025

Risks Matter for Policy

Scenarios: Fed Tealbook, Dec 2019



Fans: BoE MPR, Nov 2022



⇒ **Important to have tools to quantify risks, as well as metrics to evaluate them**

This Paper

#1. **Build statistical tools for quantifying macro risks in the UK**

#2. **Reveal drivers of risks to UK inflation and GDP growth**

#3. **Compare our estimates (in pseudo real time) to Bank of England Fan Charts**

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- Quantile regressions to estimate inflation- and growth-at-risk

↪ Account for UK-specific features, in particular exposure to global factors

- *One of many possible approaches*: dynamic skew-t, QVARs, GARCH ...

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#2. **Reveal drivers of risks to UK inflation and GDP growth**

- New insights about macroeconomic factors impacting tail risks to UK inflation

↪ π^e, π^{oil} and slack contribute to infl. persistence risks (i.e., right tail)

- Although similar to US, term structure of UK growth-at-risk has global foundations

↪ Tighter fin. conditions weigh on left tail in near term; global credit growth in medium term

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#3. Compare our estimates (in pseudo real time) to Bank of England Fan Charts

- *Calibration* and *sharpness*: how ‘reasonable’? *Relative accuracy*: is one better than another?

$\hookrightarrow$ Inflation fans relatively well calibrated, less so for GDP growth

$\hookrightarrow$ Quantile regressions outperform fans in some dimensions, especially in tails

Uses in Practice

#1. **Data-driven signal about balance of macro risks**

↪ Can highlight *key, policy-relevant, drivers* of uncertainty and skew in outlook

- Clearer foundations than fan charts, which blurred past forecast errors and ‘judgement’
- *Albeit imperfect*: only as good as past data

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#2. **Define set of density-forecast evaluation metrics to evaluate tools**

- Clarify dimensions in which fan charts had "weak conceptual foundations" [Bernanke 24]

↪ Guide to future development of macro risk-assessment tools

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↪ Guide to future development of macro risk-assessment tools

#3. **Support scenario development and synthesis**

- Act as reference for 'scenario synthesis'

↪ Gauge degree of scenario 'completeness' [Adrian et al. 25]

At-Risk Estimates

Quantile-Regression Setup

$$Q_{\mathsf{y}_{t+h}}(\tau|\mathbf{x}_t) = \alpha^h(\tau) + \mathbf{x}_t'\boldsymbol{\beta}^h(\tau)$$

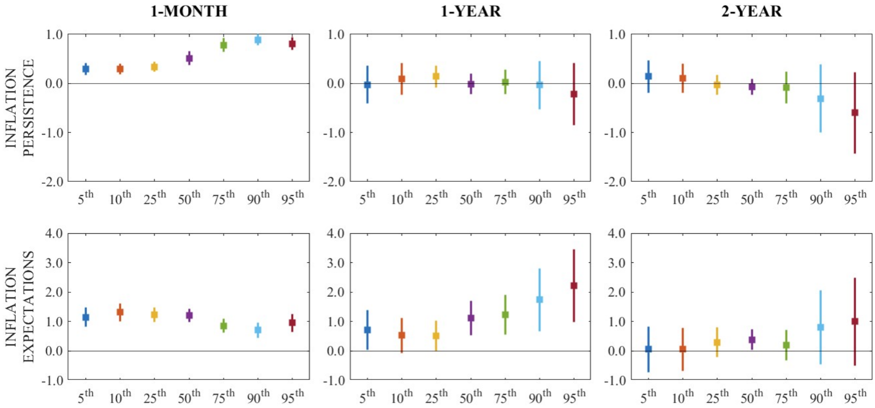
- Q: conditional quantile function
- $\tau \in (0,1)$: quantiles
- y_t: dependent variable
  - Annual UK CPI inflation (monthly): $\pi_t = \ln P_t - \ln P_{t-12}$
  - Year-on-year UK real GDP growth (quarterly): $\Delta^4 y_t = \ln GDP_t - \ln GDP_{t-4}$
- $\mathbf{x}_t$: 'risk factors', with quantile- and horizon-specific coefficients $\boldsymbol{\beta}^h(\tau)$
- Full Samples: 1990:01-2024:12 (inflation); 1980Q1-2024Q4 (GDP growth)
- Out-of-sample, expanding window, analysis from 2004:01-2025:01 (2004Q1-2025Q1)

Preferred Specifications

Search over range of specifications, minimising CRPS at forecast-relevant horizons

Inflation (1990:01-2024:12)	**GDP Growth**
I. Persistence:	
Avg. CPI inflation in previous year, $\overline{\pi}_{t-11,t}$	
II. Expectations:	
CPI infl. exp. for next calendar year, $\pi^{e}_{t,1}$	
III. Economic Tightness:	
1y chg. in vacancy–unemp. ratio, $\Delta^{12}(\frac{v_t}{u_t})$	
IV. Financial Conditions:	
UK Excess Bond Premia, ebp_t	
V. External Conditions:	
Global y-o-y oil price infl., π^{oil}_t	
Covid-19 Dummy: 2020:04-2020:09	

Inflation Persistence and Inflation Expectations



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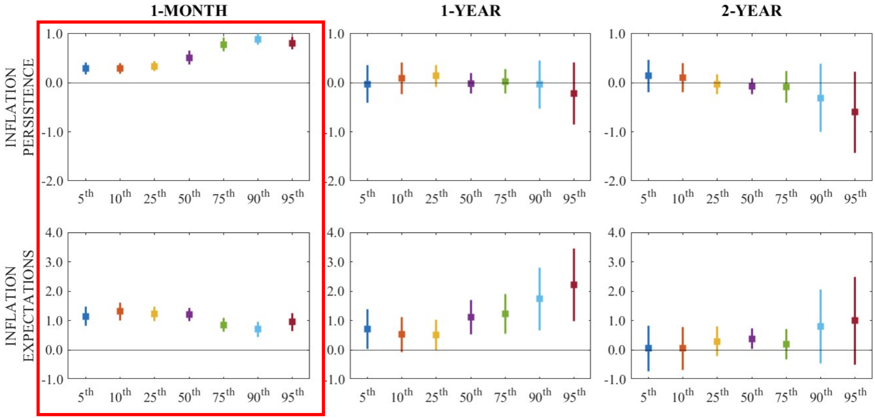

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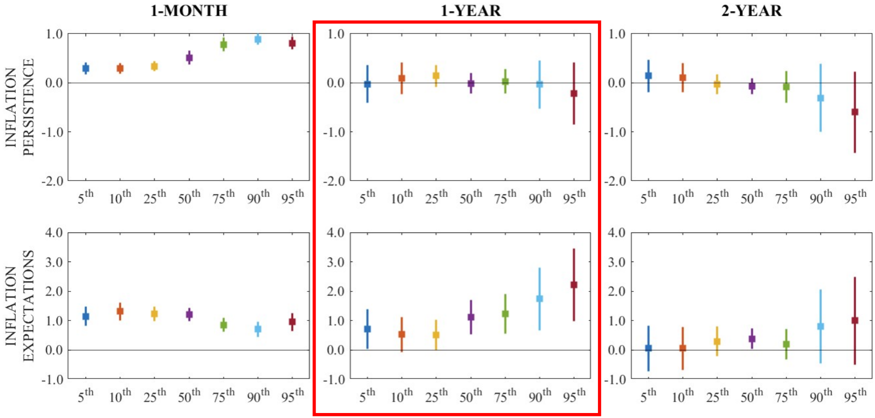
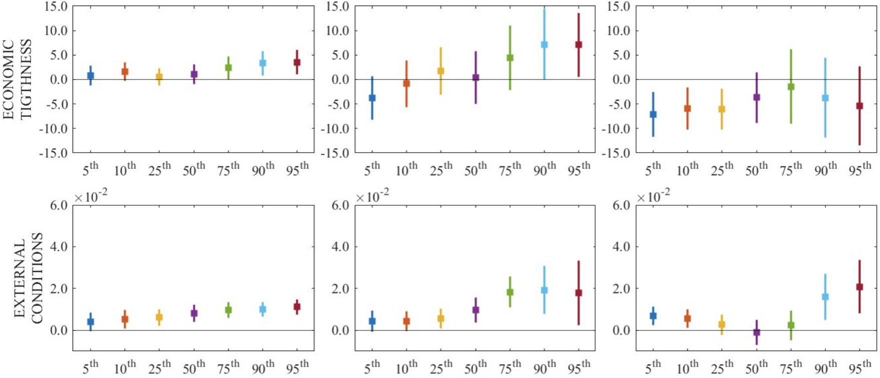


Economic Tightness and External Conditions



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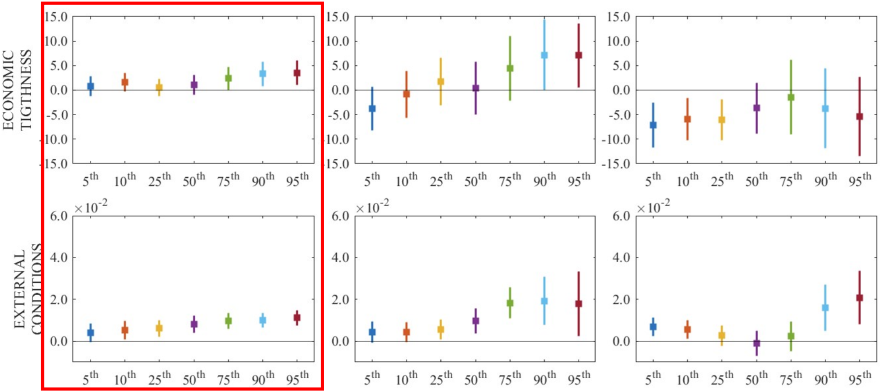

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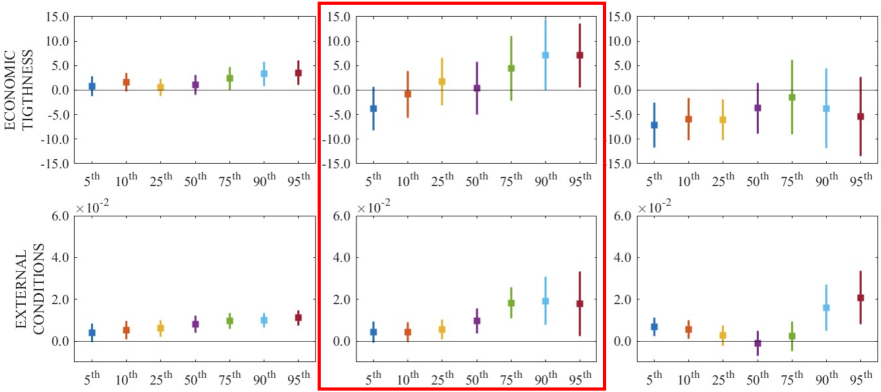
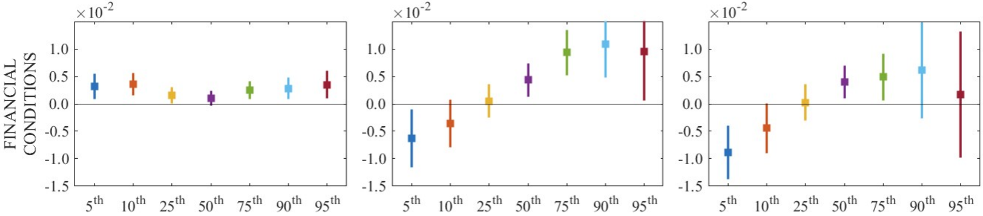


Financial Conditions



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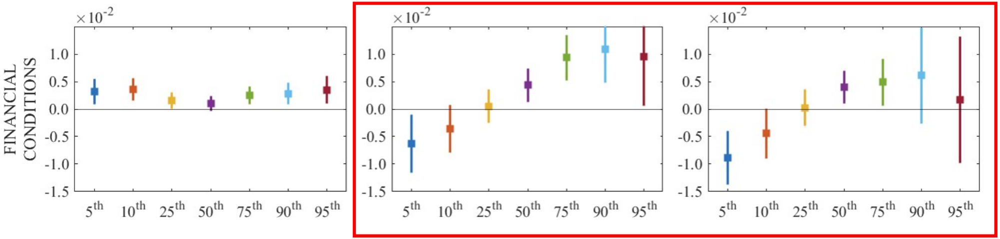
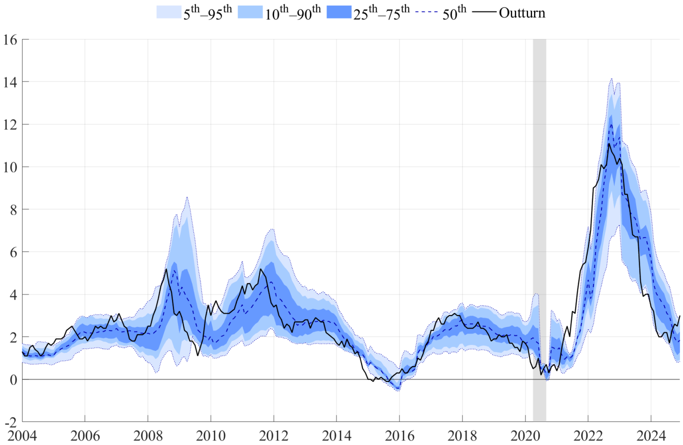


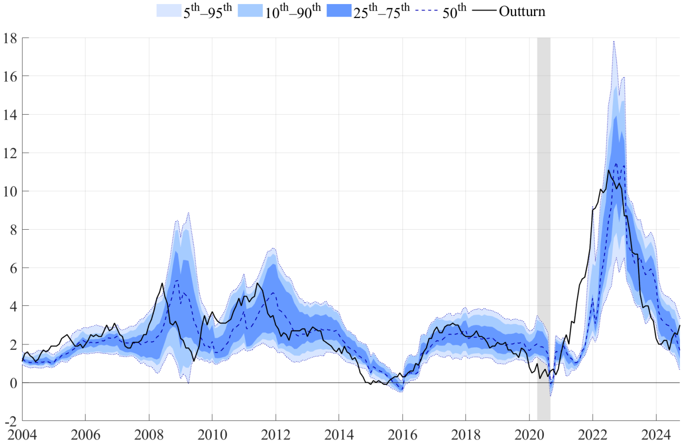
Out-of-Sample Quantile Forecasts for Annual CPI Inflation

1-month-ahead



Out-of-Sample Quantile Forecasts for Annual CPI Inflation

1-quarter-ahead



New Evidence on Macro Risks in UK

Inflation

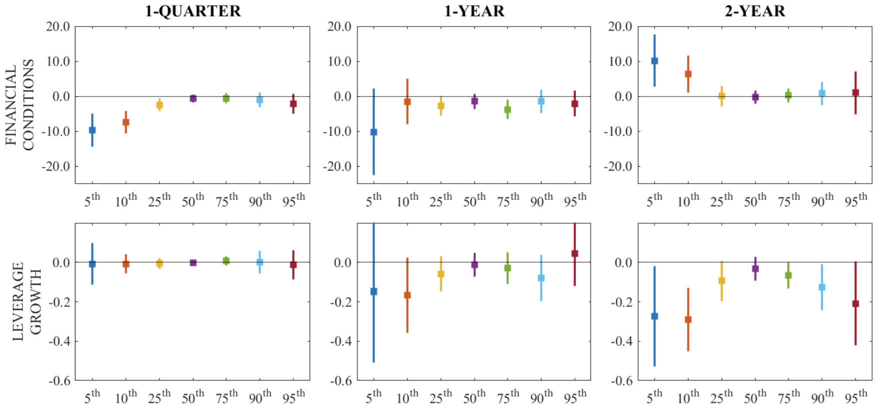
- π^e, π^{oil} and slack have outsized effect on right tail, driving persistence risks
- Tighter fin. conditions increase uncertainty and eventually tilt risks to the downside
- Forecasts and realisations closely aligned
  - At 1-month horizon, $10^{th} - 90^{th}$ forecasts bands almost always contain the realisation
  - 1-quarter horizon more challenging, but forecasts (esp. for right tail) detect the variation in risk

Preferred Specifications

Search over range of specifications, minimising CRPS at forecast-relevant horizons

Inflation (1990:01-2024:12)	**GDP Growth**
I. Persistence:	I. Economic Activity:
Avg. CPI inflation in previous year, $\overline{\pi}_{t-11,t}$	y-o-y monthly GDP gr., $\ln y_{t+1}^{m=1,2} - \ln y_{t+1-4}^{m=1,2,3}$
II. Expectations:	II. Financial Conditions:
CPI infl. exp. for next calendar year, $\pi_{t,1}^{e}$	CISS index, $ciss_t$
III. Economic Tightness:	III. Leverage Growth:
1y chg. in vacancy–unemp. ratio, $\Delta^{12}(\frac{v_t}{u_t})$	3y chg. in global credit-to-GDP, $cred_t^{WORLD}$
IV. Financial Conditions:	IV. Price Indicator:
UK Excess Bond Premia, ebp_t	y-o-y import fuel deflator, π_t^{fuel}
V. External Conditions:	
Global y-o-y oil price infl., π_t^{oil}	
Covid-19 Dummy: 2020:04-2020:09	Covid-19 Dummy: 2020Q2-2022Q2

Financial Conditions and Leverage Growth



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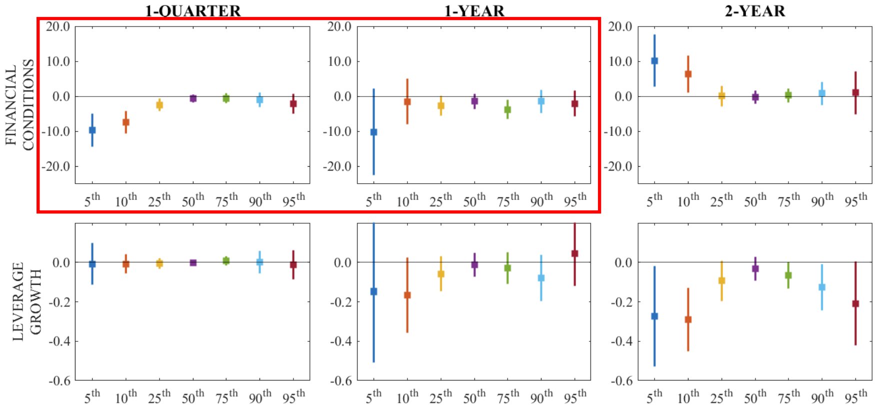

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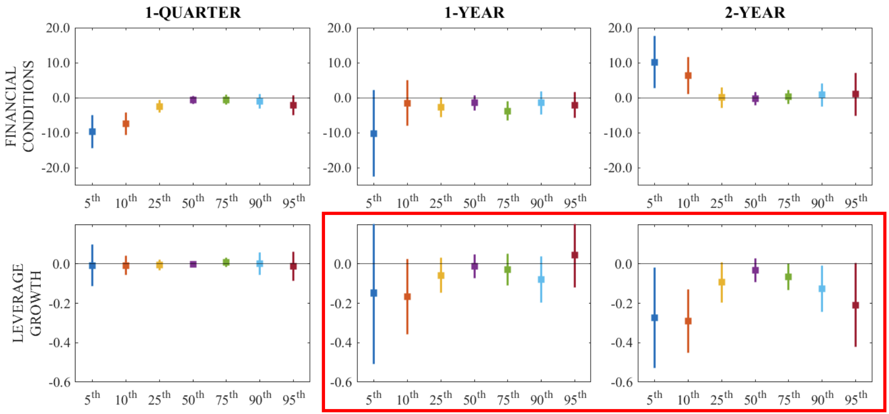
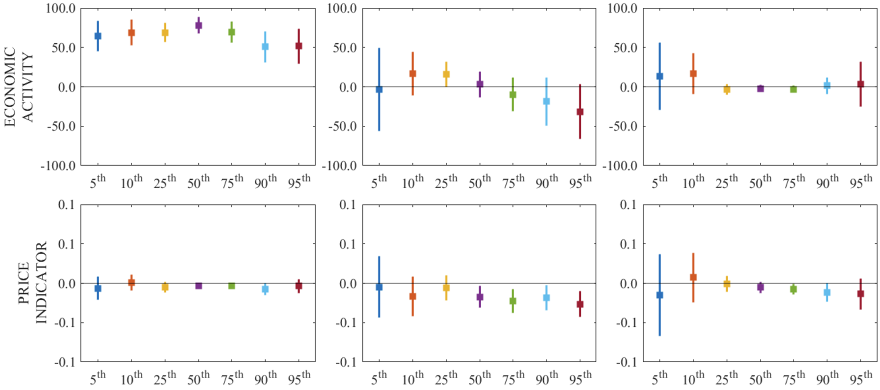


Economic Activity and Price Indicator



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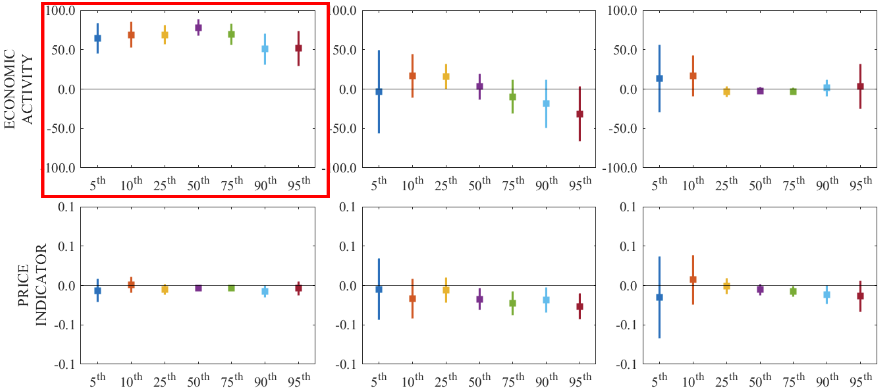

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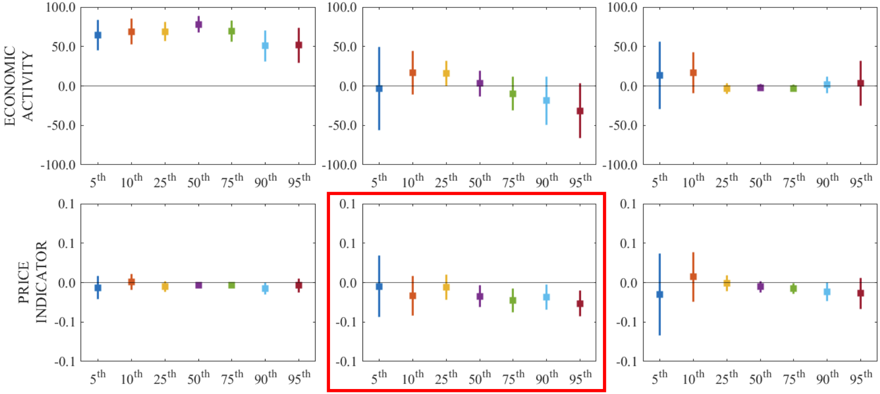

Out-of-Sample Quantile Forecasts for GDP Growth

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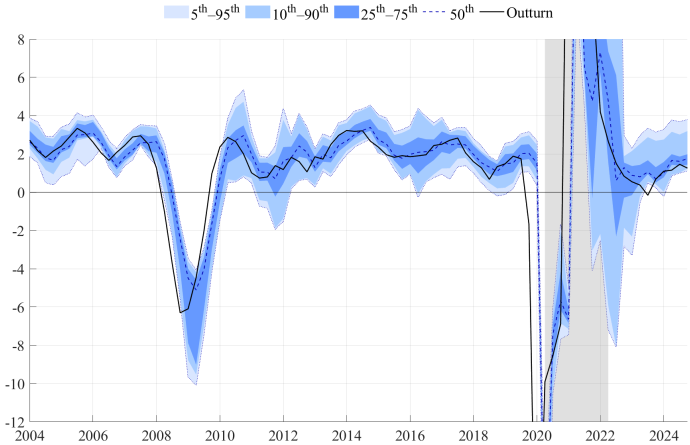
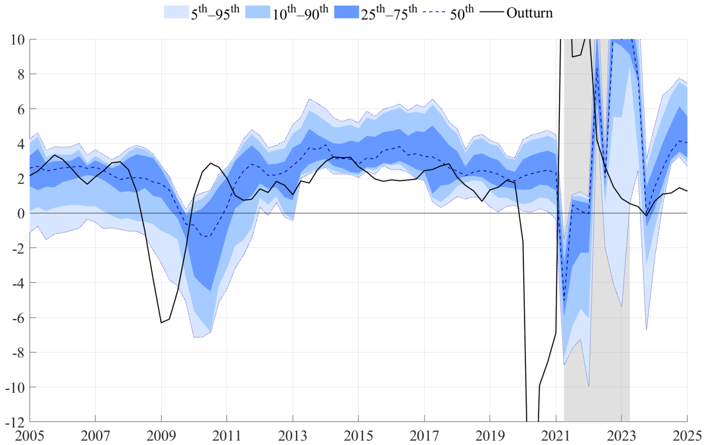


Out-of-Sample Quantile Forecasts for GDP Growth

1-year-ahead



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GDP Growth

- Tighter financial conditions increase near-term downside risks [Adrian et al. 22]
- Reflecting UK's position as open econ., global credit impacts med-term left tail [Lloyd et al. 24]
- Short-term accuracy and ability to capture downside risk

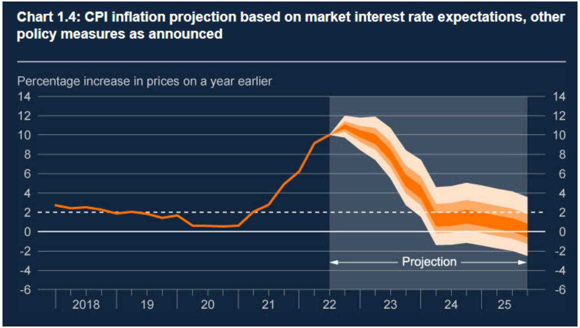
Forecast Evaluation and Comparison with Fan Charts

Fan Charts

The Bank of England fan charts are constructed as two-piece (or split) normal distributions:

$$f(\mathsf{y}|\mu,\sigma,\gamma) = A\exp\left[-\frac{1}{2\pi\sigma^2}\left((\mathsf{y}-\mu)^2+\gamma\left(\frac{\mathsf{y}-\mu}{|\mathsf{y}-\mu|}\right)+(\mathsf{y}-\mu)^2\right)\right]$$

Calibration: Past forecast errors $+$ judgement



Predictive Distributions from Quantile Regressions

Use out-of-sample quantile forecasts $\hat{Q}_{\mathsf{y}_{t+h}}(\tau|\mathbf{x}_t)$ to construct densities via 2 approaches:

#1 **Parametric**: Skew-*t*, with four moments: [Azzalini & Capitanio 03]

$$f(\mathsf{y};\mu,\sigma,\gamma,\kappa) = \frac{2}{\sigma}\, t\left(\frac{\mathsf{y}-\mu}{\sigma};\kappa\right)\; T\left(\gamma\left(\frac{\mathsf{y}-\mu}{\sigma}\right)\sqrt{\frac{\kappa+1}{\kappa+\left(\frac{\mathsf{y}-\mu}{\sigma}\right)^2}};\kappa+1\right)$$

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#2 **Semi-parametric**: [Mitchell et al. 24]

$$\hat{F}(y_{t+h}\mid x_t)=\tau_j+\frac{\tau_{j+1}-\tau_j}{x_t^\top\hat{\beta}_{\tau_{j+1}}-x_t^\top\hat{\beta}_{\tau_j}}\left(y_{t+h}-x_t^\top\hat{\beta}_{\tau_j}\right)$$

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For today: Since skew-*t* forecasts more accurate then semiparametric, focus on former

Fan Charts & Quantile Regression: How Can We Judge Them?

Probabilistic Calibration

If model predicts 70% chance of event and that event happens $\sim 70\%$ of time, forecast distribution matches reality

$\hookrightarrow$ valuable for policymakers, since well-calibrated forecasts accurately capture likelihoods

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Statistically, it means testing if the PITs of density forecast are uniform:

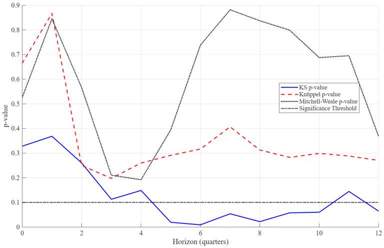
$$z_{t,t+h} = \int_{-\infty}^{y_{t+h}} f_t(\mathsf{y}_{t+h}) \, \mathrm{d}y = F_t(\mathsf{y}_{t+h})$$

Tests we apply account for nature of macro time series:

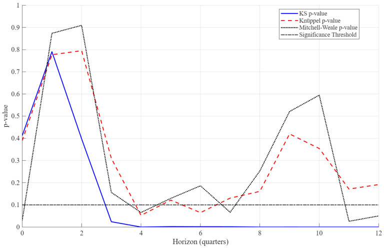
- Rossi and Sekhposyan (19): Time-series dependence
- Knüppel (15): Focus on moments
- Mitchell & Weale (23): Censoring of fans
- Galvão et al. (25): Joint test across forecast horizons

Inflation Fans and Quantile Regressions Both Well-Calibrated

Fan Charts



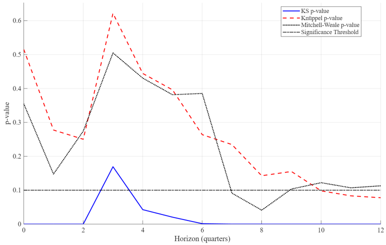
Inflation-at-risk



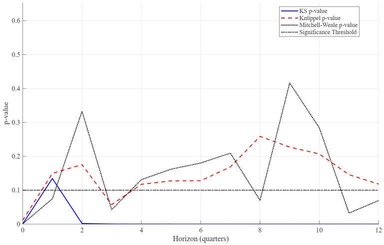
Galvão et al. ('25)	Sup test	Decr w	Incre w	Sup test	Decr w	Incre w
Joint at 5%	✓	✓	✓	✓	✓	✓

Near-Term GDP Fans Calibrated, (So Far) Mixed for Quantile Regs.

Fan Charts



GDP-at-risk



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Fan Charts & Quantile Regression: How Can We Judge Them?

Sharpness

Sharpness measures the concentration of the forecast density to distinguish between two calibrated forecasts.

Fan Charts & Quantile Regression: How Can We Judge Them?

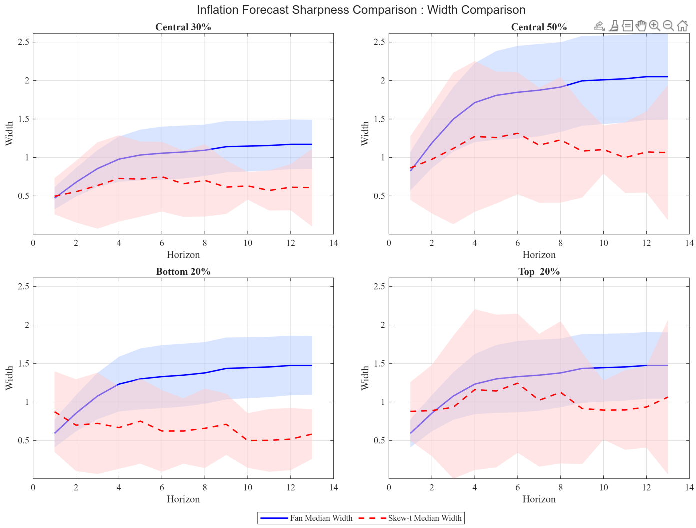
Sharpness

Sharpness measures the concentration of the forecast density to distinguish between two calibrated forecasts.

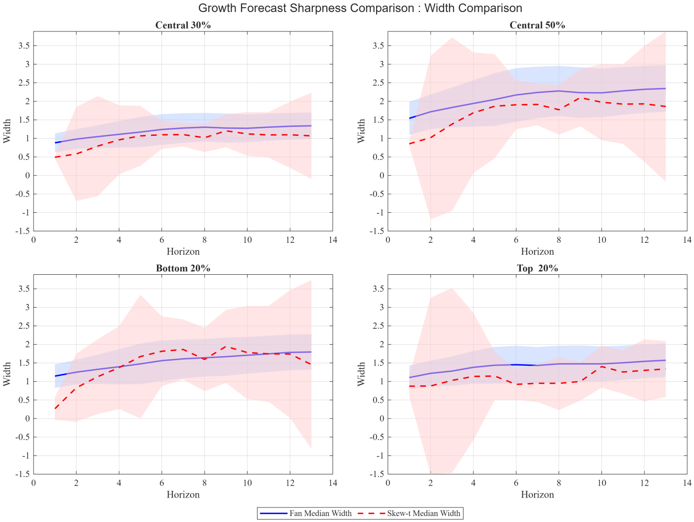
How can we measure this?

- Comparing widths of the predictive density in a given interval (implemented here)
- Proper scoring rules (e.g. CRPS)

Sharpness: Inflation



Sharpness: GDP Growth



Relative Accuracy: Weighted Likelihood Ratio

$$d_{t,t+h} \equiv w(\cdot)\left[\log\left(\hat{f}_t^{Fan}(\mathsf{y}_{t+h})\right) - \log\left(\hat{f}_t^{QR}(\mathsf{y}_{t+h})\right)\right] \begin{cases} > 0 \text{ if Fan} \succ \text{QR} \\ < 0 \text{ if Fan} \prec \text{QR} \end{cases}$$

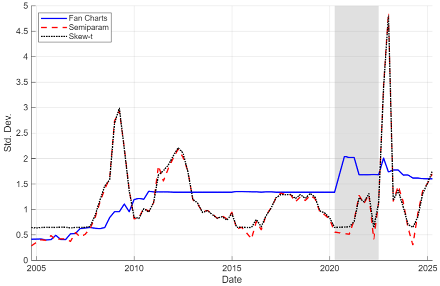
	Inflation				GDP			
Horizon	Centre	Tails	Right Tail	Left Tail	Centre	Tails	Right Tail	Left Tail
0	2.922	2.471	2.912	3.679	**-1.649**	0.552	**-4.947**	0.351
1	4.137	1.257	2.405	3.449	0.843	0.0300	0.344	0.615
4	2.748	1.844	2.230	2.453	1.805	**-1.032**	1.933	**-0.189**
8	2.537	0.243	1.507	2.805	**-1.013**	**-1.285**	**-0.907**	**-1.526**
12	1.784	**-0.573**	**-0.100**	1.728	1.131	**-1.200**	1.313	**-0.120**

↪ For inflation, fan chart more accurate across distribution. Almost expected.

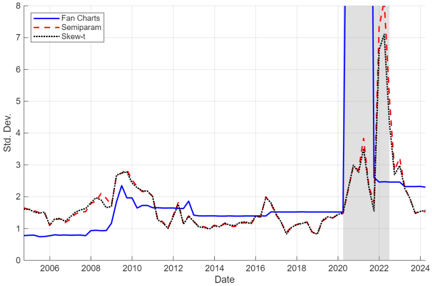
↪ For GDP, quantile regressions more accurate in tails

But Quantile Regs. Capture Better Narrative Around Higher Moments

Inflation



GDP Growth



Conclusions

In this paper we:

- **Build statistical toolkit to assess risks around UK inflation and GDP growth that**:
  - ↪ provide accurate forecasts
  - ↪ identify drivers of risks
  - ↪ inform narrative around balance of risks for policymakers
- **Provide a framework for density-forecast evaluation**:
  - ↪ allow us to elicit the best forecast according to their past performance

Still refining today's model specifications, but also exploring further work:

- Exploring other tools for forecast-density estimation
- Analysing benefits from forecast-density combination across models

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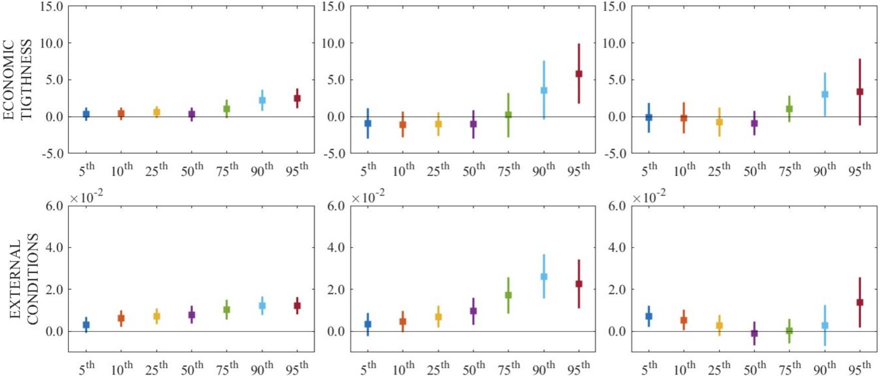
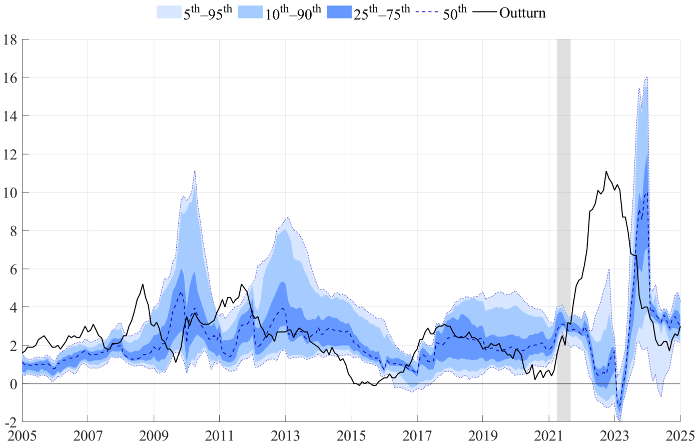
Economic Tightness and External Conditions (V/U)



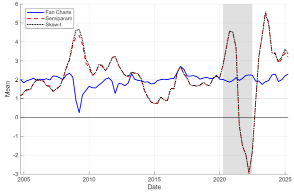
Out-of-Sample Quantile Forecasts for Annual CPI Inflation

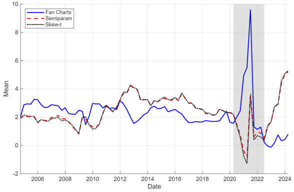
1-year-ahead



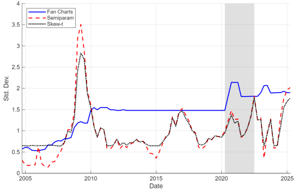
Moment Comparison: 2-Years-ahead

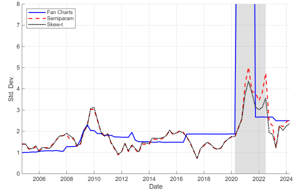
Mean



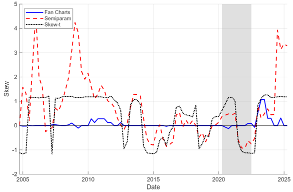


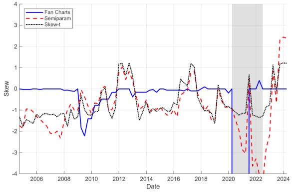
Std. Dev.



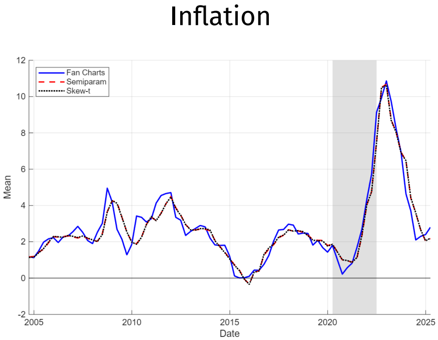


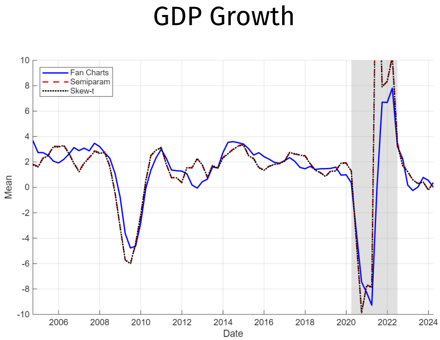
Skew





Moment Comparison: Mean





Moment Comparison: Skewness