Forecast accuracy and efficiency at the Bank of England: How errors can be leveraged to do better.

Derrick Kanngiesser Tim Willems

The views expressed do not necessarily represent the views of the Bank of England or its Committees.

Motivation

- Recent forecast errors (particularly on inflation) have put the Bank of England's forecasts, and the underlying models, under heightened scrutiny.
- "Inflation targeting" is actually "inflation forecast targeting" (Svensson 1997); places inflation forecasting practices right at the core of central bank policy decisions.
- Producing accurate forecasts is furthermore thought to be important to build and maintain central bank credibility (McMahon and Rholes 2023).

- **Our Goal:** Assess the forecast accuracy and efficiency at the Bank of England; if there are systematic forecast errors, try to identify their causes.

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Literature

- **Forecast error evaluation:** Overviews by West (2006) and Clark and McCracken (2013); applications by Timmermann (2007) for the IMF, Tulip and Wallace (2012) for Australia, Reifschneider and Tulip (2019) for the US/ FOMC forecasts.
- **BoE Forecast error evaluation:** IEO (2015) report, Bernanke (2024)
- **Forecast efficiency:** Nordhaus (1987), Blanchard and Leigh (2013, 2014).

- **Our contribution:** First paper to analyse forecast efficiency a la Blanchard-Leigh in a monetary policy context.

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BoE MPC Forecast construction

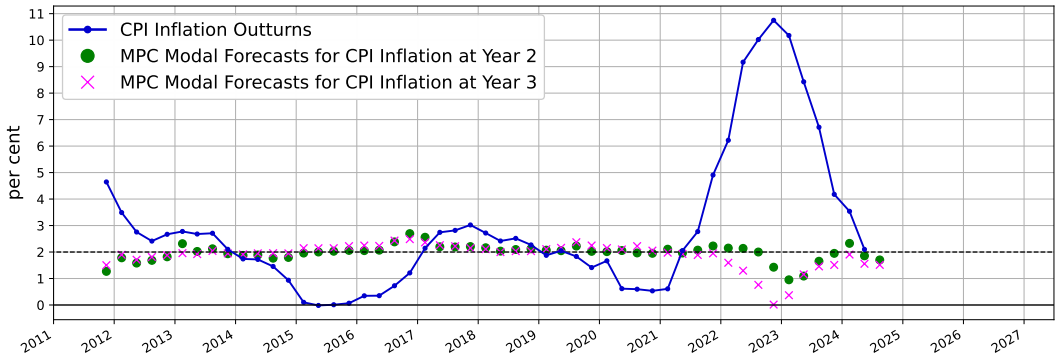
- Quarterly frequency, three-year horizon
- "Modal" in nature: most likely outcome
- Forecast is constructed 'incrementally' (incorporating news relative to previous forecast)
  - Combines COMPASS, supporting models & MPC judgement
- Conditioning assumptions:
  - Exchange rate
  - Energy prices
  - Fiscal policy
  - Other economies
  - *Market-implied* path for Bank Rate

BoE MPC Forecast is conditional in nature

- MPC's hands are tied by conditioning assumptions
- Those need not coincide with "the MPC's" beliefs
- Two important examples:
  - MPC (which sets Bank Rate) might disagree with market expectations
  - Fiscal assumptions can be outdated
- Can give rise to the MPC making "deliberate" forecast errors
  - Inflation $\neq$ 2% at Y3 can signal disagreement with market-implied path for Bank Rate

BoE MPC Forecast is conditional in nature (ii)

Figure 1: CPI Inflation, year-on-year, Outturns and Forecasts 2 and 3 years ahead



Notes: The solid blue line depicts the CPI Inflation outturns. The green dots (pink crosses) show the forecasts for inflation 2 (3) years ahead.

The Data

- We compile a dataset of the BoE's quarterly MPC forecasts from 1997:Q3 - 2024:Q2 for
  1. ⏩ Inflation (yoy)
  2. ⏩ Wage growth (yoy)
  3. ⏩ Real GDP growth (yoy)
  4. ⏩ Unemployment rate
- We also collect outturns and forecast conditioning paths for
  1. ⏩ Bank Rate
  2. ⏩ Energy price growth (yoy)

Concepts and Notation

1. Forecast Error: $FE_{t-h}(x_t)$ is the h quarters ahead forecast error for variable x in period t

$$FE_{t-h}(x_t) \equiv F_{t-h}(x_t) - x_t, \tag{1}$$

where $F_{t-h}(x_t)$ is the h quarter ahead forecast for variable x in period t that was based on the information set in period $t-h$; x_t is the outturn of variable x in period t, taken $k = 12$ quarters after the first data release. Example

2. Root Mean Square Error (RMSE) as a measure of forecast accuracy:

$$RMSE(x,h) \equiv \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left(FE_{t-h}(x)\right)^2}, \tag{2}$$

where N is the total number of forecasts. We will also look at the **root median square error (RMedSE)** to control for outliers.

3. Forecast Efficiency: It should not be possible to forecast a forecast error with information available at time $t-h$ when the h quarters ahead forecast is produced. The $t-h$ 'information set' contains the forecasts released at time $t-h$ (Blanchard and Leigh (2013, 2014)).

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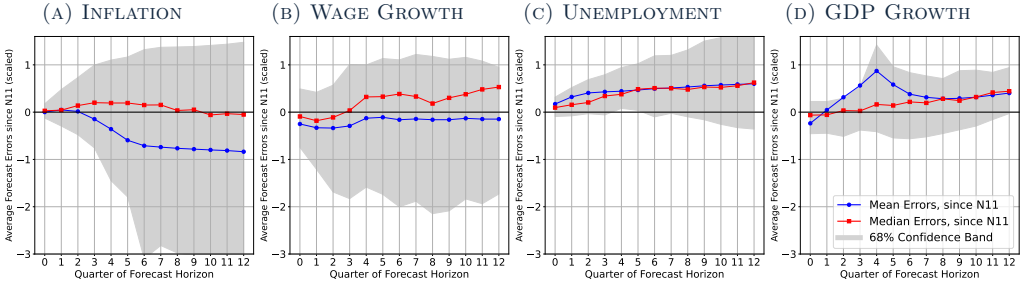
Forecast Bias

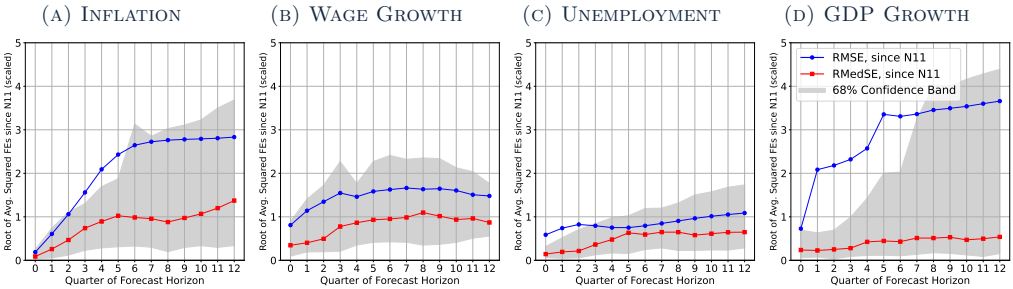
Figure 1: Average Forecast Errors since November 2011



Notes: The blue (red) lines depict the mean (median) forecast error of the MPC modal forecasts since 2011. The grey swathe depicts the 68% percentiles of the sample from 2011:Q4-2024:Q1. All forecast errors have been re-scaled by the respective pre-pandemic sample standard deviation to facilitate comparability across variables and across samples. Positive values imply over-prediction, whereas negative values imply under-prediction.

Forecast Accuracy

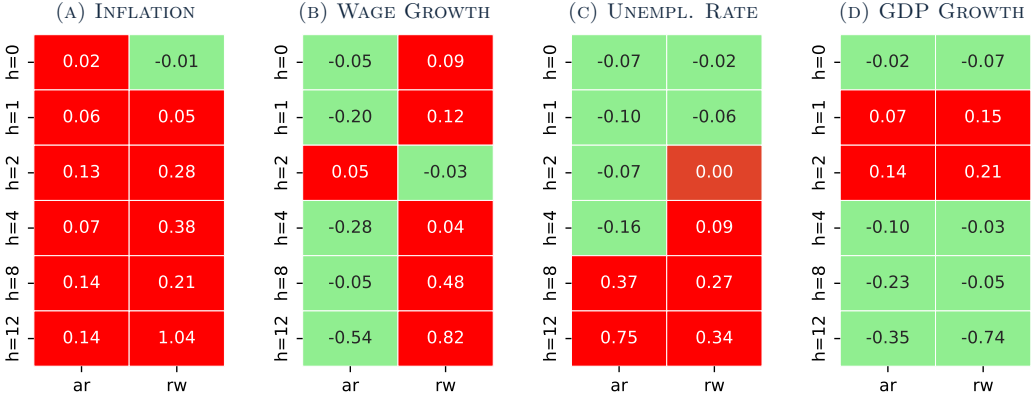
Figure 2: Root Mean and Median Squared Errors since November 2011



Notes: The blue (red) lines depict the root mean (median) squared forecast error of the MPC modal forecasts since 2011. The grey swathe depicts the 68% percentiles of the sample from 2011:Q4-2024:Q1. All forecast errors have been re-scaled by the respective pre-pandemic sample standard deviation to facilitate comparability across variables and across samples.

Bias Comparison with RW and AR(p), post-2011

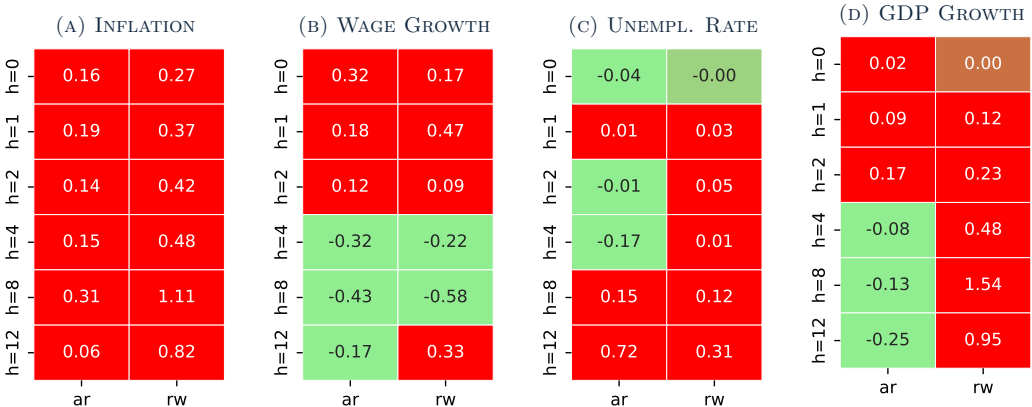
Figure 3: Bias Comparison, since November 2011



Notes: The four tables 4a, 4b, 4c and 4d (from left to right for inflation, wage growth, unemployment and GDP growth) depict a comparison of the absolute values of the forecast biases in terms of the *median* forecast errors between the cross-check forecasts and the MPC modal forecasts since 2011. The right column of each table depicts the difference between the absolute value of the bias for the random walk (RW) forecast and the absolute value of the MPC modal forecast bias. If the random walk forecast is less biased than the MPC modal forecast, the corresponding field is colored in green. The left column in each table depicts the AR(p) comparison.

Accuracy Comparison with RW and AR(p), post-2011

Figure 4: Accuracy Comparison, since November 2011



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Blanchard-Leigh Approach: Narrative Example

Blanchard and Leigh (2013) observed that Eurozone countries with more planned fiscal consolidation, systematically ended up disappointing in growth.

Suggested that the IMF had been under-estimating fiscal multipliers.

BL approach can also be applied to central bank forecasts. Back in August 2022, the BoE MPC forecast for 2024-Q3 had:

- CPI inflation return to the 2% target
- Unemployment rate to rise to 5.5% (from 3.7% mid-2022)
- Conditional on Bank Rate peaking at 3.0% in 2023-Q3

By now, inflation has returned to target but Bank Rate peaked at 5.25%, while unemployment didn't rise as much. Could suggest that the MTM embedded a more favourable trade-off ratio than assumed in the forecast process.

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By now, inflation has come down but Bank Rate peaked at 5.25%, while unemployment didn't rise as much. Could suggest that the MTM embedded a more favourable trade-off ratio than assumed in the forecast process.

Blanchard-Leigh Regressions

We regress the inflation forecast errors, $FE_{t-h}(\pi_t)$, on forecasts of variables x:

$$FE_{t-h}(\pi_t) = \alpha_h^x + \beta_h^x F_{t-h}(x_{t-h+j}) + \varepsilon_{h,t}^x, \quad (3)$$

$$x_{t-h+j} = \gamma_h^x + \delta_h^x F_{t-h}(x_{t-h+j}) + v_{h,t}^x. \quad (4)$$

Here, (3) regresses the inflation forecast errors on forecasts of variable x_t, which represents, alternatively, real wage growth (π_t^w), the unemployment rate (u_t), and real GDP growth (y_t).

We are interested in the Wald ratio $\omega_h^x = \beta_h^x / \delta_h^x$, which corrects our β_h^x - estimate for any biases in the forecasts for variable x (i.e., for cases with $\delta_h^x \neq 1$). We obtain standard errors for the Wald ratio (ω_h^x) via the delta-method.

We estimate (3) using the method of "robust regression" (Berk 1990), which (endogenously) down-weights observations that are considered "atypical".

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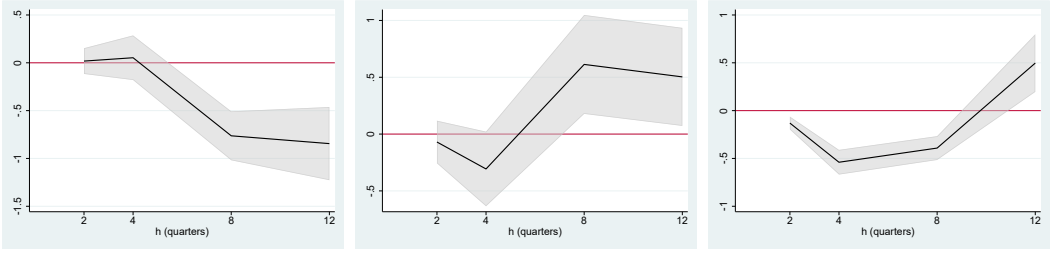
Blanchard-Leigh (BL) Regression Results

Figure 5: BL Results for Forecast Errors of Inflation as a function of forecasts for (A) real wage growth, (B) unemployment and (C) real GDP growth

(A) Real Wage Growth (B) Unemployment Rate (C) Real GDP Growth

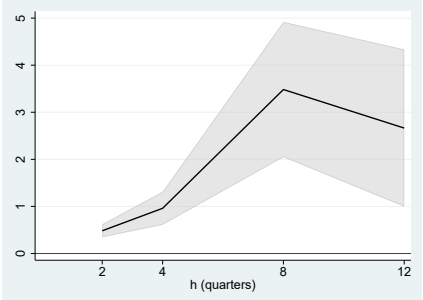


Notes: The solid lines show the estimates of ω_h^x, the Wald ratio resulting from estimating (3) and (4), for each horizon $h \in \{2, 4, 8, 12\}$ over the sample period from 2011:Q4-2024:Q1, where $x \in \{\pi_t^w, u_t, y_t\}$. A positive estimate implies that higher forecasts for x tend to be followed by inflation outturns which are lower-than-forecasted (suggesting that the underlying forecasting model overestimates the inflationary impact of x). Shaded areas represent 90% confidence bands.

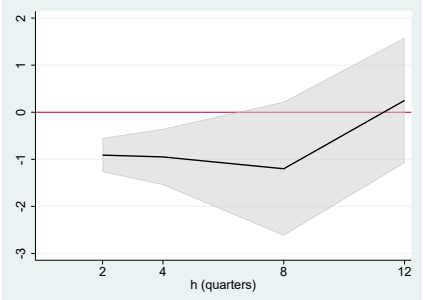
BL Regressions on 3Y Government Bond Yield

Figure 6: BL Results for Forecast Errors in (A) Inflation, (B) Real Wage Growth as a function of 3-year yield forecasts

(A) Inflation



(B) Real Wage Growth

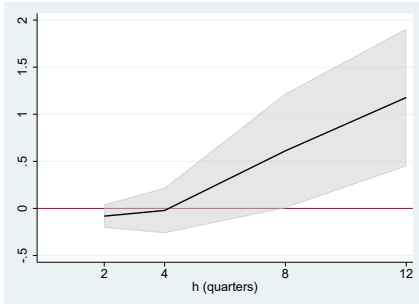


Notes: The solid lines show the estimates of β_h^X when estimating $FE_{t-h}(z_t) = \alpha_h^X + \beta_h^X F_{t-h}(3yYield_{t-h+2}) + \varepsilon_{h,t}^X$ for each horizon $h \in \{1, 2, 4, 8, 12\}$ over the sample period from 2014:Q3-2024:Q1, where $z_t \in \{\pi_t, \pi_t^W, u_t, y_t\}$. A positive estimate implies that higher forecasts for the 3-year yield tend to be followed by inflation/wage growth/unemployment/GDP growth outturns which are lower-than-forecasted. Shaded areas represent 90% confidence bands.

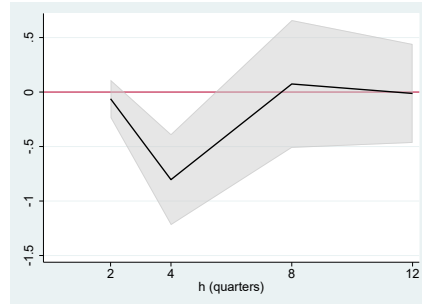
BL Regressions on 3Y Government Bond Yield

Figure 7: BL Results for Forecast Errors in (A) Unemployment and (B) real GDP Growth as a function of 3-year yield forecasts

(A) Unemployment Rate



(B) Real GDP Growth



Notes: The solid lines show the estimates of β_h^X when estimating $FE_{t-h}(z_t) = \alpha_h^X + \beta_h^X F_{t-h}(3yYield_{t-h+2}) + \varepsilon_{h,t}^X$ for each horizon $h \in \{1, 2, 4, 8, 12\}$ over the sample period from 2014:Q3-2024:Q1, where $z_t \in \{\pi_t, \pi_t^W, u_t, y_t\}$. A positive estimate implies that higher forecasts for the 3-year yield tend to be followed by inflation/wage growth/unemployment/GDP growth outturns which are lower-than-forecasted. Shaded areas represent 90% confidence bands.

Exploiting the constant rate forecast

- BL results suggests biases *relative to the forecast*
  - Begs the question: what is in the forecast?
- Can exploit the availability of the Bank's "constant rate forecast"
  - Alternative forecast, deviating from the market-implied path for Bank Rate
- Run regressions of the type:

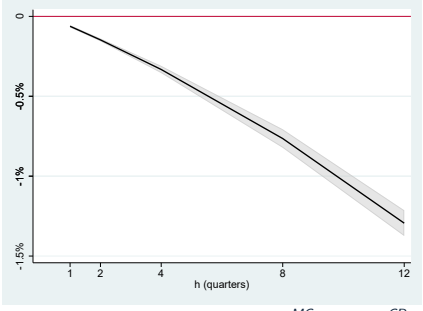
$$F_t^{MC}(Y_{t+h}) - F_t^{CR}(Y_{t+h}) = \alpha_h + \beta_h(R_t^{MC} - R_t^{CR}) + \varepsilon_{h,t},$$

  - Y is natural log
  - R is 3-year rate (but results are robust to using 2-year rate)

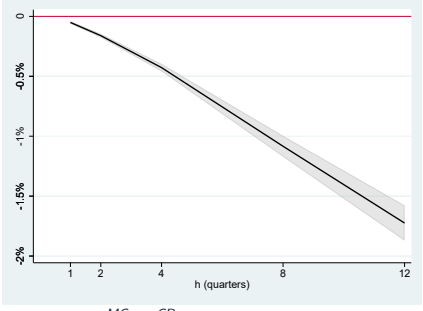
Exploiting the constant rate forecast

Figure 8: Forecast-implied Responses of (A) CPI, (B) Wages, (C) the Unemployment Rate and (D) Real GDP to a 100bp Increase in Bank Rate

(A) CPI



(B) Wages

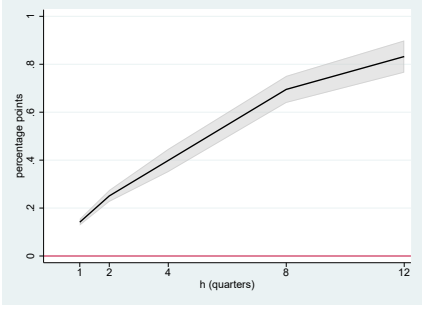


Notes: The solid lines show the estimates of β_h when estimating $F_t^{MC}(Y_{t+h}) - F_t^{CR}(Y_{t+h}) = \alpha_h + \beta_h(R_t^{MC} - R_t^{CR}) + \varepsilon_{h,t}$ for each horizon $h \in \{1, 2, 4, 8, 12\}$ over the sample period from 2014:Q3-2024:Q1. Shaded areas represent 90% confidence bands.

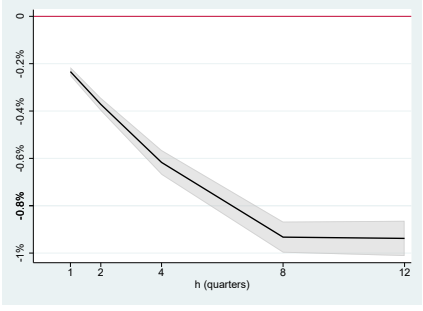
Exploiting the constant rate forecast

Figure 9: Forecast-implied Responses of (A) the Unemployment Rate and (B) Real GDP to a 100bp Increase in Bank Rate

(A) Unemployment Rate



(B) Real GDP



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Concluding Remarks

1. Pass-through from wage growth to inflation has historically been underestimated.
2. Near-term inflationary impact of increases in real GDP growth has historically been underestimated.
3. Regarding the MTM, a tightening of monetary policy:
   - Has a stronger disinflationary impact than historically modelled;
   - Does less to slow down real wage growth in the near term than historically modelled;
   - Pushes up unemployment at Y3 by less than historically modelled.

Literature

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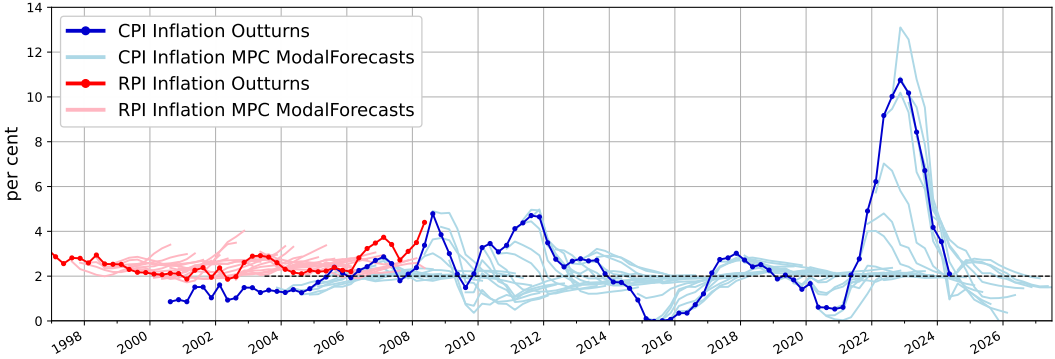
Appendix: Inflation

FIGURE 3.1: INFLATION, YEAR-ON-YEAR

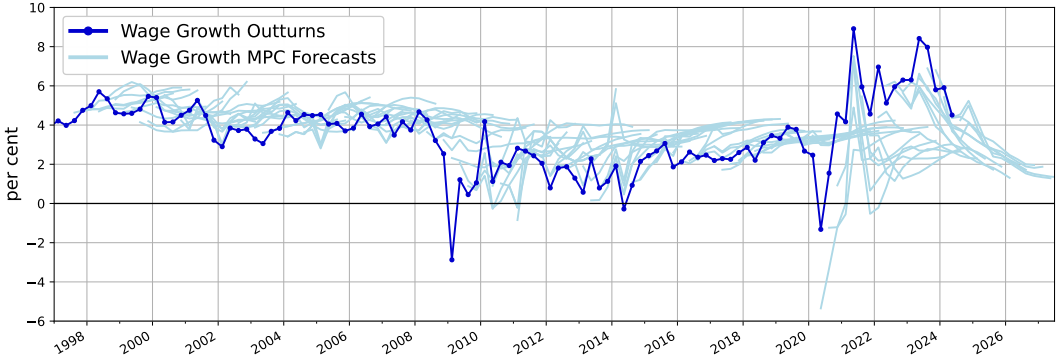


Notes: The solid blue (red) line depicts the UK CPI (RPI) inflation outturns. The light blue lines depict the CPI modal inflation forecasts. The depicted outturns in the blue line refer to the outturns $k = 12$ quarters after the first data release. For the last 12 quarters we take the latest available vintage.

back

Appendix: Wage Growth

FIGURE 3.2: WAGE GROWTH, YEAR-ON-YEAR

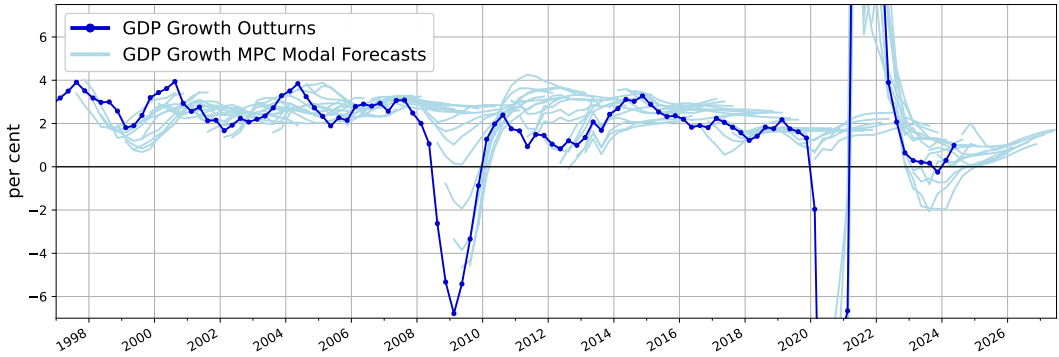


Notes: The solid blue line depicts the annual wage growth outturns. The light blue lines depict the forecasts. The depicted outturns in the blue line refer to the outturns $k = 12$ quarters after the first data release. For the last 12 quarters we take the latest available vintage.

back

Appendix: GDP Growth

FIGURE 3.3: GDP GROWTH, YEAR-ON-YEAR

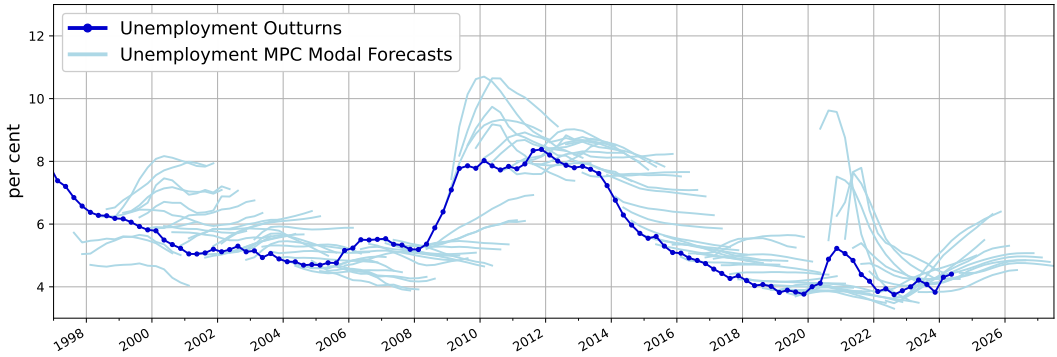


Notes: The solid blue line depicts the annual GDP growth outturns. The light blue lines depict the forecasts. The depicted outturns in the blue line refer to the outturns $k = 12$ quarters after the first data release. For the last 12 quarters we take the latest available vintage.

back

Appendix: Unemployment Rate

FIGURE 3.4: UNEMPLOYMENT RATE

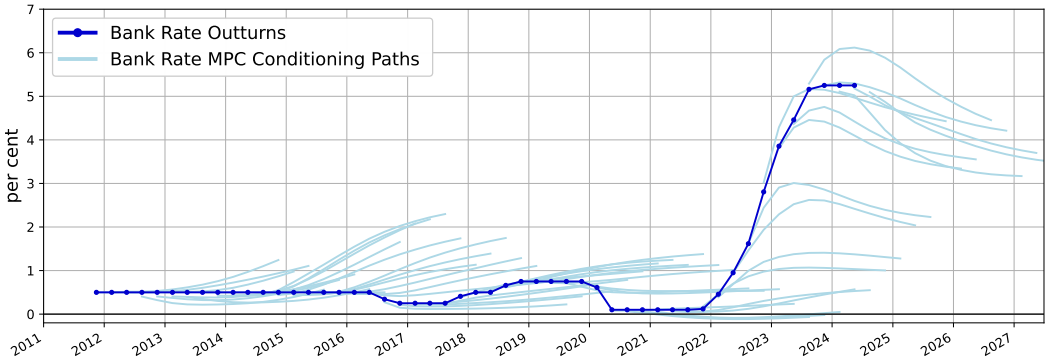


Notes: The solid blue line depicts the unemployment rate. The light blue lines depict the forecasts. The depicted outturns in the blue line refer to the outturns $k = 12$ quarters after the first data release. For the last 12 quarters we take the latest available vintage.

back

Appendix: Bank Rate

FIGURE 3.5: BANK RATE

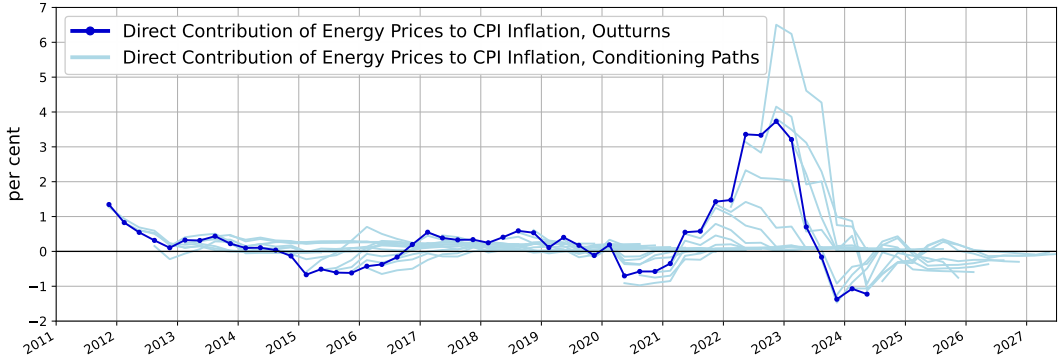


Notes: The solid blue line depicts the Bank Rate outturns. The light blue lines depict the conditioning paths. The depicted outturns in the blue line refer to the outturns $k = 12$ quarters after the first data release. For the last 12 quarters we take the latest available vintage.

back

Appendix: Energy Prices

FIGURE 3.6: ENERGY PRICE GROWTH



Notes: The solid blue line depicts the outturns for the 'direct contribution of energy price growth to annual CPI inflation'. The light blue lines depict the energy contribution conditioning paths.

back

Appendix: Outturn Definition

back

TABLE 1: INFLATION FORECASTS, A18 IN GREEN, OUTTURNS IN RED AFTER $k = 12$ QUARTERS.

	A18	N18	F19	M19	A19	N19	F20	M20	A20	N20	F21	M21	A21	N21	F22	M22	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2018:Q3	**2.48**	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	2.52	**2.52**	2.52	2.52	...
2018:Q4	2.29	**2.46**	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	**2.27**	2.27	...
2019:Q1	2.32	2.18	**1.82**	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	**1.87**	...
2019:Q2	2.34	2.32	1.94	**2.08**	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	...
2019:Q3	**2.15**	2.13	1.76	1.83	**1.68**	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	...
2019:Q4	2.17	**2.10**	1.97	1.63	1.56	**1.43**	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	...
2020:Q1	2.15	2.40	**2.35**	1.98	1.95	1.67	**1.80**	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	...
2020:Q2	2.13	2.31	2.17	**1.72**	1.77	1.20	1.32	**0.54**	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	...
2020:Q3	**2.09**	2.24	2.15	1.74	**1.90**	1.17	1.24	0.22	**0.25**	0.60	0.60	0.60	0.60	0.60	0.60	0.60	...
2020:Q4	2.04	**2.12**	2.05	1.98	2.11	**1.51**	1.43	0.07	0.26	**0.57**	0.53	0.53	0.53	0.53	0.53	0.53	...
2021:Q1	2.03	2.10	**2.07**	2.04	2.15	1.67	**1.53**	0.03	0.48	0.72	**0.82**	0.61	0.61	0.61	0.61	0.61	...
2021:Q2	2.04	2.06	2.09	**2.05**	2.19	1.95	1.84	**0.16**	1.48	1.72	1.57	**1.69**	2.05	2.05	2.05	2.05	...
2021:Q3	**2.03**	2.04	2.10	2.09	**2.23**	2.00	1.91	0.69	**1.81**	1.75	1.46	1.86	**2.70**	2.77	2.77	2.77	...
...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Notes: This table shows the Bank's modal inflation forecasts. Each column represents a specific forecast, from August 2018 (A18) until May 2022 (M22). For the A18 forecast, which was released on 02.08.2018, 2018:Q3 is the 'nowcast' quarter, the blue-colored field, the $h = 4$ quarter ahead forecast (Y1 forecast) is marked in orange, the Y2 forecast is marked in light blue and the Y3 forecast is marked in magenta. In red we show the respective outturns for the A18 forecast. The outturn is defined as the $T + k$ vintage of the data in T where $k = 12$. If $T + k$ is not yet available we take the latest available vintage.