

Simple Macroeconomic Forecast Distributions

Friederike Becker, Fabian Krüger, Melanie Schienle | February 28, 2024

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2. Methods

3. Results

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Setting and Motivation
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Small Note on Terminology

Some terms are used interchangeably within the context of this presentation

- probabilistic - distributional
- forecast - prediction - projection

An economist's favorite pastime

- various institutions issue forecasts for annual macroeconomic targets
 - most prominent targets: (real) GDP growth and inflation
 - for Germany, sources are (among others) the Bundesbank, the ifo institute, the OECD
 - fixed-event forecasts: target date is fixed, forecast date is not
- forecasts are often disseminated widely
 - extensive media coverage, influence on political discussions
 - relevant for real-world outcomes (public budget planning, collective bargaining)

Why should we explicitly quantify uncertainty?

- more honest and transparent
- can increase trust in forecasts
- broader information base facilitates better decision making
- better evaluation and accountability

Can we really be that sure?

- usual practice: issue point forecasts only
 - uncertainty is at best acknowledged, rarely quantified
- we observe artefacts in reporting
 - fixation on values slightly above/below zero
 - different horizons are often left uncontextualized
- distributional forecasts supposedly require additional ...
 - ... modeling effort (forecast issuer)
 - ... cognitive load (forecast user)

Prognose der EU

Deutschland vermeidet 2023 Rezession

Stand: 13.02.2023 12:56 Uhr

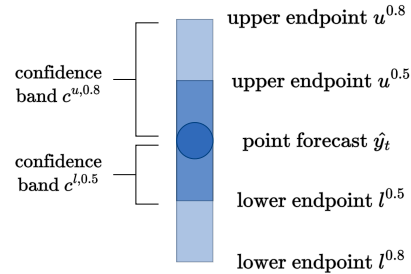
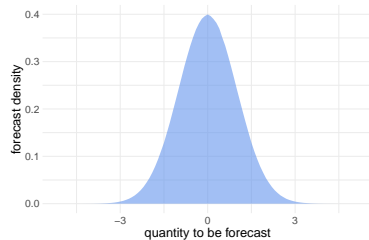
Nach Einschätzung der EU-Kommission dürfte sich die konjunkturelle Lage in Deutschland besser entwickeln als gedacht. Das Wachstum wird den Prognosen zufolge aber sehr gering ausfallen.

In ihrem aktuellen konjunkturellen Ausblick vertritt die EU-Kommission die Einschätzung, dass Deutschland im Jahr 2023 nicht in eine Rezession fallen wird. Die Brüsseler Behörde erwartet beim Bruttoinlandsprodukt (BIP) ein kleines Plus von 0,2 Prozent. Damit hat sich die Prognose deutlich gebessert, nachdem sie im November noch ein Minus von 0,6 Prozent veranschlagt hatte.

Source: tagesschau.de

Types of probabilistic forecasts

- full probability distribution
- histogram
- samples from distribution
- **quantiles or prediction intervals**



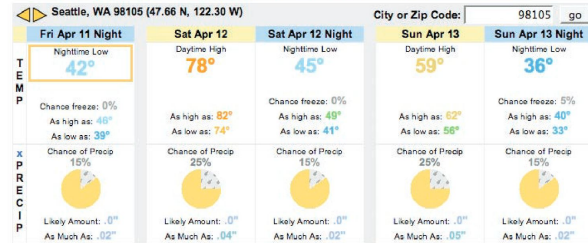
Example 1: Weather Forecasting

Uncertainty is communicated via

- 80% prediction interval for temperature
- probability for precipitation and adverse weather events

University of Washington Probability Forecast

Click a number on the table to select a new weather map; click the weather map or fill in a zip code to select a new location for the table. The yellow box shows the current map; the star shows the current location.

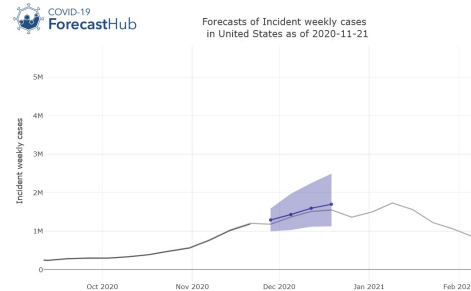


Source: Mass, C. et al. 2009. *PROBCAST*, BAMS

Example 2: Forecasting Covid-19

Uncertainty is communicated via

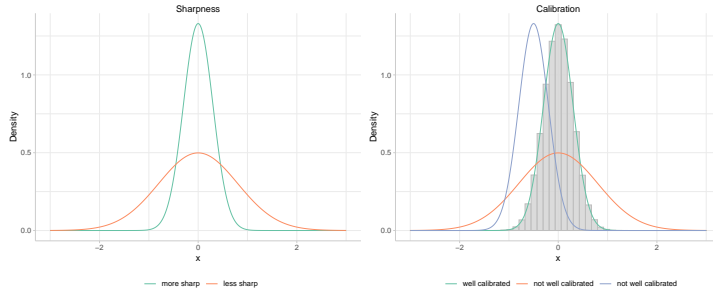
- granular prediction intervals for Covid-19 Cases and Deaths
- main prediction intervals (50%, 95%) are highlighted



Source: <https://viz.covid19forecasthub.org>

The makings of a good probabilistic forecast

- central paradigm: **sharpness subject to calibration**¹
- calibration alone can be easily asserted
 - most important metric for a trustworthy forecast
- **proper scoring rules** check calibration and sharpness simultaneously



¹Gneiting, T. et al. 2007. *Probabilistic forecasts, calibration and sharpness*. JRSS

Contributions of this work

- show that attaching prediction intervals to an existing base of point forecasts can be
 - simple
 - cheap
 - transparent
- provide competitively performing distributional forecasts for
 - GDP growth and inflation
 - all G-7 countries
 - current and next year targets

Data Source: IMF World Economic Outlook

- survey by the IMF staff, published bi-annually
 - contains forecasts with up to 6 years horizon and historic truth values
 - publication in April (horizon for current year \approx 8 months) and in October (\approx 2 months)
- publicly available² in an accessible format
- targets: real GDP growth and CPI inflation
- time range: available since 1990, giving \sim 30 years of forecast-truth pairs
- target locations: forecasts are issued for 196 countries in total

²International Monetary Fund. 2023. *World Economic Outlook: Navigating Global Divergences*. Washington, DC. October.

Methods

We apply an attractively simple and cheap method. For a given country and target:

- given forecasts $\hat{y}_{t,h}$ and the realized true values y_t ...
 - for target year t , horizon h
- ... construct sets $\mathcal{E}_{t,h} = \{\hat{e}_{t^*,h}^a | t - R \leq t^* < t\}$, containing the last R forecast errors
 - based on *absolute* errors $\hat{e}_{t,h}^a = |y_t - \hat{y}_{t,h}|$
 - currently: $R = 11$
- for each desired confidence level τ , compute $q_{t,h}^\tau = Q(\mathcal{E}_{t,h}, \tau)$
 - for conciseness, we choose $\tau \in \{0.5, 0.8\}$
- and compute the upper and lower endpoints of a central prediction interval as
 - $u_{t,h}^\tau = \hat{y}_{t,h} + q_{t,h}^\tau$
 - $l_{t,h}^\tau = \hat{y}_{t,h} - q_{t,h}^\tau$

Methods, continued

- Notwithstanding the method's simplicity, the following constraints are imposed
 - point forecast lies at the center of each prediction interval
 - intervals are reordered if their length does not increase with distance to target
- as an alternative, “directional” errors are also considered
- assess central interval coverage and score via the weighted interval score (WIS)³

$$IS_{\tau}(F, y) = (u - l) + \frac{2}{1 - \tau}(l - y)1(y < l) + \frac{2}{1 - \tau}(y - u)1(y > u).$$

³Bracher, J. et al. 2021. *Evaluating Epidemic Forecasts in an Interval Format*. PLoS Computational Biology 17 (2)

Benchmarks

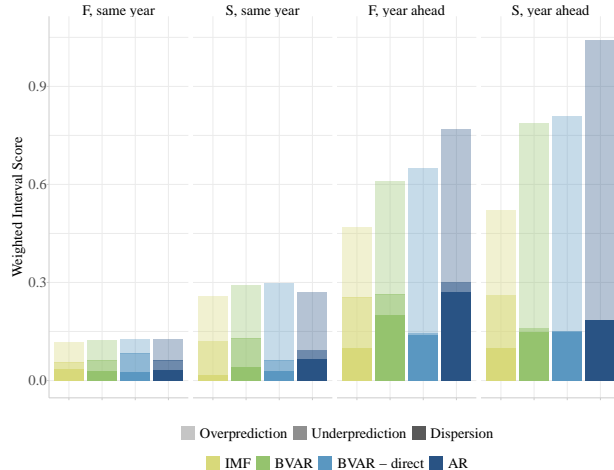
We compare with benchmarks:

- ① same methodology, alternative point forecasts
 - autoregressive (AR) model
 - Primiceri Bayesian vector autoregressive (BVAR) model⁴
- ② directly generated distributional forecasts
 - obtained from the BVAR model
- trained on quarterly data, with slight informational advantage

⁴Primiceri, G. 2005. *Time Varying Structural Vector Autoregressions and Monetary Policy*. Review of Economic Studies 72.

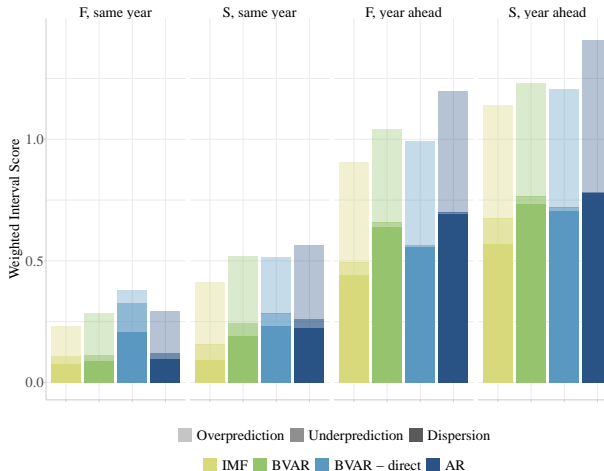
Scores - Inflation

- IMF-based forecasts perform relatively well
 - more so at long horizons
- overprediction contributes most to scores

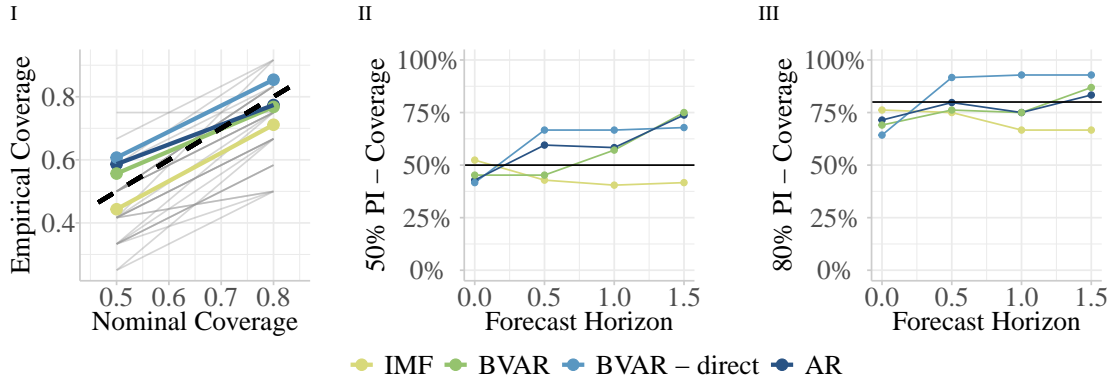


Scores - GDP Growth

- IMF-based forecasts perform slightly better
 - across all horizons
- dispersion and overprediction contribute most to scores



Calibration - Interval Coverage Levels - Inflation



Setting and Motivation
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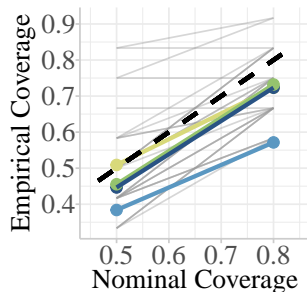
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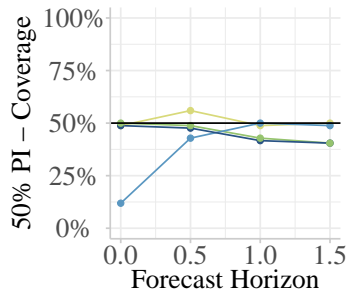
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Calibration - Interval Coverage Levels - GDP Growth

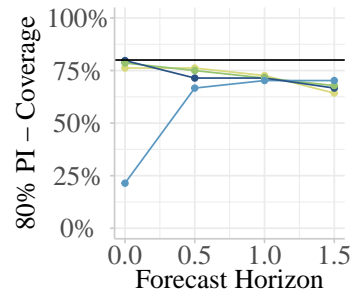
I



II



III



● IMF
● BVAR
● BVAR – direct
● AR

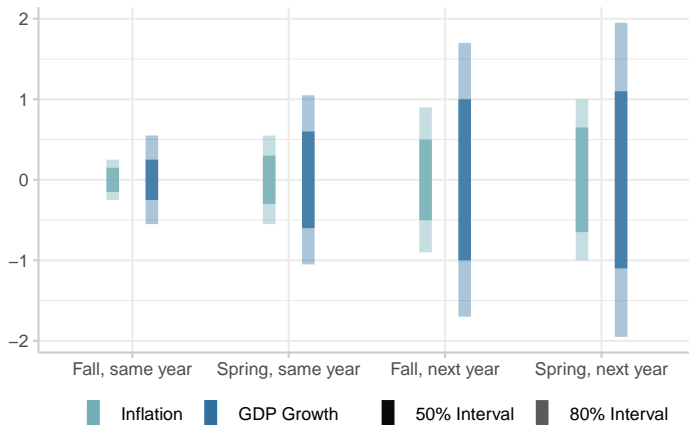
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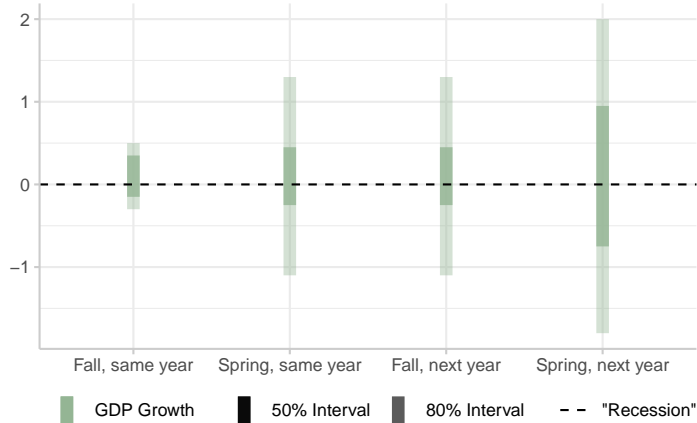
Increasing Uncertainty



Average length of intervals

	50%	80%
GDP Growth		
Fall, SY	0.5	1.1
Spring, SY	1.2	2.1
Fall, NY	1.9	3.5
Spring, NY	2.2	4.0
Inflation		
Fall, SY	0.3	0.5
Spring, SY	0.6	1.1
Fall, NY	1.1	1.8
Spring, NY	1.3	2.1

Will Germany avoid recession?



Robustness Checks / Alternative Methods

- error extraction method: absolute vs. directional errors
 - similar scores, worse calibration [link](#)
- window method: rolling vs. expanding window
 - slightly improved coverage and scores, at the cost of interpretability [link](#)
- potential dependency of results on quantile extraction
 - ordering between forecasts remains the same with sample-based CRPS [link](#)

Summing up

- Attaching distributional forecasts via past forecast errors to an existing base of point forecasts is
 - cheap
 - competitive
 - transparent
- Uncertainty around point forecasts is often substantial, making its communication necessary
- IMF forecasts are valuable source for distributional forecasts in their own right
- Outlook
 - scale to more countries and forecast sources
 - implement alternative method that utilizes the cross-section dimension
 - make forecasts easily and publicly accessible via shiny app

Making it public

Shiny App:

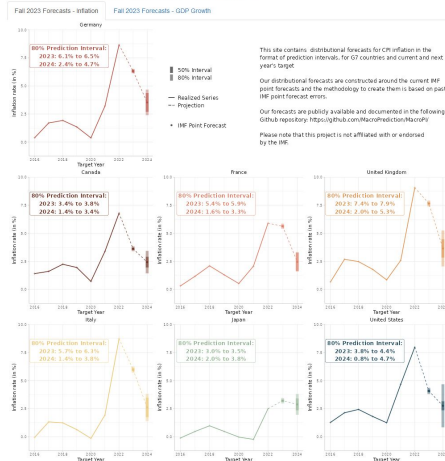
<https://probability-forecasting.shinyapps.io/macropi/>

GitHub repo with our forecasts:

<https://github.com/MacroPrediction/MacroPI>

Simple Macroeconomic Forecast Distributions

Visualisation of Forecast Distributions - G7 countries



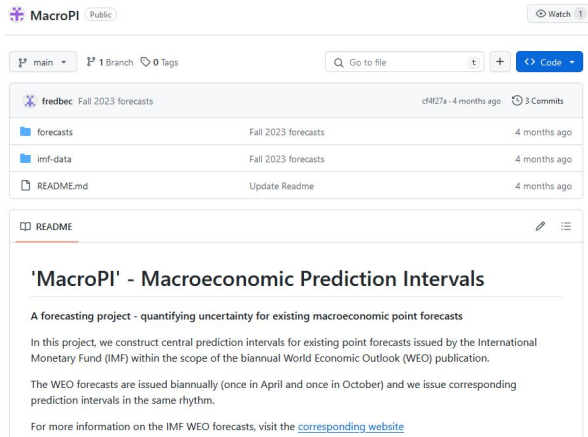
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Making it Public - GitHub



MacroPI Public Watch 1

main 1 Branch 0 Tags Go to file t + Code

fredbec Fall 2023 forecasts c4f27a - 4 months ago 3 Commits

forecasts	Fall 2023 forecasts	4 months ago
imf-data	Fall 2023 forecasts	4 months ago
README.md	Update Readme	4 months ago

README

'MacroPI' - Macroeconomic Prediction Intervals

A forecasting project - quantifying uncertainty for existing macroeconomic point forecasts

In this project, we construct central prediction intervals for existing point forecasts issued by the International Monetary Fund (IMF) within the scope of the biannual World Economic Outlook (WEO) publication.

The WEO forecasts are issued biannually (once in April and once in October) and we issue corresponding prediction intervals in the same rhythm.

For more information on the IMF WEO forecasts, visit the [corresponding website](#)

Making it Public - GitHub

fredbec Fall 2023 forecasts cf4f27a · 4 months ago History

Preview Code Blame 113 lines (113 loc) · 5.35 KB Raw Copy Download Edit

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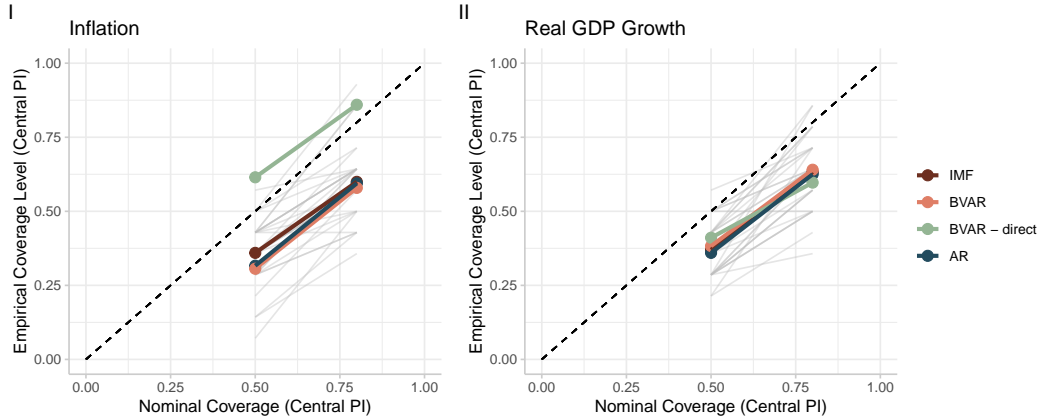
	country	target	forecast_year	forecast_season	target_year	quantile	prediction
1							
2	CAN	gdp_growth	2023	F	2023	0.1	0.96689396343828
3	CAN	gdp_growth	2023	F	2023	0.25	1.12441506878402
4	CAN	gdp_growth	2023	F	2023	0.75	1.45972715289798
5	CAN	gdp_growth	2023	F	2023	0.9	1.61724825824372
6	DEU	gdp_growth	2023	F	2023	0.1	-0.961933322250218
7	DEU	gdp_growth	2023	F	2023	0.25	-0.791801535271678
8	DEU	gdp_growth	2023	F	2023	0.75	-0.278122946830758
9	DEU	gdp_growth	2023	F	2023	0.9	-0.107991159852218
10	FRA	gdp_growth	2023	F	2023	0.1	0.478497573878853

$$WIS_{\tau_0:K}(F, y) = \frac{1}{K + 1/2} \left(w_0 |y - m| + \sum_{k=1}^K (w_k IS_{\tau_k}(F, y)) \right), \quad (1)$$

with $w_k = (1 - \tau)/2$

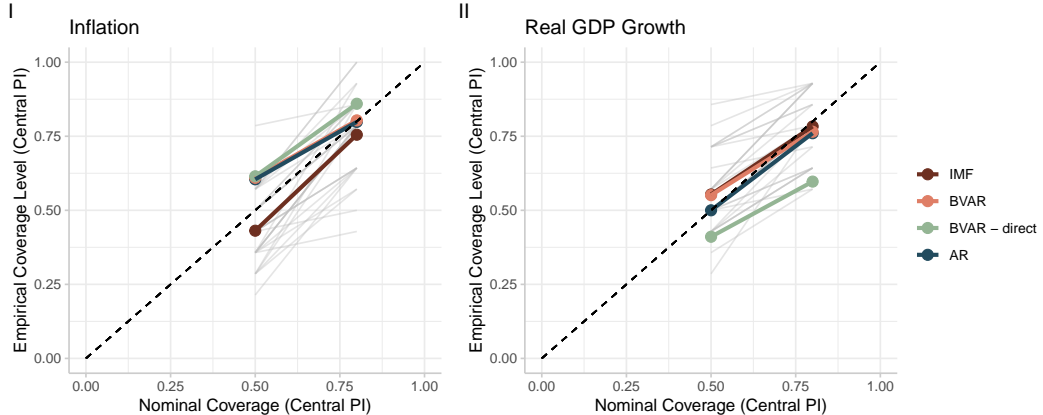


Directional Errors - Coverage





Expanding Window - Coverage



CRPS by sample

