Discussion of Paper: "Tail Forecasting with Multivariate Bayesian Additive Regression Trees" by Todd E. Clark, Florian Huber, Gary Koop, Massimiliano Marcellino, and Michael Pfarrhofer

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Disclaimer: The views expressed herein are solely those of the discussant and do not necessarily reflect the views of Norges Bank.

Summary

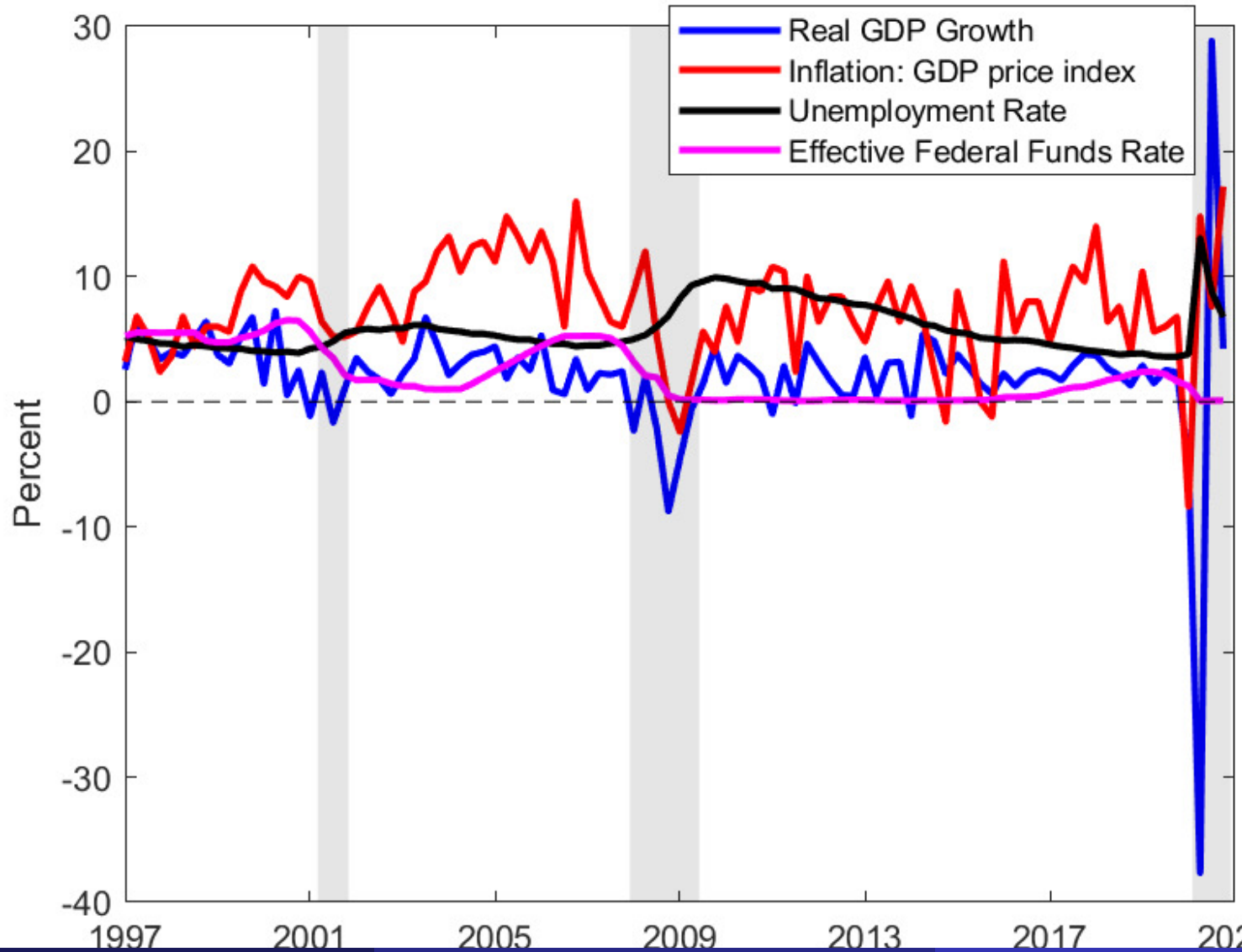
- **Flexible Nonlinear VAR's**:
  Three BART-based nonparametric VARs for macroeconomic forecasting in **unstable** times which are supposed to capture **adjustments of mean and covariance to sudden shocks, possibly with SV or a specification labeled heteroBART**
- **Computationally easy** Markov chain Monte Carlo (MCMC) algorithm:
  The algorithm combine state-of-the-art techniques for fast estimation of VAR models with an auxiliary sampler for SV models.The resulting MCMC algorithm is supposed to be scalable to large dimension.

- **Empirical results**:
  Using (real-time) data for a set of US macroeconomic and financial indicators the performance of the various BART models is evaluated for density and tail forecasting:
  - **On nonlinear mean** Most BART-based models improve linear BVAR with SV for **longer horizon; Covid-19 period and for tail forecasting**.
  - **On the covariance** **Nonlinearities take care of heteroskedasticity**. HeteroBART is only slightly better than BART-SV.
  - **On model complexity** **No major systematic gains using complex BART** specifications compared to basic BART.
  - **On risk measurement** Not much downside risk asymmetry using nonlinear structures.
  - **Strong nonlinear interaction between predictive density and financial conditions**

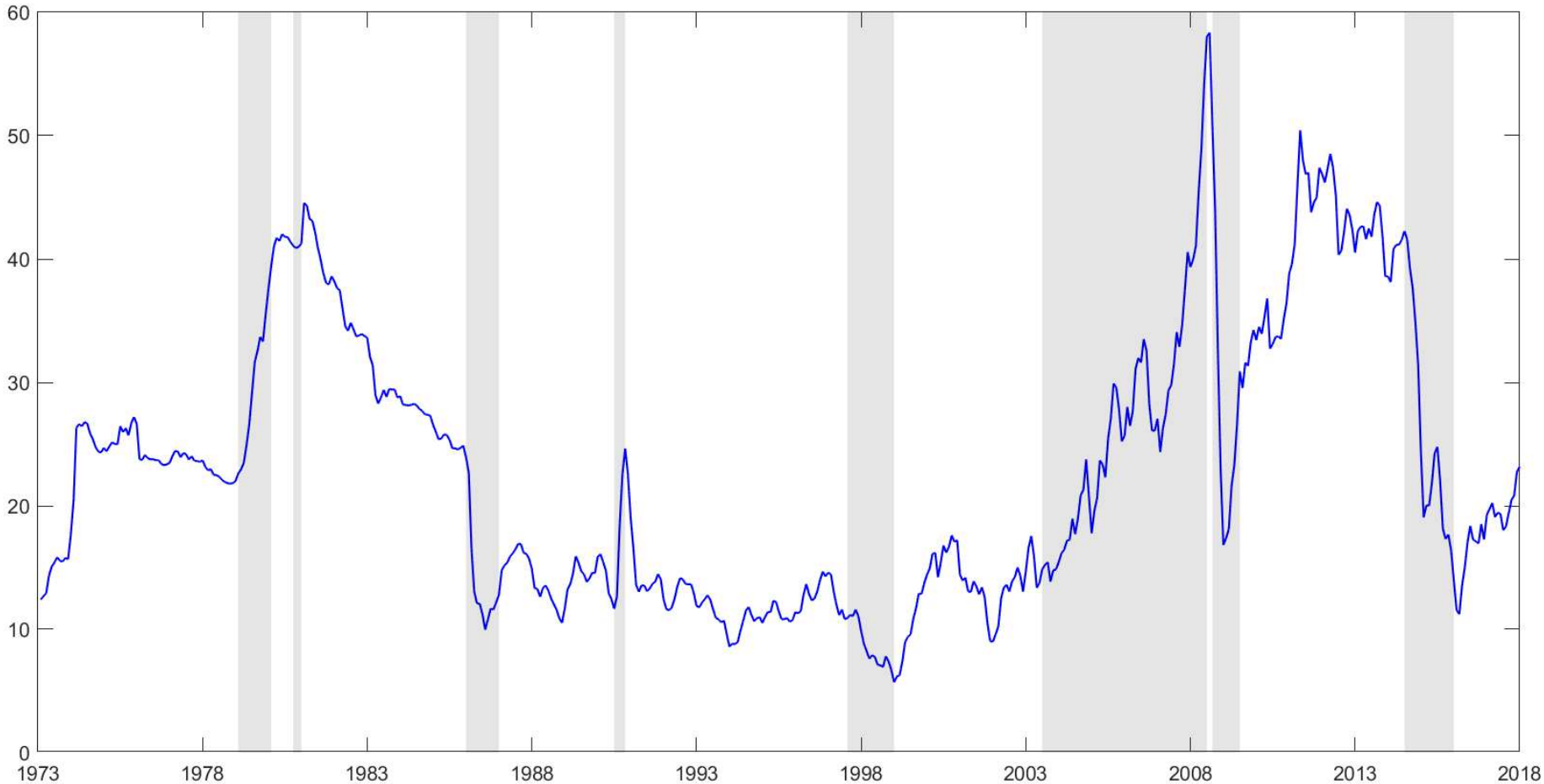
Focus of discussion

Connection
between
Typical data patterns;
Model complexity;
Ease of MCMC algorithm in Bayesian setting;
Empirical results

Data pattern of 4 key macroeconomic quarterly time series in paper



Data pattern of the real price of oil 1973M01-2017M12, see Aastveit, Cross and Van Dijk (2021), Norges Bank WP



Preliminary conclusions from data analysis

- Macro **quarterly series rather stable with some volatility**.
- Unemployment series show **no SV** but one important switch.
- Monthly series like the oil price show more switches and volatility.

Comments and questions

Mixture BART model (single equation (4) in paper)

$$\mathbf{y}_t = \mathbf{A}\mathbf{x}_t + G(\mathbf{x}_t) + \varepsilon_t \tag{1}$$

- The non-linear component, $G(\mathbf{x}_t)$ may contain **information about Time-varying parameter (TVP) behaviour with Stochastic Volatility (SV)**. It would be useful to compare with TVP and SVM
- Model specification is fine from forecasting perspective. What drives the forecast improvements? Seems like a bit of **a black box...** Can a simulation exercise provide any insights as to exactly what information BART is providing? **Are BART models useful for structural analysis?**

Comments and questions

- If $v_i(w_t)$ in Eq (9) is a linear random walk then we get SV; when approximated by (9) it's quite complicated. How do **results compare when (9) is replaced with usual SV**?
- Can some intuition be added about choices of parameter values α and β in 2.4.1? A **simulation** exercise might provide useful insights for econometricians.
- On page 15 it's stated that mixing issues might be present from a theoretical perspective, but are not an issue in the empirical study. A simulation exercise might again provide useful insights for econometricians. Are there any specific cases where mixing is an issue?

Comments and questions

- In Tables 1 and 2 **BART is univariate model while BVAR is multivariate**. Does Multivariate BART has a **dimensionality problem and suffer from large number of parameters?**
- What is the **mean/median** of the forecast densities? Policy makers usually want a point forecast - why are these not given?
- Volatility estimates in Figure 13 are very different. Any guidelines on which ones we should use in practice?
- Would be useful to **visualize** the asymmetry of the distribution. Can we get Figure 17 for the macro indicators? Present observed data distributions and highlight the estimate forecasted tails.

In the end

Model is very interesting addition to class of VaR Models.
Look forward to see more about it.