Binary Conditional Forecasts

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[1] The views expressed herein are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of St. Louis or the Federal Reserve System.

Introduction

- Central banks use conditional forecasts to assess hypothetical policies. Christoffel et al. (ECB, 2008)
- Large banks have to construct conditional forecasts as part of stress testing exercises. Sarychev (BoE, 2014)
- Recent surge in conditional forecasting in academic literature:
  - Giannone et al. (NY Fed, 2014): Big VARs
  - Baumeister and Kilian (BoC, 2013): Oil
  - Aastveit et al. (NB, 2014): Break tests
  - Clark and McCracken (Feds, 2017): Inference
- Conditional forecasting is common.

Methods

- Old-school
  - Doan, Litterman, and Sims (1984)
  - Clarida and Coyle (1984)
- New school
  - Waggoner and Zha (1999)
  - Andersson, Palmquist, and Waggoner (2010)
  - Baumeister and Kilian (2014)
  - Banbura, Giannone, and Lenza (2015)
  - Antolin-Diaz, Petrella, and Rubio-Ramirez (2018)
- Conditional forecasting is all about continuous variables?

Conditional Forecast of a Recession Indicator

- 8/2/2018 article in the NYT by Neil Irwin: "What will cause the next recession? A look at the 3 most likely possibilities."
  - The article is essentially a judgmental conditional forecast of the cause of the next US recession.

- Policy mistake
  - There is plenty of public discussion about whether continued increases in the Fed Funds Rate will induce a recession in the US.
  - Much of this was inspired by strong declines in the term spread throughout 2017 and into early 2018.

What We Do

- We revisit the QualVar model of Dueker (2005) and use it to produce conditional, probabilistic forecasts of binary outcomes.
  - Just a Gaussian VAR augmented with a single latent variable identified using historical binary outcomes
  - Given the VAR, constructing conditional forecasts of the future latent variable using Waggoner and Zha (1999) or even Antolin-Diaz et al. (2018) if we ever get the code working.
- Evaluate the usefulness of the tool for predicting recessions
  - Real-time vintage data used to estimate the model
  - Data release schedule managed using Waggoner & Zha
- Investigate to what extent monetary policy induces recessions
  - Waggoner & Zha vs. Antolin-Diaz et al.

What Is QualVAR?

- Let X_t $t = 1, ..., T$ denote a vector of observables.
- Let y_t^* denote an unobserved continuous latent variable
- Let $S_t \in \{0, 1\}$ denote an observed state indicator satisfying

$$S_t = 0 \quad \text{if } y_t^* \geq 0$$
$$S_t = 1 \quad \text{if } y_t^* < 0$$

- QualVAR is a VAR for $Y_t = (y_t^*, X_t')'$ of the form

$$\begin{bmatrix} y_t^* \\ X_t \end{bmatrix} = \begin{bmatrix} c_y \\ c_x \end{bmatrix} + \begin{bmatrix} B_{yy}(L) & B_{yx}(L) \\ B_{xy}(L) & B_{xx}(L) \end{bmatrix} \begin{bmatrix} y_{t-1}^* \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} u_t^y \\ u_t^x \end{bmatrix}$$

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  - $B_{ij}(L)$ are lag polynomials
  - $u_t = (u_t^y, u_t^{x\prime})' \sim i.i.d.\ N(0, \Sigma)$
  - Since the first equation is just a dynamic probit we normalize $\Sigma_{yy} = 1$.

Empirical Methods

QualVAR Forecasts

- Priors on $\Phi = (C, B)$ and Σ follow GLP (2015): Normal-Inverse Wishart with hyperparameters optimized on marginal data density
- At forecast origin τ we construct forecasts using the iteration

$$\text{VAR coefficients} \sim \text{Normal}$$
$$f(\Phi^{(i+1)} | \{y_t^{*(i)}\}_{t=1,\ldots,\tau}, \{X_t\}_{t=1,\ldots,\tau}, \Sigma^{(i)})$$

$$\text{Covariance matrix} \sim \text{Inverse Wishart}$$
$$f(\Sigma^{(i+1)} | \{y_t^{*(i)}\}_{t=1,\ldots,\tau}, \{X_t\}_{t=1,\ldots,\tau}, \Phi^{(i+1)})$$

$$\text{Latent variable} \sim \text{truncated Normal}$$
$$f(y_t^{*(i+1)} | \{y_j^{*(i+1)}\}_{j<t}, \{y_k^{*(i)}\}_{k>t}, \{X_t\}_{t=1,\ldots,\tau}, \Phi^{(i+1)}, \Sigma^{(i+1)})$$

$$\text{Forecast} \sim \text{Normal}$$
$$\hat{Y}_{\tau+h}^{(i+1)} = g(\{y_t^{*(i+1)}\}_{t=1,\ldots,\tau}, \{X_t\}_{t=1,\ldots,\tau}, \Phi^{(i+1)}, \Sigma^{(i+1)})$$

- Unconditional Gaussian draws for latent variable determined by Nichols & Hall (1979) $\Rightarrow$ then truncated relative to state variable S_t
- Gaussian draws for the forecasts (currently) follow Waggoner & Zha

Binary Conditional Forecasts

- The forecast draws provide a posterior distribution for each horizon. We use the probabilities of $y^*_{\tau+h} < 0$ to determine predictions of $S_{\tau+h}$.

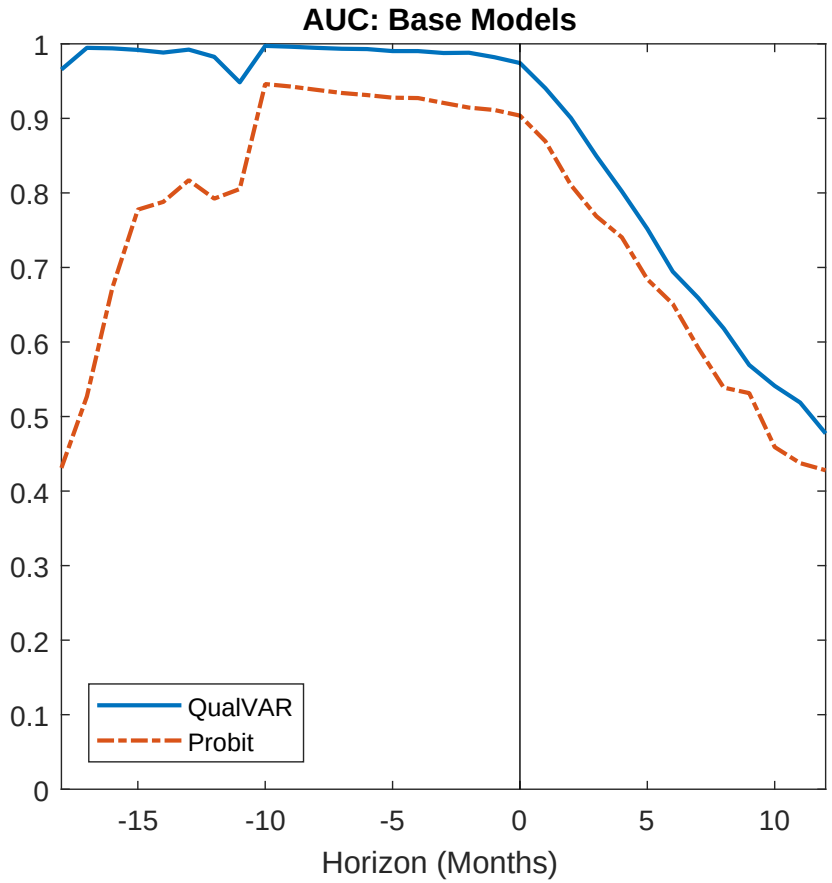
- Use Chauvet and Piger (2008) algorithm to pick peaks & troughs
  - At forecast origin τ generate recession probabilities at horizons $NBER \leq h \leq 12$
  - Peak: If there exists 3 consecutive months for which $P(S_{\tau+h} = 1|\Psi_\tau) \geq 0.8$ then the first month of the recession is the first for which $P(S_{\tau+h} = 1|\Psi_\tau) \geq 0.5$
  - Trough: If there exists 3 consecutive months for which $P(S_{\tau+h} = 1|\Psi_\tau) \leq 0.2$ then the first month of the expansion is the first for which $P(S_{\tau+h} = 1|\Psi_\tau) \leq 0.5$

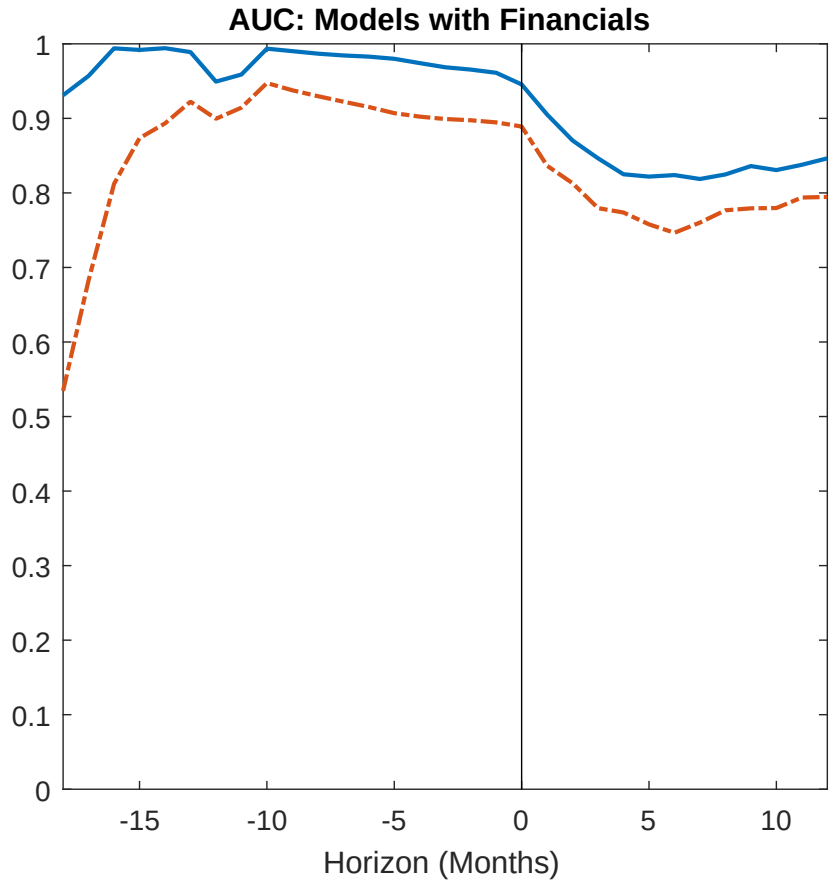
Data

- Vintages of 4 U.S. monthly series used by the NBER Recession Dating Committee
  - Industrial production, nonfarm payroll employment, real manufacturing and trade sales, real personal income ex. transfer payments
  - Vintage range 1976:11-2017:01
  - Data start 1967:01
  - Updated version of data on Piger's website
- Some experiments include effective FFR as well as the 10y-1y spread.
- NBER recession indicators in real time by announcement date
  - Caveat: Maximum announcement lag of 12 months if expansion

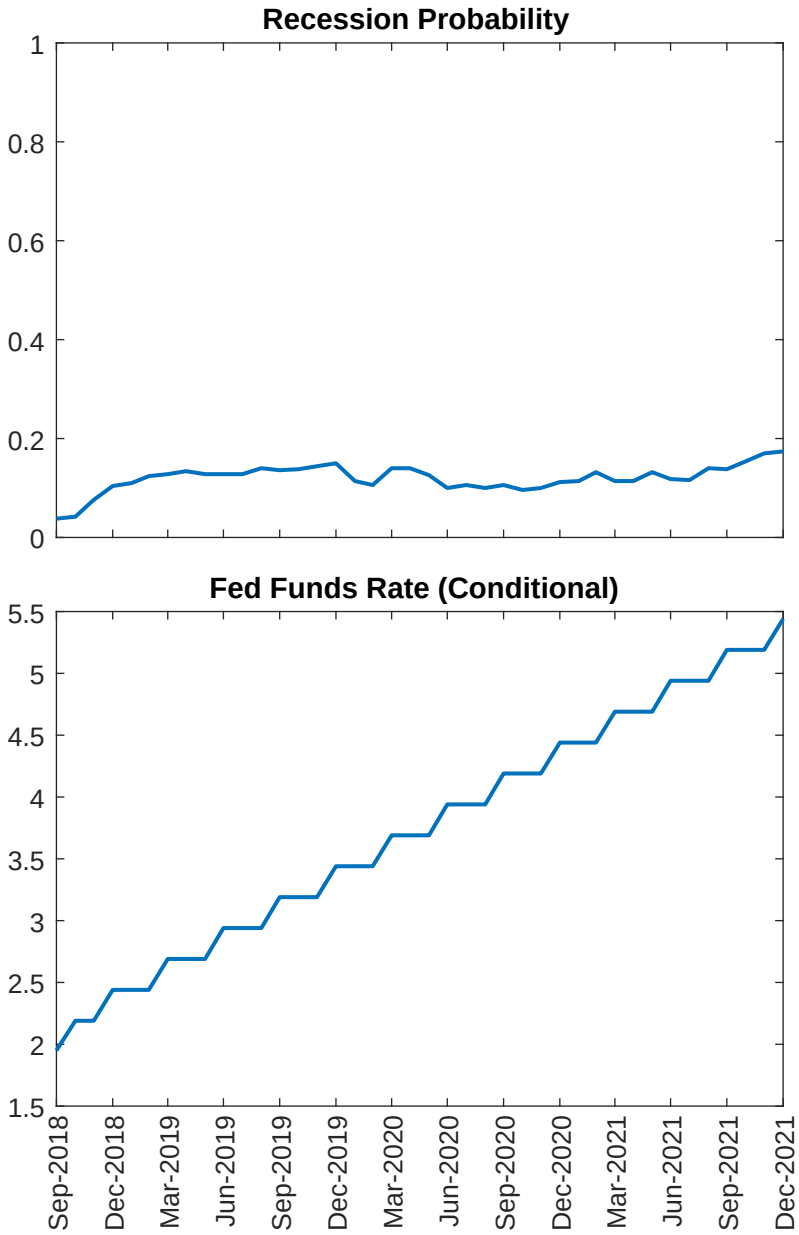
Empirical Results

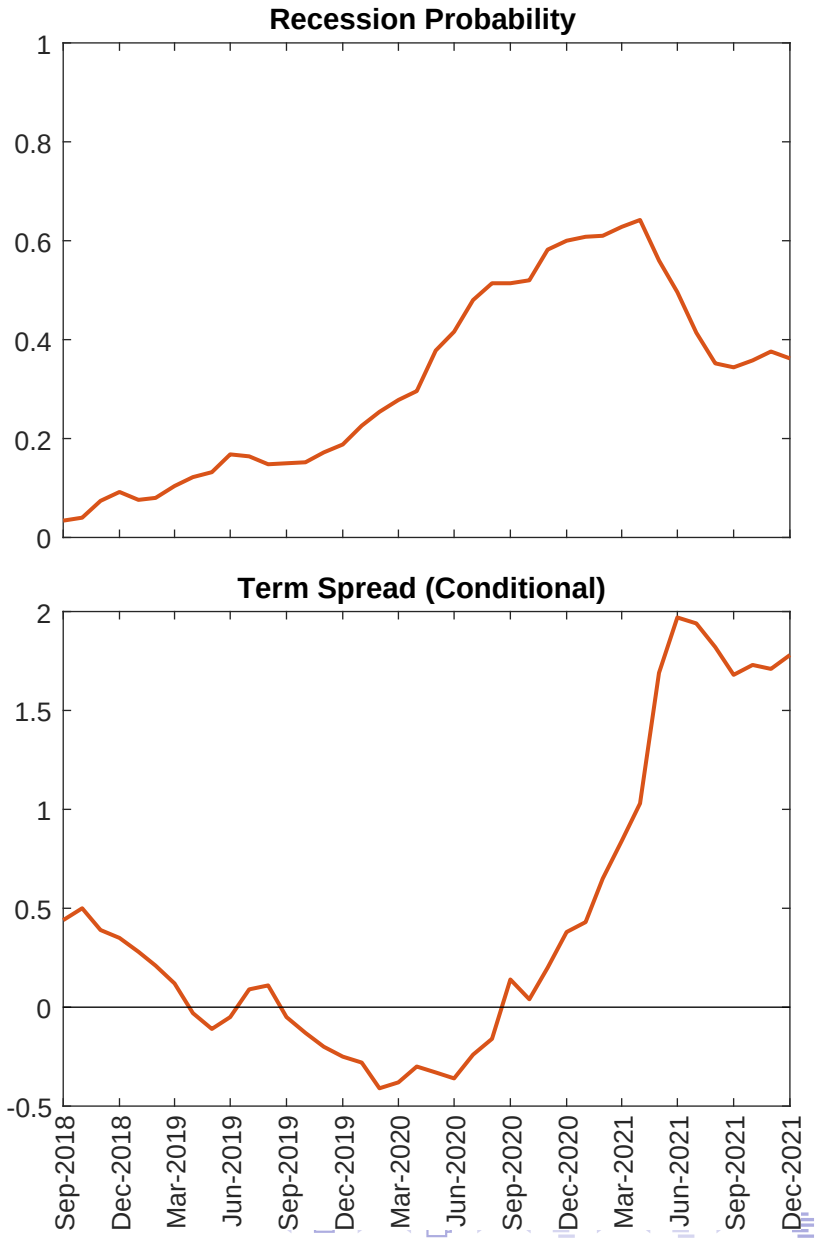
Accuracy of Recession Dating





Scenarios: Policy Mistake & Inverted Yield Curve





Conclusion

- We investigate the usefulness of the QualVAR for conditional forecasting
  - As a means of identifying recessions in real time
  - As a means of identifying the affects of hypotheticial policies
- Plenty of other work to be done
  - structural scenarios
  - use magnitude of latent variable as a metric for severity? (i.e. score bank stress tests)