Discussion of “The Term Structure of Growth-at-Risk”

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Pushing the Frontier of Central Bank’s Macro Modeling

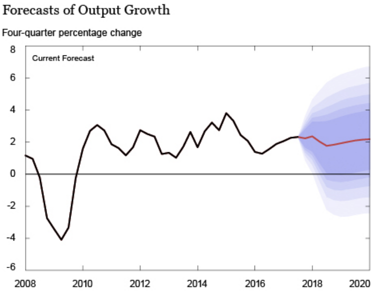
Preliminaries

- This paper measures the effect of financial conditions on the predictive distribution of GDP growth.
- Uses a multi-country panel data set with harmonized series (sources: IFS, IMF's Global Financial Stability Report, BIS).
- **Headline Finding**: "Loose financial conditions" lead to positive growth in the short-run, followed by lower growth and higher volatility in the medium run.
- Growth-at-Risk = lower 5th percentile of predictive distribution in response to loose financials is high in short-run but low in long run.
- My discussion will mostly focus on methodological aspects of the paper.

A Quote from the Introduction

Quote: *"(...) But macroeconomic models and forecasting practices predominantly focus on expected growth, and usually do not model the full forecast distribution."*
Really?

The New York Fed DSGE Model Forecast–November 2017 Liberty Stre... http://libertystreeteconomics.newyorkfed.org/2017/11/the-new-york-fed-...



Central bank modelers are technically highly sophisticated, often more so than their target audience. U.S. President Lyndon B. Johnson (according to Chuck Manski):

"Ranges are for cattle. Give me a number!"

Another Quote from the Introduction

Quote: *"DSGE models tend to focus on impulse response functions that depict conditional growth, and assume that the mean and the variance are independent. This focus on conditional growth can be too narrow as the full distribution of expected growth is important (...)"*

- It's the solution technique and not the DSGE model that leads to independence of conditional means and variances.
- Nonlinear solution techniques do not scale very well to the size of central bank models.
- Solution and likelihood-based estimation of (medium-scale) nonlinear DSGE models without *some* short-cuts remains elusive.
- Unfortunately, modeling is often more complicated than adding regressors, but some "ad-hoc" adjustments to the models could capture important mechanisms in a parsimonious reduced-form way.
- This paper provides empirical evidence consistent with:
  loose financial conditions today $\longrightarrow$ expansion and risk taking $\longrightarrow$ vulnerability $\longrightarrow$ low mean growth and high volatility in the future.

Empirical Methodology: My View Of Local Projections

1. It's Not a Model!

A simplified version:

$$\begin{aligned} \Delta y_{t+h} &= \gamma_0^{(h)} + \gamma_1^{(h)} y_t + \gamma_*^{(h)} \mathrm{FCI}_t + \epsilon_{t+h}^{(h)}, \quad \epsilon_{t+h}^{(h)} \sim N(0, \mathbb{V}[\epsilon_{t+h}^{(h)}]) \\ \log \sqrt{\mathbb{V}[\epsilon_{t+h}^{(h)}]} &= \beta_0^{(h)} + \beta_*^{(h)} \mathrm{FCI}_t. \end{aligned} \tag{1}$$

- Tom Sargent: A model is a family of probability distributions over sequences. Could be structural, e.g., DSGE, or reduced-from, e.g., VAR.
- Try simulating data from (1)...

2. They Tend to Be Inefficient – Under (Realistic) Misspecification

- Example: y_{t+h} follows infinite-dimensional process, say, $y_{t+h} = \sum_{j=0}^{\infty} C_j \epsilon_{t+h-j}$, which could be a Wold representation of a stationary nonlinear model.

- Jorda (2005): estimate C_h by projecting onto $y_t, y_{t-1}, \dots, y_{-\infty}$.

- Related to forecasting problem, e.g., with VAR(1). Two options:
  (i) **Iterative:** Estimate $y_{t+1} = \Phi y_t + u_{t+1}$ by OLS/MLE and iterate VAR forward.
  (ii) **Direct:** Regress $y_{t+h} = \Psi^{(h)} y_t + \text{resid}_{t+h}^{(h)}$.

- Large literature – including Schorfheide (2005); Marcellino, Stock, and Watson (2006):
  (i) **Iterative:** has low variance, but does not converge to pseudo-optimal value under misspecification.
  (ii) **Direct:** has high variance, bud does converge to pseudo-optimal value under misspecification.

- How large does the misspecification have to be for **direct** to be preferred to **iterative**? VERY LARGE! For typical VARs (i) works better than (ii). Schorfheide (2005) provides joint selection criterion for (i) vs. (ii) and lag length.

3. Evidence on Nonlinearities Justifying Local Projections?

- Looking at short spans of time series data makes us think that there are important linearities...

- but it is very difficult to beat linear models over a long span of time.
  Exceptions: regime-switching and conditional heteroskedasticity.

- A perturbation approximation to a nonlinear model with features that can capture the basic story:

$$\begin{aligned} y_t &= \phi_1 y_{t-1} + \phi_2 s_{t-1}^2 + u_t \\ s_t &= \phi_1 s_{t-1} + u_t^{(1)} \\ u_t &= \sigma_\epsilon [1 + \gamma s_{t-1}] \epsilon_t \\ u_t^{(1)} &= \sigma_\epsilon \epsilon_t \end{aligned}$$

- Hard to find evidence on non-zero ϕ_2 in macro data (especially in VARs). Would suggest that linear version w/o local projections might just be fine for conditional mean.

3. Evidence on Nonlinearities Justifying Local Projections?

- Example model:

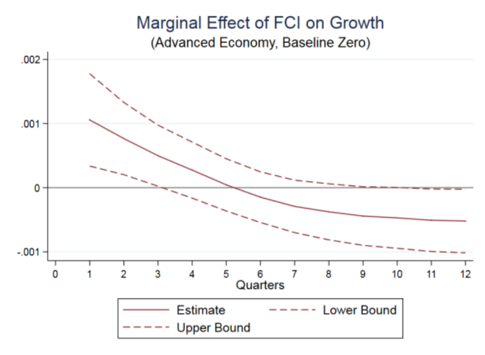
$$\begin{aligned} y_t &= \phi_1 y_{t-1} + \phi_2 s_{t-1}^2 + u_t \\ s_t &= \phi_1 s_{t-1} + u_t^{(1)} \\ u_t &= \sigma_\epsilon[1 + \gamma s_{t-1}]\epsilon_t \\ u_t^{(1)} &= \sigma_\epsilon \epsilon_t \end{aligned}$$

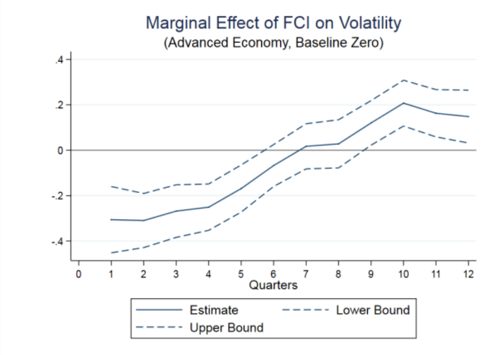
- Conditional variance

$$\mathbb{E}[u_t^2|\mathcal{F}_{t-1}] = \sigma_\epsilon^2[1 + 2\gamma s_{t-1} + \gamma^2 s_{t-1}^2]$$

- Can work out limit distribution for local projection estimators.
- How big do nonlinearities have to be for local projection methods to be attractive?

4. Strong Nonlinearity?





- Conditional mean dynamics could be captured more parsimoniously by AR polynomial.
- Evidence of predictable pattern in volatility; but paper doesn't explore the fit of alternative volatility dynamics: AR, independent vol component.

5. What About FCI Dynamics?

- Part of the story is tied to the evolution of future financial conditions.
- Approach in the paper abstracts from FCI dynamics.

Rediscovery of Density Forecasting: Anything special About Growth-At-Risk?

- The predictive density $p(y_{t+h}|Y_{1:t})$ computed from an econometric model summarizes uncertainty about future observations y_{t+h} conditional on time t information due to unknown shocks, parameters, and latent states.

- Common in forecasting literature: Density forecasts $\longrightarrow$ interval forecasts.
  Ranges are not just for cattle, after all!

- Paper defines the 5% quantile of an approximate predictive density as Growth-At-Risk:

$$\hat{y}^{(h)}_{t+h|t}(\mathrm{FCI}_t) - 1.64\sqrt{\hat{V}^{(h)}_{t+h|t}(\mathrm{FCI}_t)}$$

  - Local projection method limits ability to explore quantiles of predictive distribution. Can't simulate any trajectories.
  - The measure used in paper seems to ignore parameter uncertainty (which is large).

  - Main innovations: FCI_t is used as predictor for future volatility, interaction with credit conditions.

Are the Quantile Forecasts Well Calibrated?

- We don't know! The paper is silent in this regard.
- No pseudo-out-of-sample assessment; only in-sample analysis; credit-condition variable is based on 2-sided HP filtering.
- Extensive literature on interval forecast evaluation, e.g., Christoffersen (1998):
  - report "hit" sequence;
  - check frequency of hits and correlation.

Panel Data Aspects

- As far as I can tell the authors use pooled OLS on two subpanels: advanced economies and emerging market economies.
- Natural starting point, but a careful examination of the homogeneity assumption would be useful.
- A (correlated) random effects framework could provide more flexibility.

Summary

- Interesting empirical question and some tentative evidence from a nice panel data set.

- Authors should decide whether the goal is to provide some empirical evidence to guide macro-financial (reduced-form or structural) modeling efforts or whether the goal is to generate real-time density/interval forecasts for GDP growth.

- Local projections aren't models, but they can certainly inform the model building process.

- More work needed to convince the reader that allowing for a direct effect of FCI on volatility leads to better (central bank) econometric models. It's not difficult to build reduced-form models that capture conjectured effects; allow for model assessment; and proper accounting of uncertainty.

- I am not convinced (based on the current draft) that the regressions provide an accurate real-time growth-at-risk assessment.