Advances in Nowcasting Economic Activity: Secular Trends, Large Shocks and New Data

Juan Antolín-Díaz[1] **Thomas Drechsel**[2] Ivan Petrella[3]

ASSA 2021 Virtual Annual Meeting

3 January 2021

[1]London Business School
[2]University of Maryland
[3]Warwick Business School and CEPR

CONTRIBUTION OF THIS PAPER

- This paper is about nowcasting economic activity
- Propose Bayesian dynamic factor model (DFM), which features explicitly:
  1. Low-frequency variation in the mean and variance
  2. Heterogeneous responses to common shocks (leads/lags)
  3. Fat tails
- Evaluate model and its components in comprehensive out-of-sample exercise
  - On fully real-time, unrevised US data 2000-2019
  - Point and density forecasting
  - Taking advantage of cloud computing
- Apply model out of sample to track the Great Lockdown of 2020
  - New components critical to track activity during this period
  - Incorporate newly available high-frequency data

THE MODEL

THE MODEL: SPECIFICATION OF BASELINE

- Start from familiar specification of a DFM (e.g. Giannone, Reichlin, and Small, 2008 and Banbura, Giannone, and Reichlin, 2010)
- An n-dimensional vector of quarterly and monthly observables $\mathbf{y}_t$ follows

$$\begin{aligned} \Delta(\mathbf{y}_t) &= \mathbf{c} + \boldsymbol{\lambda}\mathbf{f}_t + \mathbf{u}_t \\ (I - \Phi(L))\mathbf{f}_t &= \varepsilon_t \\ (1 - \rho_i(L))u_{i,t} &= \eta_{i,t}, \qquad i = 1, \ldots, n \end{aligned}$$

$$\begin{aligned} \varepsilon_t &\overset{iid}{\sim} N(0, \boldsymbol{\Sigma}_\varepsilon) \\ \eta_{i,t} &\overset{iid}{\sim} N(0, \sigma^2_{\eta_i}), \qquad i = 1, \ldots, n \end{aligned}$$

THE MODEL: SPECIFICATION OF SV

- Consider n-dimensional vector of observables $\mathbf{y}_t$, which follows

$$\Delta(\mathbf{y}_t) = \mathbf{c}_t + \boldsymbol{\lambda}\mathbf{f}_t + \mathbf{u}_t,$$

with

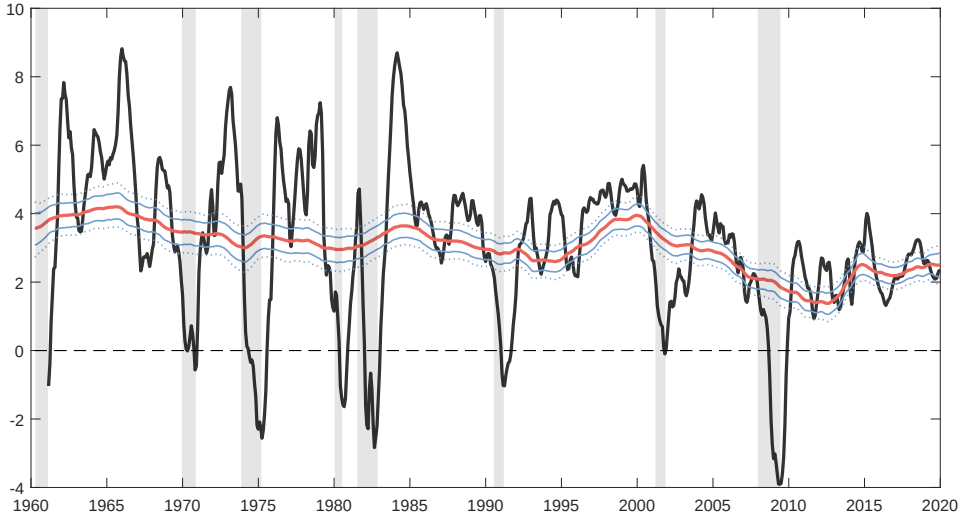
$$\mathbf{c}_t = \begin{bmatrix} \mathbf{B} & \mathbf{0} \\ \mathbf{0} & \mathbf{c} \end{bmatrix} \begin{bmatrix} \mathbf{a}_t \\ 1 \end{bmatrix},$$

and

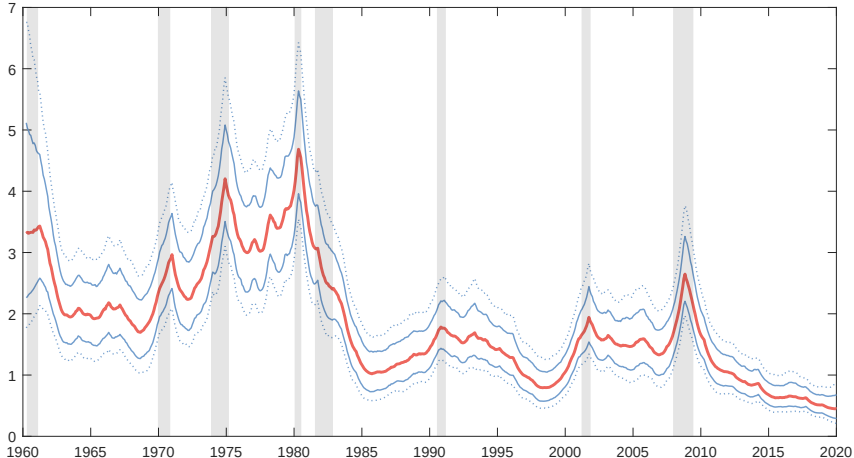
$$\begin{aligned} (I - \Phi(L))\mathbf{f}_t &= \sigma_{\varepsilon_t}\boldsymbol{\varepsilon}_t, \\ (1 - \rho_i(L))u_{i,t} &= \sigma_{\eta_{i,t}}\eta_{i,t}, \quad i = 1, \ldots, n \end{aligned}$$

- The time-varying parameters are specified as random walk processes
- Builds on Antolin-Diaz, Drechsel, and Petrella (2017)

ESTIMATED TREND



ESTIMATED VOLATILITY OF THE FACTOR



- SV captures both secular (McConnell and Perez-Quiros, 2000) and cyclical (Jurado et al., 2014) movements in volatility

THE MODEL: ADDING HETEROGENEOUS DYNAMICS

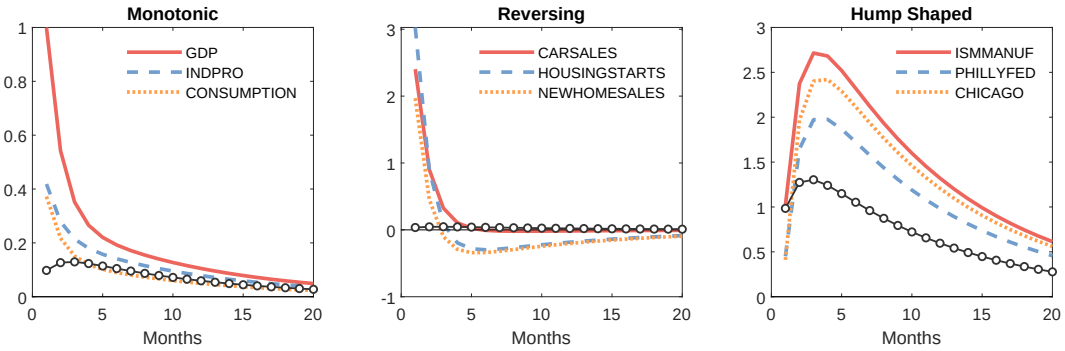
- Modify the observation equation to be

$$\Delta(\mathbf{y}_t) = \mathbf{c}_t + \mathbf{\Lambda}(\mathbf{L})\mathbf{f}_t + \mathbf{u}_t,$$

  where $\mathbf{\Lambda}(\mathbf{L})$ contains the loadings on contemporaneous and lagged factors

- Camacho and Perez-Quiros (2010) first noticed that survey data was better aligned with a distributed lag of GDP
- D'Agostino et al. (2015) show that adding lags improves performance in the context of a small model

ESTIMATED HETEROGENEOUS DYNAMICS



- Substantial heterogeneity in IRFs of to innovations in the cyclical factor

THE MODEL: ALLOWING FOR FAT TAILS

- Modify the observation equation to be

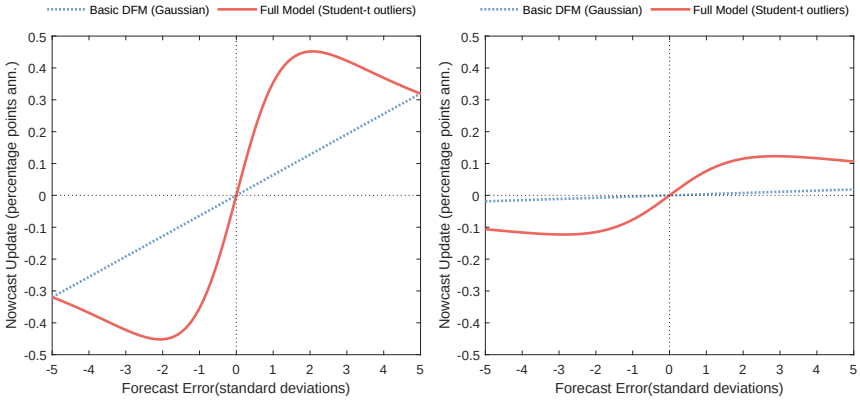
$$\Delta(\mathbf{y}_t - \mathbf{o}_t) = \mathbf{c}_t + \mathbf{\Lambda}(\mathbf{L})\mathbf{f}_t + \mathbf{u}_t,$$

  where the elements of $\mathbf{o}_t$ follow t-distributions:

$$o_{i,t} \overset{iid}{\sim} t_{\nu_i}(0, \omega_{o,i}^2), \qquad i = 1, \ldots, n$$

- The degrees of freedom of the t-distributions, ν_i, are estimated jointly with the other parameters of the model

NEWS DECOMPOSITIONS: WHAT FAT TAILS ACHIEVE

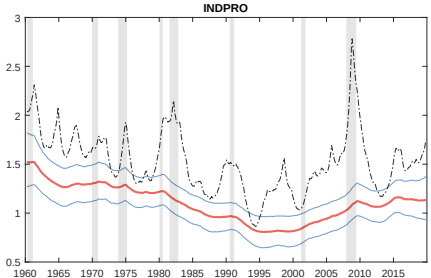


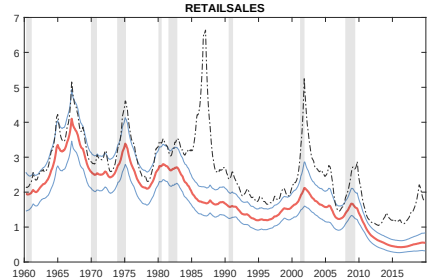
- Update of nowcast nonlinear and nonmonotic in forecast error of releases
- Some (hard) data gets more importance

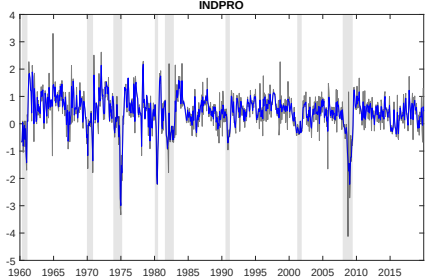
INTERACTIONS BETWEEN THE NEW COMPONENTS

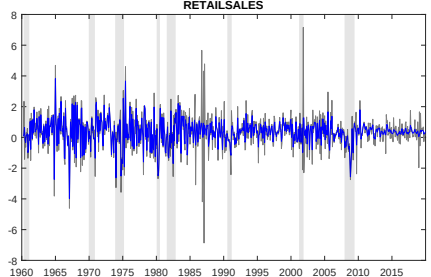
- Standard DFM model heavily influenced by persistent and timely surveys
- **Heterogeneous dynamics** "rebalance" the panel, by allowing higher weight to "hard" variables, such as IP, retail sales, etc...
  - ...but hard variables are prone to fat tailed observations
- **Fat-tailed component** captures these infrequent, large observations.
  - This stabilizes the nowcast against high frequency outliers
  - Interacts with the SV, which captures lower frequency changes in volatility

INTERACTIONS BETWEEN THE NEW COMPONENTS









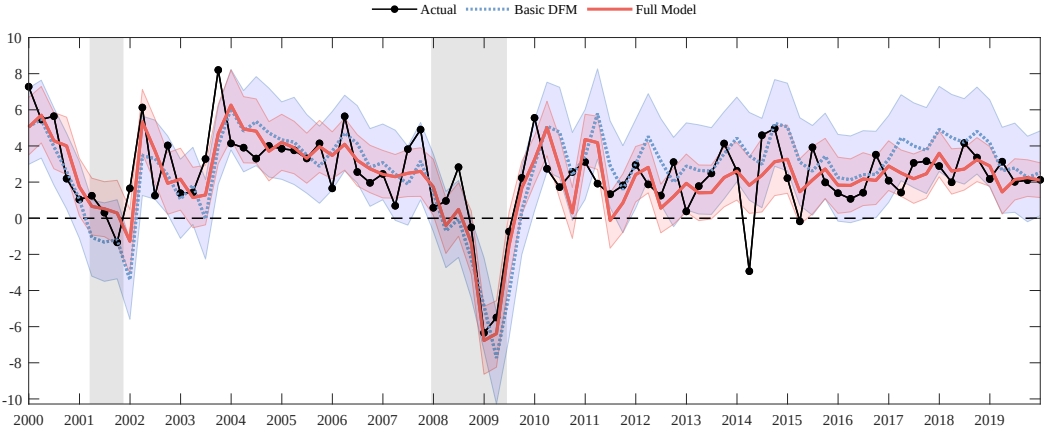
REAL-TIME EVALUATION EXERCISE

A REAL REAL-TIME EXERCISE

- **The model is fully re-estimated every time new data is released/revised**
- The exercise starts in Jan 2000 and ends in Dec 2019: on average there is a data release on 15 different dates every month $\Rightarrow$ 3600 vintages of data
- Thanks to efficient implementation, it takes just 20 min Gibbs sampler on a single computer (we use 8,000 iterations/draws)
  - Hierarchical implementaiton of the Gibbs sampler
  - Vectorized version of the Kalman filter
- Would still mean almost 2 months of time to run the evaluation
  - Use Amazon Web Services cloud computing platform

EVALUATION RESULTS

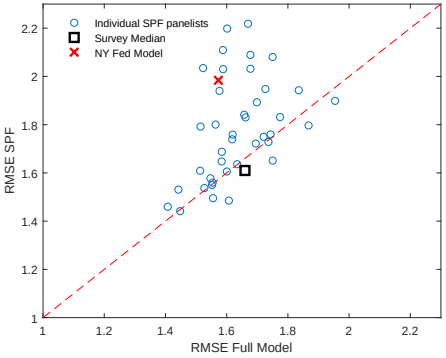
FORECASTS VS. ACTUAL OVER TIME (US)

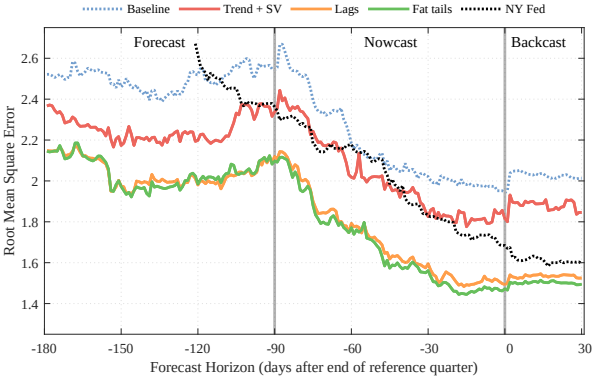


- Long run trend eliminates the upward bias in GDP forecasts after the crisis
- Lead-lag dynamics improve the mode's performance around turning points

COMPARISON WITH EXTERNAL BENCHMARKS

Survey Expectations and NY Fed model





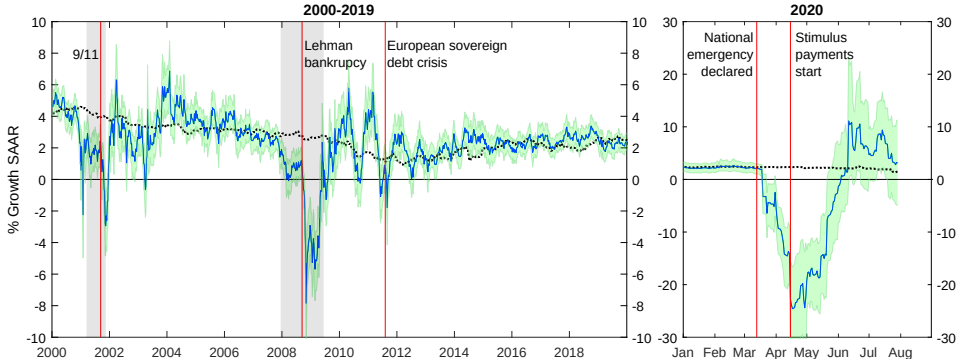
THE GREAT LOCKDOWN

Insights on nowcasting in 2020: two avenues

1. Novel model components help tracking activity in 2020
   - Many formal models simply produce nonsensical results
   - Combination of SV, heterogeneous dynamics and fat tails allow for stable tracking

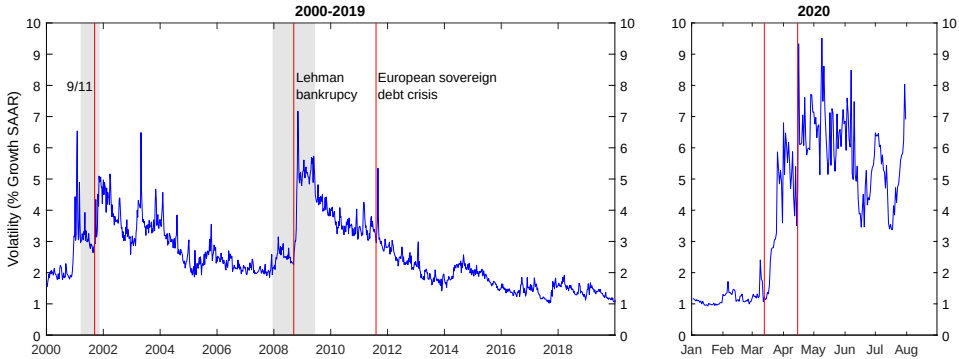
2. How to incorporate 'alternative data' in the DFM machinery
   - Novel data sources with very small history have become available
   - Tie together with observations of closely-related traditional series
   - Contributes to more timely assessment of the downturn

TRACKING DAILY ACTIVITY



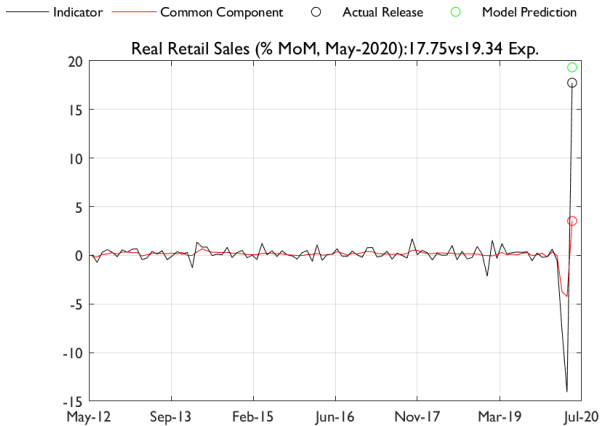
- Model with fat-tails produces stable estimates, is able to capture features like the strong rebound of economic activity during the partial re-opening

TRACKING DAILY VOLATILITY



- The volatility of underlying economic activity can be measured in real time. It shot up massively during the COVID lockdown and has stayed elevated since.

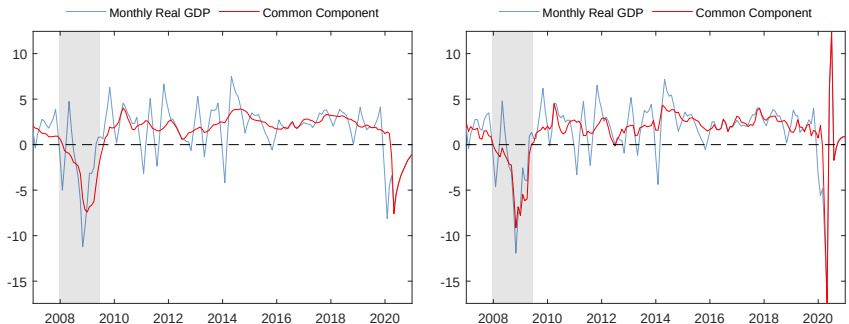
FAT TAILED OBSERVATIONS



- Model captured rebound in retail sales based on history of similar patterns

NOWCASTS AS OF JUNE 2020

BASIC DFM (LEFT) VS. FULL MODEL (RIGHT)



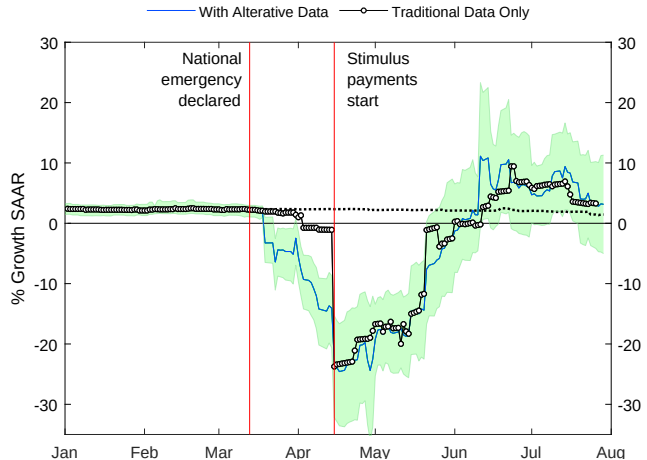
- Persistent decline or more V-shaped recovery?
- Heterogeneous dynamics capture rebound in GDP despite persistent decline in other series (in particular surveys)

USING NEW DATA SOURCES IN THE DFM

Monthly Indicator	Start	High Frequency Proxy	Freq.	Start	Estimated
Real Consumption (excl. durables)	Jan 67	Credit Card Spending (OI)	D	Jan 20	N
Payroll Empl. (Establishment Survey)	Jan 47	Homebase	D	Mar 20	N
Civilian Empl. (Household Survey)	Feb 48	Dallas Fed RPS	BW	Apr 20	N
Unemployed	Feb 48	Dallas Fed RPS	BW	Apr 20	N
Initial Claims for Unempl. Insurance	Feb 48	Weekly Claims (BLS)	W	Jan 67	N
U. of Michigan: Consumer Sentiment	May 60	Rasmussen Survey	D	Oct 04	Y
Conf. Board: Consumer Confidence	Feb 68	Rasmussen Survey	D	Oct 04	Y
U.S. Vehicle Miles Traveled	Jan 70	Apple Mobility Trends	D	Jan 20	N
Real Cons. of Food Services	Dec 69	Open Table Reservations	D	Jan 20	N

- "New data" has short history
- Key idea: use new data in combination with similar "traditional" series

USING NEW DATA SOURCES IN THE DFM



- Incorporating new data enables faster tracking of the collapse in real time

REFERENCES

Antolin-Diaz, J., T. Drechsel, and I. Petrella (2017): "Tracking the slowdown in long-run GDP growth," *Review of Economics and Statistics*, 99.

Banbura, M., D. Giannone, and L. Reichlin (2010): "Nowcasting," CEPR Discussion Papers 7883, C.E.P.R. Discussion Papers.

Camacho, M. and G. Perez-Quiros (2010): "Introducing the euro-sting: Short-term indicator of euro area growth," *Journal of Applied Econometrics*, 25, 663–694.

D'Agostino, A., D. Giannone, M. Lenza, and M. Modugno (2015): "Nowcasting Business Cycles: A Bayesian Approach to Dynamic Heterogeneous Factor Models," Tech. rep.

Giannone, D., L. Reichlin, and D. Small (2008): "Nowcasting: The real-time informational content of macroeconomic data," *Journal of Monetary Economics*, 55, 665–676.

Jurado, K., S. C. Ludvigson, and S. Ng (2014): "Measuring Uncertainty," *American Economic Review, Forthcoming*.

McConnell, M. M. and G. Perez-Quiros (2000): "Output Fluctuations in the United States: What Has Changed since the Early 1980's?" *American Economic Review*, 90, 1464–1476.