Do financial variables predict GDP growth? Why?

- The macro-finance literature has suggested several channels through which financial variables interact with macroeconomic conditions. Bernanke & Gertler (1989); Kiyotaki & Moore (1997); Bernanke, Gertler & Gilchrist (1999); Brunnermeier & Sannikov (2014); Gertler & Kiyotaki (2015)

- However, the early empirical literature found little predictive power in financial variables for the business cycle at short horizons. Stock & Watson (2003)

- Recent research suggests that the relationship between financial variables and the business cycle is non-linear and it emerges during recessions. Adrian, Grinberg, Liang & Malik (2018); Adrian, Boyarchenko & Giannone (2019); Jovanovic & Ma (2019)

- Empirical implication: Financial variables may be helpful for predicting moments other than the mean and signal risks for growth.
This paper

• Research questions:
  1. Is the data sufficiently informative to predict the dynamics of higher moments of GDP growth?
  2. Do financial variables contain advance information about growth?

• Contributions:
  1. Disentangle financial-specific information from information that is contemporaneous and common to macro and financial variables.
  2. We assess uncertainty in different forms:
     • Out-of-sample forecast uncertainty.
     • In-sample uncertainty in estimation of moments.
     • Model uncertainty – which predictors?
     • Data uncertainty – real-time and calendar.
The economic impact of COVID-19

Predictive distributions of GDP growth using financial and real information

Predictive Distributions for 2020 Q1

Predictive Distributions for 2020 Q2
Our findings

1. Financial markets have limited forward information – most info is contemporaneous.

2. Most of the action is in the mean, not the tails.

3. However, some indication of negative correlation between mean and variance, although imprecisely estimated.

4. Identity of relevant predictors is hard to pin down.
Relationship with existing empirical literature

- Predicting the mean of GDP growth: Forni et al. (2003); Stock & Watson (2003); Gilchrist & Zakrajšek (2012); Brunnermeier et al. (2019)

- Predicting the left tail of GDP growth: Manzan (2015); Giglio et al. (2016); Adrian et al. (2018, 2019); Brownlees & Souza (2019); Carrierio et al. (2019); Jovanovic & Ma (2019); Loria et al. (2019)

- Predicting crises at longer horizons: Basel Committee (2010); Jordà et al. (2011, 2013); Gourinchas & Obstfeld (2012); Mian et al. (2017)

- Our paper:
  - Short forecast horizons (1–4 quarters).
  - Many potential predictors + cross-country evidence.
  - Emphasis on in-sample/out-of-sample/model/data uncertainty.
Do financial variables predict GDP growth out of sample?

How much does the distribution of GDP growth change over time?

Which variables predict growth risk?

Conclusion
Extracting financial-specific information

• FRED-MD/FRED-QD: monthly/quarterly large panel data set of U.S. macro series.

• Extract three different latent factors using state space model:
  2. Non-financial factor: First principal component when we exclude financial series.
  3. Financial factor: Extracted from financial variables only, orthogonal to global factor.

• Global and non-financial factors almost identical (next slide).

• Question: Does financial factor contain leading information about GDP growth risk?
Evolution of global, financial, and non-financial factors
Estimating growth-at-risk

- We’re interested in characterizing the entire time-varying forecast distribution of real GDP growth $y_{t+1}$, especially the left tail.

- Influential growth-at-risk methodology due to Adrian, Boyarchenko & Giannone (2019):
  1. Run quantile regressions at quantiles $\tau \in \{5\%, 25\%, 75\%, 95\%\}$:

$$\hat{Q}_\tau(y_{t+1} \mid y_t, x_t) = \hat{\gamma}_\tau + \hat{\rho}_\tau y_t + \hat{\beta}_\tau' x_t, \quad x_t = (\text{global factor}_t, \text{financial factor}_t)' .$$

  2. Smooth the distribution: At each time $t = 1, 2, \ldots, T$, fit a flexible “skew-t” density function to the four conditional quantiles given realized values of $y_t, x_t$.

  3. Compute moments, etc., from density at each point in time $t$.

- We do this recursively out-of-sample: deals with model uncertainty, structural change.
Out-of-sample forecast moments: one quarter ahead

- Mean
- Variance
- Skewness
- Kurtosis

Global factor, Financial factor, and GDP
Global factor and GDP
GDP only

blue: GDP + global + financial  red: GDP + global  yellow: GDP only
Out-of-sample forecast moments: four quarters ahead

- Mean
- Variance
- Skewness
- Kurtosis

blue: GDP + global + financial  red: GDP + global  yellow: GDP only
Out-of-sample predictive distribution: four quarters ahead

- 2007 Q4
- 2008 Q1
- 2008 Q2
- 2008 Q3
- 2008 Q4
- 2009 Q1

*blue:* GDP + global + financial  
*red:* GDP + global  
*yellow:* GDP only
Nowcasting GDP growth

- Financial variables are typically available earlier than other types of variables. Do their timeliness make them important for nowcasting?

- We conduct a real-time exercise (since 2005) with realistic data release calendar.

<table>
<thead>
<tr>
<th>Variable group</th>
<th>Release lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer sentiment</td>
<td>15</td>
</tr>
<tr>
<td>Interest rate spreads, stock indices, and exchange rates</td>
<td>30</td>
</tr>
<tr>
<td>Unemployment</td>
<td>37</td>
</tr>
<tr>
<td>Monetary Aggregates</td>
<td>42</td>
</tr>
<tr>
<td>IP &amp; subcomponents</td>
<td>47</td>
</tr>
<tr>
<td>Housing Starts &amp; subcomponents</td>
<td>46</td>
</tr>
<tr>
<td>CPI &amp; subcomponents</td>
<td>48</td>
</tr>
<tr>
<td>New private housing</td>
<td>54</td>
</tr>
<tr>
<td>Personal consumption expenditure &amp; real personal income</td>
<td>60</td>
</tr>
</tbody>
</table>
RMSFE and predictive score as function of release calendar

**RMSE**

**Predictive Score**

- Global Factor
- Global and Financial Factors
- Non-financial Factor
Taking stock

• The global factor helps predict the mean out of sample – but no additional predictive power from the financial factor.

• Higher moments are difficult to predict, especially four quarters ahead.

• If financial variables contain advance information, it only helps at very short nowcasting horizons.
• The global factor helps predict the mean out of sample – but no additional predictive power from the financial factor.

• Higher moments are difficult to predict, especially four quarters ahead.

• If financial variables contain advance information, it only helps at very short nowcasting horizons.

• Next:
  • How uncertain are we about the time-varying moments/distribution?
  • Can we go beyond factors as predictors?
1. Do financial variables predict GDP growth out of sample?

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3. Which variables predict growth risk?

4. Conclusion
Parametric model of time-varying moments

- How large is the in-sample uncertainty about the conditional moments of GDP growth?

- We now switch to a parametric model of growth: dynamic skew-t model.

\[ y_{t+1} = \mu_t + \sigma_t \varepsilon_{t+1}, \quad (\varepsilon_{t+1} \mid F_t) \sim \text{skew-t}(0, 1, \alpha_t, \nu). \]

- Allow location $\mu$, scale $\sigma$, and shape $\alpha$ parameters to vary over time as functions of lagged GDP growth $y_t$ and predictors $x_t$ (but heavy-tailedness $\nu$ constant):

\[
\begin{align*}
\mu_t &= \gamma_\mu + \rho_\mu y_t + \beta'_\mu x_t, \\
\log \sigma_t &= \gamma_\sigma + \rho_\sigma y_t + \beta'_\sigma x_t, \\
\alpha_t &= \gamma_\alpha + \rho_\alpha y_t + \beta'_\alpha x_t.
\end{align*}
\]

- Bayesian, parametric version of Adrian, Boyarchenko & Giannone (2019) procedure.

- For now: $x_t = (\text{global factor}_t, \text{financial factor}_t)'$. 
Skew-t density

\[ \alpha = 0, \nu = \infty \]
Skew-t density

\[ \alpha = 0, \nu = \infty \]
\[ \alpha = 0, \nu = 5 \]
Skew-t density

\[ \alpha = 0, \nu = \infty \]
\[ \alpha = 0, \nu = 5 \]
\[ \alpha = 3, \nu = 5 \]
Skew-t density

- $\alpha = 0, \nu = \infty$
- $\alpha = 0, \nu = 5$
- $\alpha = 3, \nu = 5$
- $\alpha = -7, \nu = 5$
Time-varying moments: one quarter ahead
Time-varying moments: one quarter ahead

Both factors

Only global factor
Time-varying moments: four quarters ahead

- **Mean**: A fluctuating line from 1975 to 2020, showing variations over time.
- **Standard Deviation**: A line chart with a range from 1975 to 2020, displaying the variability of the data.
- **Skewness**: A line chart from 1975 to 2020, indicating the skewness of the distribution.
- **Kurtosis**: A line chart from 1975 to 2020, showing the peakedness or flatness of the distribution.

The charts illustrate the evolution of these moments over time, providing insights into the statistical properties of a dataset.
Time-varying recession prob. and expected shortfall: one quarter ahead
1. Do financial variables predict GDP growth out of sample?

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Variable selection

• Perhaps factors average away the signal from a few important predictor variables?

• For policy/modeling, we would ideally like to go beyond factors and look at individual variables/categories that predict the distribution of GDP growth.

• We now attempt to select the most relevant predictors from a list of 43 candidates.

• We impose a prior belief in approximate sparsity on the model coefficients.
  • “Horseshoe prior” of Carvalho, Polson & Scott (2010).
  • Posterior either shrinks coefficients heavily toward 0 or does not shrink much.

• In these slides I focus on a conditional heteroskedasticity model that sets $\alpha_t = 0, \nu = \infty$. More results for general skew-t model in paper.
U.S. data: Posterior distribution of conditional mean coefficients
U.S. data: Posterior distribution of conditional variance coefficients
Cross-country data set

- Are the identities of the important predictor variables robust across countries?

- Cross-country data set for 13 OECD countries:
  - AUS, BEL, CAN, CHE, DEU, ESP, FRA, GBR, ITA, JPN, NLD, SWE, USA.
  - Up to 34 predictor variables per country. Unfortunately no corporate borrowing spreads.
  - Common data sources (OECD, BIS, GFD) ensure cross-country comparability.

- Expands the list of crises/recessions: From 1980–2014, only 2004+2006 saw no banking or currency crisis in any of the 13 countries.
Cross-country data: Posterior medians of conditional mean coefficients
Cross-country data: Posterior medians of conditional variance coefficients
## Cross-country data: Unconditional skewness and kurtosis

<table>
<thead>
<tr>
<th>Country</th>
<th>avg((\alpha))</th>
<th>avg(TVD)</th>
<th>std(TVD)</th>
<th>Q1((\nu))</th>
<th>med((\nu))</th>
<th>Q3((\nu))</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS</td>
<td>5.224</td>
<td>0.387</td>
<td>0.087</td>
<td>12.0</td>
<td>18.0</td>
<td>26.7</td>
</tr>
<tr>
<td>BEL</td>
<td>1.747</td>
<td>0.311</td>
<td>0.092</td>
<td>7.6</td>
<td>13.0</td>
<td>21.6</td>
</tr>
<tr>
<td>CAN</td>
<td>0.472</td>
<td>0.273</td>
<td>0.101</td>
<td>12.0</td>
<td>18.3</td>
<td>27.4</td>
</tr>
<tr>
<td>CHE</td>
<td>-0.821</td>
<td>0.243</td>
<td>0.081</td>
<td>8.5</td>
<td>13.0</td>
<td>20.2</td>
</tr>
<tr>
<td>DEU</td>
<td>-5.574</td>
<td>0.363</td>
<td>0.093</td>
<td>13.5</td>
<td>20.1</td>
<td>29.4</td>
</tr>
<tr>
<td>FRA</td>
<td>-0.160</td>
<td>0.248</td>
<td>0.100</td>
<td>12.0</td>
<td>18.2</td>
<td>26.9</td>
</tr>
<tr>
<td>GBR</td>
<td>1.578</td>
<td>0.307</td>
<td>0.107</td>
<td>4.5</td>
<td>7.1</td>
<td>12.5</td>
</tr>
<tr>
<td>ITA</td>
<td>4.229</td>
<td>0.369</td>
<td>0.089</td>
<td>12.8</td>
<td>19.4</td>
<td>28.5</td>
</tr>
<tr>
<td>NLD</td>
<td>-4.719</td>
<td>0.392</td>
<td>0.087</td>
<td>10.9</td>
<td>16.7</td>
<td>25.4</td>
</tr>
<tr>
<td>SWE</td>
<td>2.381</td>
<td>0.331</td>
<td>0.114</td>
<td>6.5</td>
<td>10.0</td>
<td>16.2</td>
</tr>
<tr>
<td>USA</td>
<td>-2.194</td>
<td>0.321</td>
<td>0.096</td>
<td>14.6</td>
<td>21.5</td>
<td>31.0</td>
</tr>
</tbody>
</table>
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⇒ Be cautious when drawing structural conclusions for modeling macro-finance link.
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Skew-t distribution

- skew-t($\mu, \sigma, \alpha, \nu$) distribution:
  \[ Y = \mu + \sigma \frac{U}{\sqrt{V/\nu}}. \]

- $U$ has standard skew-normal distribution with density
  \[ p_U(u; \alpha) = 2\varphi(u)\Phi(\alpha u). \]

- $V \sim \chi^2(\nu)$.

- $U$ and $V$ are independent.
Posterior distribution of dynamic skew-t model

**location**
- GlobalFactor
- FinancialFactor

**scale**
- GlobalFactor
- FinancialFactor

**shape**
- GlobalFactor
- FinancialFactor

**ylag**
- GlobalFactor
- FinancialFactor

**const**
- GlobalFactor
- FinancialFactor

**ylag**
- GlobalFactor
- FinancialFactor

**const**
- GlobalFactor
- FinancialFactor
Time-varying recession prob. and expected shortfall: four quarters ahead