How Well Does Economic Uncertainty Forecast Economic Activity?

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The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.
Motivation

“It’s difficult to make predictions, especially about the future.”

- Yogi Berra
Motivation

- Ubiquitous research on uncertainty; been related to:
  - macroeconomic phenomena such as inflation and GDP growth
  - micro issues, e.g., firm-level investment, export market entry and exit
  - finance considerations like corporate strategy and equity returns

- Could spend literally the entire presentation on related research.

- Citations of Bloom (ECTA 2009), BBvR (ReStud 2007), BBD (QJE 2016), and BFJSET (ECTA 2018) approaching 10,000!

- But the forecasting performance of uncertainty measures has been surprisingly under-researched.
This Paper

Forecast using several uncertainty measures, including well-known EPU, VIX, VRP, MU, and FU. Also MPU and cross-firm equity Skewness.

- in-sample and out-of-sample forecasts
- short horizons and medium-term
- real and financial outcome variables
- distribution of GDP growth
- sub-sample stability (not crucial, will skip today)

Conclude by examining real-time data issues (highly important!)
Four Exercises, Four Main Findings

- **Kitchen sink exploration.** Prediction over 100 macro and financial outcome variables. Find some explanatory power in all uncertainty measures. Relatively good performance by MU.
- **Expanded Gilchrist-Zakrajsek regressions.** Find additional predictive content from MU (and Skewness to a lesser extent).
- **Quantile regressions for GDP growth.** Strong predictive power, especially at the lower ends of the distribution, for all uncertainty measures except the VIX.
- **Real-time data issues.** Construct new real-time versions of MU and FU. Do comparatively poorly forecasting ex-post revised data series but generally do better in forecasting real-time GDP growth.
Baseline Predictive Regression

\[ y_{i,t+h} = \alpha_i + \phi_i^y(L)y_{i,t} + \beta_i\varphi^F(L)F_t + \gamma_i^ZZ_t + \epsilon_{i,t+h}^y \] (1)

\( F_t \) are estimated factors from dynamic factor model (Bai-Ng, 2002)

\( Z_t \) is our set of uncertainty measures, added one at a time:

- Newspaper-based: EPU (Baker-Bloom-Davis, 2016); MPU (Husted-Rogers-Sun, forthcoming)
- Estimation-based: MU (Jurado-Ludvigson-Ng, 2015); FU (Ludvigson-Ma-Ng, 2019)
- Market-based: Variance Risk Premium (Bollerslev-Tauchen-Zhou 2009, Zhou 2018); VIX (CBOE); Skewness (Ferreira, 2019)
- Survey-based: not yet added. Households (Michigan survey, Leduc-Liu 2016) or Firms (SBU; FRB-ATL, Steve, Nick ... begins only in 2014)

Also include in \( Z_t \) EBP (Gilchrist-Zakrajsek, 2012) and NFCI (FRB-CH)
Uncertainty Measures

How Well Does Economic Uncertainty Forecast Economic Activity?
Correlations

MU, FU, VIX, EBP, NFCI all high pairwise correlations

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Exercise 1, Kitchen Sink: prediction over wide array (more than 120) of macro and financial indicators

In-sample fit
- evaluated through t-stats on $\gamma_i$ in workhorse eqn (1)
- MU, Skewness, VRP do well across all horizons.
- EBP and NFCI also have good predictive content.
- EPU has relatively less predictive power than other indexes, but it does improve as the horizon increases.

Out-of-sample fit
- fully recursive exercise; begin estimation window 1990:1-1999:12
- forecast 1999:12+h to 2018:6, compute MSFE; add an observation, re-select/estimate factor model, forecast 2000:1+h to 2018:6, etc
- accuracy evaluated via MSFE; use Clark-West test for significance.
- EPU improvement substantial.
Table: Summary of in-sample predictive regressions (no. sign. t-stats at 5%)

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Note: In the full sample regression, we use the complete data span for each measure.
### Table: Summary of out-of-sample forecasting (number signifies smaller MSFE)

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Note: Number of series for which Clark-West test rejects at 10%. Sample is from 1990:1-2018:6. The first ten years are used for in-sample estimation.
Exercise 2: Uncertainty measure added to Gilchrist-Zakrajsek regressions (with NFCI)

Monthly indicators: EMP, UER, IPM. Quarterly indicators: GDP, C, I

- NFCI marginal predictive power over EBP, all series all horizons.
- MU performs quite well for all components, frequencies, and prediction horizons. Knocks out significance of EBP in several cases.
- VRP and Skewness do well.
- other uncertainty measures have zero marginal predictive content, sometimes enter with wrong sign (VIX).

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<td>(-2.04) (-1.72) (-1.91) (0.13) (-1.57)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Exercise 3: Quantile regressions for GDP growth

Motivation

- importance of “vulnerable growth” (Tobias Adrian papers)
- oft-heard remark: uncertainty measures just a signal that bad stuff is happening or about to happen
- bar chart highly suggestive of that (see next)
- hypothesis: uncertainty better explains lower percentiles of distribution

Quantile coeffs $\hat{\beta}_\tau$ chosen to min. quantile weighted abs value of errors:

$$\hat{\beta}_\tau = \arg\min_{\beta_\tau \in \mathbb{R}^k} \sum_{t=1}^{T-h} \left( \tau \cdot 1(y_{t+h} \geq x_t \beta) |y_{t+h} - x_t \beta_\tau| + (1 - \tau) \cdot 1(y_{t+h} < x_t \beta) |y_{t+h} - x_t \beta_\tau| \right)$$
Uncertainty and GDP growth distribution: Group 1

Note: mean GDP growth rate by quantile and corresponding mean value of EPU, MU, FU, EBP, and negative Skewness when GDP growth is in that quantile. 1973:I-2018:III
Uncertainty and GDP growth distribution: Group 2

Note: mean GDP growth rate by quantile and corresponding mean value of MPU, NFCI, negative VRP, VIX when GDP growth is in that quantile. 1990:I-2018:III
Quantile regression results

In-sample, for $\tau = 0.1, 0.3, 0.5, 0.7, 0.9$ and $h = 1, 4$.

- all measures do well, in-sample, especially at lower quantiles and at short horizons.
- hypothesis seems verified in the data.
- MU, VRP, Skewness (and EBP, NFCI) do very well.
- EPU and VIX have the weakest relationships in the sense hypothesized. VIX sometimes has wrong sign.
<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$h=1$</th>
<th>$h=4$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>EPU</td>
<td>-0.55**</td>
<td>-0.18</td>
</tr>
<tr>
<td></td>
<td>(-1.71)</td>
<td>(-0.95)</td>
</tr>
<tr>
<td>MU</td>
<td>-1.65***</td>
<td>-1.50***</td>
</tr>
<tr>
<td></td>
<td>(-4.99)</td>
<td>(-5.54)</td>
</tr>
<tr>
<td>FU</td>
<td>-0.43</td>
<td>-0.42**</td>
</tr>
<tr>
<td></td>
<td>(-1.17)</td>
<td>(-1.90)</td>
</tr>
<tr>
<td>EBP</td>
<td>-0.94***</td>
<td>-0.76***</td>
</tr>
<tr>
<td></td>
<td>(-2.57)</td>
<td>(-3.20)</td>
</tr>
<tr>
<td>NFCI</td>
<td>-1.24***</td>
<td>-1.09***</td>
</tr>
<tr>
<td></td>
<td>(-4.89)</td>
<td>(-4.12)</td>
</tr>
<tr>
<td>MPU</td>
<td>-0.29</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>(-1.04)</td>
<td>(-1.27)</td>
</tr>
<tr>
<td>-1*VRP</td>
<td>-0.96***</td>
<td>-0.43**</td>
</tr>
<tr>
<td></td>
<td>(-3.05)</td>
<td>(-1.86)</td>
</tr>
<tr>
<td>VIX</td>
<td>-0.30</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(-1.03)</td>
<td>(1.24)</td>
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<tr>
<td>-1*Skewness</td>
<td>-0.25</td>
<td>-0.67***</td>
</tr>
<tr>
<td></td>
<td>(-0.81)</td>
<td>(-3.50)</td>
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</table>
Our results indicate that EPU and MPU have relatively weak predictive content compared to MU, FU, EBP, and NFCI.

- But EPU and MPU are also much closer to a “real time” index than the others.
- MU, FU, and EBP are all residual based (full-sample estimation, ex-post measure) and do not account for estimation error.

We construct real time MU and FU beginning in 1999 and examine its predictive content compared to “ex-post” MU and FU.
Exercise 4: Real Time Macro/Financial Uncertainty

Real time MU construction

- Financial data, never revised, are used through 2018:12.
- For each vintage, we construct a balanced panel from 1978:6 to the end month.
- Repeat estimation every vintage, use final observation to construct real-time MU.
- Due to data availability, from 2004:1 and moving forward, we include 120 series out of 132 used in Jurado et al (2015) to construct MU.

Real time FU construction

- 147 financial variables are used to construct the aggregate FU.
- Vintage macro data from 1999:08-2019:01 are used to compute common factors.

Real time EBP construction

- would love to do it.
- Rogers’ “buddy” Egon Z. slow to give us the underlying data!
Real-time MU and ex-post MU (by horizon)
Real-time FU and ex-post FU (by horizon)
Table: Summary table of in-sample predictive regression: Real time v.s. Ex-post

<table>
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<td>35</td>
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<tr>
<td>ex-post MU</td>
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<td>37</td>
<td>58</td>
</tr>
<tr>
<td>real time FU</td>
<td>12</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>ex-post FU</td>
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<td>39</td>
<td>63</td>
</tr>
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<td>EPU</td>
<td>10</td>
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<tr>
<td>MPU</td>
<td>20</td>
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<tr>
<td>VRP</td>
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</tr>
<tr>
<td>VIX</td>
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<tr>
<td>EBP</td>
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<td>52</td>
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</tr>
<tr>
<td>NFCI</td>
<td>38</td>
<td>46</td>
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<tr>
<td>Skewness</td>
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<td>26</td>
<td>36</td>
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</tbody>
</table>

Note: The time span is from 1999:8-2018:6.
Table: Summary table of out-of-sample forecasting: Real time v.s. Ex-post

<table>
<thead>
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<tr>
<td>ex-post MU</td>
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<td>56</td>
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<tr>
<td>ex-post FU</td>
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<tr>
<td>VRP</td>
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<td>VIX</td>
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<td>EBP</td>
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<tr>
<td>NFCI</td>
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<td>55</td>
</tr>
<tr>
<td>Skewness</td>
<td>41</td>
<td>33</td>
<td>23</td>
</tr>
</tbody>
</table>

Note: The pseudo out-of-sample forecasting values are computed from 2008:1 to 2018:6. Data starting from 1999:8 to 2007:12 are used for in-sample estimation.
Again, real-time measures generally do worse than ex-post counterparts

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>0.1</th>
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<th>0.9</th>
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<tr>
<td></td>
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<tr>
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<td>-0.40</td>
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<td>(-1.00)</td>
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<tr>
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<td>-0.75***</td>
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<td>-0.46*</td>
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<tr>
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<td>-0.47**</td>
<td>-0.57***</td>
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<td>-0.20**</td>
</tr>
<tr>
<td></td>
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<td>(-1.65)</td>
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<td>-0.73***</td>
<td>-0.09</td>
<td>-0.30**</td>
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<td>(-1.84)</td>
<td>(-1.23)</td>
<td>(-2.80)</td>
<td>(-0.87)</td>
<td>(-2.20)</td>
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<tr>
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<td>-0.05</td>
<td>0.32**</td>
<td>0.46***</td>
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<tr>
<td></td>
<td>(0.98)</td>
<td>(1.45)</td>
<td>(-0.95)</td>
<td>(1.92)</td>
<td>(3.18)</td>
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<td>-0.64***</td>
<td>-0.55***</td>
<td>-0.39***</td>
<td>-0.17*</td>
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<tr>
<td></td>
<td>(-3.07)</td>
<td>(-3.99)</td>
<td>(-3.16)</td>
<td>(-2.96)</td>
<td>(-1.44)</td>
</tr>
</tbody>
</table>
Forecasting real-time GDP growth with real-time and ex-post uncertainty measures (*indicates lowest mfse)

<table>
<thead>
<tr>
<th>forecast period</th>
<th>EPU</th>
<th>real time MU</th>
<th>real time FU</th>
<th>ex-post MU</th>
<th>ex-post FU</th>
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<td>5.02</td>
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<tr>
<td>2009:I-2018:IV</td>
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<td>5.01</td>
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<td>3.87</td>
</tr>
<tr>
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<td>2.77</td>
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<td>2.42</td>
<td>2.62</td>
</tr>
<tr>
<td>2011:I-2018:IV</td>
<td>2.19</td>
<td>2.10</td>
<td>1.84*</td>
<td>2.06</td>
<td>2.19</td>
</tr>
<tr>
<td>2012:I-2018:IV</td>
<td>1.44*</td>
<td>2.24</td>
<td>1.85</td>
<td>2.16</td>
<td>2.37</td>
</tr>
<tr>
<td>2013:I-2018:IV</td>
<td>1.53*</td>
<td>2.23</td>
<td>1.93</td>
<td>2.09</td>
<td>2.55</td>
</tr>
<tr>
<td>2014:I-2018:IV</td>
<td>1.72</td>
<td>1.90</td>
<td>1.57*</td>
<td>1.86</td>
<td>1.94</td>
</tr>
<tr>
<td>2015:I-2018:IV</td>
<td>1.46</td>
<td>1.73</td>
<td>1.35*</td>
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<td>1.76</td>
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<td>2016:I-2018:IV</td>
<td>1.44</td>
<td>1.87</td>
<td>1.14*</td>
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<td>1.64</td>
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<tr>
<td>2017:I-2018:IV</td>
<td>1.46</td>
<td>0.76*</td>
<td>0.89</td>
<td>1.16</td>
<td>1.37</td>
</tr>
</tbody>
</table>
Future work

Structural breaks and forecast instability

- Sub-sample analysis (not emphasized today) shows that predictability may change over time, for example pre and post 2008.
- Taking structural breaks formally into account can help improve both in-sample fit and out-of-sample forecasting. (Stock & Watson (2009), Xu & Perron (2014, 2017, 2019))

Non-linearities

- Dierks et. al. (2019). Of the type that Alex will talk about next.
Conclusions

- Ex-post measures such as MU, FU and EBP do better than EPU and MPU both in and out-of sample.
- MU shows marginal predictive power over widely-used EBP and NFCI in Gilchrist-Zakrajsek (in-sample) regressions.
- Uncertainty measures predict GDP growth well at lower quantiles, generally better than upper quantiles.
- Comparisons between real time and ex-post MU/FU demonstrate that forecasting capability is closely related to series construction (look-ahead bias non-trivial).