Discussion
Macroeconomic forecasting in times of crisis
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Solution: use (crisis) patterns to forecast during crisis?
Contribution

- How to define and find the patterns and how to use them?
- Match the current time series with the "most equal" pattern in history.
  - Cut the data into blocks of length $k$.
  - Compare the current block with all blocks via distance function:
    \[
    dist = \sum_{i=1}^{k} w(i)(y_{T-k+i} - y_i)^2
    \]
  - Only the closest blocks provide information for the forecast.
- Assume the match:
  - Current data block: $B^C = y_{T-k}, \ldots, y_T$
  - Best match data block: $B^1 = y_1, \ldots, y_{k-1}, y_k$
- To forecast $y_{T+1}$ we use information contained in $y_{k+1}$ (and $B^1$).
Framework

- Completely non-parametric approach: \( \hat{y}_{T+1} = y_{k+1} \)
- In the paper semi-parametric approach:

\[
\hat{y}_{T+1} = (y_{k+1} - \hat{y}_{k+1},ARIMA) + \hat{y}_{T+1},ARIMA
\]

- \( \hat{y}_{T+1},ARIMA \): parametric ARIMA forecast.
- \( (y_{k+1} - \hat{y}_{k+1},ARIMA) \): correction for forecast error made by ARMA model in "similar" period.

- Match with \( m \) similar periods:

\[
\hat{y}_{T+1} = \frac{1}{m} \sum_{i}^{m} (y_{l(i)+1} - \hat{y}_{l(i)+1},ARIMA) + \hat{y}_{T+1},ARIMA
\]

- Machine learning step: estimate two parameters, \( k \) and \( m \).
- Select \( k \) and \( m \) by minimizing out-of-sample forecast error.
Other variables may provide “pattern” information.

Reinhart and Rogoff (2014): Financial crisis ⇒ protracted and halting nature of the recovery

Compare multivariate block, including financial variables:

\[
dist = \sum_{i=1}^{k} w(i) ((x_{T-k+i} - x_i)^2 + (z_{T-k+i} - z_i)^2)
\]

Financial variables provide important information to identify patterns.
What is the computational burden to estimate two parameters?

In principle one could estimate more parameters:

- The weights for additional series.
- The weights for different blocks.
- The weighting function for lags.
- The weight on parametric vs. non-parametric forecast:

\[
\hat{y}_{T+1} = w y_{k+1} + (1 - w) \hat{y}_{T+1, ARIMA}
\]
Comments: Real-time vs. revised series

- Forecasting evaluation done with last vintage (revised data).
- Real-Time estimate of Industrial production (SPF) growth vs. revised estimate:

In Real-Time harder to capture changing patterns!
- Leading variables (financial variables) could be potentially even more useful.
Can this methodology be used also to produce density forecasts?

Given that multiple blocks are matched this seems natural:

\[ \hat{y}_{T+1,i} = (y_{l(i)+1} - \hat{y}_{l(i)+1,ARIMA}) + \hat{y}_{T+1,ARIMA} \]