Predicting BIP and HP-BIP

Approach: generalization of classic direct forecast

* Link to literature: abstract and introduction to paper.
  + List of alternative predictor designs (in applications)
  + Performances: short term
  + Motivation for the generic concept (regressing `indicators’ on future BIP)
* Here: more `sophisticated’ regressors (than un-filtered indicators)
  + Emphasize mid-term forecast horizons: 2<==h<=4 quarters
  + Do not need `noisy’ high-frequency data
    - Motivation of selected indicators: ip, ESI, ifo, spread
  + Do not need mixed-frequency approach
    - Mixed-frequency mostly relevant for short-term (nowcast)
    - Possible extension of paper in future work

Main `ingredients’ of new predictor design(s)

* **Remove** unpredictable high-frequency **noise**: HP(160)
  + Focus attention on components relevant for **mid-term** forecasting.
    - Mitigate overfitting
  + Classic HP(1600) is too smooth (removes information relevant for a 2-4 quarters ahead forecast), see Phillips and Jin (2021).
  + More adaptive designs do not markedly outperform (HP(16 in tutorial 7.4)
* Tracking **two-sided HP**
  + Efficient real-time filtering (predictor) for tracking HP targets: **M-SSA components**
    - Efficiency: left-shift (advancement) of predictor to track dips/peaks in a timely fashion
* Tracking **BIP**
  + Rely on previous M-SSA components (or M-MSE components) as explanatory variables in regression on future BIP
    - **Left-shift** and **smoothness** of regressors **facilitates regression**
    - Mitigate overfitting
    - Statistical significance (up to 4 quarters ahead plus publication lag)
    - Smaller rRMSEs
  + Efficiency**: WLS** regression (weight inverse proportional to GARCH-vola)
* **Control smoothness**: rate of zero-crossings (above/below average growth `alarms’)

Two predictor designs

1.Predicting **HP-BIP**

* M-SSA predictor: tutorial 7.3
* Emphasizes turning-points, dynamic shifts in BIP growth-rate
* Not designed to track future BIP explicitly (standardized series: not calibrated to BIP)
* Maybe less relevant in (this) paper?

2.Predicting **BIP**

* M-SSA component predictor (M-SSA-C): tutorial 7.4
* Emphasizes BIP and MSE forecast performances explicitly
* Difference to M-SSA predictor above**: one additional optimization stage**
  + M-SSA-C are regressed on (future) BIP
    - Weights determined by WLS regression
    - Original M-SSA: equal-weighting of M-SSA components
* Difference to direct forecast: regressors
  + Direct forecasts rely on un-filtered data
  + M-SSA relies on outputs of multivariate filter (which controls smoothness)
  + Link to earlier work
    - Summary of predictor designs
    - Need to address technical aspects of multivariate filtering in paper
* Motivation: **outperformance at longer forecast horizons** h>=2
  + Link to earlier work
  + Tutorial 7.4: outperformance of M-SSA component predictor over
    - Mean
    - Direct forecasts (based on ESI, ifo: best combination; rRMSE around 80% without Pandemic)
    - Direct HP-C forecast
    - M-SSA predictor
    - M-MSE predictor: the latter has similar rRMSE but it is noisier (more zero-crossings)
  + Out-of-sample span: starts in 2007; expanding window; includes financial crisis as well as Pandemic.
* **Explainability** part 1: why does new predictor outperform at longer forecast horizons?
  + Outperformance out-of-sample at longer forecast horizons (h>=2) is linked to **left-shift of predictor**
    - MSE is mainly determined by tracking peaks/dips timely
  + Classic benchmarks (mean, direct forecast) do not generate an explicit left-shift of the corresponding predictors
  + Univariate filters (HP-C) generate a left-shift but the latter is small and works mainly/only at zero-crossings.
  + Multivariate filters generate a systematic left-shift (strong, operating at all levels)
  + M-SSA can control smoothness (rate of zero-crossings).
    - Interestingly, M-SSA performs as well as M-MSE in terms of out-of-sample MSE forecast performances and/or left-shift.
    - Preference: everything being equal we prefer a smoother predictor
* **Explainability** part 2: why does **multivariate** filtering outperform?
  + BIP M-SSA component most important explanatory in WLS regression (on future BIP)
  + Multivariate filter (M-SSA and M-MSE) can exploit information of **all indicators** that are leading BIP (BIP is subject to publication lag) when computing M-SSA BIP component (for the WLS regression)
    - Univariate filtering (HP) does not improve performance over direct forecast (additional benchmark in tutorial 7.4)
    - Multivariate filter generates a **larger and more systematic left-shift** (advancement) by exploiting the **leading series** (cross-section)
      * Left-shift is stronger
      * Left-shift operates at **all levels**: not-only at zero-crossings (like univariate filter) but also at peaks and dips
      * The whole series is left-shifted (not only parts of it)
    - BIP forecast problem is more complex than just `filtering’
* **R-package** 
  + All the above points are addressed in full detail in tutorial 7.4: [wiaidp/R-package-SSA-Predictor](https://github.com/wiaidp/R-package-SSA-Predictor)
  + Can cut and paste results/plots directly from R-code