Predicting BIP and HP-BIP

Approach: generalization of classic direct forecast

Simple main idea**: use M-SSA filter outputs as regressors on future BIP** (instead of un-filtered indicators).

- Link to literature: abstract and introduction to paper.
    - List of alternative predictor designs (in applications)
    - Performance of direct forecast (or alternative designs)
        - Short term: nowcast, 1 quarter ahead
- Paper: 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)

- **Damp** 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: M-SSA**
    - Efficient real-time filtering (predictor) for tracking HP targets: **M-SSA components**
        - New optimization criterion: address MSE and smoothness
    - Outcome: increasing **left-shift** (advancement) of predictor as a function of the forecast horizon (track dips/peaks in a timely fashion).
- Tracking **BIP: WLS regression**
    - One additional optimization step
    - Rely on previous M-SSA components (or M-MSE components) as explanatory variables in regression on future BIP
        - **Left-shift** and **smoothness** of new regressors **facilitate regression**
        - Mitigate overfitting
        - Statistical significance (up to 4 quarters ahead plus publication lag, out-of-sample)
        - Smaller rRMSEs (out-of-sample)

    - Efficiency**: WLS** regression (weight inverse proportional to GARCH-vola)
- **Control smoothness**: rate of zero-crossings (above/below average growth `alarms')

Two different 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
- Motivation: **outperformance at longer forecast horizons** h>=2
    - Link to earlier work (short term: horizons h=0,1?)
    - Benchmarks (see tutorial 7.4):
        - Mean of BIP (expanding window)
        - Direct forecasts
            - Based on ESI, ifo: best combination out-of-sample (plausible?)
            - Based on expanding window, starting in 2007.
            - rRMSE 86% at h=0 (nowcast) and 91% at h=1, without Pandemic (plausible?). Publication lag=2.
        - Direct HP-C forecast
            - Apply univariate concurrent HP to indicators and regress on BIP
            - Performances remarkably similar to direct forecasts (univariate filtering does not work when predicting BIP at h>=1)
        - M-SSA predictor (equal weighting, tutorial 7.3)
            - Outperformed by new M-SSA-C specifically at larger forecast horizons (h>=2)
        - M-MSE component predictor:
            - Does not control smoothness (rate of zero-crossings)

        - Has similar rRMSE (as M-SSA-C) but is noisier: roughly double as many zero-crossings
    - Out-of-sample span for evaluation: starts in 2007; expanding window; includes financial crisis as well as Pandemic.
- **Explainability** part 1: why does new M-SSA-C predictor outperform at **longer** forecast horizons (h>=2)?
    - Outperformance out-of-sample is linked to increasing **left-shift** of predictor (as h increases)
        - MSE is mainly determined by tracking peaks/dips timely: left-shift is crucial.
    - Classic benchmarks (mean, direct forecast) do not generate an explicit left-shift of the corresponding predictors
        - See plots, tutorial 7.4
    - Univariate filters (HP-C) generate a weak unsystematic left-shift (works mainly at zero-crossings but peaks/dips remain more or less unaffected).
- **Explainability** part 2: why does **multivariate** filtering outperform?
    - BIP M-SSA component is the single most important explanatory variable in WLS regression on future BIP (intuitively appealing).
    - Multivariate filter can exploit information of **all indicators** that are leading BIP (BIP is subject to publication lag) when computing BIP M-SSA component.
        - 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)
    - In contrast, univariate filtering does not improve performance over direct forecast (additional benchmark in tutorial 7.4)
        - BIP forecast problem is more complex than just `filtering'
- Summary explainability:
    - BIP M-SSA is the single most important explanatory variable (for regression on future BIP).
    - Multivariate filter is particularly efficient when targeting HP-BIP (exploit leading series).
        - Multivariate filter has no advantage when targeting HP-spread, see tutorial 7.4 (in part because all other explanatory variables are lagging).

- **R-package**
    - All the above points are addressed and detaild in tutorial 7.4: [wiaidp/R-package-SSA-Predictor]
    - Can generate (and cut/paste) results or plots directly from R-code.