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An integrated approach for the estimation of the Italian output gap

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Introduction and motivation

- ✓ PO and OG determines the cyclical position of the economy and the implications for the fiscal surveillance process within the scope of the Stability and Growth Pact.
- ✓ These variables are not observable, and their estimation is characterised by considerable uncertainty: that used by the European Commission (EC) provides measures that have diverged substantially from those produced by other international organisations (OECD and IMF), especially in recent years.
- ✓ There is considerable variability not only among the various approaches but also within the same method depending on the vintage of the estimates.

Real time uncertainty

Estimates of potential output are often revised, causing sub-optimality of the policies in real-time. The instability is due to various factors:

- Backward: data revisions may have an impact on the whole time series of potential and output gap.
- Current: the end of sample bias of statistical filters affects the real time measures for the actual values for potential output.
- Future: the end of sample bias may be mitigated considering also macroeconomic forecasts, but this comes at the cost of an additional source of uncertainty.

The EU framework: the model

- Since 2002 the "official" estimates of the output gap (OG) for the EU countries are produced with a Commonly Agreed Methodology (CAM, approved by the ECOFIN); the methodology is continuously revised by the EPC-OGWG.
- The PO is based on the production function, where all the main components (except K) are decomposed between the trend and the cycle component.
- Each component (L, K and TFP) is estimated separately with different techniques: HP filter, bivariate Kalman filter, Bayesian Kalman filter.
- The model has been criticized because the potential growth is procyclical, unstable in real time and strongly affected by a priori and initial conditions.

New models for the output gap at UPB

- ✓ In a research project developed with Tommaso Proietti, we have investigated several (almost all) methods developed in the literature: purely statistical, based on the economic theory and hybrid models.
- ✓ However none of them prevails: each one has its own advantages, in terms of statistical properties, stability of the estimates or economic interpretation.
- ✓ In conclusion we have chosen an integrated approach that uses and summarizes all the results coming from the different techniques and econometric specifications.
- ✓ This allows to construct a synthetic measure of PO and OG but also some plausibility bands that are particularly useful in the process of fiscal surveillance.

Selected Models

We have selected five models, looking at their statistical and economic properties:

1. Bivariate model with inflation and output;
2. Bivariate model with inflation and output with shock in the cycle in 2009;
3. Trivariate model with inflation, output and unemployment;
4. Multivariate model in the framework of the production function approach;
5. Statistical filter, calibrated on the features of model 1.

Bivariate model with inflation and output

$$
\begin{aligned}
y_t &= \mu_t + \psi_t, && && t = 1, \ldots, n, \\
\mu_t &= \mu_{t-1} + \beta_{t-1} + \eta_t, && \texttt{trend: LLT} && \eta_t \sim \text{IID} N(0, \sigma^2_\eta), \\
\beta_t &= \beta_{t-1} + \zeta_t, && && \zeta_t \sim \text{IID} N(0, \sigma^2_\zeta), \\
\psi_t &= \phi_1 \psi_{t-1} + \phi_2 \psi_{t-2} + \kappa_t, && \texttt{cycle:AR(2)} && \kappa_t \sim \text{IID} N(0, \sigma^2_\kappa), \\
\pi_t &= \gamma_e \pi^e_t + \pi^*_t + \theta_0 \psi_t + \theta_1 \psi_{t-1} + \textstyle\sum_{k=1}^{K} \beta_k x_{kt} + \varepsilon_{\pi t}, && && \varepsilon_{\pi t} \sim \text{IID } N(0, \sigma^2_{\varepsilon\pi}), \\
\pi^*_t &= \pi^*_{t-1} + \eta_{\pi t} && \texttt{Phillips curve} && \eta_{\pi t} \sim \text{IID } N(0, \sigma^2_{\eta\pi}),
\end{aligned}
$$

We have investigated different specification for the trend following Frale and De Nardis (2018).

Bivariate model with shock in 2009

The bivariate model shows an outlier in 2009 in occasion of the deep recent recession. To pick up the special feature of the business cycle in this occasion we allow the bivariate model to include a shock:

- in the level of the trend (μ_t)
- in the growth rate of the trend (β_t)
- in the cycle (ψ_t)

Results in terms of Likelihood are very similar, but we recognize a better economic interpretation for the model with the shock in the cycle. Therefore we include this model in the suite of selected techniques, by adding an intervention variable in the specification of the cycle such as: $\psi_t = \phi_1 \psi_{t-1} + \phi_2 \psi_{t-2} + \kappa_t + \lambda I(t = \tau)$, con $\tau = 2009$.

Trivariate model: inflation, output and unemployment

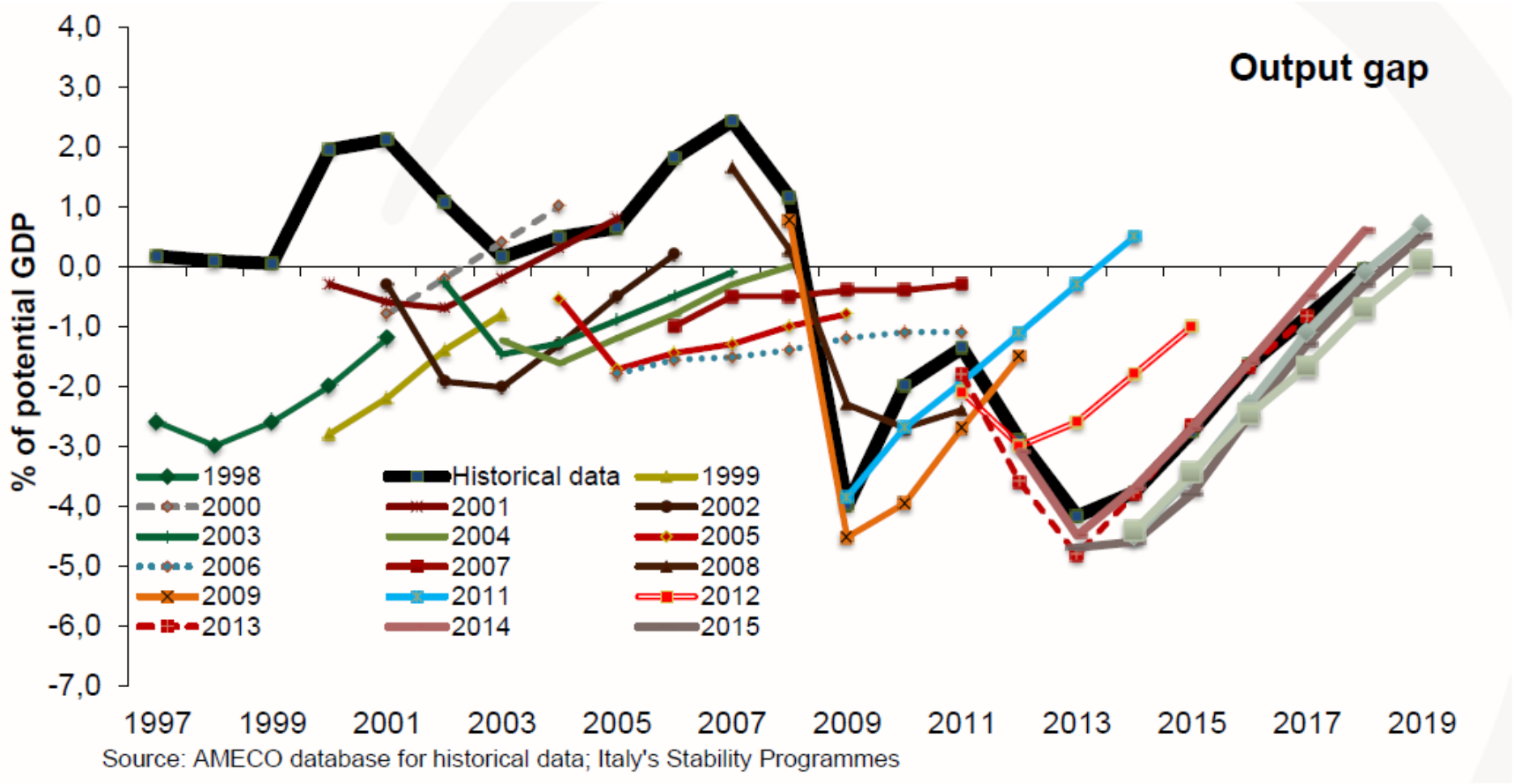
The bivariate model completely neglect the labour market. We thus extend it by adding the Okun(1962) law, that postulates a relation between output gap and unemployment gap. The trivariate model is obtained by adding an equation for Unemployment rate (U_t) to the basic structure of the bivariate model. We allow for a more general formulation than the strict proportionality:

$$
\begin{aligned}
U_t &= \mu_{ut} + \psi_{ut}, && t = 1, \ldots, n, \\
\mu_{ut} &= \mu_{u,t-1} + \beta_{u,t-1} + \eta_{ut}, && \eta_{ut} \sim \text{IID}N(0, \sigma^2_{\eta u}), \\
\beta_{ut} &= \beta_{u,t-1} + \zeta_{ut}, && \zeta_{ut} \sim \text{IID}N(0, \sigma^2_{\zeta u}), \\
\psi_{ut} &= \phi_u \psi_{u,t-1} + \delta_0 \psi_t + \delta_1 \psi_{t-1} + \kappa_{ut}, && \kappa_{ut} \sim \text{IID}N(0, \sigma^2_{\kappa u}),
\end{aligned}
$$

unemployment gap output gap

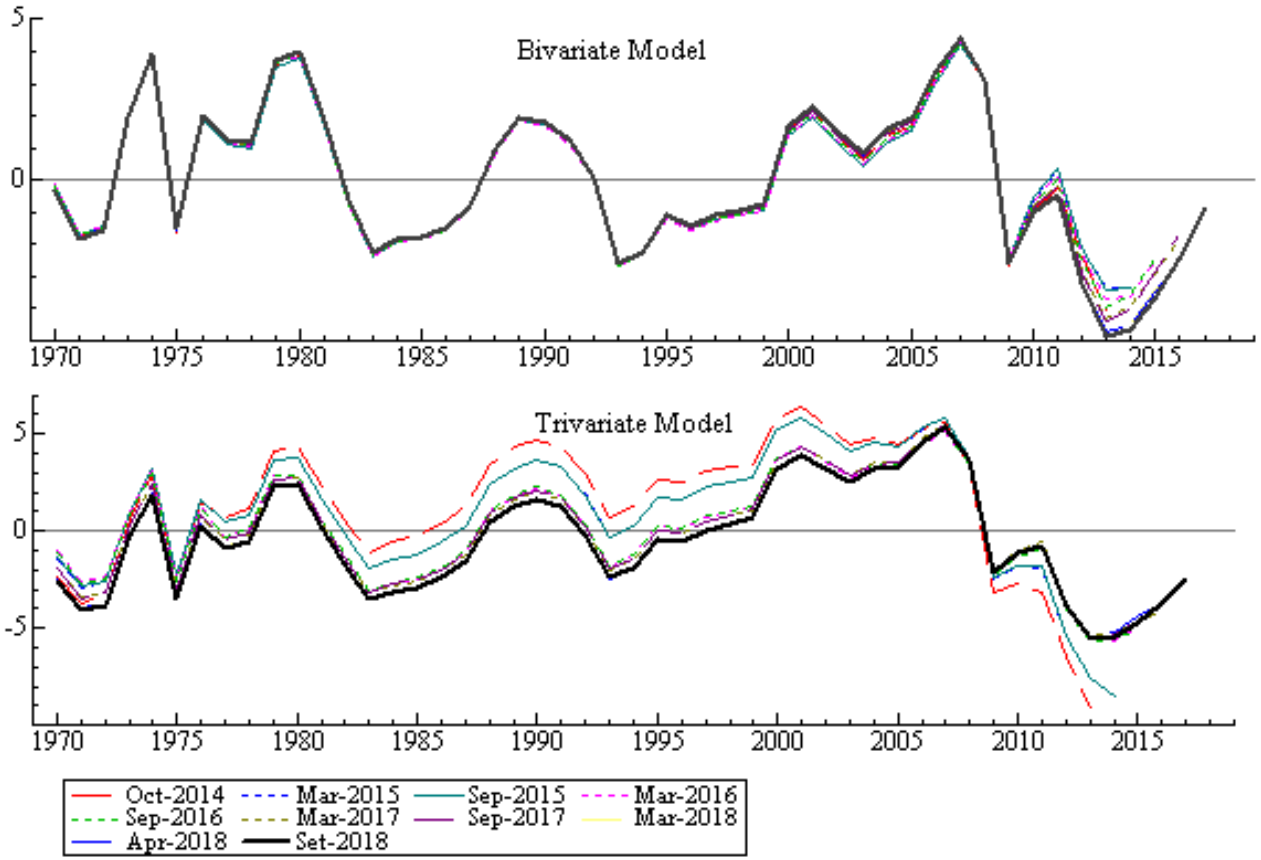
OG revisions with CAM

Estimates of OG with the EC model are generally revised (sometimes substantially) when new observations are added. This is not desirable in the framework of fiscal surveillance.



Estimation in real time

We analyse the revisions of our models running a real time experiment.



Results show that the bivariate model is more stable than the trivariate (adding UR augment the volatility).

Multivariate integrated model

We propose also a multivariate model in the framework of the production function approach, where all components (labour, capital and TFP) are estimated simultaneously and efficiently (exploiting the cross correlation among variables), as proposed by Proietti, Musso and Westerman (2007). In this framework the trend and cycle of the output are obtained as combination of the analogues extracted from L, K and TFP:

$$y_t = f_t + \alpha l_t + (1-\alpha)k_t = \mu_t + \psi_t$$

$$\begin{aligned} \mu_t &= \mu_{ft} + \alpha(\mu_{ht} + \mu_{at} + \mu_{et} + p_t) + (1-\alpha)k_t && \texttt{trend} \\ \psi_t &= \psi_{ft} + \alpha(\psi_{ht} + \psi_{at} + \psi_{et}) && \texttt{cycle} \end{aligned}$$

Thus the usual state space form is derived.

Multivariate integrated model

Given $Y_t = (f_t, a_t, h_t, e_t, c_t)'$, where f_t is the Solow residual, a_t the participation rate, h_t hours worked per capita, e_t the employment rate and c_t is the CUBS, and given $\mu_t = (\mu_{ft}, \mu_{ht}, \mu_{at}, \mu_{et})'$, $\psi_t = (\psi_{ft}, \psi_{ht}, \psi_{at}, \psi_{et})'$, $\psi_t = \gamma' \psi_t$, $\gamma = (1, \alpha, \alpha, \alpha)'$ we have:

$$
\begin{aligned}
Y_t &= \mu_t + \psi_t && t = 1, \ldots, n, \\
\mu_t &= \mu_{t-1} + \beta_{t-1} && \\
\beta_t &= \beta_{t-1} + \zeta_t && \zeta_t \sim \text{IID} N(0, \Sigma_\zeta) \\
\psi_t &= \phi_1 \psi_{t-1} + \phi_2 \psi_{t-2} + \kappa_t && \kappa_t \sim \text{IID} N(0, \Sigma_\kappa), \\
c_t &= \theta_c \psi_{ft} + \varepsilon_{ct} && \varepsilon_{ct} \sim \text{IID } N(0, \sigma^2_{\varepsilon c}), \\
\pi_t &= \gamma_e \pi^e_t + \pi^*_t + \theta_0 \psi_t + \theta_1 \psi_{t-1} + \textstyle\sum_{k=1}^{K} \beta_k x_{kt} + \varepsilon_{\pi t}, && \varepsilon_{\pi t} \sim \text{IID } N(0, \sigma^2_{\varepsilon \pi}), \\
\pi^*_t &= \pi^*_{t-1} + \eta_{\pi t} && \eta_{\pi t} \sim \text{IID } N(0, \sigma^2_{\eta \pi}),
\end{aligned}
$$

TFP cycle: CUBS

Σ_ζ is diagonal, whereas Σ_κ is full. The multivariate cycle has scalar coefficients that are the same of the OG. The CUBS indicator is a combination of survey data on capacity utilization, and business confidence, as done by EC.

Statistical filter

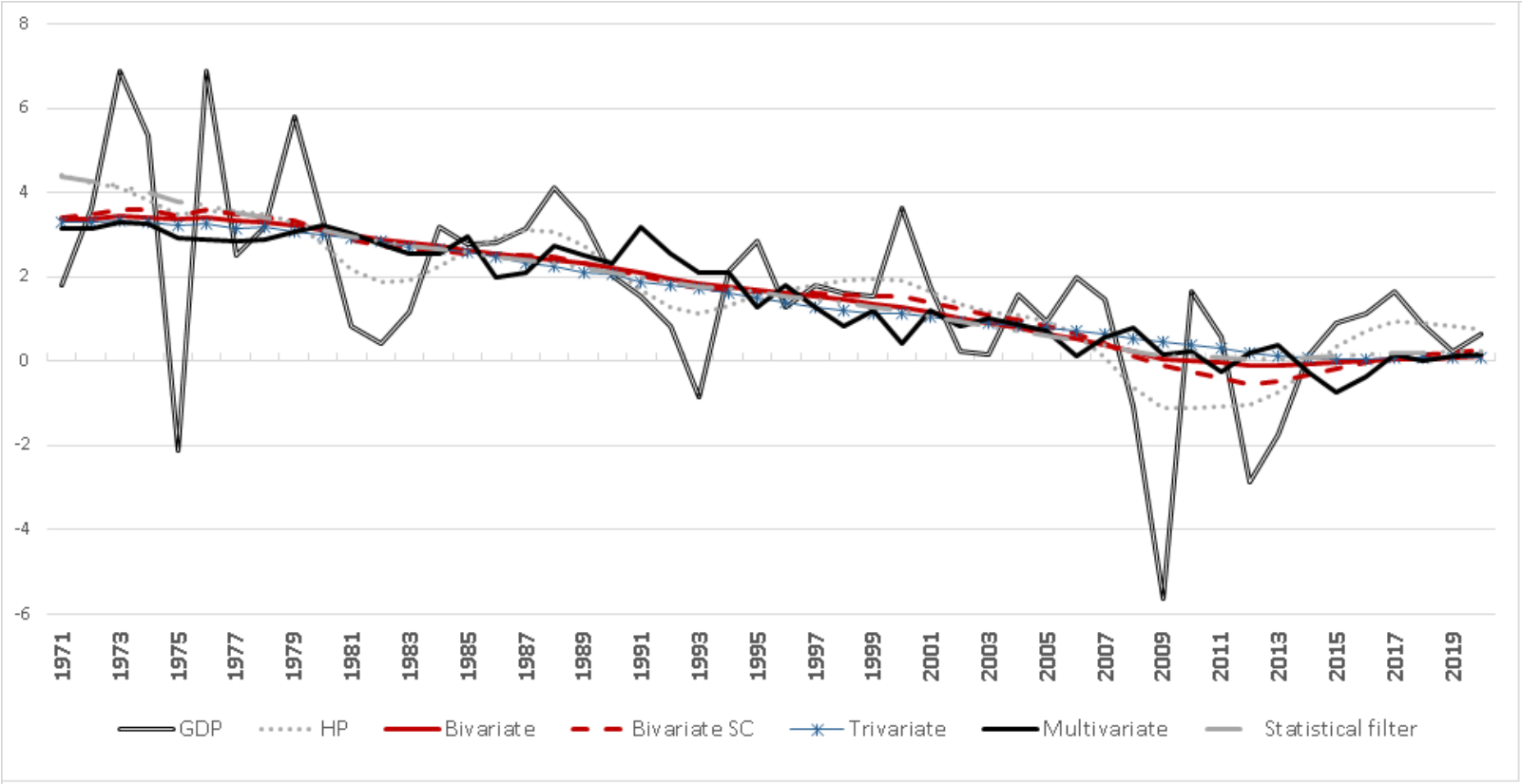
- Starting from the production function $y_t = f_t + \alpha l_t + (1-\alpha)k_t$ a simpler way to compute potential output is applying a statistical filter to each variable for extracting their trend components.
- The Hodrick and Prescott (1997) filter is the most used in this literature. HP is simple, but completely predefined and affected by the end of point bias.
- We use a specific filter, similar to HP, but set in order to mimic the behave of the cycle component of the GDP, as derived from the bivariate model presented before (which appears to be quite stable in real time).
- This is easily accomplish by using a standard (LLT) model trend+cycle for GDP with the following restrictions:

$$\sigma_\eta^2 = 0, \sigma_\xi^2 = 0.0168, \sigma_\kappa^2, \rho = 0.56, \lambda_c = 0.04,$$

where ρ is the damping factor and λ_c the cycle frequency.

Results

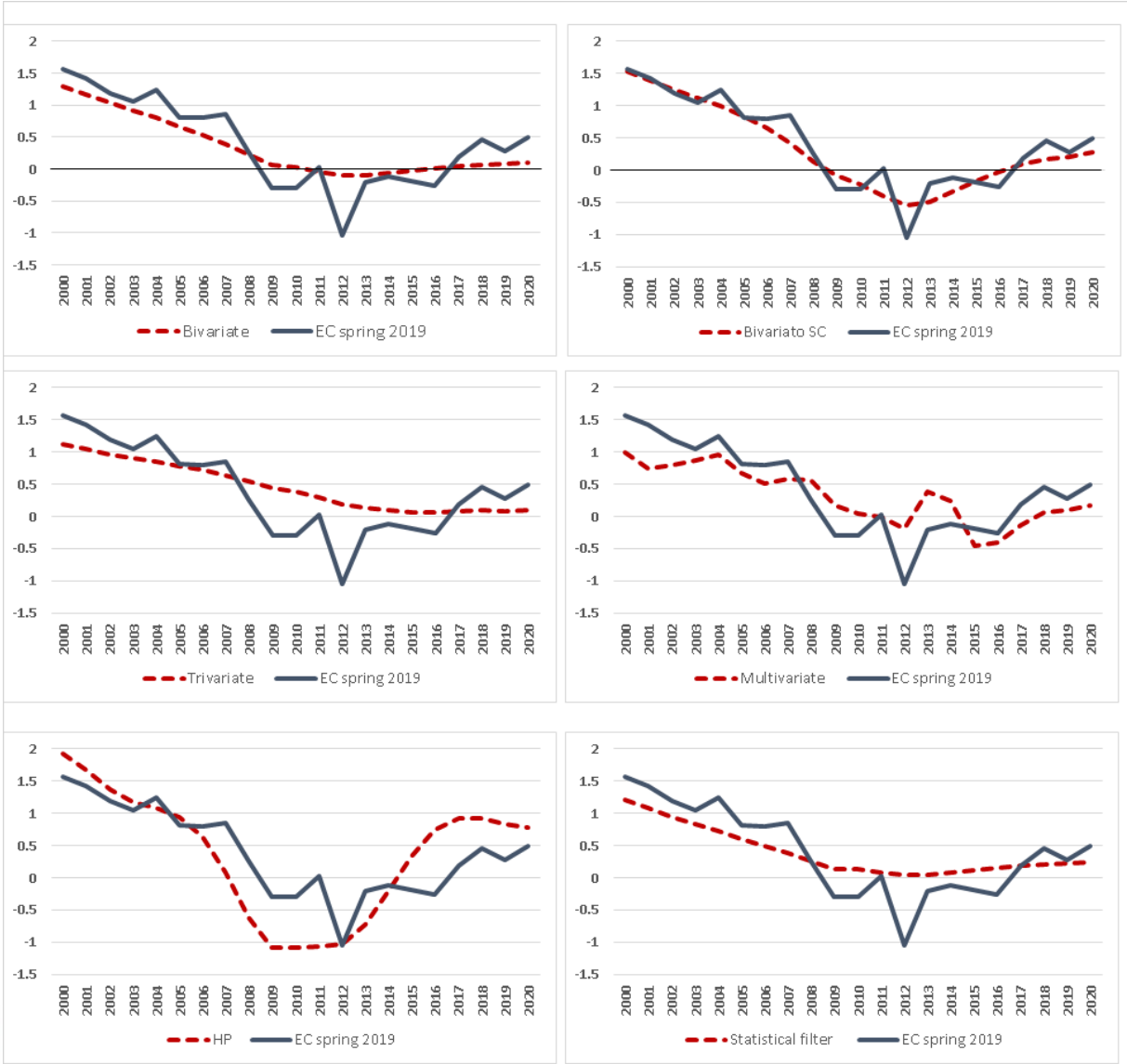
Figure: Potential output in the 5 models and GDP



There is a clear downside trend in potential output in all models, which is coherent with weak GDP growth.

Results: Potential output

Figure: Potential output in the 5 models and in EC spring 2019 forecast

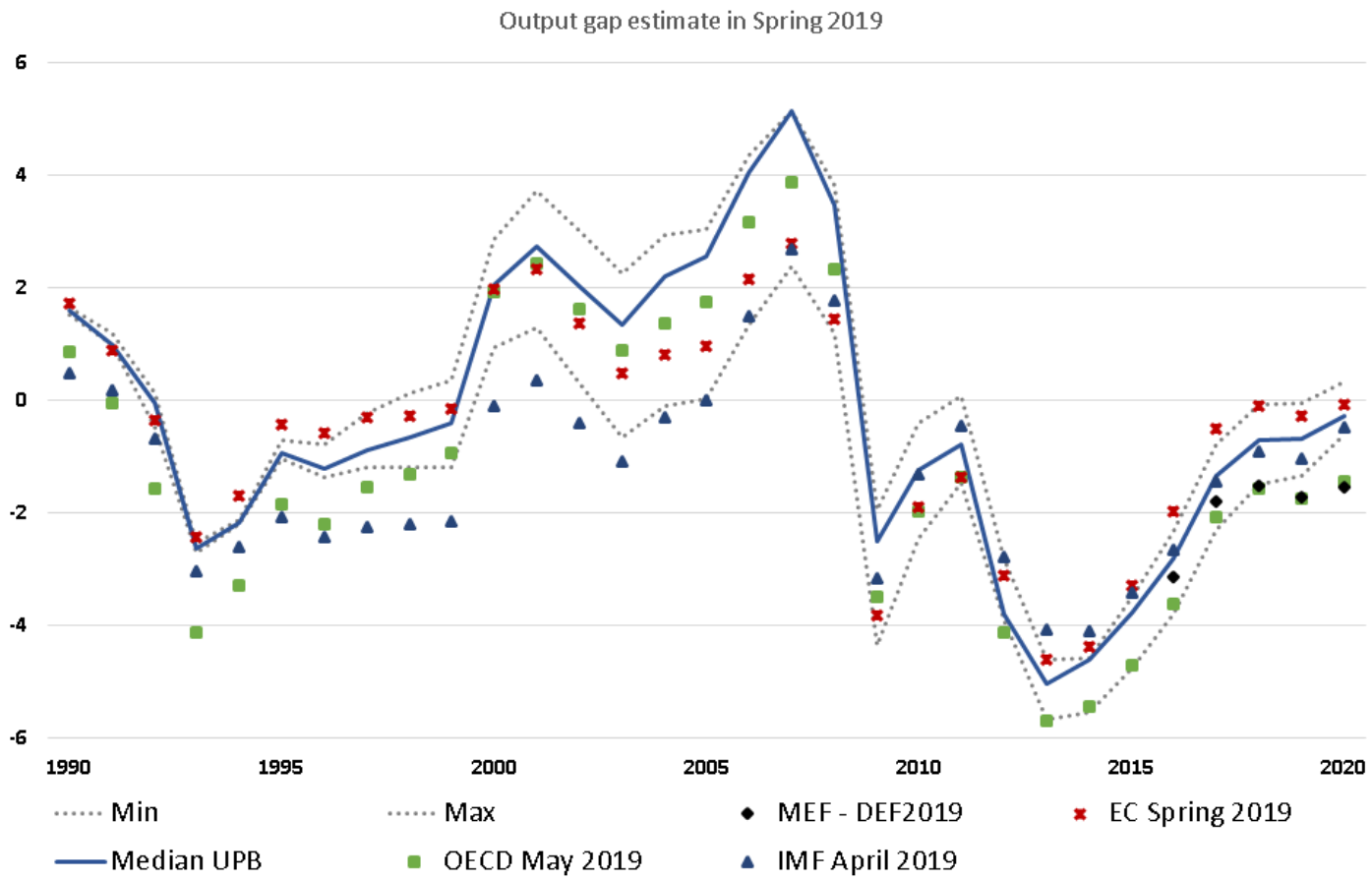


Results: Potential output

- ✓ The bivariate model with the shock estimates a stronger reduction in potential output during the last big recession but it appears more volatile that the simple bivariate as it provides a stronger rebound in recent years.
- ✓ The Trivariate model produces a smoother potential: part of the downturn in the recession period is assigned to the unemployment gap. In current years a relevant part of the unemployment is still considered temporary and thus the output gap results smaller than the same computed by the bivariate model.
- ✓ Results from the multivariate model are the most volatile as trend components appears quite smooth. After 2015 the potential growth is limited due to capacity utilization index pattern.
- ✓ The statistical filter produces intermediate results from the trivariate and bivariate models.
- ✓ In general results from all models are less volatile than those from HP filter.

UPB procedure

- UPB uses the 5 models along with the EC methodology and HP filter in order to evaluate the plausibility of Government estimates; the models are combined in order to derive a synthetic measure but also a plausibility band.
- The 5 models are integrated with the other tools used at UPB for the validation: macroeconomic forecasts are used as input to compute the future values of potential output up to 3 years ahead.



Results: OG

- ✓ We compare our OG estimates computed in Spring 2019 with those produced by the Government and EC. The macroeconomic framework is quite similar: GDP is foreseen to increase very modestly by all Institutions, especially in 2019 (around 0,1/0,2 per cent).
- ✓ The median OG by UPB models is quite close to the measure provided by EC: turning points are almost coincident. Tough potential output estimated by UPB is less procyclical and the resulting OG more volatile.
- ✓ EC estimates are almost always contained in the range between maximum and minimum of UPB models.
- ✓ Also Government estimates are inside the plausibility band, but only up to 2019, while afterwards they appear to be smaller (wider negative OG) than those produced by UPB.

Summary and conclusion

- ✓ We develop new models for the potential output and the output gap of the Italian economy, that encompass different, economic and statistical approaches.
- ✓ The models are relatively robust to data revision in real time and do not depend to initial conditions.
- ✓ We construct uncertainty measures based on the heterogeneity of the estimates across models.
- ✓ The current and expected output gap of the new models is between the estimates of the EC and the MEF up to this year and more oriented toward the EC values for 2020.

Thank you for attention!