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MINISTERO DELL'ECONOMIA E DELLE FINANZE  
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# A quarterly measure of Potential output in the new European Fiscal Framework

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# Introduction

- ❑ The new EU fiscal framework gives a prominent role to the **Cyclically-adjusted budget balance**, that is, the fiscal position net of cyclical conditions and one-off and other temporary measures.
- ❑ The estimation of the cyclical component requires two inputs:
  - ❑ a measure of the **cyclical position** of the economy expressed in terms of output gap(OG), the distance between actual and potential output (PO)
  - ❑ a measure of the link between the cycle and the components of the budget (summarised by **elasticity parameters**).
- ❑ The monitoring of fiscal developments is based on a timely estimates of fiscal variables in structural terms.
- ❑ The Commission procedure currently used to compute PO and OG can be extended to produce more robust and timely estimation, which are more suitable in the new fiscal framework.

# Motivation

To this aim we propose a new methodology that:

- ✓ Uses **mixed frequency** to combine timely statistical information available at the quarterly frequency and historical annual data by using a multivariate dynamic factor model in mixed frequency.
- ✓ Is **multivariate** and thus allows to estimate the contribution of each factor to the potential growth (the current method is, in many cases, univariate).
- ✓ Reduces **measurement error** in the estimated parameters.
- ✓ Controls for the effect of **input projections** as quarterly figures can be easily bounded to annual series (such as EU Commission forecast or EUROPOP demographic projections).
- ✓ Reduced the effect of **data revisions**.

# Outline of the presentation

- ❑ The new fiscal framework
- ❑ The EC production function approach for the estimation of output gaps
- ❑ Improving the Production function approach by the EC:
  - ✓ mixed frequency models with annual and quarterly data.
  - ✓ a multivariate approach for the Labour component.
- ❑ Sensitivity analysis:
  - ✓ The effect of input forecasts.
  - ✓ The impact of revisions in the data.



# The new fiscal framework

- ❑ After the crisis the SGP was strengthened. At the core of the preventive arm is the **country-specific medium-term objective (MTO)** which is a structural budgetary position mostly close to balance that should be achieved and maintained over the cycle in order to assure the sustainability of public finances.
- ❑ **Six Pack** has also introduced an **expenditure rule** and a **debt rule** which require somehow the use of figures that are cyclically-adjusted.
- ❑ With a view to transposing EU regulations, the balanced budget rule has been introduced in the national legal requirement at Constitutional level.
- ❑ Art. 3 and 7 of Law 243/2012, implementing the **amendment of art. 81 of the Constitution**, i) mention that public finances are in equilibrium when at MTO, ii) define how to monitor fiscal performance, iii) introduces a correction mechanism in case of deviation from fiscal target, iv) allows to deviate from the MTO in exceptional events.

## ... Still on-going

The so called **Two Pack** introduces, among other things:

- ☐ common provisions for monitoring and assessing **draft budgetary plans** and ensuring the correction of excessive deficit of the Member States in the euro area;
- ☐ a common budgetary timeline and common budgetary rules;
- ☐ **independent bodies** to monitor compliance with national fiscal rules and evaluate the soundness of national budgetary processes.

Law 243/2012 has already established the Parliamentary Budget Office, which will take part in the budgetary process through their own forecasts or endorsement.



# The Medium term budgetary objective (MTO)

MTO is a country-specific indicator defined in cyclically adjusted terms, net of one-off and other temporary measures. MTOs derivation must take into account of three components:

- ☐ The debt-stabilising balance for a debt ratio equal to the (60% of GDP) reference value (dependent on long-term potential growth), implying room for budgetary manoeuvre for member States with relatively low debt;
- ☐ A supplementary debt reduction for Member State with a debt ratio (60% of GDP) in excess of the reference value, implying rapid progress towards it;
- ☐ A fraction of the adjustment needed to cover the present value of the future increase in age-related government expenditure.

# Path to the MTO and expenditure rule

- ❑ According to the current legislation, Member States far away from the MTO should converge toward it by reducing the structural deficit by 0.5 pp per year.
- ❑ After the crisis, this mechanism has been reinforced through the introduction of an expenditure rule. If at MTO, expenditure cannot grow in real terms more than the medium term rate of potential output. If not at MTO, expenditures should grow less.
- ❑ The presumption is to use the unexpected extra revenues windfalls for deficit and debt reduction while keeping expenditure on a stable sustainable path over the cycle.
- ❑ The reference medium-term rate of potential GDP growth is determined on the basis of the EC methodology on forward-looking mechanical projections and backward-looking estimates spanning 10y.



# The debt rule

- ❑ if government debt ratio is above the reference value of 60% of GDP it should be reduced at a rate of 1/20 of the distance from that reference value as average of the previous 3 years

$$b_t > bb_t = 60\% + 0.95/3 (b_{t-1} - 60\%) + 0.95^2/3 (b_{t-2} - 60\%) + 0.95^3/3 (b_{t-3} - 60\%)$$

where  $bb_t$  stands for the backward-looking benchmark debt ratio in year  $t$  and  $b_t$  stands for the debt-to-GDP ratio in year  $t$ ;

- ❑ But also

$$b_{t+2} > bb_{t+2} = 60\% + 0.95/3 (b_{t+1} - 60\%) + 0.95^2/3 (b_t - 60\%) + 0.95^3/3 (b_{t-1} - 60\%)$$

where  $bb_{t+2}$  stands for the forward-looking benchmark debt ratio,  $b_{t+1}$  and  $b_{t+2}$  stand for the debt forecast in year  $t+1$  and  $t+2$  as estimated by the Commission under the 'no-policy-change' assumption on the basis of the fiscal outcome of year  $t$ ;

- ❑ **And the breach of the benchmark cannot be attributed to the influence of the cycle.**



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# Estimation of Output gaps

- ❑ The OG is the discrepancy between the level of **current** real GDP and its **potential** (in percentual of this one). To estimate potential output, a production function approach (commonly agreed at EU level) is adopted:

$$Y_t = L_t^\alpha \cdot K_t^{1-\alpha} \cdot TFP_t$$

- ❑ GDP is represented as a **Cobb-Douglas-type production function** with constant returns to scale on capital (K) and labour (L)
- ❑ TFP is the total factor productivity, i.e. the contribution of technical progress to economic growth.
- ❑  $\alpha$  is the output elasticity with respect to labour. Given constant returns to scale and perfect competition, is coincident to the wage share.
- ❑ Potential output is obtained by replacing in the production function, an estimate of K, L and TFP corresponding to their full or potential utilisation.

# Estimation of Potential Output by the EC

$$Y_t = L_t^\alpha \cdot K_t^{(1-\alpha)} \cdot TFP_t \quad \text{Output}$$

$$\bar{Y}_t = \bar{L}_t^\alpha \cdot \bar{K}_t^{(1-\alpha)} \cdot \bar{TFP}_t \quad \text{Potential Output}$$

$$1. \quad \bar{L}_t = PARTS_t * POPW_t * HOURST_t * (1 - NAWRU_t)$$

$$2. \quad \bar{K}_t = K_t = K_{t-1} * (1 - dep_t) + INV_t$$

$$3. \quad \begin{cases} SR_t = \bar{TFP}_t + C_t \\ CUBS_t = \mu + \beta C_t + \varepsilon_t \end{cases} \quad SR_t = \frac{Y_t}{L_t^\alpha \cdot K_t^{(1-\alpha)}}$$



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# Estimation of Output gaps – Labour contribution to potential

- The estimate of potential labour (LP) is achieved by smoothing a set of exogenous variables over the historical sample and over a medium-term extension period (usually 6y = a short-term forecast horizon + 3 year of technical extrapolation so as to minimize the end-point-bias).

$$LP_t = PARTS_t * POPW_t * HOURST_t * (1 - NAWRU_t)$$

- PARTS is the **trend** component of the **unadjusted participation rate** obtained by Hodrick-Prescott (HP) filter.
- POPW is the **working-age population**, extrapolated out of the sample period using the Eurostat 2010 long range population projections.
- HOURST is the **trend of average hours worked** per employee and it is smoothed using an ARIMA process.
- NAWRU is the **non-accelerating wage rate of unemployment**.



# Estimation of Output gaps – NAWRU specification

- ❑ NAWRU is derived by applying an unobserved component model estimated by a Kalman filter.
- ❑ The observed **unemployment** series is decomposed into a trend and a cyclical component.
- ❑ The **trend** component is modelled as a random walk with drift (the drift term itself follows a random walk). The **cyclical** component is obtained via a **Phillips curve** which regresses the change in **wage inflation** on **cyclical unemployment** as well as on other exogenous variables (labour productivity, terms of trade and wage share). In the out of sample extrapolation, the NAWRU is extended over the forecast period by a mechanical rule which allows stabilising it after a period of 3 years.



# Estimation of Output gaps – Capital contribution to potential

- ❑ Potential capital stock, measured by the perpetual inventory method, corresponds to its actual value
- ❑ The full utilisation of the existing stock is assumed.
- ❑ The capital is extrapolated in the out-of-sample period according to a given profile of productive investment (estimated through an AR(2) process) and assuming a constant depreciation rate.



# Estimation of Output gaps – TFP specification

- Technical progress (TFP) is assumed to be propagated in a neutral way through qualitative improvements both in labour and capital inputs.

$$TFP_t = (E_L^\alpha E_K^{1-\alpha})(U_L^\alpha U_K^{1-\alpha})$$

- TFP sums up both the level of efficiency of labour and capital inputs and their degree of utilisation.

# Estimation of Output gaps – TFP contribution to potential

- ❑ The long-run component of TFP is obtained through a a bivariate Kalman Filter (KF) model which exploits the link between the **TFP cycle** and the degree of **capacity utilisation** in the economy.
- ❑ Its basic structure is similar to the Phillips-curve augmented unobserved component model proposed by Kuttner (1994) for estimating potential output and output gaps in the US.
- ❑ Capacity utilization is measured using two indicators: the Capacity Utilization Indicator (CUI), which is available for manufacturing only, and the Business Survey Capacity Indicator (BS) collected for manufacturing, construction and services as part of the **European Commission's Business and Consumer Survey Programme**.
- ❑ TFP can be obtained by applying either a Maximum Likelihood or Bayesian (default model) estimation techniques to the bivariate model in state-space specification given by the **Solow Residual** (SR) and the series of **Capacity utilisation**.



# Weaknesses of the EC methodology

- ❑ The OG Production Function approach uses **annual** observation and **univariate extrapolation** procedures.
- ❑ Annual frequency is not optimal to: i) efficiently use recent information; ii) capture cyclical swings.
- ❑ Extrapolation procedures: i) not a uniform approach; ii) often univariate models are used (especially for the estimation of the potential Labour) iii) and extrapolation procedure are used to produce out of sample forecasts (by splicing one series to an other).
- ❑ Estimates are strongly affected by **two sources of variability**: input forecasts and revision in official data.



# Innovation 1: The mixed frequencies approach

- ❑ The mixed frequency approach allows to combine historical annual data available since 1960 with **recent information** released at the quarterly frequency.
- ❑ We use a **multivariate** model so that components (e.g.) of the potential Labour (such as Hours worked, participation rate and unemployment) are estimated simultaneously which is a suitable feature especially for out of sample forecasts.
- ❑ The Kalman filter produces directly out of sample forecasts **avoiding** to make **univariate extrapolations** for each components

# The Mixed frequency model

The basic framework is a Stock and Watson dynamic factor model cast in mixed frequency. We refer to the Monthly Indicator of the economic activity in the Euro Area EuroMIND, developed by Eurostat and documented in Frale et al.(JRSS-A 2010). The idea is that each variable can be decomposed into a common factor and an idiosyncratic component, both following AR process.

$$\begin{aligned} \begin{bmatrix} \mathbf{x}_t \\ y_t \end{bmatrix} &= \vartheta_0 f_t + \vartheta_1 f_{t-1} + \boldsymbol{\gamma}_t + \mathbf{S}_t \boldsymbol{\beta}, & t = 1, \dots, n \\ \phi(L) \Delta f_t &= \eta_t & \eta_t \sim \text{NID}(0, \sigma_\eta^2) \\ \mathbf{D}(L) \Delta \boldsymbol{\gamma}_t &= \boldsymbol{\delta} + \boldsymbol{\xi}_t, & \boldsymbol{\xi}_t \sim \text{NID}(\mathbf{0}, \boldsymbol{\Sigma}_\xi), \end{aligned}$$

$\phi(L)$  is an autoregressive polynomials of order  $p$  with stationary roots

The matrix polynomial  $\mathbf{D}(L)$  is diagonal and  $\boldsymbol{\Sigma}_\xi = \text{diag}(\sigma_1^2, \dots, \sigma_N^2)$ .

The disturbances  $\eta_t$  and  $\xi_t$  are mutually uncorrelated at all leads and lags.

$\mathbf{S}$  is a matrix containing intervention variables, such as outliers, calendar effects...



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# Estimation and time aggregation

- ❑ The model involves mixed frequency data, e.g. quarterly indicators and annual data. Following Harvey (1989) and Proietti(2006), the state vector in the State-Space Form is suitably augmented by using an appropriately defined cumulator variable in order to translate the time constraint into a problem of missing observations.
- ❑ The model is cast in State Space Form and, under Gaussian distribution of the errors, the unknown parameters can be estimated by maximum likelihood, using the prediction error decomposition, performed by the Kalman filter.
- ❑ Filter and Smoother are based on the Univariate statistical treatment of multivariate models by Koopman and Durbin (2000): very flexible and convenient device for handling missing values in multivariate models and reduce the time of convergence.



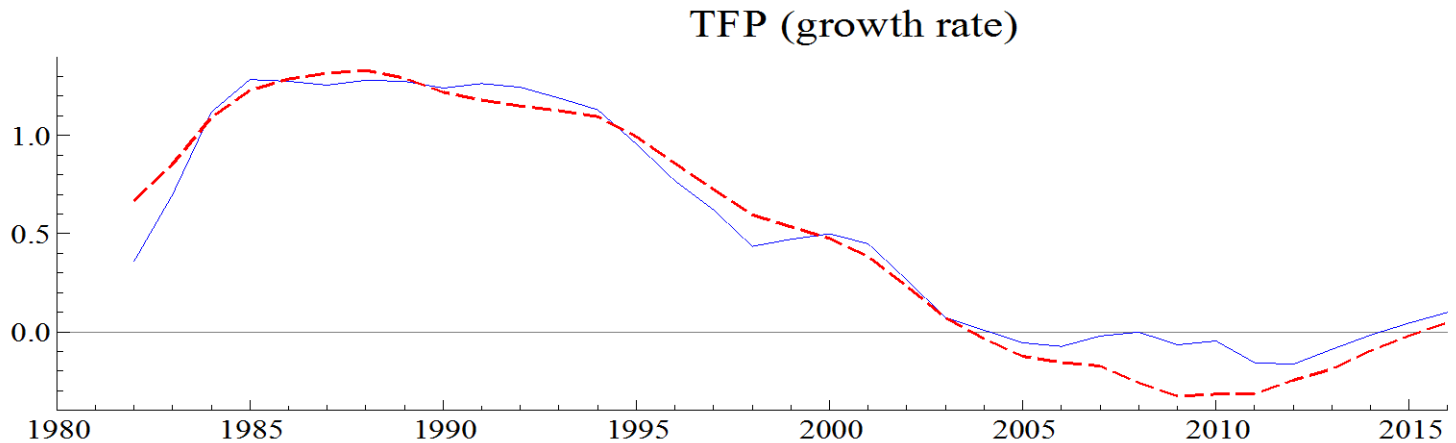
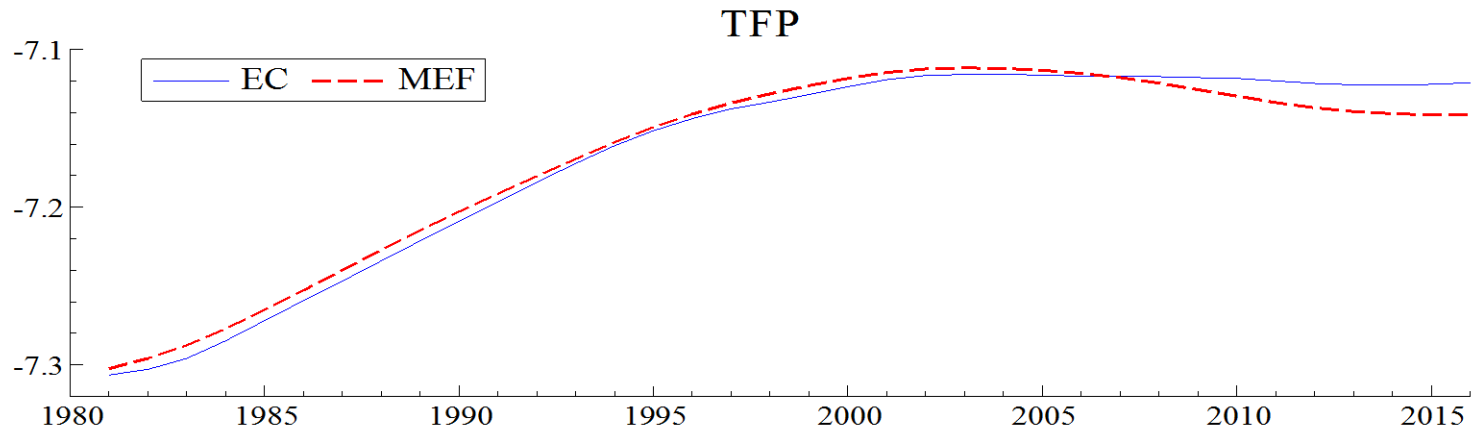
## Innovation2: A multivariate approach in mixed frequency for Potential Labour

- Recall that potential labour is calculated by

$$\bar{L}_t = PARTS_t * POPW_t * HOURST_t * (1 - NAWRU_t)$$

- Unchanged NAWRU (but we come back on it)
- We construct a multivariate model by using annual Employment, Unemployment rate, Working Age Population (POPW) and Hours Worked (HOURST)
- The model is augmented using quarterly Participation rates (PARTS) and hours worked (HOURST), so that annual data are disaggregated and updated by using quarterly values.

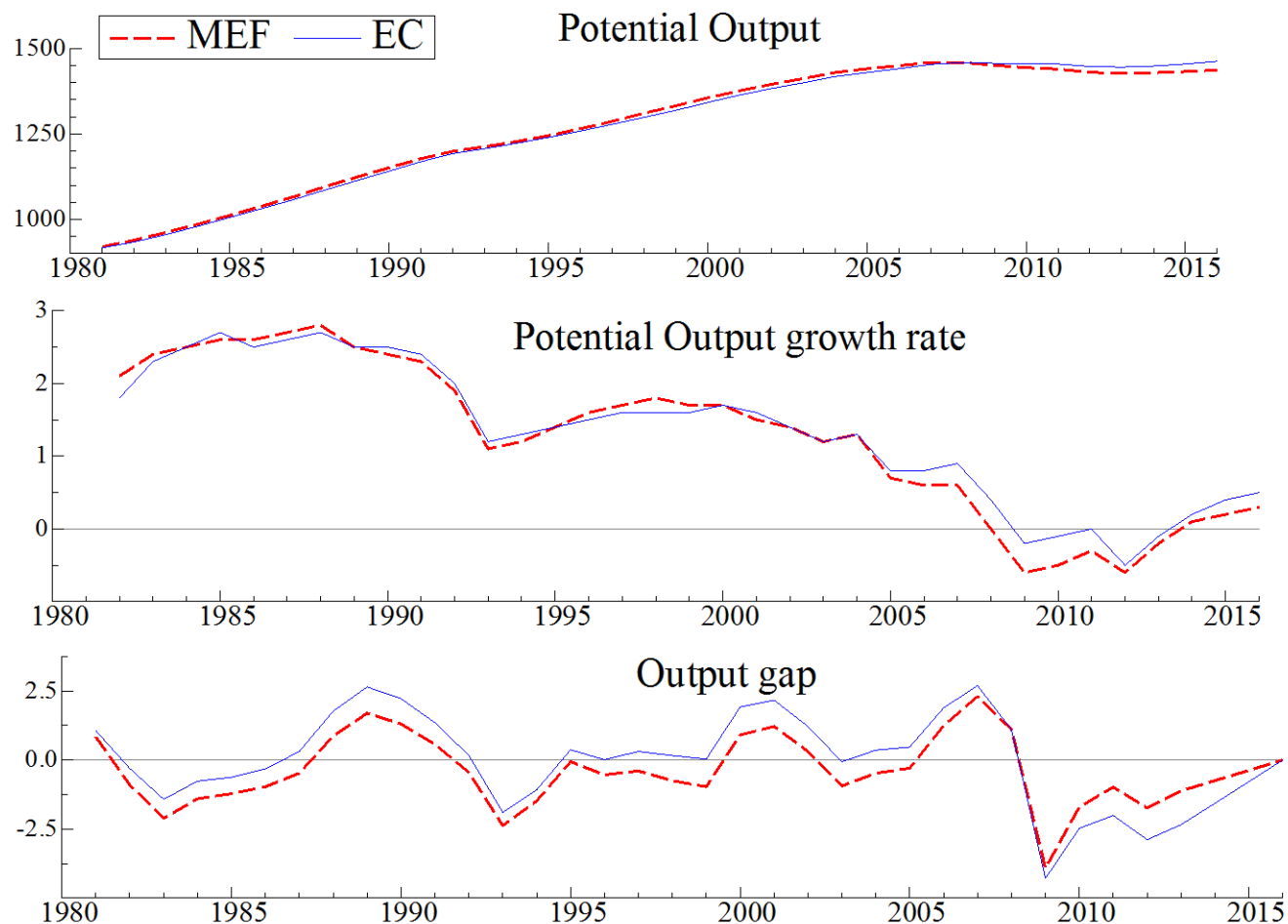
# TFP results with quarterly data



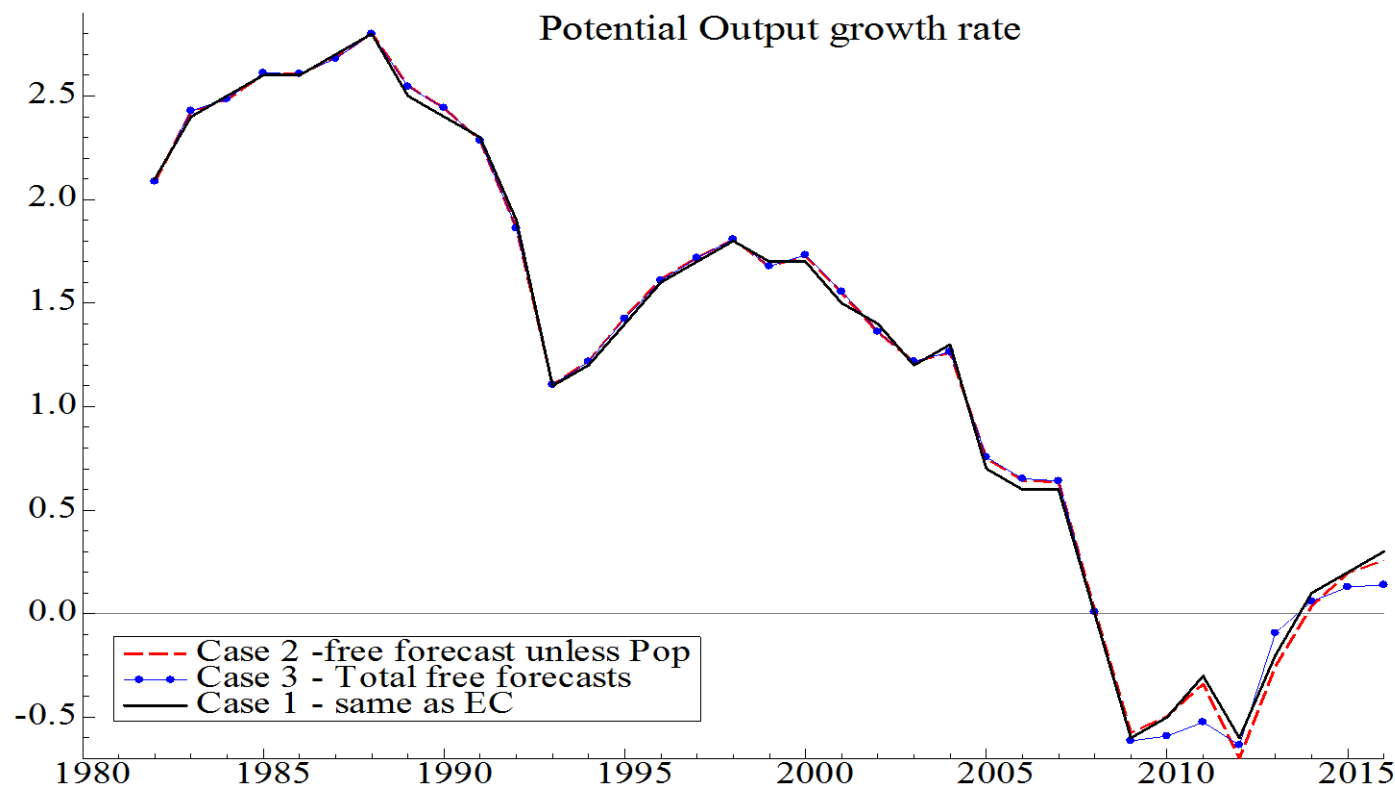
Quarterly information allows to better capture the business cycle.



# Potential output and output gap



# Sensitivity analysis 1: The effect of input projections

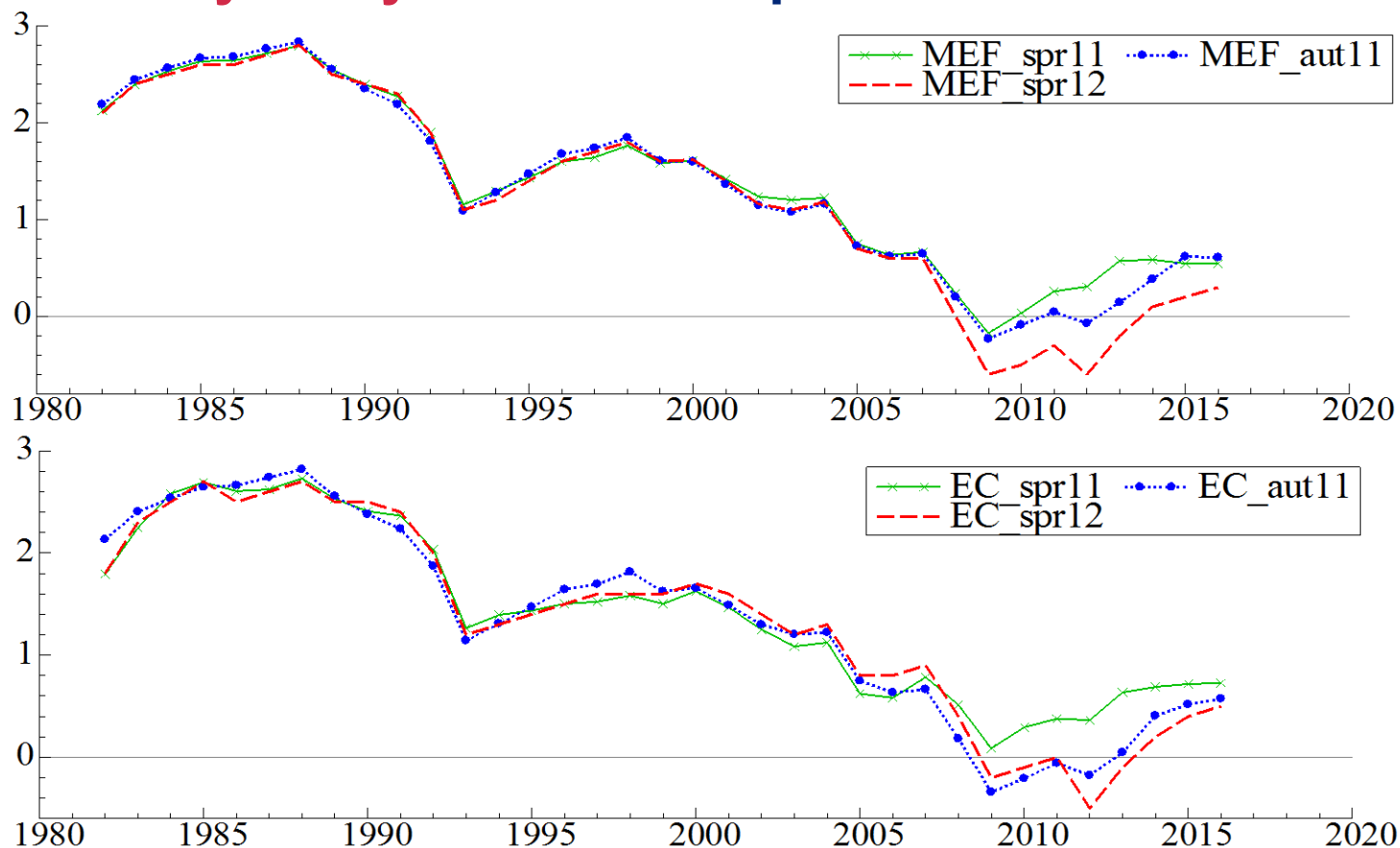


The new procedure easily allows to constraint forecasts to match annual values. Sensitivity analysis shows that the most binding constraint is given by the projection of active population





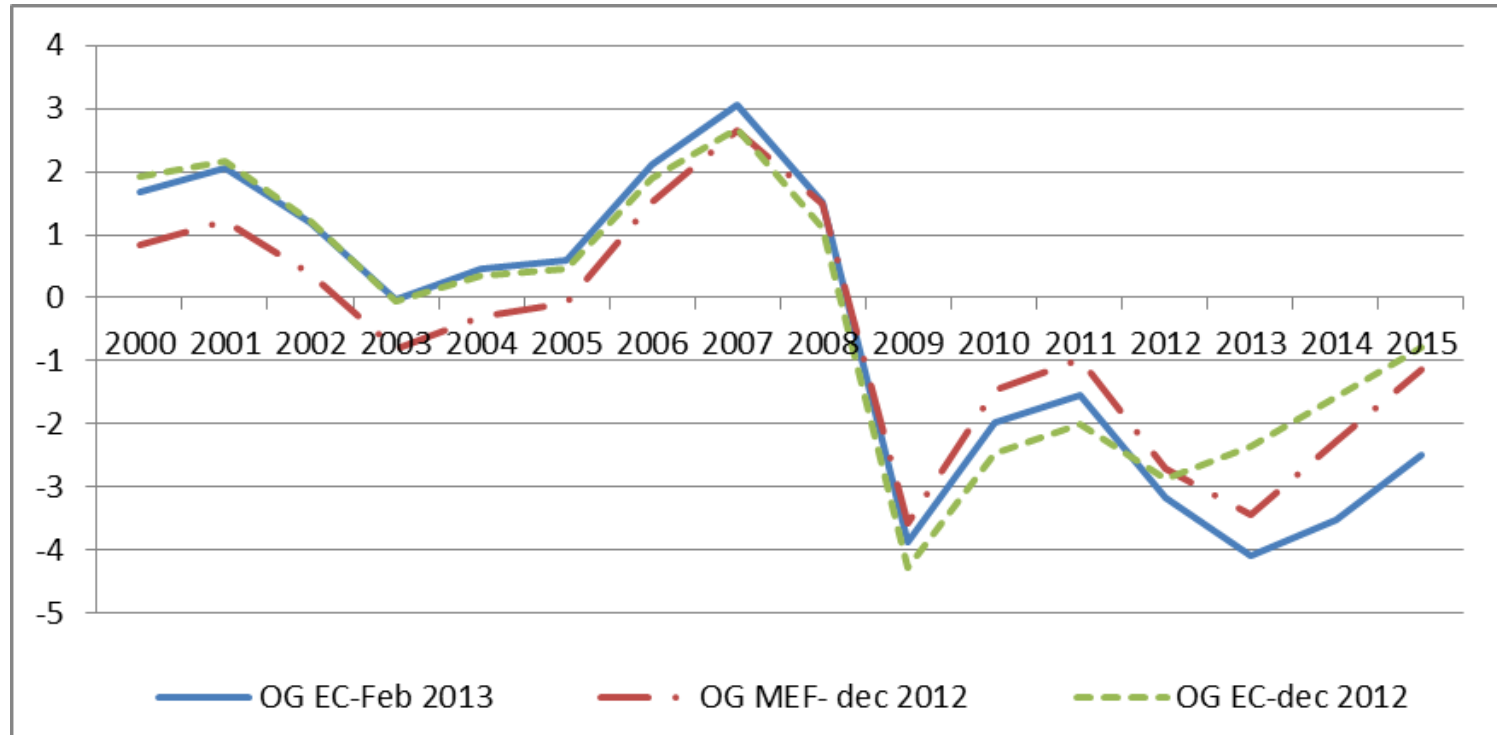
## Sensitivity analysis 2: The impact of revisions in the data



The new method produces more stable results in the historical sample and together with real time figures based on more updated forecasts (for example GDP 2012Q1 which contributes to reduce potential growth in 2012)



## Sensitivity analysis 3: The advantage of using quarterly values



The quarterly method produces a series that is closer to the value of OG estimated by using full information on GDP for 2012.

# Conclusions

- ❑ We propose some innovations to improve the current methodology used by the EC: i) TFP at quarterly frequency and mixed frequency indicators and ii) multivariate model for Capital and Labour factors.
- ❑ Our evidence suggests that this approach has at least 3 advantages:
  - ✓ It allows to easily constraint the forecast to different annual data so as to get different scenarios.
  - ✓ It reduces the revision problem
  - ✓ Multivariate out-of-sample extrapolation for Unempl, Hours, Participation rates.
- ❑ Shortcoming – computationally slightly more demanding.



# Further extensions

- ❑ Estimating quarterly NAIRU by using coherent forecast of wages and unemployment rate so as to avoid the mechanical rule for NAIRU extrapolation.
- ❑ Extending the model for the Labour market including also wages
- ❑ Computing quarterly structural fiscal balance to monitor the development of the fiscal policy

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# Estimation of NAWRU by EC

- ❑ The estimation is based on a Phillips curve that explains the short run response of nominal wages to labour productivity, labour demand shocks and the unemployment gap.
- ❑ It is a bivariate model on output and inflation + exogenous variables estimated by the Kalman filter (ML or Bayesian)

$$y_t = c_t + \mu_t + \sum_i \alpha_{1i} z_{1i}$$

$$\Delta\pi_t = \mu_\pi + \varphi_1 \Delta\pi_{t-1} + \varphi_2 \Delta\pi_{t-2} + \gamma(1-L)^d y_{t-1} + \sum_j \beta_j c_{t-j} + \sum_k \theta_k \varepsilon_{t-k} + \sum_i \alpha_{2i} z_{2i}$$

- ❑ Restrictions on parameters and various trend specifications are allowed

# Quarterly estimation fo NAWRU

- ☐ We add Wages to the Labour market mixed frequency model so as to get a comprehensive quarterly estimation for all variables of Labour Supply.
- ☐ Forecast out of sample also Wage Growth
- ☐ Report the unemployment rate and wages in the model for NAIRU and get a quarterly estimate and foreacast for NAIRU over the periodo (t+3 – t-5) that is until 2016.
- ☐ This allows to use coherent series for the labour market and to avoid using the mechanical rule for the extrapolation of NAIRU.