Stress testing the EU fiscal framework

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Abstract

This paper analyzes the suitability of the cyclically adjusted budget balance (CABB), as estimated by European Commission in measuring fiscal policy stance. We do this by means of a simulation experiment, in which we use and estimated DSGE model to simulate data to which the EC methodology is applied. The model contains an expenditure fiscal rule that accounts for non-automatic variation of the budget deficit. In the simulation we can thus observe discretionary measures of fiscal policy and test the ability of EC methodology to identify them. Our results indicate that the EC methodology frequently fails to identify the true fiscal policy stance and also frequently fails to signal correctly potential violations of the SGP limit on structural deficit. If the CABB is used to trigger corrective fiscal contractions in order to comply with the SGP the result is increased macroeconomic instability. In addition, we show that allowing for a bigger role for stability-oriented discretionary policy and thus relaxing the SGP limit on structural deficit could enhance the stabilization efficiency of fiscal policy, while simultaneously increasing the compliance with the Maastricht Treaty.

JEL-Codes: E61, E62, H62

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1. Introduction

The sovereign debt crisis questioned the economic and fiscal governance of the European Union (EU) and emphasized the need for more effectiveness in economic and fiscal coordination. The institutional setting of the Economic and Monetary Union (EMU) consists of a single monetary policy coupled with decentralized (national) fiscal policies subject to supra-national fiscal rules. The latter were designed to ensure fiscal discipline (Maastricht Treaty on European Union - TEU) and maintain sound fiscal stance (Stability and Growth Pact - SGP), but revealed to be ineffective already before the crisis[1], thus intensifying after 2008 the need for a shift in economic governance.

The EU recently strengthened its fiscal framework and SGP through two cornerstones: the Six-Pack and the Fiscal compact. Despite the fact that a large body of literature questions the appropriateness of the cyclically adjusted budget balance (CABB) as a gauge of discretionary fiscal policy (Blanchard, 1990; Chouraqui et al., 1990) together with its estimation shortcomings (Alberola et al., 2003; Larch and Salto, 2003; Larch and Turrini, 2009, among others), it remains one of the key targets in the reinforced economic and fiscal governance framework. Namely, the main provision of both cornerstones involves the cyclically adjusted budget balance still left as the main reference criterion. This implies that also in the reinforced EU fiscal framework the question whether the CABB is a reliable gauge of fiscal policy stance still remains. Consequently, the effectiveness of the framework in terms of fostering fiscal discipline, while simultaneously allowing member countries to use fiscal policy as a tool of macroeconomic stabilization, continues to be an open issue.

The main goal of this study is to analyse the efficiency of the CABB, estimated with the official methodology of the European Commission (EC hereafter), in evaluating fiscal discipline and determining fiscal policy stance. We do this by means of a simulation experiment. We use an estimated DSGE model, with detailed specification of the fiscal block, to simulate macroeconomic variables. Such an approach is new to the literature. Using an estimated structural macroeconomic model as the data-generating process has one important advantage. It includes a structural equation for government expenditure, which captures non-automatic or discretionary changes in government spending. In other words, with a structural model we can directly distinguish between automatic and discretionary fiscal policy measures. In a large number of replications, we apply to generated macroeconomic data the official European Commission methodology for estimating the CABB and check whether it can identify the true discretionary fiscal policy measures as generated by the DSGE model. With our experiment we therefore assess whether the official EC methodology for estimating the CABB correctly identifies structural measures of fiscal policy or whether it incorrectly assigns a significant share of cyclical variation in fiscal deficits to such measures.

In addition to measuring the precision in determining the fiscal policy stance, we can use the analysis to assess the macroeconomic implications of the two most important targets used in the EU fiscal framework. The first is the Maastricht 3% of GDP limit on the fiscal deficit, while the second is the SGP 0.5% of GDP limit on structural deficit. Breaching either of the two limits

[1] Already in 2008, the ECB concluded that the SGP has not been effective in fortifying fiscal discipline and lacked sufficient rigour and political will. ECB (2012, p. 81) points that in times before the crisis, member states were spending revenue windfalls instead of using them to foster fiscal consolidation, violations in the deficit criterion were only slowly corrected while the debt criterion was largely ignored. Moreover, as pointed by van Riet (2010) the lacking enforcement of the SGP was one of the reasons why public finances of many EMU members were incompetent and deficient when the financial crisis erupted in 2007.

triggers corrective restrictive fiscal policy measures. In this respect we address two issues. The first concerns potential mis-signalling of the breach of the 0.5% structural deficit. Namely, if the CABB estimated by the EC methodology results to be less than 0.5% of GDP and this is wrongly attributed to discretionary policy, corrective measures triggered by the breach of the limit might destabilize the economy.[2] With our simulation experiment we are able to identify such cases and evaluate their welfare implications.

The second issue is about the appropriateness of the 3% deficit-to-GDP and 0.5% structural deficit-to-GDP ceilings in terms of stabilization efficiency. To this end we compute the optimal fiscal expenditure rule for our DSGE model. Such a rule, albeit simple in structure, but by definition consistent with solvency of public finances, minimizes the loss function specified in terms of output gap and inflation variability. Simulating the model dynamics under the optimal fiscal rule enables us to test whether the 3% of GDP deficit and 0.5% of GDP structural deficit limits allow for sufficient room to manoeuvre for stability-oriented fiscal policy.

Our main results show that the official EC methodology performs rather poorly in determining the fiscal policy stance. On average it wrongly signals the fiscal policy stance in more than 20% of cases. To a large extent this is due to the fact that too much of cyclical variation in the budget deficit is wrongly attributed to discretionary fiscal policy.

In line with the Resolution to the European Council on the SGP, that specifies how "adherence to the objective of sound budgetary positions close to balance or in surplus will allow member states to deal with normal cycle fluctuations while keeping the government deficit within the value of 3 per cent of GDP", we show that in principle this is almost true. In our model the budget is balanced over the business cycle, while the 3% deficit-to-GDP limit is exceeded in only 12% of periods. Such cyclical variation is, however, accompanied with the structural deficits that exceed 0.5% of GDP in more than one third of the periods. The provisions of the SGP thus seem to be too stringent for compliance with the Maastricht 3% deficit-to-GDP limit. Namely, the analysis of macroeconomic dynamics under the optimal fiscal rule reveals that automatic stabilizers are insufficient for stabilization of headline fiscal deficit.

Stringency of the SGP provisions, combined with weak capacity of the CABB to capture dicretionary fiscal policy measures, bears negative welfare consequences. The official EC methodology missignals the violation of the SGP structural deficit limit in more than 30% of cases. Triggering corrective measures (fiscal tightening) in such cases results in a substantial increase in the volatility of the key macroeconomic variables, such as GDP, private consumption, private investment and employment as the corresponding standard deviations of these variables increase by 28%, 18%, 27% and 31% respectively. Such negative welfare effects of the inability of the official EC methodology to successfully recover true discretionary measures of fiscal policy are even more pronounced during periods of Great Recessions that in our simulated data occur once every 100 years.

Given that our model is estimated on real data (for Austria) our simulation experiment replicates a realistic environment faced by policy makers and offers two policy implications. The first is the need for a revision of the SGP provisions as regards the targets on structural deficit by acknowledging the need for active fiscal stabilization. The second is a revision of the methodology for estimating the CABB. Instead of being based on filtering cyclical variation it should explicitly incorporate a structural description of discretionary policy like the expenditure fiscal rule of our

[2]The annual average fiscal effort recommended by the European Council for 20 EU countries (excluding Greece and Cyprus) in EDP procedures for the period 2009-2016 equals 1.11% of GDP (European Commission, 2014).

model.

Our work contributes to the literature of fiscal policy analysis in three main ways. First, in discussing the methodological pitfalls of the CABB we use a model-based measure of disaggregation of headline fiscal deficit into the structural and cyclical part. This way we are directly able to contrast our results to the same obtained using the official EC methodology and evaluate the efficiency of the official approach in quantifying structural measures. A number of empirical studies discusses already the level of efficiency, but relying on ex-ante (forecasted) and ex-post budgetary and macroeconomic figures in assessing the estimation shortcomings, emphasizing thus the problem of fiscal policy lags. However, none quantified the (in)efficiency of the official approach by proposing an alternative measurement of structural and cyclical budget figures.

Second, we provide a discussion of the EU fiscal governance framework. Our simulation framework provides an empirical test of the suitability and effectiveness of EU deficit- and structural deficit-to-GDP rules within the reinforced governance framework. Namely, we can evaluate whether the set ceilings allow for sufficient room to manoeuvre for efficient stabilization, especially during severe economic downturns. In addition, our analysis provides an evaluation of likely welfare implications in case of excessive stringency of the current EU fiscal governance framework.

Finally, our study is based on simulation of macroeconomic data and CABB measures. This way our result do not suffer from small sample issues. This is an important advantage given that the SGP entered into force only 15 years.

The rest of the paper is organized as follows: Section 2 gives an overview of the economic and fiscal governance framework within the E(M)U. Section 3 explains the methodological approach of the paper, the DSGE and the data. Moreover it inspects the approaches in measuring the structural balance and motivates an alternative view of estimating the cyclical and structural components within a DSGE model. Section 5 commences with the estimation results regarding fiscal policy stances and the probabilities of breaching the E(M)U fiscal rules, while Section 6 continues with the results conferring about the EU fiscal framework and welfare implications in case of alternative methods in measuring fiscal policy. Section 7 investigates the implication of fiscal policy under the European fiscal framework using the optimal simple rule and Section 8 is reserved for concluding remarks.

2. The EU fiscal framework

In the European Union fiscal rules are legislated at the supra-national level and oblige member states to avoid excessive government deficits and public debt, and to maintain sound and sustainable public finance. The latter is regulated within the Stability and Growth Pact (SGP) that demands from member states to achieve a budgetary position that will allow them to respect the Maastricht deficit criterion even during periods of unfavourable growth. The core of the SGP embraces strengthening the surveillance of budgetary positions (preventive arm) and explicating the implementation of the excessive deficit procedure (corrective arm). Furthermore, the preventive arm of the SGP binds member states to maintain or adjust toward their medium-term budgetary objective (MTO), while the corrective arm is designed to ensure the correction of excessive deficits in case they still occur.

The MTO is a country-specific reference value for medium-term budgetary positions defined in cyclically adjusted (structural) terms, outlined in order to ensure *healthy* budgetary positions.

Initially, the preventive arm of the original SGP required member states to target *close to balance or in surplus* budgetary positions, i.e. provide a safety margin that will allow the fulfillment of the Maastricht deficit criterion under normal circumstances while enabling the free operation of automatic stabilizers[3]. A numerical quantification of the structural deficit rule entered into force after the reform of the SGP in 2005. The intention for such a rule is threefold: (i) to preserve a safety margin against breaching the 3 percent deficit-to-GDP threshold, (ii) to ensure rapid progress toward sound public finances and prudent debt level, and (iii) to allow adequate room for budgetary maneuver, in particular with respect to public investment needs.

Despite its aims, the SGP is considered unsuccessful in securing fiscal discipline in European countries and its full implementation in practice showed to be problematic (Verhelst, 2011; ECB, 2008, 2012). As underlined by the EC, such developments *"have in particular highlighted the need for strengthening national ownership and having uniform requirements as regards the rules and procedures forming the budgetary frameworks of the Member States"*[4]. In order to strengthen economic governance in the EMU (and the EU), the EC has initiated a set of enforced fiscal policy coordination tools, considerably narrowing down the discretionary powers of its member states at their national level. This set of tools embraces the so-called Six- and Two-Packs, the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (Fiscal compact), the European Semester and the Euro Plus Pact.

In order to improve national fiscal planning and avoid further neglecting of fiscal rules by member states, the EC, inter alia, opted for several measures that intervene for the first time at the national level. Member states are obliged to implement numerical fiscal rules in their national law throughout provisions of *"binding force and permanent character, preferably constitutional"* (Fiscal compact), to adopt multi-annual budgetary perspectives in order to attain to the MTO, and to discuss their budgetary plans with other EU members enabling the EC to give policy guidances before decisions are made at the national level (European Semester).[5]

The cornerstones of the revised EU fiscal framework are the Six-Pack and the Fiscal compact. The aim of the first is to strengthen the procedures of the SGP, while the scope of the second is to foster fiscal discipline, to a large extent by requiring its provisions to be implemented in the national legislation of member countries.[6] For the purpose of our analysis, it is important to single out that the Fiscal compact sets the ceiling for the structural deficit at the level of 0.5% GDP.[7]

According to the EC, the structural budget balance is a measure of the underlying trend in the budget and refers to the balance net of the cyclical component, one-off and other temporary measures.[8] In such a framework the cyclically adjusted budget balance (CABB) is defined as

[3] More on the choice of a MTO in Dalgaard and de Serres (1999); Artis and Buti (2001); Barrel and Dury (2001)

[4] Point 1 of the preamble within the Council directive 2011/85/EU.

[5] Nevertheless, even before the revisions, the SGP and the TEU stressed the relevance of national rules for sound budgetary discipline for the Union as a whole. Although not imposed by European institution, national fiscal rules existed in a large sample of countries. For a survey on fiscal rules see Ayuso-i-Casalas (2007) and Schaechter et al. (2012).

[6] For a deeper discussion and a detailed comparison refer to (ECB, 2012).

[7] A member state can set the MTO structural deficit higher than 0.5% GDP if its debt-to-GDP ratio is significantly below the 60 percent threshold and the risks for running into unsustainable public finances are low.

[8] As pointed by Larch and Turrini (2009, p. 27) finding a common understanding about *one-off and temporary measures* was in practice not always easy.

follows:

$$CABB_t = BB_t - CC_t = BB_t - \eta OG_t \tag{1}$$

where BB represents the actual (nominal) budget in year t, CC the cyclical component of the budget in year t, obtained as the product of the budgetary sensitivity parameter (η) and the output gap OG in year t. Important to point out is that the cyclical component should reflect the effect of automatic stabilizers, while the cyclically-adjusted (structural) component underlines discretionary fiscal policy. In this respect, changes in the $CABB$ indicate the fiscal policy stance[9].

The budgetary sensitivities (η) used by the EC are based on OECD estimates of budgetary elasticities[10] The OECD follows the methodology developed in Giorno et al. (1995), van den Noord (2000) and Girouard and Andre (2005). The budgetary sensitivity parameter is obtained as a weighted sum of four revenue (personal income tax, corporate income tax, indirect taxes, social security contributions) and one expenditure (unemployment related benefits) budgetary item elasticities. The latest available elasticities published in 2005 by Girouard and Andre include changes from the policy environment (such as tax reforms) and changes in the methodology. While the initial methodology was based on van den Noord (2000) using the OLS estimator, Girouard and Andre (2005, p. 14) introduce a GLS estimator for each country, and then based on these results and on economic and geographic criteria, they create a subset of countries for each equation and apply the SURE procedure in estimating the parameters.

The output gap is estimated by the methodology adopted by European Commission. At the Ecofin Council meeting of May 2004, the European Commission decided that for the estimation of the output gaps the production function constitutes the reference method for estimating the output gap, when assessing the cyclically adjusted budget balance. Moreover, the Hodrick-Prescott filter is to be used when assessing the stability and convergence programme for the new member states (NMS-12) and remains a backup method for old member states.[11] For comparison, we apply both methods for comparison in out simulation experiment.

The cyclically adjusted budget balance as a measure of discretionary fiscal policy has often been subject to criticism. Alberola et al. (2003) show that CABBs tend to be systematically overestimated during recessions and underestimated during expansion, mainly due to the computation of elasticities. Larch and Salto (2003) as well as Larch and Turrini (2009) confer that diverging estimates of the CABB are due to shortcomings in the uncertainty of the output gap estimation as well as the assumption of constant tax elasticities. Namely, the link between the cyclical component of the GDP and the budget is taken to be invariant over time[12]. Hallett et al. (2011) find that real time CABBs are not better at forecasting the ex post figures than simpler benchmarks. Additionally, they find that CABBs are less reliable under conditions of poor or deteriorating public finances, meaning that they are more fallible when are needed most. Barrios

[9]If the difference of $CABB$ in time t and $t-1$ is positive then fiscal policy is said to be restrictive, while, oppositely, a negative change in the CABB may be considered as the indicator of expansive fiscal policy.

[10]The budgetary sensitivity parameter η is the semi-elasticity that measures the change of the budget balance, as a per cent of GDP, for a 1% change in GDP. Since the OECD performs the elasticities estimation for its members only, for the non-OECD EU members the elasticities are estimated by the EC.

[11]Although the production function method is preferable in that it allows to identify the different supply components of potential output, statistical filters might be the best or the only alternative in case of serious problems related to data quality or data availability.

[12]The EU gives ground for such a simplification by stressing that the best predictor for tax elasticities in the future is their average of the past.

and Fargnoli (2010) show that discretionary measures significantly affect tax elasticities and can therefore alter the link between tax revenues and the business cycle, resulting in discretionary changes (especially in direct taxes) to often be pro-cyclical. Although criticisms on the CABB were extreme even in the pre-crisis period, it remained one of the key indicators in the field of fiscal policy, proving that in fact there was no better alternative available (Larch and Turrini, 2009, p. 18). In particular, in surveilling fiscal policy at the EU level, the CABB, despite its flaws, provides a better guidance than the nominal deficit. After all, it was the volatility of the latter that motivated the decision to target the cyclically adjusted budget balance under the preventive arm of the SGP.

3. The simulation experiment

3.1. DSGE as the data-generating process

Our simulation experiment uses and estimated medium-scale small open economy DSGE model as the data generating process. The structure of the model is based on Adolfson et al. (2007). A detailed presentation of key model equations is in Appendix A. Here we comment the most important features.

The model of Adolfson et al. (2007) has one important feature for our purpose. Namely, the trending behaviour of the economy is captured by stochastic technology trend with drift. The first advantage of such a specification is empirical as the DSGE can be estimated on "raw" data, without prefiltering. The second advantage is theoretical. The stochastic technology trend represents the trend (or potential) output.[13]. The remaining exogenous shocks in the model (16 in number) induce only cyclical movements around the stochastic trend. This way we can directly distinguish between trend and cyclical variation in generated data.

It should be noted that trend output in the model is not a smooth process. The concept of trend output in the official EC methodology is different. If the Hodrick-Prescott filter is applied it delivers a smooth trend. The production function approach (see D'Auria et al. (2010)) assumes a non-smooth unit-root process for trend employment. To determine trend total factor productivity, however, the HP filter with a smooth trend is frequently applied in practice. For these reasons we can expect the estimated cyclical components to differ across methods. A non-smooth trend output in the DSGE implies that the cyclical component of output retrieved directly from the DSGE will be more volatile than the cyclical component obtained with either the production function (PF) approach or the HP filter.

We made several alterations to the model of Adolfson et al. (2007). The first an adjustment for a small open economy as part of a monetary union. This implies that the monetary policy instrument is set exogenously and the stationarity of the model is achieved with the expenditure fiscal rule as specified below.

More substantial changes involve the fiscal part, which has been endogenized and extended. The revenue side of the model includes the value added tax, personal income tax, social security contributions and corporate and capital income taxes. The corresponding tax rates are fixed, while Adolfson et al. (2007) allow for exogenous time variation. Fixed tax rates are necessary

[13]Besides Adolfson et al. (2007), Ehrmann and Smets (2001), Adolfson et al. (2008), Christoffel et al. (2008) and Vetlov et al. (2011) define trend output as the level of output equal to the sequence of permanent (unit-root) technology shocks

to keep the the sensitivity of budget revenues to the business cycle fixed in time, which is also assumed in the EC framework. We added social transfers and unemployment benefits, which are indexed to nominal wages and depend on unemployment rate.

In Adolfson et al. (2007) government spending adjusts so to keep the budget balanced. Consequently there is no public debt. This is not so in our case. The government borrows to finance budget deficits, while government consumption is determined by the following (log linearized) fiscal rule:

$$g_t = \rho_g g_{t-1} - \rho_\pi \left(\hat{\pi}_t - \hat{\overline{\pi}}_t^c\right) - \rho_y \hat{y}_t - \rho_b b_t - \rho_{def} def_t + \varepsilon_{g,t}. \tag{2}$$

Government spending contains a inflation (π_t), deviation of output from trend output (y_t), deviation of public debt (b_t) from its steady-state level, and government deficit (def_t). $\varepsilon_{g,t}$ are government spending shocks. Government consumption is also assumed to be persistent. The budget deficit is zero along the steady growth path. The model therefore complies with the provisions of the SGP.

The steady state of the model is calibrated on Austrian data. The parameters of the dynamic equations model, including the parameters of the fiscal rule, are estimated with Bayesian MCMC method on 14 Austrian macroeconomic series on quarterly frequency from 1996:1 to 2010:3 using 10.000 posterior draws.[14]

Austria was selected for estimation because it can be considered as as one of the most fiscally stable EU countries. In particular, our choice was guided by three main criteria:

1. *Tax system stability*, i.e. tax legislation stability, tax rates in particular. In this respect Austria can be considered as one of the most stable EU countries, as it did not change the top personal income tax rate and the standard VAT rate in the last two decades, while the top corporate income tax rate was changed only once. Moreover, Austria experienced smallest changes in all three implicit tax rate categories from 1995 to 2010 on one hand, while on the other, if the fiscal stimulus (just tax cuts) in the latest crisis is considered, Austria opted mainly for tax reliefs without changing any tax rate.
2. *Fiscal discipline and prudence*, i.e. compliance of fiscal rules set in the Maastricht Treaty. On average, Austria registered a deficit of the general government budget of 2.2 and 2.4 percentage points of GDP in the period 1995-2007 and 1995-2011 respectively, which is below the the EU or EMU average. Same is true for the debt criterion.
3. *Fiscal projection accuracy*, i.e precision of budget planning. Unbiased and realistic macroeconomic and budgetary projections are essential for sound fiscal planning. Given that budgetary revenue are strongly conditional on macroeconomic developments the ECB (2013) shows Austria as one of the EU countries with the lowest government revenue projection errors, where the latter are proxied by the average annual difference between government revenue projections one year ahead and actual revenues in periods 2000-2007 and 2000-2011.

3.2. Simulating macroeconomic variables

In each iteration of the simulation experiment the data are generated as follows. The model contains 17 structural shocks, including the government spending shock $\varepsilon_{g,t}$. These shocks are then randomly generated under the assumption of normal distribution with corresponding standard deviations set to posterior means.

[14]See Appendix A for variables' definition and sources.

The length of the generated time series was set to 300. The first 200 observations were discarded, which yielded 100 quarterly observations corresponding to 25 years of macroeconomic data. The number of simulation iterations was set to 10.000.

Descriptive statistics of simulated and actual data are presented in Table 1. The standard deviations of simulated and actual output and budget deficit series data are very comparable. The generated consumption series are less volatile than real data, while for the generated investment, government spending and wages it is larger than in the data. Actual correlation between output and consumption and output and government spending is lower than simulated. The one between output and investment is quite comparable. In actual data GDP and wages don't seem to exhibit any significant correlation, in simulated data it is slightly positive. Very low is also actual correlation between budget deficits and output, while it is, as expected, moderately negative in the simulated series.

Table 1: *Descriptive statistics: actual (Austrian) data 1996:1-2010:3 and simulated data*

Data	σ_y	σ_c	σ_i	σ_g	σ_w	σ_{def}
Actual	0.0072	0.0014	0.0163	0.0076	0.0090	1.9668
Simulated	0.0072	0.0008	0.0339	0.0125	0.0132	1.9654
		σ_c/σ_y	σ_i/σ_y	σ_g/σ_y	σ_w/σ_y	σ_{def}/σ_y
Actual		0.1979	2.2582	1.0513	1.2448	272.61
Simulated		0.1187	4.7113	1.7403	1.8315	272.898
		$Corr(y,c)$	$Corr(y,i)$	$Corr(y,g)$	$Corr(y,w)$	$Corr(y,def)$
Actual		0.2960	0.6996	0.1541	-0.0453	0.1120
Simulated		0.6261	0.5256	0.4246	0.1734	-0.2729

Notes: Output (y), private consumption (c), private investment (i), government consumption (g) and wages (w) are measured in growth rates, while deficit (def) corresponds to the deficit in percent GDP. Actual data for the latter are available for a shorter time span (1999:1-2010:3).

3.3. Simulating Great recessions

In the Great recession that started in 2008 several EU member countries recovered very slowly or not at all, which raised the issue whether the EU fiscal framework offers sufficient room to maneuver for stabilization. For this reason we pay special attention to the performance of the EU fiscal framework in periods that in our simulated series resemble the Great recession.

Our definition of the Great recession reflects the dynamic of the Euro Area GDP between the peak in the second quarter of 2008 and subsequent 5 years. The Euro area GDP dropped 5% in the first four quarters after the peak and it reached the pre-crisis level only five years later. Out of our simulated data we single out episodes that exhibit at least as bad performance. Simulated GDP drops at least 5% between t and $t+4$ and subsequently recovers only by $t+19$ or later. In our case, such Great recessions occur on average slightly more than once per 100 years.

Table 2 presents the basic descriptive statistics of selected variables on average across all generates samples and across Great recessions. It is possible to observe that the average quarterly GDP growth rate of 0.09% turns to be -0.38% during Great Recessions (Table 2). Private consumption growth rate decreases, but remains positive. Same observation applies to real wages. The most significant is a drop in private investment. Government consumption also plunges in Great recessions and actually shrinks on average much faster than output. The budget balance results to be in surplus by 0.18% GDP if the whole time span is taken under analysis, while turns to be on average in deficit by 2% GDP during periods of Great Recessions.

Table 2: *Descriptive statistics of key variables: comparison between whole sample and periods of Great Recession*

	Whole sample		**Great Recessions**	
Growth rate of*	mean	stdev	mean	stdev
GDP	0.19	0.72	−0.38	0.81
Private consumption	0.19	0.09	0.13	0.08
Private investment	0.18	3.39	−1.38	3.44
Government consumption	0.19	1.25	−0.71	1.10
Wages	0.48	1.32	0.37	1.21
Budget balance (% GDP)	0.18	1.97	−2.02	1.40

* % of DGP for the budget balance.

3.4. Simulated CABB estimation

Simulated data include all the necessary variables to apply the EC methodology to estimate the output gaps, the cyclically adjusted budget balances and fiscal policy stances within each replication. In principle we do this in in four different approaches.

Equation 1 shows that the EC official methodology depends on the budget sensitivity parameter (η) and the output gap (OG). The estimation of the output gap is done in three different ways. The first two are the official methods of the European Commission. i.e. the production function (PF) method and HP filtering, respectively. The estimation of the output gap using the PF approach follows the official procedure presented in D'Auria et al. (2010). In this method capital is not filtered, the trend component of the total factor productivity is obtained with the HP filter, while a structural unobserved-components model for the unemployment rate is estimated by maximum-likelihood and the Kalman filter. We estimate the parameters of the unobserved-components model on real data and keep the fixed across iterations. Trend and cyclical unemployment, however, are obtained in each interaction with the Kalman filter.

The third way of estimating the output gap is by filtering it from the data with the DSGE model. As explained above, the permanent technology trend represents the long-run growth trajectory of GDP. The output gap can then be estimated as the difference between simulated level of GDP and simulated technology trend.

Each of the three methods for estimating the output gap is combined with estimation of the sensitivity parameter (η), where we rely on the OECD method updated in Girouard and Andre (2005), which involves estimating a set of equations related to different budget revenue and expenditure components in order to calculate respective elasticities on one hand and the overall budget sensitivity parameter on the other hand, as noted in Section 2.[15]

The fourth approach to determining the fiscal policy stance is directly from the DSGE model. Namely, our model contains the expenditure fiscal rule (2) the is the only source of non-automatic

[15]Similarly to the authors, we use ordinary least squares for estimation. We checked for robustness of our results also using the TSLS estimator. As a second robustness check we also used the value of η equal to 0.47 as repaired by the European Commission for Austria. Results available upon request,

variation of the budget deficit. This is done by simulating a purely automatic trajectory of model variables. In particular, we use the random draws of structural shock in each replication with two restrictions: the parameters of the fiscal rule (2) and government expenditure shocks ε_t set to zero.[16]

In sum, the cyclical component of the budget (CC) was estimated by means of four alternatives as follows:

1. as the product of the budget sensitivity (η) following Girouard and Andre (2005) and the HP filtered output gap - referred in tables as European Commission approach with HP;
2. as the product of the budget sensitivity (η) following Girouard and Andre (2005) and the production function based output gap - referred in tables as European Commission approach with PF;
3. as the product of the budget sensitivity (η) and a DSGE consistent measure of cyclical variation obtained as a deviation of GDP from the permanent technology trend - referred in tables as European Commission approach with DSGE;
4. as a purely automatic trajectory of deficit, obtained from the DSGE model - referred in tables as Model.

The first three approaches differ only in the estimation of the output gap. The first two approaches can be thought of as pure official EC methodologies. The third one is in essence the EC method augmented with a DSGE-based measure of the output gap. The "Model" approach does not rely on estimation of the output gap and budget sensitivity to the output gap. Discretionary, or non-automatic, measures of fiscal policy can be directly retrieved from generated data as it occurs due to shocks $\varepsilon_{g,t}$ and the endogenous reaction of spending to endogenous variables, with which the government attempts to stabilize the economy.

4. Estimation of the CABB

This and the following sections present the results of our simulation experiment. If not noted otherwise, the reported values reffer to averages across all simulation iterations. In terms of the notation we use, it is worth repeating at this point that the expression *Model* applies to the results obtained directly with the DSGE model (fourth alternative in Section 3.4), i.e. without using the official EC procedures for estimating the cyclical and structural component of the budget. Moreover, when comparing results across alternatives, we often label these results as *true* or *benchmarks.*

The basic descriptive statistics of estimated CABBs and budget sensitivity porameters are reported in Table 3. It is possible to observe that the two official alternatives to estimating the output gap (HP and PF) give quite similar estimates on average. As a consequence, the estimated budget sensitivity parameter η is also similar. An average it is 0.52% GDP with a standard deviation of 0.11.[17] This results also in similar estimates of the CABB, ranging from -4.5 to 3.8 percent of GDP.

[16] The only parameter that is not set to zero is the coefficient of the public debt, which is needed to achieve stationarity of public debt.

[17] The official estimate of the overall budget balance sensitivity in Girouard and Andre (2005) and used by the EC in the Austrian case amounts to 0.47% GDP. Our estimate is fairly close to the latter. Moreover, in order to check the stability of our results, we estimated the budget component's elasticities and the overall budget sensitivity parameter following van den Noord (2000) as well. In this case our results show a budgetary sensitivity of 0.32% GDP on average, while van den Noord reports the same to be 0.31% GDP in the case of Austria.

As expected, the output gap measured as deviation from the permanent technology trend of the DSGE model results to be more volatile and ranges from -11 to 9 percent of GDP. The correposonding budget sensitivity is also higher - 0.83 on average, leading also to a wider range of the cyclically-adjusted budget balance ranging from -7 to 8 percent of GDP.

If these are compared to the estimates of the cyclical component and the CABB obtained directly from the DSGE model (Model) it is possible to observe that the official methodology on average underestimates the variability of the cyclical component, while it overestimates the structural component. In other words, the official EC method wrongly attributes some cyclical variation in the budget to discretionary fiscal policy measures. If the variability of the estimated output gap is larger, as it is the case of the DSGE-based measure of the output gap, this feature of the official EC methodology is only amplified.

Table 3: *Descriptive statistics of the cyclically-adjusted budget balance (CABB), cyclical component (CC) and budget elasticities (% of GDP)*

Estimation approach	**Output gap**		**Cyclically-adjusted budget balance** $CABB = BB - CC$	**Cyclical component** $CC = OG\eta$ **CC**	**OG**	η
European Commission	**HP**	range	$-4.52, 3.85$	$-1.26, 1.24$	$-2.45, 2.39$	0.52
		stdev	1.95	0.53	1.03	0.11
	PF	range	$-4.36, 3.69$	$-1.33, 1.28$	$-2.59, 2.49$	0.52
		stdev	1.86	0.57	1.10	0.11
	DSGE	range	$-6.85, 7.84$	$-9.18, 7.74$	$-10.95, 9.22$	0.83
		stdev	3.87	4.80	5.71	0.07
Model	-	range	$-2.82, 2.81$	$-3.20, 2.53$		
		stdev	1.27	1.48		

Notes: *BB* - budget balance; *HP* - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

Fundamental differences between the methods can be seen also from the correlation matrix of estimated cyclical components. The correlations between true cyclical components of the budget (Model) and the two cyclical components obtained with the official EC method (PF and HP) are on average low, about 40% for the output gap estimated with the production function approach, and about 20% for the HP filtered output gap. In Great recessions, the correlation are even smaller, 26% and 9% respectively. These low correlations between cyclical components clearly signal important methodological drawbacks of the EF methodology of determining the cyclical variation of budget deficits. The fact that the correlation between the true cyclical component (Model) and the EC approach using DSGE estimates of the output gap (DSGE) is considerably higher (80% or more both overall and in Great recessions), we can say the output gap estimation methodology clearly plays a role. The output gap estimated with our DSGE is not based on a concept of a smooth output and the corresponding cyclical component exhibits the highest correlation with true cyclical components. The HP filtered output gap is based on the concept of a smooth trend output and exhibits the lowest correlation. This implies that treating trend output as a smooth process can lead to significant biases in estimating the cyclical components of the budget deficit. Below we show, however, that only replacing the notion of trend output with a non-smooth concept is not sufficient for the official EC methodology to successfully capture the fiscal policy stance.

Table 4: *Cyclical components' (CC) correlation matrix*

Estimation approach	Output gap	Estimation approach: European Commission HP	PF	DSGE	Model
W H O L E S A M P L E					
European Commission	**HP**	1.0000			
	PF	0.9054	1.0000		
	DSGE	0.2433	0.3940	1.0000	
Model		0.2070	0.3973	0.7998	1.0000
G R E A T R E C E S S I O N S					
European Commission	**HP**	1.0000			
	PF	0.9156	1.0000		
	DSGE	0.0745	0.2075	1.0000	
Model		0.0910	0.2644	0.8537	1.0000

Notes: *BB* - budget balance; *HP* - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

Additional descriptive statistics of the estimated CABB are provided in Table 5. Clearly, the true CABB in the model and consequently also in generated data is on average zero (see the last line of Table 5. The official method, however, signals a negative average cyclical position and consequently also a violation of the main SGP provision that the budget should be "close to balance or in surplus over the business cycle". In periods of great recessions, the differences are even more pronounced. The true structural position is moderately negative (-0.17%), which is well in line with the SGP ceiling of 0.5%. The official methodologies, however, signal a deep structural deficit that on average exceeds 1.5% of GDP. The same methodology applied to DSGE-based output gap, conversely, signals just the opposite, a structural surplus. These statistic reveal that great recessions in our model induce significant cyclical deteriorations of the budget deficit. While the average budget deficit in Great recessions is 1.9% of GDP (see last line of Table 2), only a tenth of that can be attributed to structural policy measures. The official methodology of estimating the CABB, however, fails to capture this feature and attributes a large share of cyclical variation in the budget to structural measures.

Table 5: *Descriptive statistics of cyclically adjusted budget balance (CABB): comparison between whole sample and periods of Great recessions*

CABB Estimation approach	Output gap	**Whole sample** mean	stdev	**Great recessions** mean	stdev
European Commission	**HP**	-0.16	1.95	-1.76	1.44
	PF	-0.16	1.86	-1.59	1.41
	DSGE	0.23	3.87	1.10	2.36
Model	-	0.00	1.27	-0.17	1.20

Notes: *BB* - budget balance; *HP* - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

5. Assessing the fiscal policy stance

Knowing the fiscal policy stance is important for policymakers as they can use the information on fiscal policy stance to implement counter-cyclical policy measures. For this reason we investigate In this section the efficiency of the CABB estimated with EC methodology in determining the fiscal policy stance.

In defining the measures of fiscal policy stance we follow Cimadomo (2005), who relates it to the change in the cyclically adjusted budget balance ($\Delta CABB$). He defines the fiscal policy stance to be *neutral* for small variations in the structural budget balance that range from -0.2 and 0.2 percentage points of GDP. Changes of the structural balance that exceed 0.2% of GDP denote a (*restrictive*) fiscal stance, while changes of more than 0.2 percentage points into the negative side denote an (*expansive*) fiscal stance.

Table 6 reports the shares of periods of a certain fiscal policy stance as estimated by the three alternative methods. From the last column we observe that in about 45% of periods overall the fiscal policy in our generated data is either positive of restrictive. The share of periods with neutral stance is below 10%. The shares determined by the official EC methodology, regardless of the output gap estimation methodology, are quite similar. At first sight this indicates that the official EC methodology quite successfully captures the correct fiscal policy stance.

In Great recessions the results are a bit different. It turns out that in our simulated series the share of periods with a neutral policy stance is 30%. In about a third of Great recessionary periods fiscal policy is on average expansive, while it is restrictive in 36% of cases. Also in this case, however, the two official EC methods (HP and PF) produce similar shares, slightly overestimating the shares of expansive and restrictive episodes, and underestimating the share of neutral episodes. Using the DSGE-based output gap, however, quite significantly overestimates the share of periods with restrictive policy stance.

Table 6: *Measuring the fiscal policy stance - shares of periods in a given regime (in %)*

Estimation approach	**European Commission**			**Model**
Output gap	**HP**	**PF**	**DSGE**	
WHOLE SAMPLE				
Restrictive	46.55	46.53	47.04	45.68
Expansive	47.14	47.09	47.46	46.13
Neutral	6.32	6.39	5.50	8.18
GREAT RECESSIONS				
Restrictive	37.39	37.52	54.53	36.89
Expansive	39.31	38.95	26.63	33.07
Neutral	23.60	23.79	19.35	30.20

Notes: Fiscal policy stance (FPS) is the change in the cyclically adjusted budget balance ($\Delta CABB$); *Restrictive* - Δ CABB $>$ 0.2% of GDP, *Expansive* - Δ CABB $<$ -0.2% of GDP, *Neutral* - $|\Delta CABB|$ $<$ 0.2% of GDP. *HP* - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

The similarity of shares of periods attributed to some fiscal policy stance, however, does not say *per se* that alternative methods provide similar signals about the policy stance, as they could provide similar signals in different time periods. For this reason we need to check for concordance of fiscal policy stance measures in time. To this end we proceeded as follows. For the European commission approaches to estimating the CABB with each of the three methods of output gap estimation we check the signal they give for fiscal policy stance and compare to the true stance as generated by the model. In Table 7 we presents the shares of cases where the European commission methodology gives a wrong signal about the policy stance.

Table 7: *Average share of wrong signals about the fiscal policy stance obtained with EC approach (in %)*

	Model wrt		
Estimation approach	**European Commission**		
Output gap	**HP**	**PF**	**DSGE**
WHOLE SAMPLE			
Restrictive	20.77	20.51	25.86
Expansive	21.01	20.75	26.10
Neutral	33.33	33.17	35.58
GREAT RECESSIONS			
Restrictive	23.74	23.50	32.23
Expansive	24.56	24.37	26.01
Neutral	33.92	33.94	35.30

Notes: Fiscal policy stance (FPS) is the change in the cyclically adjusted budget balance ($\Delta CABB$); *Restrictive* - Δ CABB $>$ 0.2% of GDP, *Expansive* - Δ CABB $<$ -0.2% of GDP, *Neutral* - $|\Delta CABB| < 0.2\%$ of GDP. HP - Hodrick-Prescott filter; PF - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

The results show a significant share of wrong signals given by the EC methodology. Independently of the output gap estimation method, the wrong signal occurs in more than 20% cases on average for either the expansive or restrictive case. This means, for instance, that in more than 20% of cases, when the official methodology signals a deterioration in the cyclically adjusted budget balance in time t, a DSGE model-based estimation would disagree and show either its improvement or a neutral development. The levels of disagreement during Great Recessions are even higher. Such a results is very important in the context of fiscal discipline and surveillance within the SGP, since it can trigger correction mechanisms in the wrong phase of the business cycle. The expected negative welfare effects of such misguided corrections are evaluated below.

6. Stress testing the EU fiscal framework

The analysis in the previous section revealed the difficulties the official EC methodology has in determining the fiscal policy stance. In the EU fiscal framework, however, determining the fiscal policy stance is crucial for the functioning and monitoring the SGP provisions. Namely, the main scope of using the MTO within the preventive arm of the SGP is to provide a safety margin against breaching the Maastricht 3% deficit criterion. In this section we investigate how does the EC methodology perform in supporting the SGP objectives.

The estimate of the CABB is needed to determine whether a 0.5% of GDP threshold is breached or not. In case it is, an active policy correction is needed to put the budget balance back in line with the SGP requirements. In case the CABB estimates are unbiased, such corrections could indeed help a country to stay within the 3% budget-to GDP Maastricht limit. In case the CABB estimates do not capture correctly the true structural position of the budget, then the corrections could results in using restrictive fiscal policy measure in the wrong phase of the business cycle. The result would be a procyclical policy with destabilizing effects, leading to lower welfare and even higher probability of breaching the Maastricht criterion.

Table 8 reports the frequencies of breaching the Maastricht and SGP criteria. As before, the results labelled "Model" represents the true frequencies. It is possible to observe that in simulated data the Maastricht deficit criterion is on average not fulfilled in 12% of the periods. In great recessions the frequency is larger, 32%. The SGP 0.5% of GDP upper limit on the structural deficit is breached in about one third of time in simulated data. In line with observations above that the official EC methodology for estimating the CABB on average attributes some cyclical variation in the budget to structural fiscal policy measures, the frequency of estimated CABBs that exceed the SGP ceiling is overestimated by the official methodology. Across methods for estimating the output gap the frequency is consistently above 41%.

Results in the upper panel of Table 8 give also an indication whether keeping the structural deficit below 0.5% of GDP provides a safety margin agains breaching the 3% Maastricht limit. On average in only 3.6% overall deficit exceeds 3% of GDP when also the structural budget is above 0.5% of GDP. The fact that the official EC methodologies attach a zero probability to such events is not far from reality. The policy implication to keep the structural deficit within the SGP in order to avoid the Excessive Deficit Procedures thus seems about right. A more problematic feature of this is that in simulated data there are 26% of cases where the deficit is below 3% of GDP while the structural deficit is below 0.5% of GDP. This implies that the SGP provision precludes an important share of situations, in which active fiscal policy is not associated with excessive deficits. The official EC approach, using either the PF or HP approach to estimate the output gap, indicates such situations with approximately equal probability. This clearly raises the issue whether keeping with MTOs that excluded structural deficits above 0.5% of GDP induces a potential procyclicality to fiscal policy. It is an issue that we address more in detail below.

As expected, the probabilities of breaching the SGP structural deficit rule and the Maastricht 3% limit increase during periods of Great Recession. The true frequencies increase from 34% to 41% and 12% to 32% respectively. The fact that the frequency of structural deficit limit breaches increases by 20%, while the incidence of deficits above 3% almost triples indicates that the worsening of the budget blanches in big economic crises occur mostly due to cyclical reasons.[18] Nevertheless, a worsening of structural balances is expected given that through the fiscal rule in our model the government actively reacts with increased spending to stabilize the economy.

The official EC methodology attributes some cyclical variation in the deficit to structural fiscal measures to an even larger extent than normal times. The shares of violation of the SGP structural deficit limit are in Great recessions are indicated in above 70% of cases, while the true frequency stands at 41%. Using the DSGE-based output gap estimate results on only about 5 percentage points lower frequency (66%), which is still a significant overestimation. From this we might expect that the MTOs set in crises so as to keep with the provisions of the SGP might

[18]Note that in our simulated data this does not occur because of the model assumption that the economy automatically reverts to pre crisis level of output. Trend output in our DSGE model is not modeled as a smooth trend, which means that our simulated Great recessions include L-shaped recessions.

have an even stronger procyclicality bias and raise even stronger concerns about the stabilization efficiency of the EU fiscal framework to cope with deep and prolonged recessions.

Table 8: *Frequency of violations of the Maastricht and SGP criteria (in %)*

Deficit (% GDP)		Estimation approach			
		European Commission Output gap			Model
Total	Structural	HP	PF	DSGE	
		Whole sample			
≥ 3		12.28	12.28	12.28	12.28
	≥ 0.5	41.85	41.75	41.85	34.66
≤ 3	≤ 0.5	58.12	58.23	41.38	61.69
≥ 3	≤ 0.5	0.00	0.00	10.85	3.65
≤ 3	≥ 0.5	29.57	29.47	46.33	26.02
≥ 3	≥ 0.5	12.28	12.28	1.43	8.63
		Great recessions			
≥ 3		32.17	32.17	32.17	32.17
	≥ 0.5	72.35	70.03	66.38	41.29
≤ 3	≤ 0.5	30.74	33.04	29.12	47.80
≥ 3	≤ 0.5	0.00	0.01	26.92	11.93
≤ 3	≥ 0.5	37.09	34.79	38.70	20.06
≥ 3	≥ 0.5	32.17	32.17	5.25	21.23

Notes: HP - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

It is interesting to note that also in Great recessions the joint occurrence of the deficit above 3% and the structural deficit above 0.5% is not very probable as the corresponding frequency is on average about 12% (up from 3.6% overall). The official EC methodology, however, again attaches a zero probability to such events. Only if the official EC methodology is combined with DSGE-estimated output gap, it attaches a positive probability, which is, however, overestimated by a factor of more than 2.

The results in Table 8 are already a good indication that the official EC methodology faces significant difficulties in providing a suitable tool for monitoring the provisions of the SGP. They do not, however, provide a full indications of potential procyclicality. Take for instance the second row of the upper panel of Table 8. It shows that on average the official EC methodology overestimates the true frequency of the breaches of the 0.5% SGP limit, but not by a large margin. If the SGP provision requires to revert back to below 0.5% structural limit, then the official EC methodology would signal such corrective measures on slightly too frequently. In other words, some of the signals for corrections would not be necessary. Note, however, that these might not be the only signals for unnecessary corrective measures. Namely, what the numbers in Table 8 do not reveal is whether the signals for corrective measures occur simultaneously. In our simulation experiment we can easily check for concordance of signals for SGP limit breach. The results are presented in Table 9.

In Table 9 we look at what the EC methodology (with all three estimators of the output gap) signals about the violation of SGP 0.5% of GDP structural deficit limit and verify whether the signal is correct by comparing it to the true signal in the model where non-cyclical (discretionary) changes in budget deficit occur through the fiscal rule.

Table 9: *Monitoring SGP structural deficit provision with the official EC methodology (% of periods)*

Structural deficit		**Model wrt**		
Model (true state)	Signal with EC methodology	Output gap estimation HP	PF	DSGE
Whole sample				
< 0.5	< 0.5	46.77	47.06	35.30
> 0.5	> 0.5	22.85	23.09	18.18
> 0.5	< 0.5	11.86	11.63	16.54
< 0.5	$> 0.5^*$	18.52	18.23	29.98
Disaccordance		30.38	29.85	46.52
Mis-signal probability		28.35	27.89	45.89
Great recessions				
< 0.5	< 0.5	25.37	27.13	35.05
> 0.5	> 0.5	35.15	34.94	20.95
> 0.5	< 0.5	5.30	5.51	19.50
< 0.5	$> 0.5^*$	34.18	32.41	24.50
Disaccordance		39.48	37.93	44.00
Mis-signal probability		58.22	55.21	41.73

Notes: * - mis-signals.
The entries to the table represents shares (in %) of periods with a given combination of the signal given by the EC method and the true structural deficit in the model. *HP* - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

Results show that on average in more than 30% of the cases the EC methodology, using either PF or HP for output gap estimation, incorrectly signals whether the SGP limit on structural deficit is violated or not. Mis-signalling a violation of SGP limit occurs in 18% of periods. The probability that the EF method mis-signals a violation of SGP given that does not occur is almost 30%. In other words, almost every third instance in which fiscal policy fully complies with the provisions of the SGP is incorrectly classified as a violation. Using a non-smooth measure of trend output from the DSGE model makes things worse, as the level of mis-signals reaches almost 30%, with corresponding probability equal to 45%.

The level of dis-accordance is larger in Great recessions. Mis-signaling frequency also increases to about one third in Great recessions. The corresponding conditional probability is over 50%. This shows that the EC methodology is particularly ill-designed for significant economic downturns, as it would inhibit countries with sound public finances to use fiscal policy for more than necessary stabilization. Interestingly, using a non-smooth trend to estimate the output gap decreases both the dis-accordance and mis-signalling frequency.

Mis-signalling the violation of the SGP limit bears potential negative welfare implications of. To evaluate the extent of pro cyclicality induced by mis-signals of actual policy stance we do the following. For each mis-signalled SGP violation we compute the difference between the estimated structural deficit (as share of GSP) and 0.5. This gives time series of notional corrections (a cut in government consumption) that would be needed in order to comply with the provisions of the SGP.

Corrections are used to re-simulate the data. In the re-simulation we use exactly the same structural shocks that entered our original simulation, with the exception of government spending shocks. These are corrected for the estimated fiscal corrections described in the previous paragraph. Ii other words, we re-simulate the macroeconomic variables under the assumption that incorrectly identified breaches of the 0.5% structural deficit with the official EC methodology are immediately followed by the corrective actions.[19] Such a procedure yields different dynamics of variables than originally generated. The only source of differences between the two simulations are the restrictive fiscal shocks induced in periods of incorrectly identified violation of the 0.5% structural deficit limit, that is obtained with the EC methodology for estimating the CABB.

Table 10 compares the standard deviations of re-simulated variables and originally simulated variables. The entries to the tables are percent increases in the standard deviation of variables due to corrective measure that occur in case of mis-signals. We can observe that the mis-signaled corrections increase the standard deviations of all main variables under consideration. In other word, the fiscal tightenings implemented in wrong times increase macroeconomic instability.

Table 10: *Effect of fiscal tightening in case of mis-signals on macroeconomic stability: increase in standard deviations (in %)*

	Estimation approach		
	European Commission		
	Output gap		
	HP	PF	DSGE
GDP growth rate	4.25	3.63	37.03
Private consumption	2.86	2.65	24.32
Private investment	4.34	3.73	35.93
Government consumption	11.51	10.04	55.05
Inflation	7.28	6.63	54.74
Wages	1.46	1.36	22.25
Employment	7.07	5.82	18.01
Deficit	19.68	16.71	103.18

Notes: *Mis-signals* are cases when the official methodology wrongly points to a breach of the SGP structural deficit limit; Wages are in real terms; *HP* - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

We can note that the increase in volatility of variables is the largest in case of mis-signals obtained with the DSGE-based estimates of the output gap. This is an expected results. Trend output in the DSGE is not smooth and, as reported in Table 3, the output gap is also more volatile. Given that the EC methodology attributes a significant share of cyclical variation to discretionary policy, the estimated CABBs, which represent mis-signals are large in absolute terms. This implies that the required fiscal tightenings are frequent (29.9% of periods) and relatively large (4.5% of quarterly GDP on average). Consequently, the corresponding increase in the volatility of variables is larger. Note, however, that these results should not be interpreted as a realistic description of welfare cost of mis-signaling violations of the SGP rule. They should rather be

[19] As a robustness check we considered also fiscal corrections delayed one period. Our conclusions below remain valid. Results available upon request.

interpreted as a demonstrations of weaknesses of the EC methodology to determine the fiscal policy stance. The concept of non-smooth trend output is well founded in the literature. The correspondingly high volatility of the measure of output gap is just the other side of the same coin. If using such a concept of the output gap leads to unrealistic signals, both in frequency and size, of the corrections to comply with SGP provisions, this is more an indication of the problems of the EC approach to estimating the CABB than it is a problem of output gap measures. Indeed, the same model that the contains the non-smooth output trend delivers realistic variability of the budget deficit.

For the official EC approaches (the production function or the HP filter to estimate the output gap) the increases in standard deviations of variables are moderate, not exceeding 10%. The standard deviation of GDP growth, for example, increases by 3.6% when the mis-signals occur with the production function based estimation of the output gap. For the budget deficit the increase is more sizeable, almost 17%.

However, such corrections portray an increase in macroeconomic volatility due only to corrections in case of mis-signal, whereas in practice the fiscal adjustments are foreseen at each violation of the SGP limit. As seen from Table 8 these occur more frequently. The simulated effects on variability of variables for the case of corrections for every identified violation of the SGP are presented in Table 11. Because the corrections are now induced not only for the case of mis-signals with one of the variants of the official methodology, we simulated the effects also for the SGP violations identified by our model (last column of Table 11).

Table 11: *Fiscal tightening for each identified violation of the SGP fiscal rule: increase in standard deviations (in %)*

	Estimation approach			
	European Commission			Model
	Output gap			
	HP	PF	DSGE	
GDP growth rate	16.40	15.59	21.91	5.86
Private consumption	11.81	11.58	15.82	5.93
Private investment	17.05	16.28	17.84	7.90
Government con.	48.43	45.55	68.69	14.91
Inflation	28.55	28.05	31.73	14.19
Wages	0.30	0.21	2.51	0.06
Employment	22.56	19.70	38.65	3.03
Deficit	90.22	85.27	111.64	34.85

Notes: HP - Hodrick-Prescott filter; PF - production function approach; $DSGE$ - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

The increases in standard deviation of variables are sizable. For the SGP violations identified by the official EC methodology the standard deviation increases by more than 10% for each variable we report the results for. For GDP growth by more than 15%. Only for real wages the effect is moderate. For the deficit, on the other hand, the standard deviation is almost double. Similar to above, the destabilizing effect of fiscal tightenings are considerably larger if a more volatile measure of the output gap is used (DSGE-based gap). Most importantly, the effects of fiscal tightenings are considerable smaller if the CABB is measured directly with the DSGE (Model). This is due to the fact that the fiscal corrections are less frequent (36% relative to 42%, see

Table 8) and smaller on average (roughly 1.5% of quarterly GDP in case of FE or HP based EC method, relative to 0.9% of GDP in case of Model). Again, these differences are because the EC methodology attributes part of automatic variation in the budget to structural measures.

The corrections we induce in our re-simulation are realistic in size. In case of mis-signals by production function based EC methodology they are on average of 1.10% of (quarterly) GDP.[20] The average adjustment approved by the European Council for 20 EU countries in the EDP procedures (excluding Greece and Cyprus) in 2009 - 2016 is 1.11% of GDP. The average corrections for each violation of SGP identified by the same method are 1.5% of GDP. Moreover, the corrections are of one-off type, i.e. they are induced only in the quarter of mis-signal. In reality, however, the required corrections tend to be significantly more persistent. For the case of the fiscal efforts recommended by the European council to 20 EU countries in the EDP in 2009 - 2016 the average duration of recommendations was 4.5 years or 18 quarters. It is true that 2009 - 2016 is a specific period, a period of Great recession, but we document above that in such episodes the probability of mis-signals is also larger. This is why we consider the increases in standard deviations of variables as reported in Table 10 as the lower bound of likely negative effects in reality.

Clearly, for the Great recession of 2009 one cannot say that all of the required adjustments required by the European Commission is due to mis-signals. It is highly likely that a large share of deteriorations of budget deficits was due to discretionary measures. But this opens also the issue of the appropriateness of the SGP provisions as such and not only the issue of the methodology used to monitor them, which is the topic of the next section.

7. EU fiscal framework and an optimal simple fiscal rule

In Table 8 we report that if the structural deficit is kept below 0.5% of GDP, there is a very small probability of breaching the Maastricht deficit criterion. However, it is also possible to observe from the same table that quite a significant share of observations, 26%, are such that structural deficit is above 0.5%, while the overall deficit stays below 3% of GDP. This would suggest that the SGP limit might be too restrictive as even a larger structural deficit could be with a high probability consistent with providing a sufficient safety margin against breaching the Maastricht deficit criterion.

The macroeconomic consequences of the SGP provisions are analysed by means of an optimal expenditure fiscal rule. Boostrapping procedures so far used the expenditure fiscal rule estimated on Austrian data. For the estimated DSGE model we can compute the optimal coefficients of the fiscal rule with the same structure by specifying an objective function for fiscal policy. By simulating macroeconomic dynamics boostrapping the same structural shocks as in the basic simulation under the optimal expenditure rule we can evaluate how budget deficit and the structural deficit behave optimally. Optimal policy is fully consistent with the main SGP objectives. Besides the fact that the government remains solvent with balanced budget over the business cycle, it also delivers efficient macroeconomic stabilisation. In this respect, we can evaluate whether the SPG limit on structural budget deficit and the Maastricht limit on headline budget deficit can deliver solvency and stabilization efficiency.

[20] In the case of HP-filtered output gap, the average correction is similar, 1.17% of quarterly GDP.

The estimated expenditure fiscal rule is

$$g_t = 0.75 g_{t-1} - 0.25 \left(\hat{\pi}_t - \widehat{\overline{\pi}}_t^c\right) - 0.04 \hat{y}_t - 0.24 b_t - 0.26 def_t + \varepsilon_{g,t}, \tag{3}$$

where the parameters correspond to posterior means. In specifying the optimization problem for fiscal policy we borrow from monetary policy literature and use

$$min_{g_t} \left(y_t^2 + \pi_t^2\right), \tag{4}$$

where y represents the deviation of output from the trend value and π stands for CPI inflation. Fiscal policy thus attempts to stabilise the cyclical variation of output and inflation with equal weights.[21]

The coefficients of the optimal expenditure fiscal rule for our DSGE model are

$$g_t = 0.89 g_{t-1} - 0.25 \left(\hat{\pi}_t - \widehat{\overline{\pi}}_t^c\right) - 0.35 \hat{y}_t - 0.47 b_t - 0.27 def_t + \varepsilon_{g,t}. \tag{5}$$

One can observe that there are only two substantial changes relative to estimated coefficients. For macroeconomic stabilization it seems better to have public consumption more persistent and to put a higher weight to output and public debt stabilization. Under the optimal simple rule fiscal policy reacts more aggressively to cyclical downturns, but also more aggressively reverts spending in response to higher deficit that the higher effort to stabilize output produces.

What the optimal simple fiscal rule implies for the the cyclically adjusted budget balance and overall budget balance is presented in Table 12. For easier comparison the table reproduces also the corresponding results obtained with the estimated fiscal rule. We can observe that under the optimal fiscal rule the cyclically adjusted budget balance on average even slightly improves in the model (true state) and according to both EC methods (PF and HP methods to estimate the output gap). It is, however, significantly more volatile, which is an expected result given that the optimal rule implies a more active policy. Same observation applies to periods of Great recessions. The overall budget deficit on average slightly worsens, but is balanced on average. Interestingly, the average budget deficit in Great recessions improves.

Table 12: *CABB and budget balance under the optimal simple rule (in % of GDP)*

CABB		Estimated fiscal rule				Optimal fiscal rule			
		Whole sample		**Great recessions**		**Whole sample**		**Great recessions**	
Estimation approach	**Output gap**	mean	stdev	mean	stdev	mean	stdev	mean	stdev
EC	**HP**	−0.16	1.95	−1.76	1.44	−0.03	2.20	−1.59	1.98
	PF	−0.16	1.86	−1.59	1.41	−0.03	2.16	−1.37	1.98
	DSGE	0.23	3.87	1.10	2.36	0.22	4.89	2.73	3.58
Model	-	0.00	1.27	−0.17	1.20	0.11	2.19	0.08	1.93
Budget balance		0.18	1.97	−2.02	1.40	−0.03	2.20	−1.73	1.93

Notes: HP - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

As mentioned, an improved budget balance on average is achieved with more active fiscal policy.

[21] We checked robustness of our results against unequal weighting. Using a smaller weight on output as is common in monetary policy literature leaves our results virtually unchanged. Results available upon request.

What a more active policy implies about compliance with the Maastricht and SGP criteria is presented in Table 13). Under the optimal rule the frequency of SGP violations increases by almost 7 percentage points both across all simulated periods and Great recession (compare columns labelled Model). The frequency of signals obtained with the EC methodology remains virtually unchanged under the optimal rule on average and even decreases in Great recessions. A higher frequency of SGP violation is, however, accompanied by a smaller frequency of the violations of the Maastricht 3% on overall budget deficit. The decrease is about 3 percentage points both on average and Great recessions. Using a more active discretionary policy therefore more effectively stabilizes the deficit and, consequently, debt. In the previous section we saw that sticking with the 0.5% limit on structural deficit increases macroeconomic instability. In this section we see that it also decreases the probability of fulfilling the Maastricht criteria. This is just the opposite of the intent of SGP provisions.

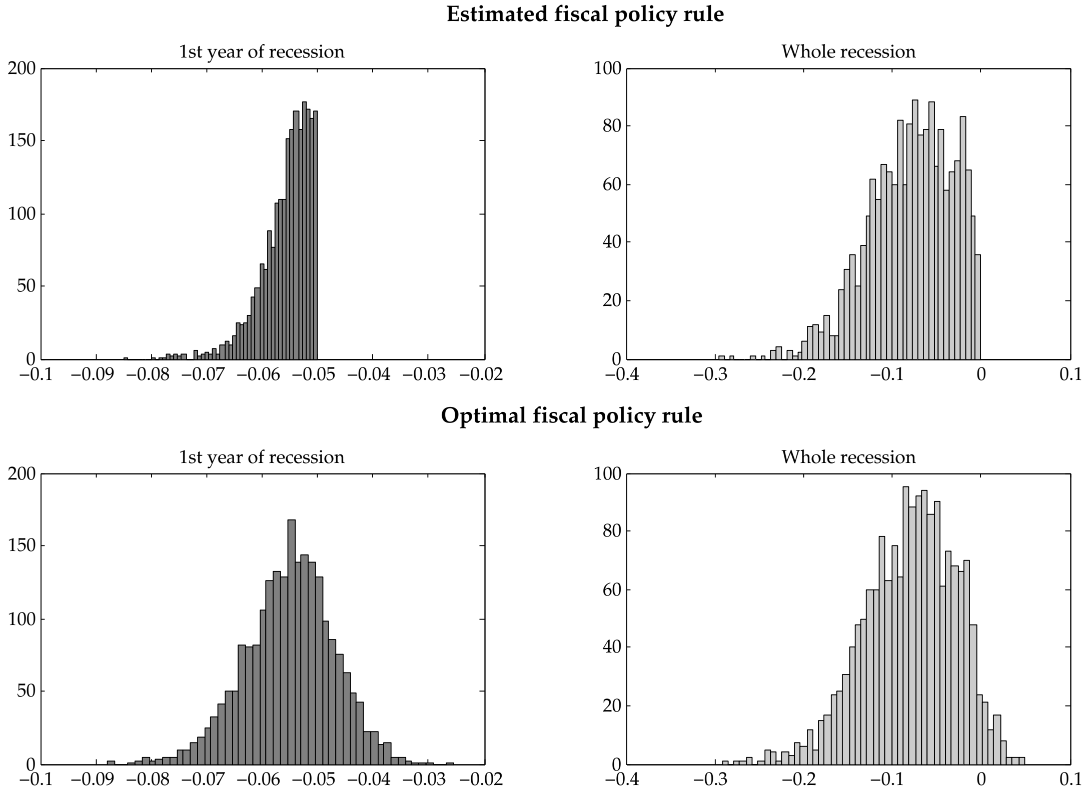
Clearly, the optimal fiscal rule cannot deliver a higher average growth rate on average. It improves, however, the stabilization efficiency of fiscal policy. An illustration of what this represents for output stabilization in Great recessions is presented in Figure 1. The Figure plots the distribution of cumulative changes in GDP across recessionary periods in the first year of the recession (left panel) and the entire duration of the recession (right panel). We can observe that under the optimal rule the distribution shifts to the right. This implies on average shallower and shorter Great recessions. Note also that in our simulation the stabilization efficiency of fiscal policy is independent of the phase of the business cycle and/or monetary policy stance. In other words, the fiscal multiplier is constant in time. The fiscal multiplier, can be larger in recessions (Auerbach and Gorodnichenko, 2012) and when the central bank instrument is at the zero-lower bound (Woodford, 2010). In such a case, our results would only be reinforced.

Table 13: *Frequency of violations of the SGP criterion under estimated and optimal fiscal rule (in %)*

		Estimated fiscal rule				**Optimal fiscal rule**			
		Estimation approach							
Deficit (% GDP)		European Commission Output gap			Model	European Commission Output gap			Model
Total	Structural	HP	PF	DSGE		HP	PF	DSGE	
		Whole sample							
≥ 3		12.28				9.52			
	≥ 0.5	41.85	41.75	41.85	34.66	41.17	41.28	41.17	42.19
		Great recessions							
≥ 3		32.17				29.36			
	≥ 0.5	72.35	70.03	66.38	41.29	65.81	62.87	53.49	48.30

Notes: HP - Hodrick-Prescott filter; *PF* - production function approach; *DSGE* - DSGE output gap; *Model* - the cyclical and structural (cyclically adjusted) components directly from the DSGE model.

Figure 1: Distribution of cumulative growth rates in periods of Great Recessions under the estimated and optimal expenditure fiscal rule



8. Conclusion

The EMU decentralized fiscal policies are subject to common fiscal rules. The Maastricht Treaty requires member states not to violate the 3% GDP deficit limit, while the Stability and Growth Pact (SGP) demands from member states a structural deficit of 0.5% GDP at most, in order to be able to fully attain the Maastricht deficit rule. The SGP, legislated in order to complement and tighten fiscal requirements laid down in the Maastricht Treaty, represents the pillar of fiscal discipline in EMU. However, both fiscal rules share the same goal, i.e. the reduction of budget deficits to close to balance or in surplus after which the automatic stabilizers should be left to work freely.

When assessing the structural budget balance, the European Commission relies on the cyclically adjusted budget balance and the underlying fiscal policy stance. This paper investigates the effectiveness of the CABB as a measure of discretionary fiscal policy and compares the official method of computation with a DSGE model-based measure, obtained directly from the model with no need for estimations. We build on a model of Adolfson et al. (2007) by adjusting its government sector. On one hand, we discerned different tax components as well as social security contributions, and singled out social transfers and benefits from the total government spending. On the other hand, the assumption that the budget balance is not equal to zero allows for public deficit and debt. Such a structural representation of fiscal policy (i.e. fiscal policy rule) allows for measurement of fiscal shocks and reactions of policy to the cycle. It is worth emphasizing that the official methodology contains a structural model in the sense that it combines the production function with the Phillips curve for example, but does not contain a structural representation of what it is craving for: fiscal policy.

Our results indicate that the EC methodology for CABB estimation tends to attribute a significant share of cyclical variation in the budget to discretionary policy measures. As a consequence, the EC methodology frequently fails to identify the true fiscal policy stance and also frequently fails to signal correctly potential violations of the SGP limit on structural deficit. If the official methodology is used to trigger corrective fiscal contractions in order to comply with the SGP the result is increased macroeconomic instability.

These findings can be attributed to methodological weaknesses of official CABB estimation, which is centered heavily on filtering cyclical variation, but does not include an explicit description of discretionary fiscal policy. For this reason our results suggest that the EC methodology should be augmented to include one.

Our simulation experiment allows us to asses whether the SGP provisions allow for effective stabilization policy. By computing an example of an optimal simple rule for our estimated DSGE model we show that allowing for a bigger role for stability-oriented discretionary policy and thus relaxing the SGP limit on structural deficit could enhance the stabilization efficiency of fiscal policy, while simultaneously increasing the compliance with the Maastricht Treaty. Such a "free lunch" result is clearly conditional on the fact that in our model the budget is on average balanced by construction and the government has no "spending bias" that leads a trend increase in the indebtedness of the economy. These are all issue that a robust fiscal framework should address. Nevertheless, our analysis signals a direction a potential revision of the EU fiscal framework should take.

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Appendix A Description of data

Table A1: *Data definition and sources*

Symbol	Definition	Country	Source and code
Y_t	*GDP*: Gross domestic product in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	AT	Eurostat: namq_gdp_k Code: B1GM
C_t	*Private consumption*: Household and NPISH final consumption expenditure in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	AT	Eurostat: namq_gdp_k Code: P31_S14_S15
G_t	*Government consumption*: Final consumption expenditure of general government in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	AT	Eurostat: namq_gdp_k Code: P3_S13
I_t	*Investment*: Gross fixed capital formation in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	AT	Eurostat: namq_gdp_k Code: P51
X_t	*Exports*: Exports of goods and services in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	AT	Eurostat: namq_gdp_k Code: P6
M_t	*Imports*: Imports of goods and services in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	AT	Eurostat: namq_gdp_k Code: P7
x_t	*Real exchange rate*: Real Effective Exchange Rate, consumer price indices deflator, 2000=100, 17 trading partners, Euro Area.	AT	Eurostat: ert_eff_ic_q Code: NEEREA17
W_t	*Wages*: Labour cost index for wages and salaries in industry and services (except public administration and community services; activities of households and extra-territorial organizations), 2000=100, seasonally adjusted.	AT	Eurostat: lc_lci_r1_q Code: D11
π_t^d	*GDP deflator*: GDP price index, 2000=100, seasonally adjusted.	AT	Eurostat: namq_gdp_p Code: B1GM, CPI00_NAC
R_t	*Short term interest rate*: 3–month short term interest rates in percent.	AT	Eurostat: irt_h_mr3_q Code: 3MR
E_t	*Employment*: Total employment (residence population concept – LFS) in 1000.	AT	Eurostat: lfsi_emp_q Code: EMP_LFS
Y_t^f	*Foreign GDP*: Gross domestic product in millions of euro, chain-linked volumes, reference year 2000, seasonally adjusted.	EA	Eurostat: namq_gdp_k Code: B1GM
$\pi_t^{d,f}$	*Foreign inflation*: GDP price index, 2000=100, seasonally adjusted.	EA	Eurostat: namq_gdp_p Code: B1GM, CPI00_NAC
R_t^f	*Foreign interest rates*: 3–month money market interest rate in percent.	EA	Eurostat: irt_st_q Code: MAT_M03

Source: Authors' systematization.