Finding the Bottom Line: A Quantitative Model of the EU's Fiscal Rules and their Compliance

Tero Kuusi*

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Abstract

The EU's new fiscal framework is complex. It includes multiple rules and target measures that steer fiscal policy both in the short and long term. While the complexity may be necessary, it is not without problems, as ambiguous fiscal rules are hard to communicate, implement, and enforce. To provide more clarity, this paper uses a dynamic simulation model to quantify the constraint that the rules impose on fiscal policy during consolidations. In particular, the simulator quantifies multi-year adjustment programs that minimize the need of fiscal adjustments while being compliant with the key elements of the framework. By using the European Sovereign Debt Crisis data, the paper shows that the model is consistent with the actual consolidation programs. The paper also finds that revisions of the economic forecasts have a large effect on the simulated adjustments and may increase policy volatility. Furthermore, the results of this paper suggest that the use of appropriate output responses of the fiscal policy can help to anticipate the change in economic conditions and thus to avoid the resulting policy volatility.

Keywords: Fiscal Policy, Fiscal Rules, EMU.

JEL Classifications: E62, H60, H77.

1 Introduction

The recent reforms of the EU's fiscal framework have aimed at stronger control of the long-term sustainability of public finances, while at the same time leaving scope for counter-cyclical fiscal policy. These aims are justifiable, but in practice the framework is obscured by the multiplicity of rules and target measures that steer the member states' fiscal policy both in the short and

*The Research Institute of the Finnish Economy (ETLA). Email address: tero.kuusi@etla.fi. This study has been funded by the Horizon 2020 Framework Programme of the European union under the grant agreement number 649261 (the Firstrun project). I would like to thank Niku Määttänen, Guido Traficante, Tarmo Valkonen, Vesa Vihriälä, Jukka Lassila, as well as the participants in the seminars organized by the Finnish Ministry of Finance, FIRSTRUN, JYU, and ETLA for their useful comments

long term.[1] A clearer view is necessary to enhance the functioning of the EU framework, as ambiguous fiscal rules are hard to communicate, implement, and enforce. The ambiguity limits the usefulness of the rules and may bring about macroeconomic uncertainty (Eichengreen 2005; Ferré 2008, 2012).

This paper contributes to the previous literature by providing practical guidance on how to *objectively* assess the size of the necessary adjustments. The paper uses a dynamic simulation model that quantifies the constraint that the rules impose on fiscal policy during consolidations. In particular, the simulator estimates multi-year adjustment programs that minimize the need of fiscal adjustments while being compliant with the key elements of the framework. The rules are analyzed collectively, i.e. they are introduced together as constraints to a mathematical minimization problem. They govern different parts of an adjustment program towards the fiscal targets at the end of the adjustment including requirements for the pace of adjustment (the deficit rule and the flexibility guidance), the target at the end of the program (the debt convergence rule and the medium-term objective of the structural balance MTO), and deadlines (the debt transition rule).

This paper shows that the collective approach has merits. When the simulator is used to analyse fiscal policy during the European Sovereign Debt Crisis, the simulated fiscal adjustments (in structural balance terms) fit well with the actual adjustment programs. In particular, the results show that the strong fiscal adjustment in the EDP programs of the early 2010 corresponds well with the simulated minimum adjustments based on the economic forecasts of the same time period. The approach extends the previous literature that has mainly devoted to the analysis of individual minimum rules of the framework, or focused on the identification of fiscal effort and shortcomings of using the structural balance (see, e.g., Eyraud and Wu 2015; Barnes et al. 2016; Claeys et al. 2016). A key problem has been that the observed adjustments have typically exceeded the statutory minimum of the individual rules.[2] Thus, the interplay of the rules has to be considered in order to better understand their functioning.

In addition to providing the collective analysis of the rules, this paper studies the role of the underlying economic forecasts in determining the minimum adjustments. It considers the actual economic forecasts to analyze how the data revisions affect the required size of the simulated

[1] The new rules include the so-called six-pack of legislative measures and a new treaty incorporating the fiscal compact that aim at strengthening the procedures to reduce public deficits and address macroeconomic imbalances. The rules consist of several target measures: the headline deficit, the debt-to-GDP ratio, the structural budget balance, and government expenditure. Furthermore, there are explicit convergence rules for the debt-to-GDP ratio and the structural budget balance, and there is a mix of headline and cyclically-adjusted measures.

[2] For example, in most of excessive deficit procedures that started in the year 2009, the required adjustment was faster than the framework's minimum (0.5 % of GDP per year in structural terms), especially for countries that faced acute debt sustainability problems.

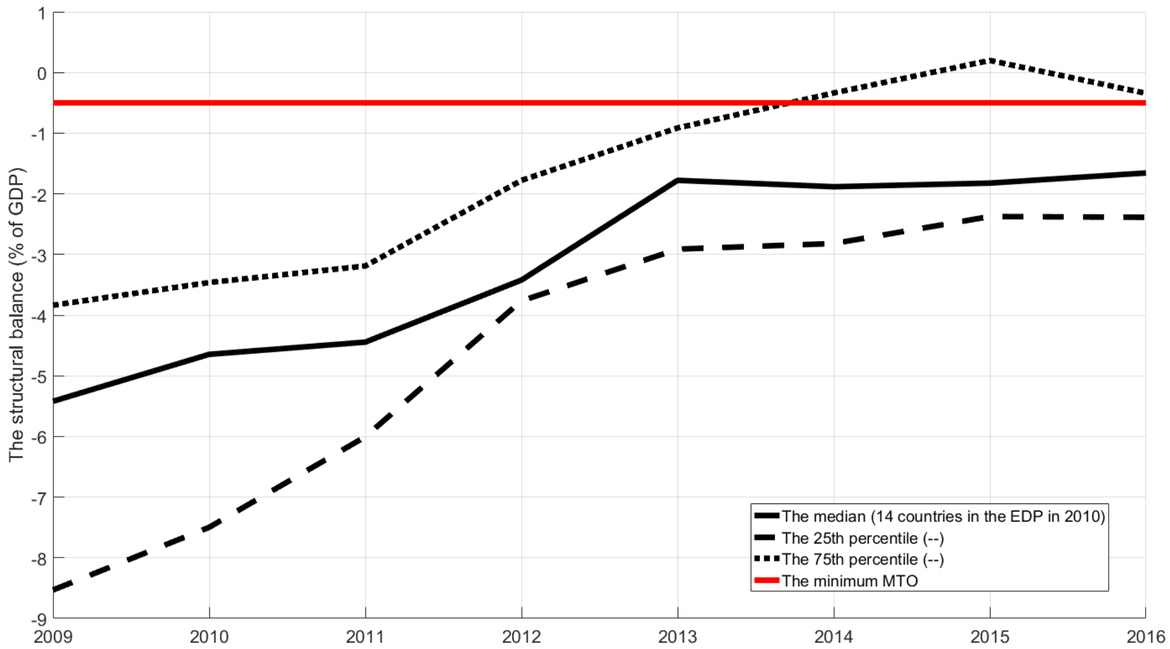

Figure 1: The adjustment of structural balance 2009-2016 for 14 Euro area member states that were in the EDP in the early 2010: Austria, Belgium, Cyprus, France, Germany, Greece, Ireland, Italy, Malta, Netherlands, Portugal, Spain, Slovakia, Slovenia.

adjustments, and also endogenizes economic forecasts so that they take into account the output response of the fiscal policy. The endogenous output responses are modelled by using a state-of-the-art framework: regime-switching SVAR model by Auerbach and Gorodnichenko (2012) and the fiscal policy simulation framework by Kuusi and Keränen (2016).

The current analysis suggests that the worsening of the economic outlook after the early 2010s have validated a slowdown of fiscal adjustment similar to what has been experienced in the countries that entered the excessive deficit procedure (EDP) in the early 2010 (see, Fig. 3). Thus, while this slowdown potentially undermines the credibility of the framework, as the adjustment towards the frameworks minimum medium-term fiscal objectives is still under way, the results suggest that it is in accordance with the fiscal framework. Furthermore, the results of this paper suggest that the use of appropriate output responses of the fiscal policy can help to anticipate the change in economic conditions, and help to avoid the resulting policy instability. Thus, it seems that the economic outcomes be anticipated already during the planning of the fiscal adjustment and recurrent policy mistakes can be avoided,

This paper is organized as follows. Section 2 outlines the key fiscal rules used in the simulator. Section 3 introduces the methodology, and Section 4 describes the used data. Section 5 applies the simulator, and Section 6 concludes.

Enforcement mechanism	Fiscal measure bound by the rule	Rule/correction
Corrective arm of the SGP, the excessive deficit procedure triggered by non-compliance	General gov. budget deficit (”deficit rule”)	not higher than 3 %
		If higher, the structural balance (SB) to be adjusted by min 0.5 pps per year
	General gov. gross debt (”Debt convergence rule”)	not higher than 60 % of GDP
		If higher, debt in excess of the 60% of GDP to be reduced by 1/20th per year
	General gov. gross debt (”transition debt rule”)	Compliance with the debt benchmark by the end of 3rd year following exit from the EDP.
Preventive arm of the SGP + Fiscal compact	The SB (”MTO/SB rule”)	not lower than the medium-term objective (MTO)
		If the MTO is not achieved, the adjustment follows the ”flexibility guidance”.
	General gov. expenditures (”the expenditure rule”)	Growth of expenditures net of discretionary revenues not higher than long-term output growth
		0.5 pps adjustment per year

Table 1: Source: Barnes et al. (2016), but updated with the flexibility guidance

2 A description of the key fiscal rules

In recent years, a few descriptions of the new fiscal framework has been written. This section collects the individual elements and shortly discusses them. The approach is mostly related to the literature that aims to assess the functioning of the rules (Eyraud and Wu 2015; Barnes et al. 2016; Claeys et al. 2016). Building on the previous literature, the key elements of the framework are collected in Table 2. The table follows closely Barnes et al. (2016) with the main exception being the inclusion of the flexibility guidance that governs the pace of fiscal adjustment in the preventive part of the SGP (see Fig. 2) based on European Commission (2015, 2016).

The preventive arm of the SGP is applied when the 3 and 60% deficit and debt criteria of the excessive deficit procedure criteria are not breached. Its objective is to promote sound public finances and to ensure the sustainability of public finances of the Member States (European Commission, 2016). The preventive arm obliges the member states to set a medium-term objective (MTO) for their fiscal policy. The target is set in terms of the structural budget balance (SB). The SB measures the budgetary position of the public finances, when the effects of economic cycles and one-off expense and income items are eliminated (Mourre et al., 2013; Havik et al., 2014).

The lower limit of the MTO for countries in the Eurozone was set to a structural budgetary position of -0.5%, except in the case of countries whose debt is less than 60% and which do not

		Required annual fiscal adjustment*	
	Condition	Debt below 60% and no sustainability risk	Debt above 60% or sustainability risk
Exceptionally bad times	Real growth <0 or output gap <-4	No adjustment needed	
Very bad times	-4 ≤ output gap <-3	0	0.25
Bad times	-3 ≤ output gap < -1.5	0 if growth below potential, 0.25 if growth above potential	0.25 if growth below potential, 0.5 if growth above potential
Normal times	-1.5 ≤ output gap < 1.5	0.5	> 0.5
Good times	output gap ≥ 1.5%	> 0.5 if growth below potential, ≥ 0.75 if growth above potential	≥ 0.75 if growth below potential, ≥ 1 if growth above potential

* all figures are in percentage points of GDP

Figure 2: Flexibility guidance

have long-term sustainability risks (in which case the lower limit is -1%).[3] Furthermore, the preventive arm uses the structural budgetary position and the increase in spending to assess deviations from the MTO or from the path towards it. If the country has not achieved its MTO, the adjustment towards the required objective must be at least 0.5% of the GDP on an annual basis, in such a manner, however, that the adjustment effort is higher in good times and lower in bad times. At present, the adjustment towards the MTO is defined in accordance with the European Commission's matrix of required annual fiscal adjustments (European Commission 2015, appendix 2).

Compliance with the preventive arm of the Pact should ensure that countries are kept out of the corrective arm - also referred to as the Excessive Deficit Procedure (EDP) - under all except the most unusual of circumstances. Therefore the EDP ought not to be thought of as being part of the normal budgetary procedure in the Member States, but as being the end of

[3]The MTO links the rules to the long-term sustainability assessments of the public economies, since the MTO is evaluated every 3 years as based on a long-term sustainability indicator that estimates the level of debt of public economy and the ageing of the population. For more information on the estimation of the MTO, see European Commission (2016).

the line where previous budgetary policy errors are rectified. (European Commission 2016)

The corrective arm is applied, when the 3 and 60% deficit and/or debt criteria are breached. In such a case, the Council makes a decision on an excessive deficit and approves recommendations for the member state to amend such a deficit. These recommendations define a path towards a nominal deficit, the required annual improvement of the SB (usually 0.5% of GDP) and the deadline for amending the excessive deficit. Furthermore, countries are required to converge towards the 60% of GDP debt target at a sufficient pace. A numerical debt reduction benchmark is set whereby the excess of debt over 60% of GDP must be reduced by 1/20 each year after a three-year transition period following the abrogation of an excessive deficit procedure (EDP). The debt benchmark is governed by three conditions, and to reach compliance with the benchmark, at least one of them has to hold (European Commission 2016).

While this paper mostly focuses on programs that meet the aforementioned requirements, it is worth noticing that the rules also include margins that define a deviation from the requirements. The MTO is considered to have been achieved if the structural balance deviates from the objective by less than 0.25% of GDP. When the MTO has been achieved, it must be continuously adhered to. It is notable that the assessment of the SGP's preventive arm deviates with respect to the ex post, in-year and ex ante evaluation. Based on the preventive arm the assessment of the sufficiency of measures, particularly over the last year (ex post), is the key issue. In the ex post evaluation, the significant deviation procedure can only be applied if the deviation from the MTO in the previous year was more than 0.25% of the GDP. Furthermore, a significant deviation from the required structural adjustment path must be observed - at least 0.5% of GDP in one year, or 0.25% of GDP in two subsequent years - as compared to the adjustment path. The deviation assessment is performed on the basis of both the structural balance and the spending benchmark, while taking account of the cyclical state. According to the spending benchmark, public spending may only grow at the same rate as the potential medium term GDP used as the reference. Unlike the SB, the spending rule evaluate potential production in the medium-term, cyclical spending items are subtracted from public spending more directly than in assessments based on an output gap or standard cyclic elasticity, and the revenue trend is measured based on the observed decisions on the revenue basis and assessments of their effects (See, e.g., Kuusi 2017 for details).

In the excessive deficit procedure of the corrective arm, the deviation from the corrective path is considered significant, if the deviation is more than 0.5 pps in one year, or 0.25 in two adjacent years. The effectiveness of corrective measures is assessed not only via the SB, but also in terms of the number of discretionary measures in question. In practice, such an assessment is based on a method that resembles the expenditure rule very closely. Using this method, cyclical items are eliminated from the expenditure trend, which is then compared to the medium-term growth of potential production, taking account of changes in the revenue basis (bottom up assessment).

3 Methodology

The key innovation of this paper is to introduce the rules as constraints to a mathematical simulation model. The average change of the structural primary balance (i.e., the public balance excluding the interest expenditures and cyclical budget items) during an adjustment program is minimized with respect to unknown features of the program.

A general discussion of the approach is warranted. First, it seems natural to introduce the rules as constraints to a dynamic simulation model. As Fig. 3 illustrates, the rules govern different parts of an adjustment path towards the fiscal targets at the end of the adjustment. They include requirements for the pace of adjustment (the deficit rule, the flexibility guidance), the target at the end of the program (the debt convergence rule, the MTO), and individual time lines (the debt transition rule). To answer what the rules actually imply in different situations, it is a good starting point to ask how large is the minimum effort that is necessary to achieve all of the individual requirements.

Second, the minimization of fiscal measures also strikes as a reasonable modelling choice. The approach emphasizes the role of the rules as constraints to fiscal policy. A large literature on the governance of fiscal policy stresses the role of fiscal rules in curtailing political incentives to adopt policies likely to benefit the policy-makers rather than the interests of the economy (Begg, 2016). It encompasses issues such as the nature of the contract between citizens as principals and their governments as their agents, the most appropriate design of institutions, and transparency. Moreover, in practice rules have impose stricter fiscal policy than in the past. As the analysis in the Appendix shows, the initial response of the crisis countries was stronger than the historical reference based on fiscal response functions and pre-2008 data for the same countries. Thus, the rules seem to have had a binding effect on fiscal policy.

Third, the (cyclically-adjusted) primary balance is typically used to measure the size of the fiscal consolidations. A large literature has devoted to analyze the pace and total amount of fiscal adjustment using this metrics both in the historical context and during the current crisis. (see, e.g., Guichard et al. 2007; OECD 2012; Rawdanowicz 2014; Ali Abbas et al. 2013; Eyraud and Wu 2015; Barnes et al. 2016). It is worth noticing, however, that alternative policy goals

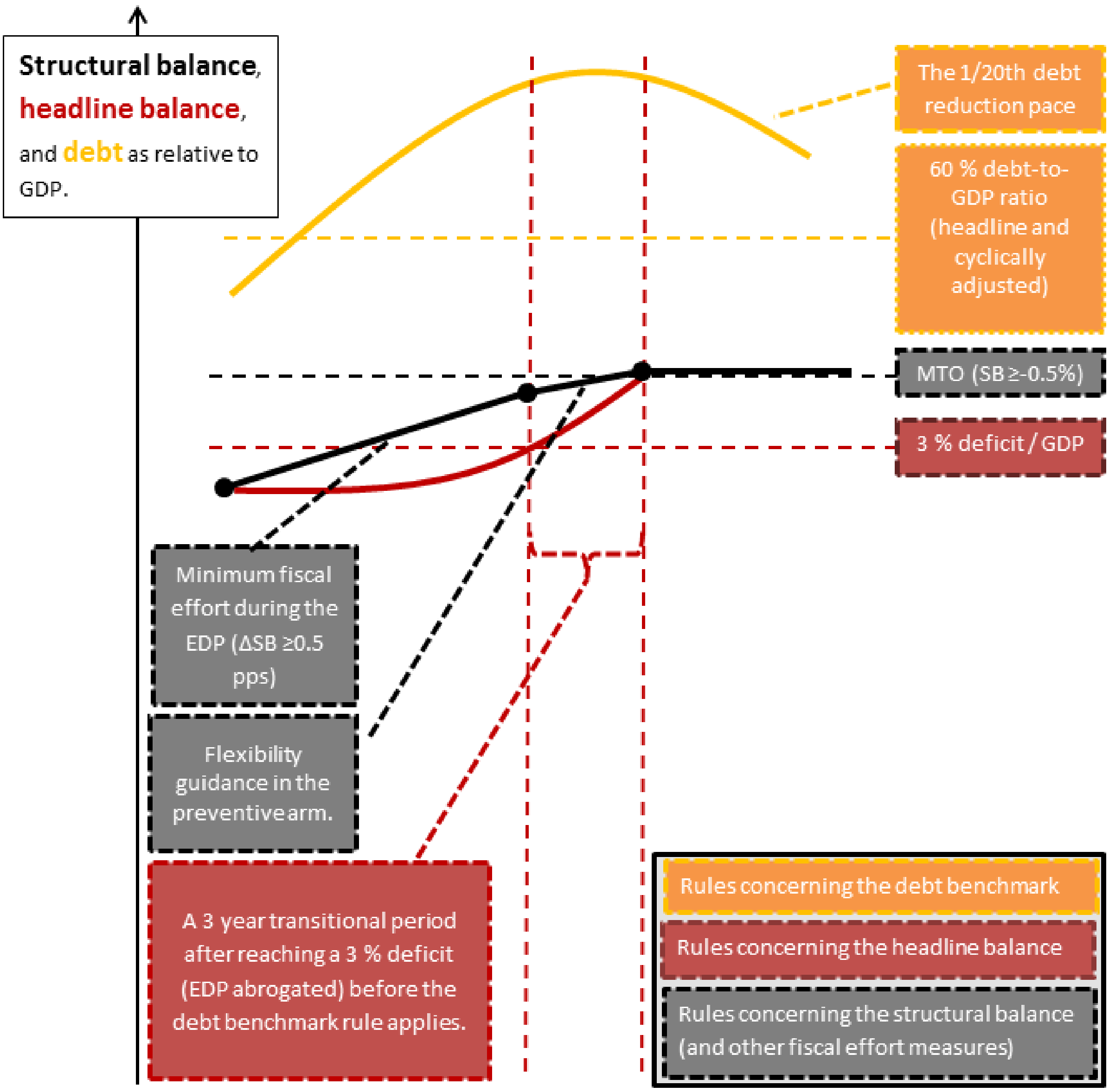

Figure 3: An illustration of the dynamic interactions between the rules

have also been considered in the previous literature.[4]

3.1 Variable definitions

Before formulating the problem mathematically, it is worthwhile to define a few key variables used in the analysis. First, the structural balance (SB) is determined as the difference between the actual budget position and the cyclical effect in proportion to GDP net of one-off spending measures. With the time variable t defined in annual terms in this subsection,

[4]A literature on the measurement of the fiscal effort has also discussed alternative metrics than the cyclically-adjusted primary deficit, such as discretionary fiscal effort (Perotti 2011; Carnot and de Castro 2015; Kuusi 2017). In terms of the optimization, alternative examples have been maximization of the present value of GDP or debt stock, or the minimization of GDP's variance minimized (see, e.g., Rawdanowicz 2014; Fletcher and Sandri 2015)

$$\frac{SB_t}{GDP_t} = \frac{PB_t}{GDP_t} - \frac{i_t * D_{t-1}}{GDP_t} - \xi * OG_t + OO_t \tag{1}$$

where the primary balance PB_t measures the general public balance B_t net of the interest rate expenses. The cyclical correction is the product of the output gap OG_t and the (semi)elasticity between the output gap and budgetary balance, ξ. In addition, the headline budgetary position is adjusted in proportion to GDP by using the effect of certain one-off revenue and spending items, OO_t. The (annualized) interest expenditures are defined for a given initial gross government debt (D_{t-1}), and a path of the interest rate of the public debt (i_t). Second, the debt accumulation equation is

$$D_t = D_{t-1} - B_t + sfa_t \tag{2}$$

where the second term is the headline budgetary position B_t, and the last term is the exogenous stock-flow adjustments of the government debt (sfa_t).

The debt benchmark is governed by three conditions. First, the differential of debt with respect to the reference value has decreased over the past three years at least at an average rate of one-twentieth as a benchmark, which is measured by an excess of the debt ratio reported for the year t over a backward-looking element of a benchmark for debt reduction computed as follows (DD = debt benchmark)

$$\begin{aligned} DD_t = {} & 0.6 + (0.95)/3(D_{t-1}/(GDP_{t-1} - 0.60) \\ & + 0.95^2/3(D_{t-2}/GDP_{t-2} - 0.60) + 0.95^3/3(D_{t-3}/GDP_{t-3} - 0.60) \end{aligned} \tag{3}$$

Second, the budgetary forecasts as provided by the Commission services indicate that, at unchanged policies, the required reduction in the differential will occur over the three-year period encompassing the two years following the final year for which the data is available, which is measured by an excess of the debt ratio forecast by the Commission services for the year t+2 over a forward-looking element of a benchmark for debt reduction computed as follows

$$DD_{t+2}^f = 0.6 + (0.95)/3(D_{t+1}/(GDP_{t+1} - 0.60) \\ + 0.95^2/3(D_t/GDP_t - 0.60) + 0.95^3/3(D_{t-1}/GDP_{t-1} - 0.60) \quad (4)$$

Third, the breach of the benchmark can be attributed to the influence of the cycle, to be assessed according to a common methodology to be published by the Commission. In particular, the Commission shall use a cyclically adjusted debt measure (with C denoting the cyclical component of the budget, g^{pot} the potential output, and p the GDP inflation)

$$\tilde{D}_t = \frac{D_t + \sum_{j=0}^{2} C_{t-j}}{GDP_{t-3} \prod_{h=0}^{2}(1 + g_{t-h}^{pot})(1 + p_{t-h})} \quad (5)$$

3.2 The implied minimum adjustment

The minimization program is solved with respect to two unknown variables: The change of the structural balance during the EDP phase of the program (x), and the total length of the adjustment program (τ). The program is started from initial economic and fiscal conditions at year 0:

$$\min_{x,\tau}[\frac{CAPB_\tau - CAPB_0}{\tau}] \tag{6}$$

so that

the adjustment pace exceeds the minimum in the EDP / preventive arm:

$$\frac{SB_t}{GDP_t} - \frac{SB_{t-1}}{GDP_{t-1}} = \begin{cases} x \geq 0.005 & \text{if } \frac{B_t}{GDP_t} < -0.03 \text{ and } 0 < t \leq \tau \\ \text{Flex. guidance} & \text{if } \frac{B_t}{GDP_t} \geq -0.03 \text{ and } 0 < t \leq \tau \\ x \geq 0.005 & \text{if flex. guidance indetermined,} \end{cases} \tag{7}$$

while the MTO and the debt benchmark are reached at the end of the program:

$$\frac{SB_\tau}{GDP_\tau} \geq MTO \tag{8}$$

$$\min\big(\frac{D_\tau}{GDP_\tau} - DD_\tau, \frac{D_{\tau+2}}{GDP_{\tau+2}} - DD^f_{\tau+2}, \frac{\tilde{D_\tau}}{GDP_\tau} - 0.6\big) \leq 0 \text{ if } \frac{D_\tau}{GDP_\tau} \geq 0.6 \tag{9}$$

... in max 3 years after the EDP exit, and the final SB is maintained for 3 years:

$$\frac{B_t}{GDP_t} < -0.03 \text{ if } 0 \leq t < \tau - 3 \tag{10}$$

$$\frac{SB_t}{GDP_t} = \frac{SB_\tau}{GDP_\tau} \text{ if } \tau \leq t \leq \tau + 2 \tag{11}$$

In Eq. 7 it is assumed the structural deficit reduction effort is a constant, x ($> 0.5\%$ of GDP), during the EDP, i.e. when the nominal deficit is higher than 3 % of GDP. The constancy reflects a typical EDP program in which the amount of fiscal effort is fixed over a several years' period. Furthermore, after the EDP is abrogated (the nominal deficit falls below 3 % of GDP), the required adjustment follows the flexibility guidance. x is assumed to also hold in the preventive arm if the flexibility guidance does not determine the sufficient fiscal effort.[5] Eq. 8 states that the MTO must be reached by the end of the adjustment at τ. Eq. 9 ensures that the debt reduction benchmark must be met at the end of the consolidation program if the level of debt is higher than the 60 % reference value. That is, at least one of the measures (forward-looking and backward-looking debt reduction, cyclically adjusted debt) has fallen below their reference value. Eq. 10 sets an additional limit to the schedule: After the country has reached 3% level of (structurally unadjusted) deficit / GDP, it should not take more than 3 years before the debt reduction benchmark / MTO is reached. That is, 4 years before the program ends the country

[5]Further information regarding the correct use of macroeconomic variables when applying the flexibility guidance is provided by European Commission (2016), concerning for example the choice of appropriate, no-policy-change forecasts.

still will have deficit / GDP higher than 3%. Finally, to solve for the forward-looking debt reduction benchmark in Eq. 10 this paper follows European Commission (2016) and assume that the structural deficit is kept constant at its level in year τ for three years starting from the year τ (Eq. 11).

In practice, the endogenous variables are first solved for programs of alternative lengths (τ). For each τ, fiscal outcomes are solved on a tight grid of possible rates of adjustment, x. Programs that are in breach of the rules are discarded and the minimum is selected from the remaining set of feasible adjustment programs. Finally, after the minimum program is solved for a reasonable variety of transition periods (τ), the program that minimizes the annual average fiscal adjustment can be chosen.

While most of the numerical rules and schedules are definite, it is, however, not without problems to apply them together in a simulator. One of the main concerns is the overlap between the different rules concerning the corrective and the preventive arm of the pact. The set-up well illustrates how the rules have blurred the distinction between the two arms (see also Eyraud and Wu 2015). In particular, when a country enters the preventive arm after the excessive deficit procedure, the debt convergence rule continues to limit fiscal policy by setting the schedule for the debt adjustments. A few practical modelling choices have to be made to capture the fiscal dynamics. First, compliance with both the convergence rule and the preventive arms legislation are required. That is, if the preventive arm sets tighter schedules for the fiscal adjustments than the debt convergence rule, they are applied. Second, the simulation necessitates to take stand on, when the MTO in the preventive arm should be reached. There is no clear guidance on this matter when a country faces a large structural deficit after exiting the corrective arm. The assumption is made here that the three-year transition set an ultimate limit to the duration of the adjustment programs, and thus it applies also to the schedule of reaching the MTO. In principle, it is possible that the MTO transitions are longer. However, comparison of the simulated programs to the data, as well as the recent example of France provides evidence that supports the use of this assumption.[6]

[6]The results of the simulations are provided in the next section, while the fiscal consolidation in France is here shortly addressed. Based on the assessment of the 2017 stability programme for France, as made by the Commission in the spring 2017, the country is currently in the aforementioned situation: According to the fiscal plans it will correct its excessive deficit by 2017 in a durable manner and will then be subject to the preventive arm of the Stability and Growth Pact from 2018 onwards and to the three-year transition period as regards compliance with the debt criterion. The analysis on the other hand shows that the MTO is planned to be reached in 2019, that is, before the end of the three-year transition period.

3.3 Output responses of the fiscal adjustments

The simulation model is extended to simultaneously estimate the output impacts of the fiscal adjustment measures. This work builds on the Blanchard and Perotti's (2002) classical paper that identifies structural government revenue and expenditure shocks by making use of the implementation lags and micro-level information of the output elasticities of revenues.[7] However, this paper makes several refinements to their identification scheme following more recent literature. Next, a short overlay is provided while closer details of the identification scheme are available in the Appendix of this paper.

First, regime-specific multipliers similar to Auerbach and Gorodnichenko's (2012a) are considered. They use a non-linear smooth transition vector autoregressive (STVAR) model and find that the multiplier is larger in recessions than in economic expansions.[8] This result is in line with the basic Keynesian notion that the multiplier is larger when there are idle resources in the economy. The finding has potentially important policy implications. The variation could, under some conditions, be exploited by using a more counter-cyclical fiscal policy in order to achieve gains in cumulative GDP (see Fletcher and Sandri, 2015). Furthermore, it seems that the effects of fiscal consolidation were underestimated by economic forecasters in the recent economic crisis (see Blanchard and Leigh, 2013).

Second, this paper follows the recent literature that modifies the Blanchard and Perotti (2002) framework by considering expectations of future fiscal measures. An important issue in fiscal multiplier analysis is the effect of fiscal foresight (see, for example, Beaudry and Portier, 2014; Leeper et al., 2013). With fiscal foresight it is meant that economic agents can anticipate future shocks to fiscal variables. If this is not taken into account, there is a risk that the results are biased as the researcher and the agents in the economy have different information sets. In fact, this scenario can considerably affect the results (see Leeper et al., 2013).

Auerbach and Gorodnichenko (2012a) find that taking fiscal foresight into account has an effect on the estimated multipliers in recessions and expansions compared to the baseline model, although the size and the direction in which the multipliers change varies with the specification used. In a recent paper, Caggiano et al. (2015) analyze the fiscal multiplier in a similar STVAR framework and take into account fiscal foresight. They use generalized impulse responses instead

[7] Perotti (2005) uses the same modeling strategy but includes additional variables (inflation and interest rates) in the model. Overall, the size of the estimated multipliers in these two related studies is is quite modest.

[8] In addition to the multiplier depending on the economic cycle, the literature has identified other qualities that might affect the size of the multiplier over time or across countries. For example, multipliers are expected to be larger when monetary policy does not endogenously respond to a fiscal policy shock (see Christiano et al., 2011) and multipliers are found to be smaller in developing than in developed countries (Ilzetzki et al., 2013). In addition, countries that have a floating exchange rate are more open to trade or that are under a large debt burden are found to have smaller multipliers (Ilzetzki et al., 2013). The size and persistence of the fiscal shock and how it is financed can also affect the multiplier.

of impulse responses where the regime is assumed to stay in a full-blown recession or expansion for the entire period as in Auerbach and Gorodnichenko (2012a). Caggiano et al. (2015) find that in their baseline specification the output response to an anticipated government spending shock is not statistically larger in recessions than in expansions. However, there is a meaningful difference in these estimates if one focuses on deep recessions and strong expansions that are defined as points in time when the regime variable is at least two standard deviations from its mean (Caggiano et al., 2015).[9]

Although this paper reports estimated regime-specific multipliers, the focus is on the effects of alternative consolidation programs which is something not widely done in the literature. In a somewhat related study, Jorda and Taylor (forthcoming) analyze the regime-specific effects of fiscal consolidation. They find that austerity measures may have a considerable negative effect on growth and that the effect is larger when the economy is in recession (fiscal consolidation of 1% of the GDP results in a GDP loss of 3.5% in five years) than in an expansion (GDP loss of 1.8% under the same consolidation).

3.3.1 Econometric model

The extension is build on a smooth-transition vector autoregression (STVAR) model by Auerbach and Gorodnichenko (2012a) that is used to estimate effects of fiscal policies that can vary over the business cycle. It is noticeable that the model is estimated with quarterly data, and therefore t refers here to quarterly frequency, while y refers to annual frequency. All the results from the model are annualised when the simulator model is used. The key equations of the econometric model are:

$$X_t = C + F(z_{t-1})\Pi_R X_{t-1} + (1 - F(z_{t-1}))\Pi_E X_{t-1} + \epsilon_t \tag{12}$$

$$\epsilon_t \sim N(0, \pi_t) \tag{13}$$

$$\Omega_t = F(z_{t-1})\Omega_R + (1 - F(z_{t-1}))\Omega_E \tag{14}$$

$$F(z_{t-1}) = \frac{exp(-\gamma z_{t-1})}{(1 + exp(-\gamma z_{t-1}))}, \gamma > 0, z_t \sim N(0, 1) \tag{15}$$

[9] It should be acknowledged that methods other than the usual SVARs have also been used to empirically estimate fiscal multipliers. One method is local projection introduced by Jorda (2005). This method relies on directly estimating the fiscal multiplier by using linear regressions instead of trying to estimate the true multivariate model of the economy in the form of a VAR. Using local projections, Auerbach and Gorodnichenko (2012b) estimate regime-specific fiscal multipliers for a group of OECD countries and find again that the multipliers are larger in recessions than in expansions. However, Owyang et al. (2013) and Ramey and Zubairy (2014) find using the same framework, that there is no difference in the multipliers in different regimes. This, however, can be explained by the way that the multiplier is calculated as explained in Ramey and Zubairy (2014).

The model allows two ways for differences in the propagation of structural shocks: 1) contemporaneous via differences in covariance matrices for disturbances Ω_R and Ω_E ; 2) dynamic via differences in lag polynomials $\Pi_R(L)$ and $\Pi_E(L)$. In the benchmark estimation four endogenous variables X_t are used: general government (net) revenues (R_t^{net}) that includes government gross revenues minus transfers, general government spending G_t that includes government consumption and investments, gross domestic product GDP_t, and expected change of the structural budget balance one year ahead $E_t = E_t[SB_{t+4}/GDP_{t+4} - SB_t/GDP_t]$ with quarterly indexation. The first three variables are measured in (log) per capita and real terms. GDP deflator is used as the inflation variable in each case. The role of the expectation variable is to control for both fiscal foresight, and the consistency of expectations during the consolidation program.[10]

Variable z is an index normalized to have unit variance so that γ is scale invariant of the business cycle, with positive z indicating an expansion. Adopting the convention that $\gamma > 0$, $\Omega_R(L)$ and $\Pi_R(L)$ are interpreted as describing the behavior of the system in a (sufficiently) deep recession ($F = 1$) and $\Omega_E(L)$ and $\Pi_E(L)$ as describing the behavior of the system in a (sufficiently) strong expansion ($F = 0$). The index z is dated by t - 1 to avoid contemporaneous feedbacks from policy actions into whether the economy is in a recession or an expansion.

Following Auerbach and Godornichenko (2012a) z is set equal to a seven-quarter moving average of the output growth rate. However, instead of using the centered average over the quarters $[t-3, t+3]$ as in Auerbach and Godornichenko (2012a), Caggiano et. al. (2015) is followed in using the moving average of past values. In particular, the moving average over the period $[t-6, t]$ as z_t is considered. The key advantages of using this measure of z is that it can easily be used to consider dynamic feedbacks from policy changes to the state of the regime (policy shocks can alter the regime).

Following Auerbach and Gorodnichenko (2012a), maximum likelihood and the Markov Chain Monte Carlo (MCMC) method of Chernozhukov and Hong (2003) is used to estimate the nonlinear STVAR model represented in Eqs. 12-15. The Metropolis-Hastings algorithm is employed which means that at each iteration a candidate vector of parameter values is drawn and stochastically either rejected or accepted with a probability that is proportional to the value of the associated likelihood function. After multiple iterations, this method yields a chain of possible parameter values and given the algorithm used their distribution gives also the probability distribution of the parameter values as the time spend at each candidate vector is proportional to the value of the likelihood function. The only differences in the current estimation procedure

[10] Biannual forecasts of fiscal variables are collected and differentials between potential and actual GDP growth rate to approximate changes in the structural balance. In the exercise the variables are interpolated to quarterly frequency.

compared to Auerbach and Gorodnichenko (2012a) is that more draws are used and a longer burn-in period for the MCMC to make sure that it is achieved, in all of the current estimations, the wanted acceptance rate of candidate draws (0.3) when applying this method.

3.3.2 Assumptions that characterize the adjustment path

To characterize the adjustment path, two constraints are set on the fiscal policy. First, the structural balance adjusts according to the simulated adjustment program ($\widetilde{\Delta SB_t}$). Second, the balance between revenue and expenditure measures is set exogenously at $\widetilde{rat}$ so that the annual average ratio remains constant during the program.[11] Furthermore, the economic environment is controlled with additional constraints: one-year-ahead expectations are assumed unbiased, and the economy may be subjected to exogenous, surprise output shocks $\tilde{s}_{gdp,t}$. Formally, the constraints can be expressed as

$$\frac{SB_t}{GDP_t} - \frac{SB_{t-1}}{GDP_{t-1}} = \widetilde{\Delta SB_t} \tag{16}$$

$$\frac{s_{r,y}}{s_{g,y}} = \widetilde{rat} \tag{17}$$

$$E_t[\frac{SB_{t+4}}{GDP_{t+4}} - \frac{SB_t}{GDP_t}] = \frac{SB_{t+4}}{GDP_{t+4}} - \frac{SB_t}{GDP_t} \tag{18}$$

$$s_{gdp,t} = \tilde{s}_{gdp,t} \tag{19}$$

where s_r, s_g and s_{gdp} denotes structural shocks to revenue, expenditure and output, respectively. Their identification is further discussed in the Appendix.

To maintain the solution tractable, certain additional assumptions has to be made. First, the debt-to-gdp ratio is defined in nominal terms, and thus one has to take stand on the level of inflation in the model. In the current benchmark specification, a simple Phillips curve is used. It is assumed that each percentage point increase in the output gap contemporaneously lowers the inflation by 0.3 percentage points. Second, an estimate of the current output gap is obtained by modelling its dependence on the regime variable as well as the past quarter's value of the output gap (see the specification of the output gap forecasting model in the Appendix). Furthermore, the interest rate is assumed to be exogenous, and it is assumed that the interest expenditures in quarter t are paid in the following quarter $t + 1$.

Forward recursion is used to solve the structural shocks so that the endogenous variables fulfil Eq. 7 - 11 and 16-19. Under the aforementioned assumptions, the solution is found to be

[11] In this subsection, t continues referring to quarterly data while y marks years

linear conditional on the regime-specific impact of the history of the endogenous variables, the interest expenses, and the output gap. In practice, the PB_t in Eq. 19 is adjusted by changing public sector net revenues R_t^{net} and the public sector spending G_t (government consumption and investment): $PB_t = R_t^{net} - G_t$.[12] The size of the required fiscal adjustment depends directly on the discretionary measures that are taken to adjust the primary balance in Eq. 19, as well as their propagation to the fiscal variables, economic activity and expectations. Changes in the output gap partly compensates the impact of the business cycle in so far that it is captured by the cyclical correction. Finally, the adjustment affects the government interest expenditures, and alters the size of necessary changes in the primary balance to achieve a certain improvement in the SB.

The following steps are taken to achieve counter-factual scenarios and to extend the simulator model with endogenous output responses:

1. A no-policy-change scenario is built based on the actual fiscal forecasts. The model is then calibrated to yield a benchmark path that shares similarity with the actual, no-policy-change scenario.

2. A counter-factual path is solved w.r.t. exogenous expenditure, revenue, and expectation shocks using the KK (2016) framework, to achieve a certain SB adjustment of the endogenous revenues, expenditures, GDP, etc.

3. Differences between the model's counter-factual path and the benchmark path are collected, and they are used to augment the actual fiscal forecasts' no-policy-change scenario.

4. The **average** outcomes of a SB adjustment are used in the simulator model: A minimum adjustment path is selected. It is used to make inferences on the economic outcomes of the adjustment.

Finally, the current estimates of the impulse responses to policy shocks contain a fair amount of uncertainty. This uncertainty is represented by the confidence intervals that are constructed for each of the conducted simulations. While the simulator is used to select the minimum adjustment in terms of the average outcomes of a fiscal adjustment, the uncertainty in terms of achieving the fiscal targets is also reported. As in Auerbach and Gorodnichenko (2012a), the confidence intervals are constructed by drawing a set of parameter values from the MCMC chain to calculate the lagged response of variables. In order to calculate the contemporaneous

[12] It is noticeable that the (primary) budget balance can be equally written in net or gross terms by changing the position of transfers. However, the current revenue and spending variables omit some items that are included in the actual budget balance. As the focus is on the changes of the SB, that is not a major problem as long as the value of these items stay constant during the simulations.

response, a set of residuals is drawn from the covariance matrix of residuals. The variance of this covariance matrix is calculated by using the duplication matrix (see Auerbach and Gorodnichenko (2012a) and Hamilton (1994) for more details). The 90 % confidence intervals used in this article are constructed by using 1000 draws from the MCMC chain and the covariance matrix of residuals. The Blanchard and Perotti identification scheme is used for each draw of residuals, and thus the current confidence intervals takes into account the uncertainty involved in the estimation of the structural shocks in Eqs. 20-23.

4 Data

4.1 Economic forecasts during the European sovereign crisis

The dataset includes macroeconomic data and initial fiscal conditions for the 14 Euro area member states that were in the EDP in the late 2009 and the early 2010.[13]. The measurements are repeated with two datasets, the early 2010 SGP forecasts and the late 2016 Ameco data. The variables include the government interest rates, the government debt, the real GDP, inflation, stock-flow adjustments, and the structural adjustments of the public balance. The former dataset allows to analyze whether the fiscal plans were in accordance with the real-time data that was available during the inception of the EDP programs. The latter dataset is used to compare the actual outcomes to the ex-post view on the required fiscal pace.

Considering the two views is important because of the major data revisions between the considered vintages. Table 2 shows the averages of key macroeconomic variables for the years 2009-2015. The economic growth has been several percentage point weaker than expected, while the impact of the business cycle on the public balance has been much larger than anticipated. There have been large stock-flow adjustments such as bank recapitalizations. On the other hand, the interest rate on public debt turned out to be lower than expected.[14]

This paper does not directly address the origins of the economic forecast errors in the data, and in particular, whether the weaker economic performance has been due to higher than expected fiscal multipliers. Partly, the forecast errors could be explained by the fact that the early forecasts did not take into account the full size of the required fiscal consolidations later

[13] Austria, Belgium, Cyprus, France, Germany, Greece, Ireland, Italy, Malta, Netherlands, Portugal, Spain, Slovakia, Slovenia. The countries include all EDP countries except for Finland that was found not to have been breaking the deficit or debt rule based on the ex post data

[14] Some assumptions concerning the evolution of the variables at the end of the forecast horizons are needed to estimate the adjustment paths. Most of the year 2010's economic forecasts span until the year 2013 or 2014, but the durations of the consolidations may exceed the forecast horizon. It is assumed that the economy is returning to its normal state by the end of the forecast period. The negative impact of the business cycle to the public finances is expected to linearly disappear in the following two years after the forecast horizon ends. There is no further expected stock-flow adjustments after the forecast horizon, and the growth rate of the economy, interest rates, and inflation are assumed to continue at the pace of the last observed value of the forecast.

	Nominal GDP growth %		Government implicit interest rate %		Stock-flow adjustment % of GDP		Cyclical component of the gov. budget % of GDP	
	Early 2010	2016	Early 2010	2016	Early 2010	2016	Early 2010	2016
Austria	2.5	2.2	4.2	3.5	0.2	1.4	0.7	1.1
Belgium	2.9	2.1	3.9	3.5	0.1	0.3	0.9	0.4
Cyprus	3.5	-1	4.4	3.8	0	2.7	0.4	2.8
France	3.2	1.3	3.6	2.9	0.1	0.1	1.5	0.8
Germany	1.9	2.5	3.7	3	0.4	1.7	0.6	0.8
Greece	3.2	-4.4	4.7	3.3	0.4	-7.5	0.5	6.6
Ireland	2.8	5.2	4.7	3.9	0.2	-0.8	0.8	5.1
Italy	2.7	0.1	4.7	3.9	0.1	1	0.9	1.2
Malta	4.2	5.4	5	4.7	0	1	0	-0.4
Netherlands	1.8	0.8	3.8	2.7	-0.5	-1.5	0.8	1.3
Portugal	2.5	0.1	4.6	4	0.1	1.2	0.7	2.3
Spain	2.9	-0.5	4.3	3.9	0.7	0.2	0.8	3.7
Slovakia	6.2	2.6	5	3.9	0.4	-0.1	0.5	0.4
Slovenia	3.7	0.3	5.1	4.7	0.8	2.8	0.8	3.3
Average	3.1	1.2	4.4	3.7	0.2	0.2	0.7	2.1
Average (excl. Greece)	3.1	1.6	4.4	3.7	0.2	0.8	0.7	1.8

Table 2: The averages of key exogenous macroeconomic variables for the years 2009-2015. Early 2010 = data collected from the SG programmes of the late 2009 and the early 2010. Ameco data, the autumn 2016 vintage.

during the crisis. However, in most cases the economic adjustments in the plans are already substantial. For example, the average pace of improvement in the primary balance is 1.51% of GDP per year, whereas in the 2016 Ameco data it is almost the same, 1.58% of GDP per year. Moreover, Blanchard and Leigh (2013) find that, in advanced economies more generally, stronger planned fiscal consolidation has been associated with lower growth than expected. The relation is particularly strong, both statistically and economically, early in the crisis. A natural interpretation is that fiscal multipliers were substantially higher than implicitly assumed by forecasters.

4.2 Data used in the estimation of the endogenous economic responses

The STVAR model is estimated with Finnish data from 1975Q2 to 2015Q2. Following Keränen and Kuusi (2016), the model includes government spending (G_t), tax revenues net of transfers (R_t^{net}), GDP (Y_t), and an expectations variable (E_t). Except for the expectations variable, which is the expected change in the structural balance over the next year, this is the typical set-up of variables for a structural VAR model studying fiscal multipliers. The usual definitions for the fiscal variables is used. G_t is defined as the sum of general government consumption and investment, and R_t^{net} is general government tax revenue net of transfers to households and subsidies to the private sector. Tax revenue is defined here as the sum of direct taxes on business, direct taxes on households, social security contributions, and indirect taxes. All series G_t, R_t^{net}, and Y_t are quarterly, real valued (the GDP deflator is used for all variables) seasonally adjusted (using the TRAMO-SEATS method) and divided by population so that the variables are per capita.

To control for the expectations during the program, a proxy for the expected changes in the SB is constructed.[15] The use of the expectation variable serves two purposes. First, the adjustment program affects the medium-term expectations of the economic agents regarding the fiscal policy that may greatly affect their economic behavior. The expectation variable control these changes in the expectations. Second, Blanchard and Perotti's (2002) classic identification scheme unrealistically assumes that there is no fiscal foresight in addition to the VAR model's forecasts. One way to tackle this problem is to directly use fiscal forecasts as controls in the model.

5 The simulated policy during the European Sovereign Debt Crisis

In this section the implied minimum adjustments by the rules are compared to the actual EDP plans and fiscal outcomes. The first perspective is that of exogenous economic conditions. The questions are, were the fiscal plans in accordance with the simulated effort, and how does the minimum effort response to the changing economic outlook? In the last subsection, the output responses are made endogenous, and the simulated adjustment under anticipation of economic responses is analysed.

5.1 Analysing the simulated policy under the original economic forecasts

Fig. 4 shows a scatter plot of the simulated effort for the years 2009-2012 against the original EDP goals that were set out in the early 2010.[16] Further details of the simulation results are collected in Table 3.

Based on Fig. 4 it seems that the simulation model captures quite well the fiscal effort during the initial few years of the simulation for most of the countries. Notable exceptions are Cyprus and Greece. For both countries, the required EDP adjustment is much faster than the simulator would indicate. The finding strikes as a reasonable one, as these countries faced the most acute fiscal sustainability problems, and their adjustment programs were thus subjected to more political discretion than the programs in the other countries.

It is noticeable that the minimum adjustment in the early years of the program exceeds the

[15] For further information, see the Appendix.

[16] The latter data are the reported minimum fiscal efforts for varying time periods spanning from 1 to 3 years found from European Commission (2013). For Malta, separate Commission communication is used.

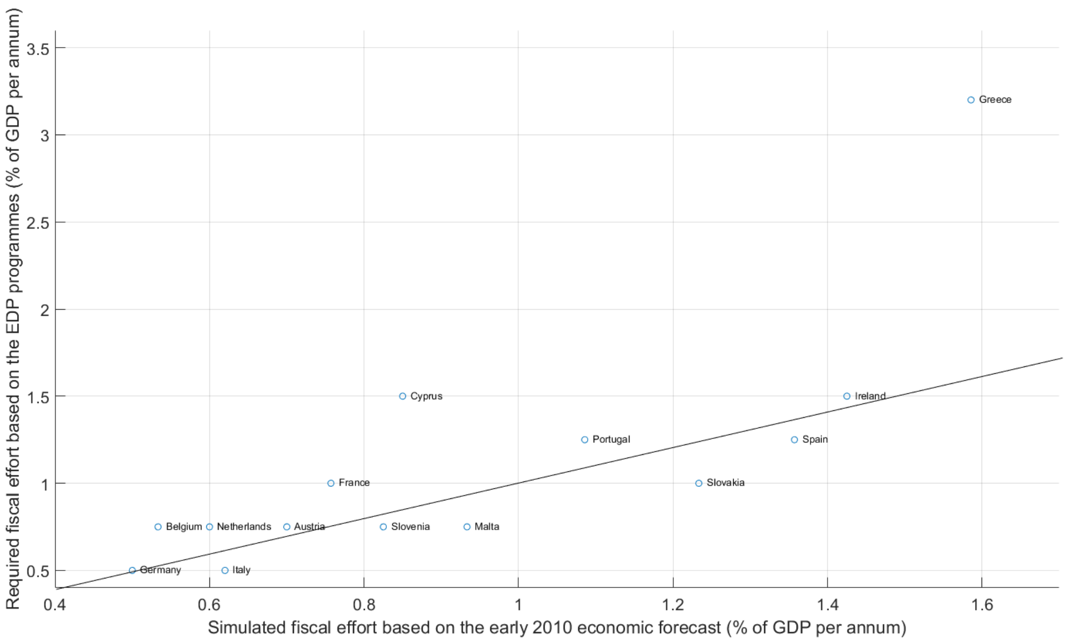

Figure 4: The simulated minimum fiscal effort based on the early 2010 forecasts, and the 2010 EDP program goals. Fiscal effort is measured as the improvement of the structural balance per annum. The line indicates when the EDP goals and simulated effort is the same. On top of the line the EDP goal is stricter. Below the line the simulated effort is stricter.

0.5 % of GDP in all, but one case (Germany). In the more longer term, the average structural adjustment implied both by the rules and observed in the data are slower. In most cases the MTO target, the structural balance - 0.5 % of GDP, is sufficient to reduce debt at the end of the program. However, the debt-to-gdp ratio peaks are much higher in the actual data, suggesting that the debt limits of the original programs were violated.

	Adjustment (09-12) $\frac{SB_{12}-SB_{09}}{3}$ (pps.)		EDP target Annual ΔSB	Adjustment (09-16) $\frac{SB_{16}-SB_{09}}{7}$ (pps.)		Final target SB_τ	Debt ratio at the peak (% of GDP)		The year of the debt peak (median)	
	Simulator 09 data	Observed 16 data	Observed 09-10 plans	Simulator 09 data	Observed 16 data	Simulator 09 data	Simulator 09 data	Observed 16 data	Simulator 09 data	Observed 16 data
Austria	0.7	0.26	0.75	0.3	0.24	0.5	68	86	2011	2015
Belgium	0.53	0.17	0.75	0.46	0.17	0.5	101	107	2011	2017
Cyprus	0.85	0.63	1.5	0.73	0.93	0.5	64	108	2011	2015
France	0.76	0.66	1	0.76	0.52	0.5	88	97	2013	2018
Germany	0.5	0.18	0.5	0.21	0.19	0	73	81	2010	2010
Greece	1.59	5.03	3.2	1.59	2.47	0.5	131	182	2012	2016
Ireland	1.43	1.28	1.5	1.26	1.13	0.5	79	120	2011	2012
Italy	0.62	0.91	0.5	0.44	0.38	0.5	117	133	2010	2017
Malta	0.93	0.05	0.75	0.4	0.36	0.5	67	70	2010	2011
Netherlands	0.6	0.69	0.75	0.43	0.53	0.5	67	68	2012	2014
Portugal	1.09	1.67	1.25	1.09	0.87	0.5	92	131	2013	2014
Spain	1.36	1.72	1.25	1.36	0.68	0.5	79	100	2013	2014
Slovakia	1.23	1.41	1	0.67	0.83	0.5	42	55	2011	2013
Slovenia	0.83	0.92	0.75	0.61	0.37	0.5	43	83	2012	2015
Average	0.93	1.11	1.1	0.74	0.69	0.5	79	102		
Average (excl. Greece)	0.88	0.83	0.95	0.68	0.56	0.46	76	96		
Median									2011	2015

Table 3: Details of the implied minimum adjustments based on the early 2010 forecast data.

5.2 How does the simulated policy change when the 2016 data is used?

There is a large discrepancy on one hand between the fiscal plans and the fiscal outcomes, and on the other hand between the forecast economic conditions and the actual economic outcomes. This finding raises the question how strongly does the implied fiscal adjustment respond to the economic conditions? To answer this question, the implied minimum adjustments are next calculated using the actual economic outcomes based on the 2016 Ameco data.

Figure 5 shows how the minimum fiscal adjustment changes for the years 2009-2012 when the vintage of the data is changed. Table 4 shows further details.

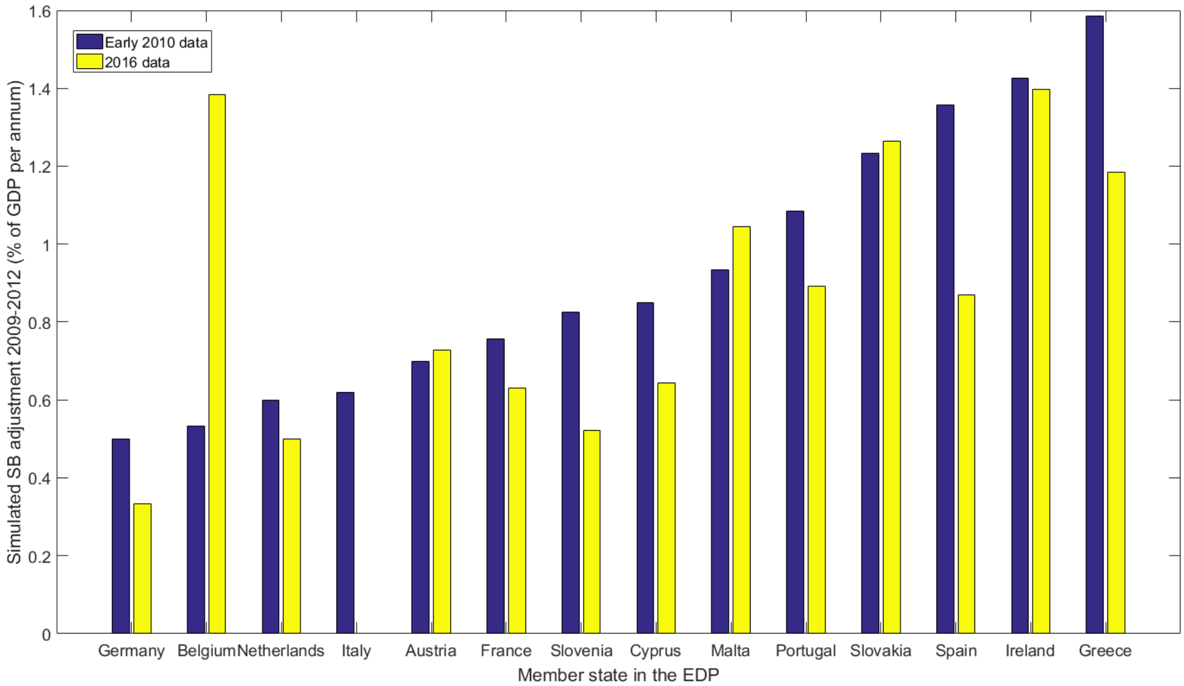

Figure 5: The simulated average fiscal effort for the years 2009-2012 based on the early 2010 forecasts, and the 2016 Ameco data. Italy is omitted from the ex post analysis, as its macroeconomic data includes substantial positive stock-flow adjustments that renders the required adjustment implausible high.

For most of the countries, the pace of adjustment is moderately slower due to the changes in the underlying macroeconomic scenarios, especially for the years 2009-2012.[17] This is due to the longer timespan of the program; most of the member states stays longer in the corrective arm of the SGP, and therefore, the debt transition rule applies later. While the overall adjustment may become larger as a result of the longer adjustment, it nevertheless leads into lower annual adjustment pace of the SB (see, Fig. 6). Meanwhile the peak debt-to-gdp ratio increases due to

[17] Belgium is the only country for which the 2016 data assigns substantially higher adjustment pace. That is because Belgium experienced substantial increases in the estimates of the SB following the year 2010. Italy is omitted from the ex post analysis. Its macroeconomic data includes substantial positive stock-flow adjustments that renders the required adjustment implausible high.

	Adjustment (09-12) $\frac{SB_{12}-SB_{09}}{3}$ (pps.)		Adjustment (09-16) $\frac{SB_{16}-SB_{09}}{7}$ (pps.)		Debt ratio at the peak (% of GDP)			The year of the debt peak (median)		
	Simulator 16 data	Observed 16 data	Simulator 16 data	Observed 16 data	Simulator 09 data	Simulator 16 data	Observed 16 data	Simulator 09 data	Simulator 16 data	Observed 16 data
Austria	0.73	0.26	0.31	0.24	68	81	86	2011	2010	2015
Belgium	1.38	0.17	0.59	0.17	101	100	107	2011	2009	2017
Cyprus	0.64	0.63	0.64	0.93	64	123	108	2011	2016	2015
France	0.63	0.66	0.63	0.52	88	96	97	2013	2015	2018
Germany	0.33	0.18	0.14	0.19	73	79	81	2010	2010	2010
Greece	1.18	5.03	1.18	2.47	131	252	182	2012	2017	2016
Ireland	1.4	1.28	1.31	1.13	79	118	120	2011	2013	2012
Malta	1.05	0.05	0.45	0.36	67	68	70	2010	2009	2011
Netherlands	0.5	0.69	0.5	0.53	67	71	68	2012	2014	2014
Portugal	0.89	1.67	0.89	0.87	92	136	131	2013	2016	2014
Spain	0.87	1.72	0.87	0.68	79	109	100	2013	2014	2014
Slovakia	1.26	1.41	1.05	0.83	42	57	55	2011	2013	2013
Slovenia	0.52	0.92	0.52	0.37	43	82	83	2012	2015	2015
Average	0.88	1.13	0.7	0.71	76	106	99			
Average (excl. Greece)	0.85	0.83	0.66	0.58	72	94	93			
Median								2011	2014	2014

Table 4: Details of the simulated programs based on the 2016 Ameco data

the lower adjustment of the budget balance, lower economic growth, and the larger stock-flow adjustments. That can happen because the rules focus on the debt reduction effort rather than the debt levels.

All in all, the results presented in Table 5 suggest that the recent slowdown of the fiscal adjustments has been, at least so far, in line with the fiscal rules. The average fiscal adjustment in the years 2009-2016 has been only marginally lower in the actual data when compared to the minimum adjustment. The peak of the debt-to-gdp ratio has not on average increased above the peak of the simulated minimum adjustment. Moreover, the median peak year is the same in the simulations and in the actual data.

Table 5 further illustrate the exceptional nature of the Greek debt crisis. In the simulated adjustment program that uses the 2016 data, the debt-to-gdp ratio increases to 250 % of GDP. It seems that in practice such debt ratios have not been considered acceptable. Due to the exceptional nature of the crisis, the cross-country averages are reported also without Greece.

5.3 Simulated adjustment under endogenous output responses

While analysing the effects of different data vintages for the functioning of the fiscal rules can be illustrative, the ultimate policy question is, can the economic outcomes be anticipated already during the planning of the fiscal adjustment? Recurrent policy mistakes can be avoided only when the forecasts of economic responses are not systematically biased.

In this paper, measuring the output response builds on the state-of-the-art methodology by Auerbach and Gorodnichenko's (2012). Their so-called smooth transition SVAR model is used to estimate upturn and downturn fiscal responses separately. Implementation of the fiscal adjustment follows Keränen and Kuusi (2016). Identifying assumptions and the data is discussed

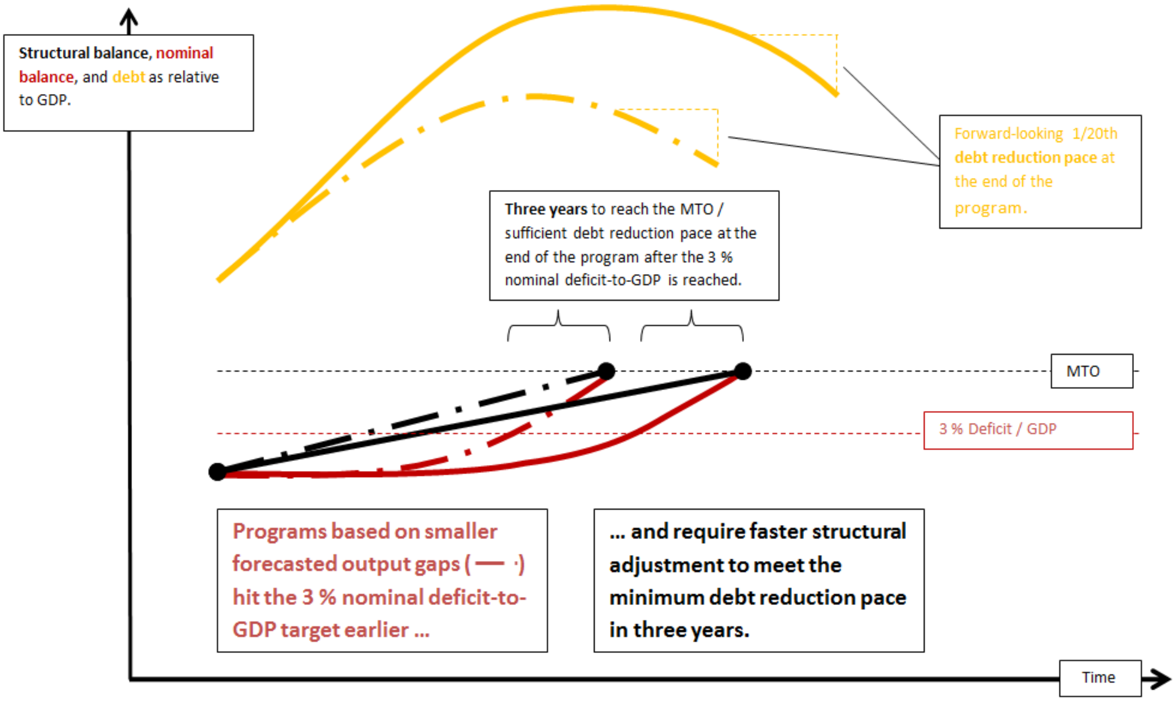

Figure 6: Intuition behind the lower pace of fiscal adjustment.

more closely in Section 3 and in the Appendix.

While ideally the output responses would be calibrated separately for each of the member states, that is beyond the scope of this paper. Rather, this paper estimates the responses using one country's economic data. The Finnish data is considered here as an example. The Finnish economy is a typical, developed small open economy.The high-quality quarterly data allows to analyse a lengthy time period (1975-2015) that includes rapid swings in both business cycles and fiscal policy. In particular, the period entails the Finnish Great Depression of the early 1990s; one of the worst economic crisis in industrialized countries after the Second World War.

In order to achieve a meaningful comparison to the previous exercise with exogenous economic forecasts, a no-policy-change scenario is first built based on the European Sovereign Debt Crisis data. In particular, the annual averages of the 14 EDP countries' early 2010 economic forecasts are used to build a no-policy-change scenario.[18] To summarize the initial conditions in 2009: Government gross debt is 71 % of GDP, the headline balance is -7 % of GDP, and the structural balance is -5.6 % of GDP. The initial output gap is -2.6 % of the potential GDP. In the no-policy-change scenario, inflation and the real GDP growth revive to 1.9 % and 2.6 % by

[18] As the original forecasts already include fiscal consolidations, they may also reflect the corresponding output effects. However, the original economic forecasts imply rapid growth and improvement of the business cycle, and thus it seems fair to say that the influence was considered to be small. The previous literature suggests that the output effects may have been substantially underestimated in the initial phase of the crisis (Blanchard and Leigh 2013). In any case, the no-policy-change path has only an illustrative role in this exercise, while the focus is on the change of the economic forecasts as a result of the consolidation.

2012, respectively. The average stock-flow adjustments have been small, and they are therefore omitted in the simulation.

The results of the simulation are collected in Fig. 7 and 8. The figures show the no-policy-change scenario based on the actual fiscal forecasts (black, dashed line). Second, the differences between the generated adjustment path and the model's no-policy-change path are collected, and they are used to augment the actual fiscal forecasts' no-policy-change scenario (red line). The figures also show the 90 % confidence intervals.[19] The mean outcome of an adjustment is used in the fiscal policy simulator model to assess the compliance of the path with the EU's fiscal rules. The confidence intervals, on the other hand, show how much uncertainty the estimates of the output response involve. The uncertainty affects the fiscal outcomes. While in each scenario the fiscal adjustment in terms of the structural balance is fixed, the variation of the output response indicates that the debt-to-GDP ratio of the consolidation may differ from the mean. Depending on the sign of the error, the debt targets may be either under- or overachieved.

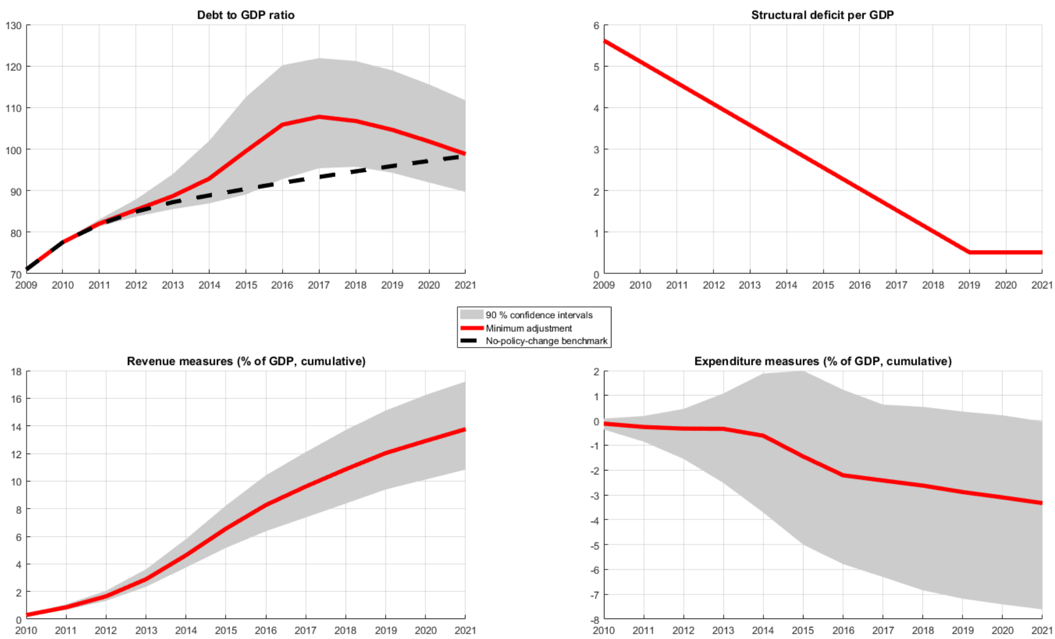

Figure 7: Simulated fiscal outcomes in a minimum adjustment that is measured based on the anticipated output responses.

The simulations suggest that the minimum adjustment necessary to reach compliance with the rules involves a 0.51 % per year adjustment of the structural balance towards the final 0.5

[19] In the benchmark model, following Auerbach and Gorodnichenko (2012a) and Keränen and Kuusi (2016), the lag length of the model is calibrated to 3. Keränen and Kuusi (2016) have tested the optimal lag length, but the results are not definite. In similar simulation, they find that the lag length 2 indicated moderately smaller required consolidation. However, the solution seems to suffer from unrealistic oscillations. They also find that the use of lag lengths higher than 3 yields unstable estimates. Furthermore, in the benchmark model, they use $\gamma = 2$. Their results suggest that the choice of γ has only a small effect on the current results. In addition, they find that using γ's higher than 3 would not divide the data meaningfully into recessions and expansions. Finally, their analysis also suggest that the results are robust to different assumptions of a_1 ($a_1 = 1.16$ vs. $a_1 = 1.06$).

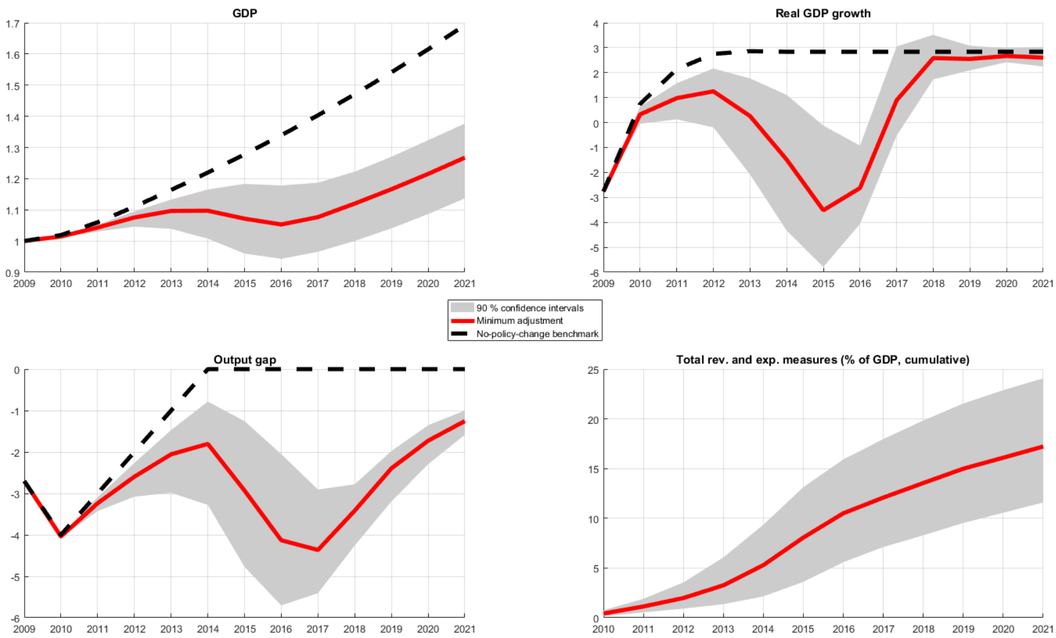

Figure 8: Economic outcomes in a minimum adjustment that is measured based on the anticipated output responses.

structural deficit in the year 2019. Before that the debt ration peaks in 2015. At that time the debt ratio has increased from 71 % of GDP to 107 % of GDP.

The increase of the debt ratio is caused by a rather significant contraction in the economic activity due to the adjustment of the public sector. The business cycle worsens and the output gap becomes larger as a result of the consolidation. The change partly covers the improvement in the structural balance.

	Adjustment (09-12) $\frac{SB_{12}-SB_{09}}{3}$ (pps.)	Adjustment (09-16) $\frac{SB_{16}-SB_{09}}{7}$ (pps.)	Debt ratio at the peak (% of GDP)	The year of the debt peak (median)
Simulated minimum based on the (fixed) 2009 forecasts	0.73	0.73	79	2012
Simulated minimum based on 2009 data, but modelled output responses	0.51	0.51	107	2015
Actual outcomes based on the 2016 Ameco data (excl. Greece)	1.11 (0.83)	0.69	102	2014

Table 5: Comparison of simulated effort based on exogenous and endogenous output responses

Finally, Table 5 compares the results to the simulated rules-based policy when the forecasts are not adjusted, but rather the original no-policy-change path is used. The results show that the minimum adjustment decreases in a similar manner than when the simulated adjustment with the fixed early 2010 forecasts were compared to the simulated adjustment using the Ameco 2016 data. The necessary rate of average structural adjustment decreases by 0.22 pps per annum which is comparable to the prior change in the minimum based on the ex-ante and the ex-post forecasts. Similarly, the peak year of the debt-to-GDP ratio changes from 2012 to

2015 while the peak increases considerable from the original fiscal plan (79% to 107%). When compared to the actual data, the simulated minimum adjustment is moderately slower. One of the underlying reasons is that the forecasted GDP growth in the years when the debt reduction target is supposed to be achieved, is lower in the actual data. This long-term growth slowdown is not captured by the output responses, but rather reflects changes in the views regarding more long-term structural factors.

6 Conclusions

This paper uses a dynamic simulation model to quantify the minimum constraints that the EU's fiscal framework imposes on fiscal policy during fiscal consolidations. In particular, the simulator is used to estimate multi-year adjustment programs that minimize the need of fiscal adjustments while being compliant with the key elements of the framework.

The simulator model can provide novel insights into the European Sovereign Debt Crisis. The particular focus of this paper is on the countries that were in the Excessive Deficit Procedure in 2010. The results show that the model can replicate fairly well the fiscal adjustments that these countries faced during the early phase of the crisis. This paper also illustrates how the revisions of the economic forecasts have a large effect on the simulated adjustments. The optimistic early 2010 forecasts imply faster fiscal adjustments than the weaker ex-post forecasts for the countries in question. This effect corresponds well with the recent slowdown of the pace of fiscal adjustment, thus suggesting that the revisions in the economic data may validate the slowdown. Further analysis shows that the weakening of the economic conditions can be anticipated when endogenous policy output responses are considered. This result suggests that the appropriate anticipation of the responses may help to facilitate more stable policy in the future.

All in all, this paper shows that subjecting the fiscal rules to rigorous numerical analysis has merits. First, this paper provides practical guidance on how to *objectively* assess the size of the necessary adjustments. The guidance is necessary to enhance the functioning of the framework, as ambiguous fiscal rules are hard to communicate, implement, and enforce. Furthermore, the collective analysis of the rules can pinpoint caveats in the overall design of the rules, and may therefore guide their further development.

Having said that, the analysis is not without caveats. The EU's fiscal framework is a difficult target for economic modelling because of its hierarchical, juridical structure, and the large amount of discretion that is used when the rules are applied. There is an inherent trade-off between the clarity provided by the definite rules, and the flexibility provided by the discretionary elements. While the trade-off may seem difficult, or even impossible, in the end the results of this paper are encouraging. A simulation model, such as the one used in this paper, can provide clarity even to a very complex set of rules as long as the different elements of the framework are explicitly stated.

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Appendix

Appendix A. Comparison to past fiscal policy in similar conditions

Based on a collection of data regarding the fiscal policy responses of the aforementioned EDP member states, fiscal policy reaction functions are estimated. The idea is to use data prior to the year 2008, that is prior to the Great Recession, to estimate how fiscal policy would have responded historically to similar economic conditions.

Various different specifications are considered. As it is conventional in the literature, the policy is measured using the cyclically-adjusted primary balance ($CAPB_t$). It is expected that high level of public debt and high fiscal deficits put pressure for a country to increase the pace of its fiscal adjustment to sustain the possibility to maintain the level of public consumption at an adequate level in the future. An indicator of debt sustainability and a sign of higher default risk is the interest on public debt that is also considered as an explanatory variable. Higher interest rate can be both a signal of the government's willingness to manage the debt problem, and a trigger for the government to start consolidation. Fiscal outcomes may also depend on the economic conditions during the consolidation. The variables considered here are the real GDP growth, changes in the output gap, and the real interest rate. Furthermore, a dummy variable is also consider that has value 1 if there is a reported fiscal consolidation ongoing in a country, as defined by Ali Abbas et al. (2013).

Different estimation methods are considered to avoid spurious estimations that suffer from endogeneity of the explanatory variables, and could lead into biased counterfactual scenarios.

Estimator Dependent variable	Model 1 DPE $CAPB_t$	Model 2 DPE $CAPB_t$	Model 3 DPE $CAPB_t$	Model 4 DPE $CAPB_t$	Model 5 Kiviet $CAPB_t$	Model 6 OLS, FE $CAPB_t$	Data
$CAPB_{t-1}$	0.688***	0.439***	0.410***	0.334***	0.751***		
Gov. gross debt$_{t-1}$	0.020***	0.030***	0.029***	0.030***	0.016*	0.065***	
Output gap$_t$	-0.037						
Real GDP growth$_t$	-0.046	-0.015	0.034	0.046			
Pos. output gap$_t$		0.051	0.074	0.038			
Neg. output gap$_t$		-0.067	0.033	0.029			
Adjustment dummy$_t$			0.776***	0.701**	0.648	-0.002	
Long-term interest$_t$				-0.074			
Pos. output gap$_{t-1}$					0.003	-0.091	
Neg. output gap$_{t-1}$					0.019	0.021	
Real GDP growth$_{t-1}$					-0.039	0.162	
Constant	-1.111***	-2.073*	-2.244**	-1.695		-4.780***	
N	341	341	341	321	341	348	
Estimated average adjustments, models and data							
Adjustment 2009-2012							
Mean	0.12	0.25	0.24	0.22	0.11	0.57	1.11
25th percentile	-1.45	-0.57	-0.38	-0.27	-1.29	0	-0.18
75th percentile	0.85	0.59	0.55	0.49	0.86	1.02	1.83
Adjustment 2009-2016							
Mean	0.3	0.29	0.32	0.39	0.33	0.33	0.64
25th percentile	-0.42	-0.31	-0.26	-0.09	-0.58	-0.58	-0.41
75th percentile	1	0.69	0.68	0.79	1.05	1.05	1.31

Table 6: Different specifications of the fiscal policy reaction functions.

Lagged explanatory variables are less prone to endogeneity, and thus they are used either directly or as instruments. In most cases, the Arrelano and Bond dynamic panel estimator (DPE) is considered in which contemporaneus explanatory variables are instrumented with lagged differences of the model's variables. Kiviet dynamic panel regression is also considered. It aims at correcting autocorrelation of the error terms in the panel following Eyraud and Wu (2015). Finally, only lagged explanatory variables are considered in a fixed-effect panel regression model.

Table 6 respesents the results. First, it shows that in most cases only the lagged fiscal variables have a significant effect on the CAPB. Second, the predicted fiscal adjustment are consistently lower than the actual adjustments during the years 2009-2016. That is especially the case for the initial years of the crisis.

Appendix B. Details of the Keränen & Kuusi (2016) simulation framework

6.0.1 Identification

To identify structural shocks during the simulation, the Blanchard and Perotti identification scheme is utilized similarly to Keränen and Kuusi (2016). The starting point is the Blanchard and Perotti (2002) paper, which estimated multipliers for government purchases and taxes on quarterly US data with the identifying assumptions that (i) discretionary policy does not respond to output within a quarter; (ii) nondiscretionary policy responses to output are consistent with auxiliary estimates of fiscal output elasticities; (iii) innovations in fiscal variables not predicted within the VAR constitute unexpected fiscal policy innovations; and (iv) fiscal multipliers do not vary over the business cycle. This paper considers an expectation augmented, regime-specific extension to the classic identification scheme. [20] To capture the structural shocks, the following system of identifying equations is considered:

$$\epsilon_{g,t} = s_{g,t} \tag{20}$$

$$\epsilon_{r,t} = a_1 * \epsilon_{gdp,t} + a_2 * \epsilon_{g,t} + s_{r,t} \tag{21}$$

$$\epsilon_{gdp,t} = c_1 * \epsilon_{r,t} + c_2 * \epsilon_{g,t} + s_{y,t} \tag{22}$$

$$\epsilon_{E,t} = d_1 * \epsilon_{r,t} + d_2 * \epsilon_{g,t} + d_3 * \epsilon_{g,t} + s_{E,t} \tag{23}$$

The first equation states that shocks in tax revenues and output have no contemporaneous effect on government spending (within a quarter). As argued in Blanchard and Perotti (2002) and Auerbach and Gorodnichenko (2012a), this identifying minimum-delay assumption may be a sensible description of how government spending operates because in the short run government may be unable to adjust its spending in response to changes in fiscal and macroeconomic conditions.

The second equation states that unexpected movements in taxes within a quarter, t, can be due to one of three factors: the response to unexpected movements in GDP, captured by $a_1 * \epsilon_{gdp,t}$, the response to structural shocks to spending, captured by $a_2 * \epsilon_{g,t}$, and to structural shocks to taxes, captured by $s_{r,t}$.

This paper relies on institutional information about tax, transfer and spending programs to construct the parameter a_1. The coefficient could capture two different effects of activity on net revenues: the automatic effects of economic activity on the revenues under existing fiscal policy rules, and any discretionary adjustment made to fiscal policy in response to unexpected events within the quarter. The key to the current identification procedure is to recognize that the use of quarterly data virtually eliminates the second channel. As Blanchard and Perotti (2002) argue, direct evidence on the conduct of fiscal policy suggests that it takes policy makers

[20] Whereas Auerbach and Gorodnichenko (2012a) rely mainly on the Cholesky decomposition in identifying structural shocks, here it is resorted to the Blanchard & Perotti (2002) framework to make comparisons between the impact of revenue and spending side measures on economic activity.

and legislatures more than a quarter to learn about a GDP shock, decide what fiscal measures to take in response, pass these measures through the legislature, and actually implement them.

Thus, to construct a_1, it is only needed to construct the elasticities to output of government purchases and of taxes minus transfers. To obtain these elasticities, information on the features of the spending and tax/transfer systems is used. [21] To solve, a_2, OLS estimation is used, and two, regime-specific explanatory variables ($F_t * \epsilon_{g,t}$, $(1 - F_t) * \epsilon_{g,t}$) to explain the cyclically-adjusted, reduced form tax residuals, $\tilde{\epsilon}_{r,t} = \epsilon_{r,t} - a_1 * \epsilon_{gdp,t}$. The estimated coefficients of the two explanatory variables yield the regime-specific a_2's.

The third equation in the system of Eqs. 20 states that unexpected movements in output can be due to unexpected movements in taxes, $c_1 * \epsilon_{r,t}$, unexpected movements in spending, $c_2 * \epsilon_{g,t}$, or to other unexpected shocks, $s_{y,t}$. The regime-weighted, cyclically-adjusted, reduced form tax residuals, $(F_t * \tilde{\epsilon}_{r,t}, (1 - F_t) * \tilde{\epsilon}_{r,t})$ are used as instruments to estimate regime-specific c_1 and c_2 in a regression of $\epsilon_{gdp,t}$ on the regime-specific spending and tax residuals ($F_t * \epsilon_{g,t}$, $(1 - F_t) * \epsilon_{g,t}$, $F_t * \epsilon_{r,t}$, $(1 - F_t) * \epsilon_{r,t}$).

Finally, the fourth equation states that expectations regarding the structural balance can change as a result of changes in revenues $d_1 * \epsilon_{r,t}$, spendings $d_2 * \epsilon_{g,t}$, the output $d_3 * \epsilon_{gdp,t}$, as well as surprise changes in the expectations $d_4 * \epsilon_{E,t}$. In case of the expectations the regime-specific d_1, d_2, and d_3 are solved in a standard OLS regression of $\epsilon_{E,t}$ on the regime-specific spending, tax, and output residuals.

This paper uses the estimated Eqs. 20-23 to write the structural shocks s as a function of the reduced form shocks ϵ, and solve a vector of structural shocks $(s_{t,g}, s_{t,r}, s_{t,y}, s_{t,E})$ that maintains the economy at the assigned adjustment path.

Further details of the data

To construct the fiscal forecast variable, the Research Institute of the Finnish Economy's (ETLA's) biannual, one-year-ahead forecasts of government spending, revenues, as well as GDP growth are used. The variables are interpolated to quarterly frequency, and use levels of the variables to construct forecasts of the budget balance.[22] Keränen and Kuusi (2016) have also collected forecasts of the potential GDP growth that are compared to the actual GDP growth

[21] Following Keränen and Kuusi, the parameter is calibrated to 1.16 based on ETLA's earlier estimations based on quarterly data 1995 onwards (See also, Virkola, 2014), but it is acknowledged that there is some uncertainty in the estimate. The European commission uses currently 1.12, while Virkola (2014) suggest that the estimate is smaller when earlier data is used. Thus, the robustness of the current results to different values of a_1 is investigated

[22] It should be acknowledged that the interpolation only partially controls for the (quarterly) changes in the fiscal forecasts, and thus provides only a partial solution to the fiscal foresight problem.

and calculate changes in the output gap as their difference.[23] Changes in the budget balance are corrected using the output gap estimates and the output gap semi-elasticity of the budget balance (0.57).

To obtain data for the other variables, Virkola's (2014) dataset for the years 1975-2011 is used. These data are from the Statistics Finland quarterly national accounts except for the data on direct taxes on business, which comes from the Bank of Finland quarterly estimates (Virkola, 2014). For the rest of the currentsample period, these series are updated by using quarterly data on government finances from Eurostat for the fiscal variables and quarterly national accounts data from Statistics Finland for the GDP, GDP deflator, and population. The series for G_t and R_t^{net} in Virkola (2014) and those constructed using Eurostat are found to closely follow each other in the overlapping period 1999–2011. Thus, following Keränen and Kuusi (2016), this paper uses the period-by-period changes in these series after 2011 to update the original time series.

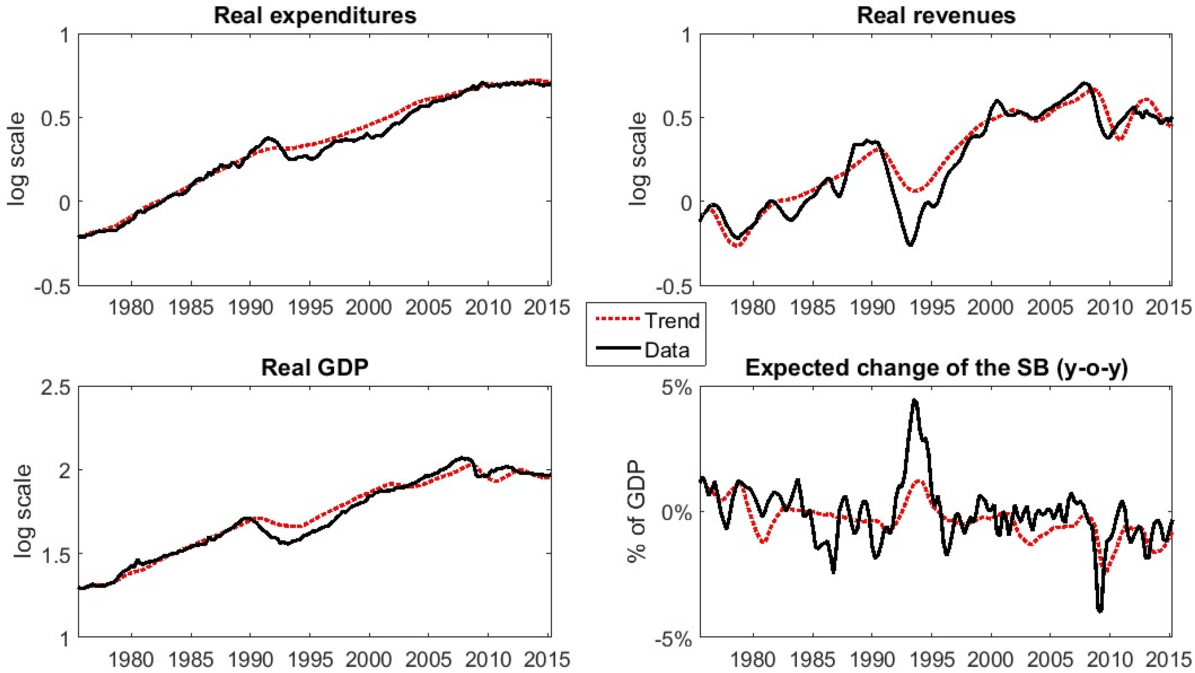

Figure 9: Data and trends.

In Fig. 9, the used data (black line) is plotted, as well as the estimates of the trend growth (red, dotted line) that are accounted for by the vector of constants C in the dynamic model.[24] To give an overview of the trends, Keränen and Kuusi (2016) begin from the initial values of

[23]The potential output growth estimates for 2002 onward are based on reference values provided by the Commission to the individual member states. Potential output growth estimates for 1989–2001 are based on the estimates made by the OECD at the end of the same year on average growth for the following two years and the preceding five years. For the 1980s, the potential output growth is estimated based on the average five-year growth forecast made by the ETLA in the same year. The series is interpolated to quarterly frequency.

[24]In the benchmark model, the lag length of the VAR is 3, while $\gamma = 2$ (see the following subsection).

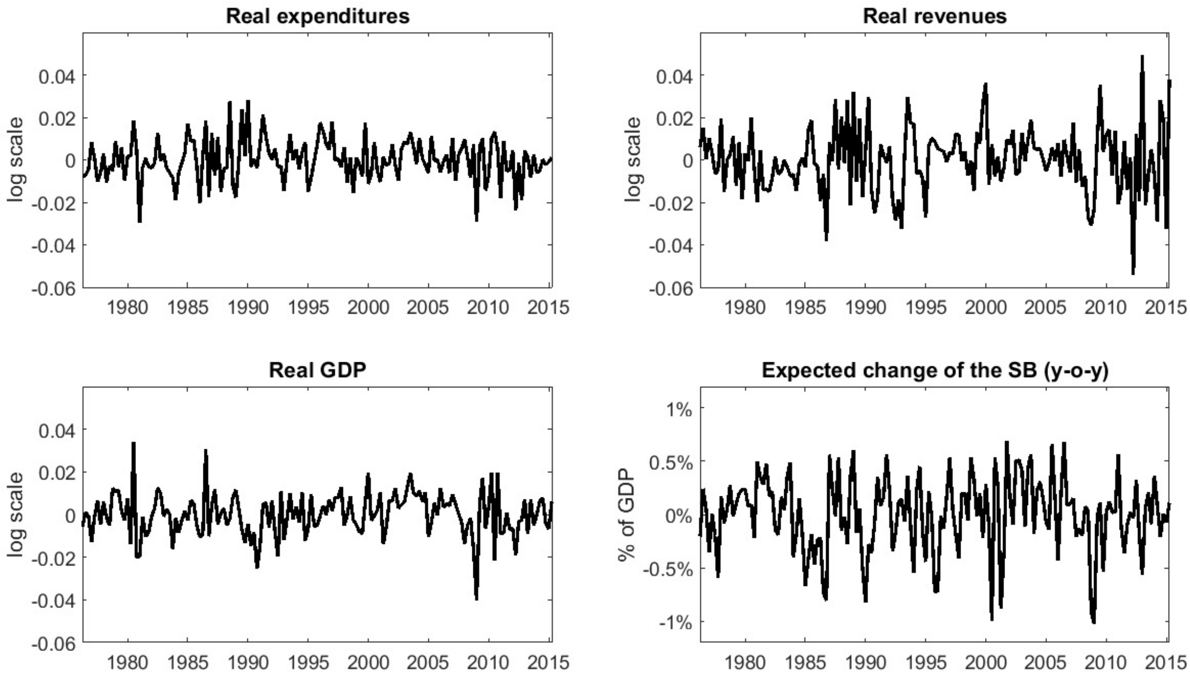

Figure 10: Shocks.

the data and solve the contributions of C without additional shocks. However, the regime is allowed to follow the regime variable during the simulation. Fig. 10 reports the estimated, reduced form shock processes (ϵ).

Responses of economic activity to fiscal shocks

The regime variable (7 quarters moving average of real GDP growth) is reported in Fig. 11. Different values of the γ parameter are considered. In the benchmark simulations, $\gamma = 2$ is used, which is relatively close to the parameterization $\gamma = 1.5$ in Auerbach and Gorodnichenko (2012a). The smaller the γ, the deeper (expansionary) the economic downturn (upturn) that is qualified as an extreme recession (expansion). To analyze the robustness of the results, Keränen and Kuusi (2016) also consider $\gamma = 3$.[25]

In both cases, it is found that the Finnish economy reached the recession state ($F = 1$) in two periods during years 1975–2015. The first period was the Finnish Great Depression of the 1990s, while the second time was at the onset of the global financial crisis. Furthermore, periods close to the recession regime are reported during the oil crisis and in recent years. In addition, there have been several expansionary periods, when the regime has been close to 0.

A concern that the choice of the regime variable raises is that the GDP growth alone may not provide a sufficient measure of the business cycle. For example, in a small open economy a

[25] The paper finds that the choice of γ does not greatly affect the results.

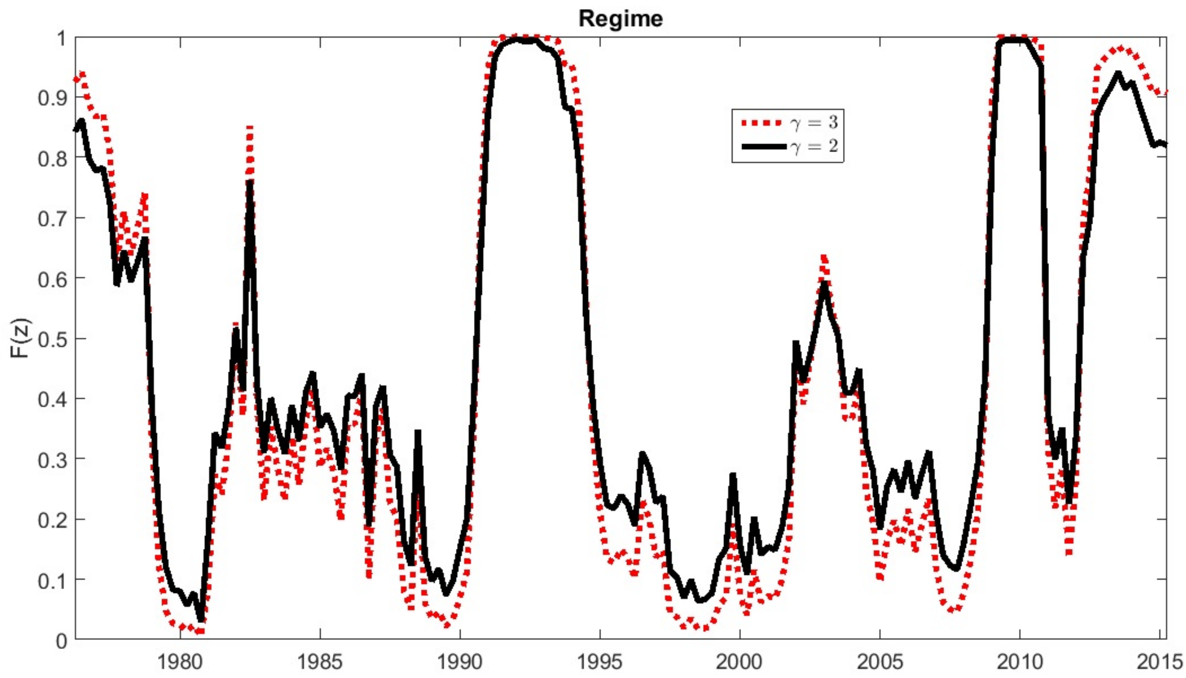

Figure 11: Regime variable, seven quarters moving average of real GDP growth, $\gamma = 2$ and $\gamma = 3$.

GDP contraction may generate different amounts of economic slackness – and thus the size of the fiscal multipliers may vary – depending on whether the shock that caused the contraction hits the external sector or the home market.

As a part of the exercise, the European Commission's output gap estimates are forecasted. It is found that the regime variable and the lagged output gap predict well the current value of the output gap as shown in Fig. 12 in the Appendix. Fig. 12 reports the predicted values of the following autoregressive model: $OG_t = 0.91 * OG_{t-1} + 0.38 * Z_t$). The estimated coefficients are highly significantly different from 0 with standard errors, .016 and .048, respectively.

In Table 7, the estimates of the regime-specific coefficients are reported. They are defined

	Expansion regime (F=0)			Recession regime (F=1)		
	median	05th perc.	95th perc.	median	05th perc.	95th perc.
a_1	1.16	-	-	1.16	-	-
a_2	0.52	0.49	0.54	0.29	0.25	0.34
c_1	-0.61	-0.57	-0.64	-0.29	-0.26	-0.35
c_2	0.25	0.21	0.31	0.82	0.72	0.91
d_1	0.05	0.04	0.06	-0.04	-0.03	-0.04
d_2	-0.11	-0.09	-0.12	0.00	-0.02	0.03
d_3	-0.05	-0.03	-0.06	0.18	0.15	0.20

Table 7: Estimates of the coefficients in Eqs. 20-23.

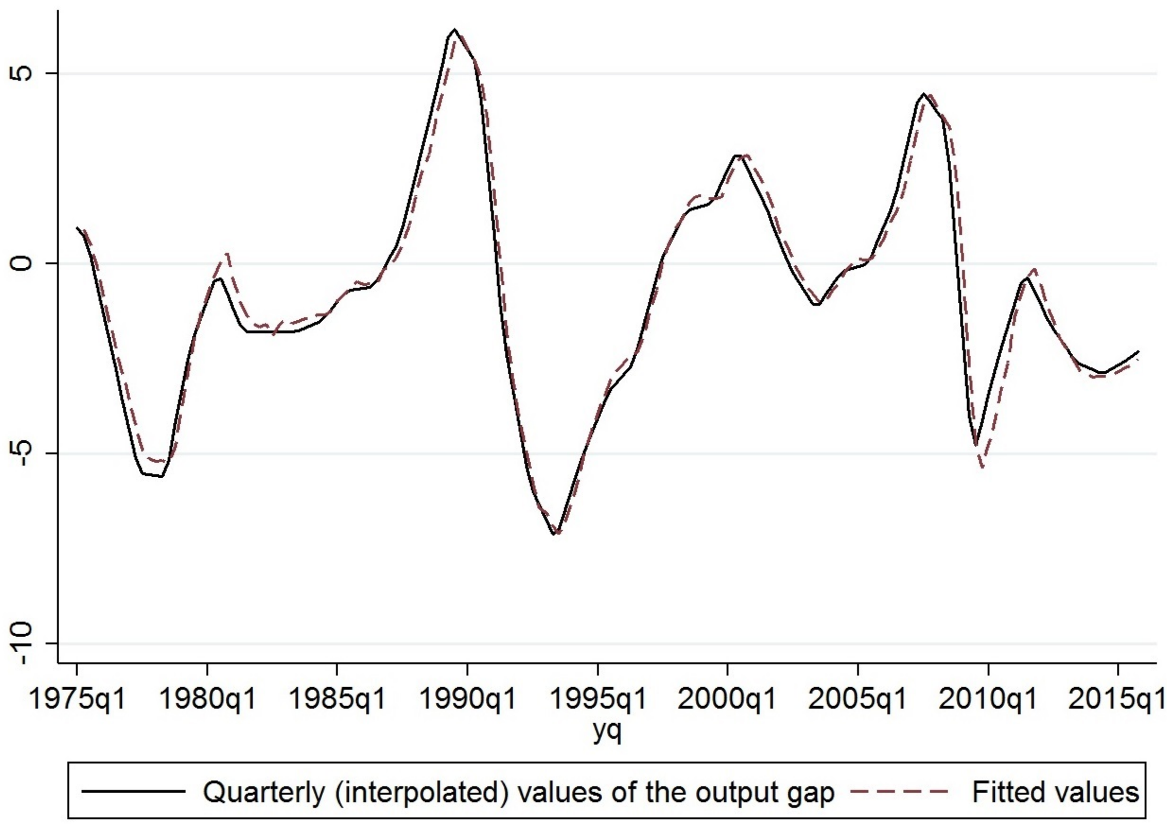

Figure 12: The European Commission's output gap estimates and fitted values of the forecasting model.

in Eqs. 20–23. It is found that the estimates are reasonable and the uncertainty related to their estimation is moderate. Unexpected movement in government spending has, on average, increased government revenue ($a_2 > 0$), while the effect is smaller in recessions. Surprise increases in government revenue lower the GDP ($c_1 < 0$), but less in recessions. On the other hand, increases in government spending increase GDP ($c_2 < 0$), but much less in expansions. Finally, a surprise increase in revenue generate expectations of an increase in the SB ($d_1 > 0$) in expansions, while the effect is marginally negative in recessions. An increase in spending has a negative effect on the expected SB in expansions ($d_2 > 0$), while the effect is small and insignificant in recessions. Unexpected GDP shocks have a marginally negative effect on the expected SB in expansions ($d_3 < 0$), while the effect is positive in recessions.

Next, the model's behavior is further illustrated by reporting the expansion (F = 0) and recession (F = 1) impulse response of the output to an unanticipated government spending increase and net tax increase shock in Fig. 13. The shock is normalized to have the sum of government spending increase or revenue increase over 20 quarters equal to one % of GDP.[26]

[26]Figs. **??** and **??** report the corresponding, unscaled shock processes of the fiscal variables . Following Auerbach and Gorodnichenko (2012a), the impulse responses of the model are solved without the influence of the time trends. Furthermore, the initial values of the endogenous variables is set to 0.

This measure has been advocated by Woodford (2011) and others since the size of the multiplier depends on the persistence of fiscal shocks.[27] Even in the largest Finnish downturns and expansions, the extreme regime has lasted no more than few years, and therefore, the focus on the analysis of the regime-specific multipliers should be on the initial responses. After the initial impact, the impulse becomes a mixture of the two regimes that can be analyzed using dynamic impulse responses.[28]

In terms of the spending multipliers, the estimates are in line with Auerbach and Gorodnichenko's (2012a) findings. The multiplier is much larger in recessions than in expansions. In the recessions, this paper's (expectations augmented) multiplier can rise well above 2. On the other hand, in expansions the multiplier can be negative. Overall, it is found that the regime-specific spending multipliers are of the same size magnitude as the estimates for the US economy.

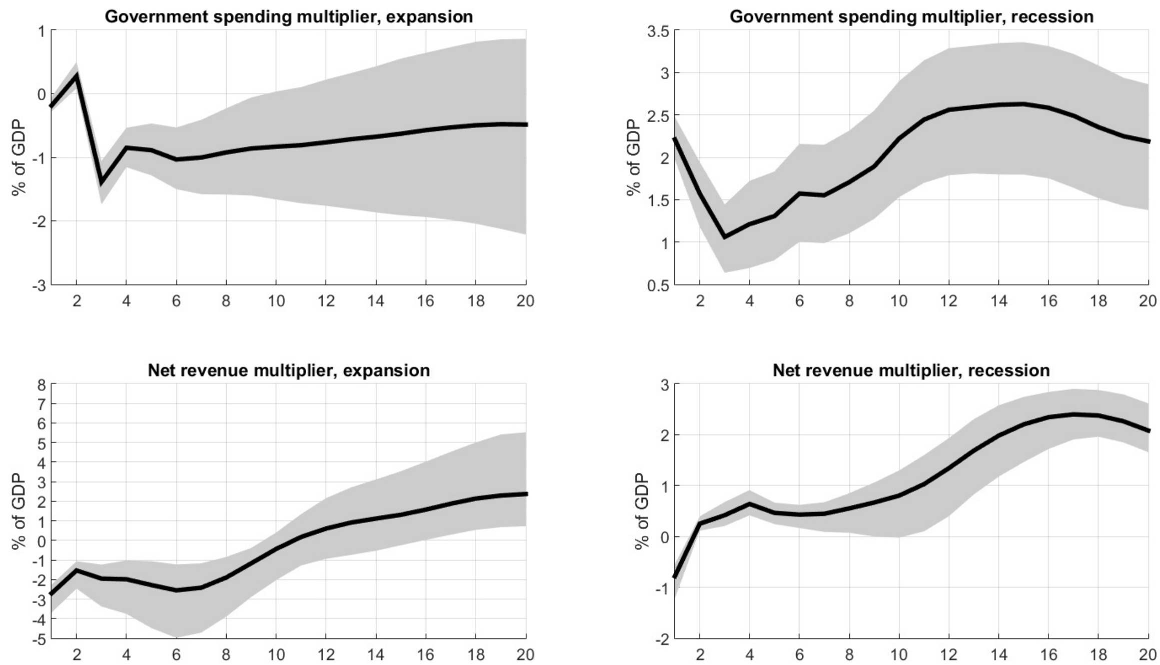

Figure 13: Figure plots the expansion (F = 0) and recession (F = 1) impulse response of the output to an unanticipated government spending increase shock and a net revenue increase shock that is normalized to have the sum of government spending increase or revenue increase over 20 quarters equal to one. The shaded region is the 90% confidence interval.

As a stand is taken on the revenue-spending mix of the consolidation, this paper also uses the regime-specific revenue multipliers. Although the estimation has caveats, the results are

[27]Figs. **??** and **??** suggest that the corresponding maximum impact factors of the initial spending increase and net revenue increase shocks are roughly 2.5 and -1 in recessions, and -1 and -1.5 in expansions.

[28]Here, the estimates are mainly shown to allow a meaningful comparison with Auerbach and Gorodnichenko (2012a). In the main simulations, this paper instead use dynamic impulse responses that include dynamic responses to changes in the regime variable.

found to be similar to what Auerbach and Gorodnichenko (2012a) report in the Appendix of their paper.[29] In the expansions, the revenue multiplier behaves similarly with the spending multiplier, while the multiplier in recessions suggests that (in the relevant time horizon) the revenue impact can be quite sluggish.

[29] Auerbach and Gorodnichenko (2012a) are less confident of the SVAR framework as a tool for measuring the effects of tax policy, because many of the unexpected changes in revenues may arise as a result of a change in the relationship between tax revenues and aggregate activity rather than policy change, and the elasticity of revenue is likely to vary over the cycle, thereby introducing a bias of unknown magnitude and direction to the regime-specific estimates.