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Choosing the European Fiscal Rule

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Abstract

Contributing to the ongoing discussions at the European Union level about the potential simplification of its fiscal framework, we evaluate the economic and public finance stabilization properties of two benchmark fiscal rules – the structural balance rule and the expenditure growth rule – using a New Keynesian small open economy model. If these fiscal rules are implemented one at a time, having just an expenditure growth rule tends to yield more stable macroeconomic outcomes, but more volatile public finances, as compared to having only a structural balance rule. Much of the quantitative differences in relative volatilities can be accounted for by the modifications of the public expenditure definition in the expenditure growth rule, in particular, the removal of debt service payments. Accounting for debt service payments in fiscal rules strengthens the monetary-fiscal policy interaction but it may turn vicious to macroeconomic stability at business cycle frequencies. Strong-enough debt correction for either fiscal rule contains public debt volatility at little expense to macroeconomic stability in the long run. The households' welfare gain from having the expenditure growth rule instead of the structural balance rule is 4% for a small country in a monetary union and 5% for a country with sovereign monetary policy.

Keywords: fiscal policy, DSGE, small open economy, fiscal-monetary policy interaction

JEL codes: E0, E2, E3, E6, F4, H2, H3, H6

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1 Introduction

A growing body of policy discussions and literature has recently highlighted the shortcomings of the existing set of fiscal rules stipulated in the European Union (EU) Stability and Growth Pact (SGP). The EU fiscal framework has been subject to several reforms, each adding new provisions. As a result, the fiscal framework is now perceived to have become excessively complex and opaque – thus violating a basic property of an optimal fiscal rule formulated by Kopits and Symansky (1998), that is, simplicity, and to suffer from low credibility and effectiveness, as vividly illustrated by different outcomes arising from two – structural balance and expenditure growth – benchmarks being applied simultaneously. The presence of two simultaneous operational benchmarks gives rise to the possibility of cherry-picking, a state in which a member state can choose the least stringent benchmark to comply with. Contrary to what was expected, the introduction of the Fiscal Compact (a reform of the SGP in 2012, see European Commission, 2017) has not eliminated procyclicality in the conduct of national fiscal policies and has not fostered a rapid reduction in public debt levels (European Fiscal Board, 2019). Hence, neither the debt reduction nor the macroeconomic stabilization objective of the EU fiscal policy framework has been achieved.

This has triggered discussions on revisiting the EU fiscal framework and simplifying the rules.[1] The very need for fiscal rules is based on historical evidence that governments tend to run excessively large deficits and that markets are not effective in disciplining governments since markets tend to react too much too late (Bayoumi *et al.*, 1995). Fiscal discipline is especially needed in an economic and monetary union to curb negative spillovers between countries with a common monetary policy. A rich strand of literature suggests that fiscal rules are able to mitigate deficit bias and enforce fiscal discipline (Debrun *et al.*, 2008; Wyplosz, 2012; Heinemann *et al.*, 2018). Among the analysed fiscal rules, the following rules are found to lead to procyclical fiscal policy: deficit, debt, and revenue rules. Moreover, they are not in the direct control of policymakers. Combining fiscal rules can help avoid some of these problems but raises serious implementation concerns, both from a technical (e.g. cyclical adjustment) and an institutional (hard to implement) perspective (Symansky *et al.*, 2008). Structural deficit (deficit adjusted to the output gap) can be subject to large ex post revisions (Kamps *et al.*, 2014; Claeys *et al.*, 2016; Coibion *et al.*, 2017; Darvas *et al.*, 2018; Kamps and Leiner-Killinger, 2019) and may lead to misguided policy advice (Claeys *et al.*, 2016). Historically, the structural deficit is subject to larger revisions than long-term potential growth, on which the expenditure growth rule is based (Kamps *et al.*, 2014; Claeys *et al.*, 2016).

Empirical studies indicate that, unlike deficit caps, expenditure growth rules help creating buffers in good times, thus allowing automatic stabilizers to operate (Eyraud *et al.*, 2018). Therefore, expenditure growth rules are associated with improved fiscal discipline (Cordes *et al.*, 2015). In expenditure growth rules, interest payments are most often excluded, as they are subject to large fluctuations and are not in direct control of the government in the short term. Cyclical components such as the cyclical part of unemployment benefits are often excluded as well (Ljungman, 2008; Cordes *et al.*, 2015). In addition

[1] Alternatively, Blanchard *et al.* (2021) suggest abandoning fiscal rules in favour of country-specific standards.

to these benefits, the compliance rate of governments tends to be higher for expenditure growth rules, as compared to other fiscal rules (International Monetary Fund, 2014; Cordes *et al.*, 2015). This is so since expenditure growth rules are easy to monitor and are most directly connected to instruments that the policymakers effectively control. A downside of an expenditure growth rule is its dependence on the initial level of expenditure and its weaker relation to debt stability (among others, due to expenditure exclusions); consequently, having an explicit fiscal medium-term anchor, that is, a government debt target, is recommended (Symansky *et al.*, 2008; Eyraud *et al.*, 2018).

Therefore, several proposals (Benassy-Quere *et al.*, 2018; Claeys *et al.*, 2016; Darvas *et al.*, 2018; German Council of Economic Experts, 2017; European Fiscal Board, 2019) suggest an EU fiscal framework based on a reference value for the public debt ratio with an operational annual limit for expenditure growth. Benassy-Quere *et al.* (2018) suggest an expenditure growth rule that prevents government expenditure from growing faster than the long-term economic growth rate. Similar recommendations are given by Claeys *et al.* (2016), Darvas *et al.* (2018), and European Fiscal Board (2019). Also, Kamps and Leiner-Killinger (2019) suggest putting less emphasis on the structural deficit, while considering that an entire removal of a reference to the structural deficit could be politically difficult. German Council of Economic Experts (2017) and Christofzik *et al.* (2018) suggest retaining the structural balance as a medium-term target and as an additional element in the operational expenditure growth rule, while Debrun and Jonung (2019) suggest using a simple rule relating the fiscal deficit to the output gap, whose effect would be enhanced by independent watchdogs. To improve the quality of public finances and safeguard public investment, European Fiscal Board (2019) proposes a limited golden rule by excluding growth-enhancing expenditure from fiscal rules. While agreeing on the basic principles, Bundesbank (2019) recommends using *net* investment for such a golden rule. Many of the above proposals suggest removing interest payments and cyclical components from the expenditure growth rule. In addition, some of them consider a debt correction term.[2] Such an overwhelming support for the expenditure benchmark is related to the conventional view that the expenditure growth rule is more transparent, more predictable, and easier to communicate to the public. Overall, most of these proposals demonstrate that there is space for streamlining the EU fiscal framework to enhance its effect on fiscal sustainability.

The empirical literature suggests that, via constraining fiscal policy discretion, fiscal rules tend to reduce output volatility (Fatas and Mihov, 2003). However, besides historical case studies (Ljungman, 2008), quantitative examinations of how alternative fiscal rules affect public finance and economic fluctuations do not feature prominently in the literature. Specifically, there is lack of a comprehensive structural model-based analysis of the trade-off between alternative fiscal rules and of the effects of various expenditure exclusions in the expenditure growth rule in particular. Such an analysis is important for the optimal design of the EU fiscal framework that, besides simplicity, elasticity, and implementability, would strike a balance between the stabilization of public finances and macroeconomic quantities.

The few model-based studies are the following articles. Bruck and Zwiener (2006) use a macroeconometric model for Germany to study the business-cycle stabilization properties of a deficit versus

[2] Christofzik *et al.* (2018) consider as speeds of annual debt-to-GDP correction values of 1/75 and 1/50.

an expenditure target. They find that a deficit target yields less stabilization than the expenditure target. Yet, they use nominal deficit and not structural deficit, as well as total expenditure without subtracting interest payments or other frequently mentioned items such as cyclical benefits. They are fixing expenditure at some level, not targeting its growth at a (stochastic) long-term growth rate. They are investigating the reaction for one-off shocks and only for a 7-year horizon. Moreover, they do not report the effects on the volatility of the debt-to-GDP ratio. As a debt build-up is typically a slow-moving process, looking just at a horizon of a few years might not be sufficient. Also, they are not stochastically simulating the model economy.

Symansky *et al.* (2008) suggest an expenditure growth rule with an error-correction mechanism (both linear and quadratic) with respect to debt deviations from target. They use a partial equilibrium model and thus their model does not feature any feedback effects on the economy. There is also no uncertainty about their output gap or trend growth measure. Like Bruck and Zwiener (2006), they investigate the dynamics after a one-off shock and only for a horizon of a few years. Additionally, they consider only total expenditure, without subtracting the commonly mentioned items. Finally, they do not provide results from stochastic simulations. Similarly, Kinda (2015) compares several fiscal rules for Canada, following the methodology of Symansky *et al.* (2008), thus subject to the aforementioned limitations.

Carnot (2014) considers targeting the primary balance (that is, nominal balance minus interest payments) deviation from its target together with a measure of the output gap (that is, the output gap combined with changes in the output gap), while the fiscal effort is expressed in expenditure growth terms, net of discretionary revenue measures. He conducts a retrospective, partial equilibrium analysis only on the effects for fiscal variables but not for macroeconomic quantities. Neither real-time uncertainty is taken into account nor stochastic simulations are performed.

The closest to our setup is the study by Andrle *et al.* (2015). They use the total expenditure in their expenditure growth rule but not modified expenditure. In addition to expenditure and structural balance targets, they also include a debt-deviation term in their rules that ensures debt stabilization. Their results demonstrate that the (total) expenditure growth rule together with a debt-stabilizing term performs the best in stabilizing output, but the structural deficit rule together with a debt-stabilizing term is close. However, output stabilization comes at the cost of a higher debt variation, since automatic stabilizers move debt more than just targeting the nominal deficit; therefore, an additional debt-correction term is necessary. For the expenditure growth rule, their model is unstable without any debt-correcting term. So, they introduce a 'minimal adjustment' – the smallest possible adjustment required by the model. Using this minimal adjustment, the (total) expenditure growth rule yields twice as much standard deviation of the debt-to-GDP ratio as the structural balance rule without any debt adjustment. They do not consider the effects of expenditure modification though. Also, they limit their study by considering aggregate demand shocks only.

Our study thus aims to fill this gap in the literature and to contribute to the current debate on the reform of the EU fiscal framework. We compare alternative fiscal rules, including the effects of different expenditure modifications, in both stochastic and deterministic simulations, based on a New

Keynesian small open economy fiscal model. Specifically, we compare the dynamic properties of having an expenditure growth rule relative to having a structural balance rule. Both rules are complemented by a debt-stabilization term to ensure sufficient stability of the model. Also, we consider the golden rule versions of both fiscal rules. We consider both a version of a small open economy in a monetary union and a small open economy with sovereign monetary policy. Our main contribution is the detail in which we consider fiscal rules. Our main results are the following.

First, the expenditure growth rule tends to yield slightly more stable macroeconomic variables than the structural balance rule. This is because the expenditure growth rule, in contrast to the structural balance rule, does not react to revenue windfalls and shortfalls, and excludes cyclical items, such as cyclical unemployment benefits, from the modified expenditure definition.

Second, the expenditure growth rule dampens the public investment volatility, compared to the structural balance rule. This is done mainly via three channels. The first channel is the one mentioned above, namely, the expenditure growth rule does not react to revenue windfalls and shortfalls. Second, the expenditure growth rule ignores the short-term economic fluctuations by targeting long-run growth. Third, the expenditure growth rule dampens its reaction to shocks via the modification of expenditure definition, such as the removal of debt service payments, and investment averaging.

Third, and for comparable calibrations of both fiscal rules, the expenditure growth rule yields considerably more volatile public finances than the structural balance rule. Having more volatile public finances is not desirable since it raises the probability of reaching unsustainable debt levels. The key channel for the incongruence between the expenditure growth targeting and the public debt stabilization objective is the removal of interest payments from the modified expenditure definition of the expenditure growth rule, as it is done by the European Commission and proposed in the literature.

Fourth, the expenditure growth rule is more sensitive to the strength of the debt-to-GDP correction term than the structural balance rule. For weak enough debt-to-GDP correction, the expenditure growth rule does not ensure debt stability, while for strong debt-to-GDP correction, the public debt may converge in a sinusoidal manner around its target.

Fifth, and *ceteris paribus*, the higher the public debt target, the more volatile public debt. This is due to shocks to the bond yield that apply to a larger amount of debt, as the stock of debt grows. The volatility curve is steeper for the expenditure growth rule, compared to the structural balance rule due to the aforementioned interest payments channel. For both fiscal rules, the volatility of public debt is transferred to the real economy.

Sixth, after a build-up of debt, the expenditure growth rule tends to postpone fiscal consolidation to future periods. Compared to the structural balance rule, the resulting growth is larger in the near term at the expense of slower growth in the future.

Seventh, both fiscal rules can contain debt volatility effectively if the debt correction term is strong enough. A stronger debt correction term results in a more volatile real economy, as the government forfeits some of its potency to stabilize output. However, the slope of the volatility of the real economy is much flatter than the slope of the debt volatility. Therefore, having a strong-enough debt correction for either fiscal rule curbs public debt volatility at a relatively small cost to the real economy in the *long run* (this should not be confused with the potentially painful effects from a speedy debt reduction in the *near term*).

Eighth, accounting for interest payments in fiscal rules (as is done in the structural balance rule) strengthens the co-movement between monetary and fiscal policies, as the monetary policy easing reduces debt service payments, thus creating the fiscal space. However, this interaction may turn vicious for the real economy if it works in typical business-cycle frequencies. As the extra fiscal stimulus affects the macroeconomic quantities with some time lag, its peak effect may be overdue, failing to smooth out the recession phase but rather boosting the recovery phase. Also, a subsequent monetary policy normalization reduces the fiscal space causing a slower recovery in the medium term. Over the business cycle, this interest payments channel may cause higher – rather than lower – macroeconomic volatility. This may be another reason to support the exclusion of debt service payments from the modified expenditure definition in the expenditure growth rule.

Ninth, a secular decline in the bond yield helps contain the public debt both due to the decrease in the mean interest payment, but also due to the narrowing of the debt distribution. The debt volatility curve is significantly steeper under the expenditure growth rule than the structural balance rule because of the interest payments channel. This means that, under the expenditure growth rule and with a secular decrease in the bond yield, the government may allow itself raising debt levels without raising tail risks. However, this debt game plays the other way around as well – an increase in the bond yield will widen the debt distribution under the expenditure growth rule more considerably, compared to the structural balance rule.

Tenth, the exclusion of public investment from fiscal rules, as in the case of the golden rule, helps protecting public investment and achieves higher growth outcomes during the period of considerable and persistent boost in public investment, such as the Next Generation EU programme. However, the differences between the golden rule and the benchmark rule are less remarkable for typical public investment shocks. Given that the golden rule gives incentives for the governments to misclassify public investment, the merit of using the golden rule on a permanent basis is not so evident.

Finally, the household welfare is 4% (or 0.7% if measured in consumption equivalent units) higher under the expenditure growth rule than under the structural balance rule for a small open economy in a monetary union. The respective numbers in a small open economy with its own monetary policy are 5% (1% if measured in consumption equivalent units). The difference between the two fiscal rules would be smaller if the debt service payments were taken into account in the expenditure growth rule.

The remainder of this study is structured as follows. Section 2 provides a brief history and an overview of the EU fiscal rules, Section 3 outlines the fiscal model used in our simulations, Section 4 describes the way we are modelling the fiscal rules, Section 5 discusses the results from our simulation exercises for a small open economy in a monetary union, Section 6 studies the results for the case of a small open economy with a sovereign monetary policy, Section 7 analyses welfare implications, and Section 8 concludes. The appendix contains additional results and robustness checks.

2 An Overview of EU Fiscal Rules

The widespread recognition of the need for fiscal rules, facilitated by rising public debt levels, dates back to the 1990s (Debrun *et al.*, 2008). Europe was not an exception, even though only a small number of European countries had numerical rules. Germany, Italy, and the Netherlands introduced fiscal rules in the aftermath of World War II (Debrun *et al.*, 2008), while countries, such as Sweden and Finland, responded to the financial and fiscal crises they experienced by imposing fiscal constraints. The circumstances changed with the creation of the Economic and Monetary Union (EMU). Given the risk of a negative impact of excessive fiscal deficits in a common currency area (Levin, 1983) undermining its internal stability, the importance of fiscal policy coordination in the EU became obvious. The Maastricht Treaty and the Stability and Growth Pact (SGP), introduced in 1992 and 1997, respectively, established a fiscal policy framework and imposed fiscal constraints on all EU member states. The former introduced reference values for budget deficit (3% of GDP) and public debt (60%)[3], while the latter specified the procedures when a country's fiscal position exceeded the thresholds[4] and the surveillance mechanism aimed at safeguarding budget deficit from exceeding the 3% threshold by requiring to maintain a fiscal position "close to balance or in surplus"[5].

Since its introduction in 1997, there have already been several reforms of the supranational EU fiscal governance framework. First, in 2005, after the European Commission failed to impose sanctions on France and Germany, the SGP was made more flexible and the concept and definition of the medium term objective (MTO) was adopted[6], including specifying the required speed of adjustment towards the MTO[7]. In 2011, in the aftermath of the European sovereign debt crisis, EU member states agreed on the Fiscal Compact[8] that strengthened the rules by adopting an automatic procedure to impose sanctions[9] and obliging member states to incorporate fiscal rules into their statutory legislation[10]. The Fiscal Compact also raised the importance of the Maastricht debt criteria[11] in the assessment[12] and introduced the expenditure benchmark as an additional element to gauge progress towards the MTO alongside the improvement in the structural balance[13].

Following the introduction of the above-listed modifications, the EU fiscal policy framework now consists of the following elements. There are two reference values or fiscal targets:

1. The budget balance is not allowed to fall below -3% of GDP (budget balance target).

2. Gross public debt should not exceed 60% of GDP (public debt target). If public debt is above 60%

[3] Article 126 and Protocol annexed to the TEU.
[4] Council Regulation 1467/97.
[5] Council Regulation 1466/97.
[6] The MTO operationalised the notion of a fiscal position "close to balance or in surplus".
[7] Council Regulation 1055/2005.
[8] The Treaty on Stability, Coordination and Governance in the Economic and Monetary Union, signed by all EU countries except Czechia and the UK.
[9] Regulation (EU) 1173/2011.
[10] Council Directive 2011/85/EU.
[11] Regulation (EU) 1177/2011.
[12] It is now required that a member state with a debt-to-GDP ratio above 60% reduces the gap anually by 1/20.
[13] Regulation (EU) 1175/2011.

of GDP, it should decline annually at a pace of at least one twentieth of the gap between the actual debt ratio and the debt target.

A member state's structural balance should attain a country-specific MTO (with a lower limit of -1.0% of GDP) that is set to provide a safety margin with respect to target to limit the budget deficit to 3% of GDP and to ensure debt sustainability against the background of the current public debt level and long-term ageing costs. When the MTO is not met, a country is required to deliver an adjustment towards it. The adjustment path is defined by two operational rules, in terms of a change in the structural balance and the permitted rate of expenditure growth. The two operational rules are:

(a) A member state should commit to implement an annual improvement in its structural balance of 0.5% of GDP. Faster adjustment is required if public debt is above 60% of GDP and the economy is booming. On the contrary, the structural balance rule is less stringent during economic downturns.

(b) Budget expenditure, net of discretionary revenue measures, should grow in line with the benchmark of the medium term rate of potential GDP or at a slower pace, if the fiscal position is not at the MTO. The expenditure benchmark applies to only a part of total expenditure, as several modifications are made. In particular, it is not applied to government borrowing costs, government expenditure on EU programmes that are fully matched by the EU fund revenue, cyclical unemployment benefit expenditure, and the part of public investment exceeding the four year average. The arguments against the inclusion of interest payments and cyclical unemployment benefits are usually related to their unpredictability and the fact that they are out of the government's control, at least in the short run.

As discussed in the introduction, most of the discussion leans towards leaving just one operational fiscal rule (with expenditure growth rule being commonly mentioned) and one fiscal target (with debt target being commonly mentioned) active. In what follows, we evaluate the stabilization properties of each of the operational fiscal rules regarding public finances and macroeconomic quantities, including the effects of expenditure modification, in a stochastic, general equilibrium environment.

3 The Model

In this paper, we are using a rich fiscal DSGE model for a small open economy in the euro area, which is briefly outlined in this section and whose full description is provided in Bušs and Grüning (2020).

3.1 The non-fiscal part of the model

The non-fiscal part of the model consists of several sectors which can be also divided into three main blocks: the core block, the financial frictions block, and the labour market block. We discuss the sectors in the core block first, before discussing the specifics of the other two blocks.

The core block builds on Christiano *et al.* (2005) and Adolfson *et al.* (2008). The domestic intermediate goods sector is populated by a competitive, representative firm and produces a homogenous domestic intermediate good, using capital and labour as inputs in a Cobb-Douglas production function. Capital accumulation and usage is subject to two real frictions: investment adjustment and capital utilisation costs. Labour supply is subject to search and matching frictions, as will be discussed below. This homogenous domestic intermediate good is allocated between public expenditure and the production of three types of final goods: private consumption goods, investment goods, and export goods.

The three final goods – consumption, investment, and exports – are produced by competitive final goods producers, taking as inputs the domestic homogeneous intermediate good and a specialised intermediate good, different for each type of final good. These two inputs are combined by a constant-elasticity-of-substitution (CES) aggregator into the respective final good. Specialised domestic importers purchase the homogeneous foreign intermediate good, which they turn into a specialised input. They sell the resulting specialised input to domestic import retailers. Therefore, there are also three types of import retailers. Each type of import retailer uses the specialised inputs to create the specialised intermediate good used in the production of the respective final good. All import retailers are subject to Calvo-style price stickiness frictions.

The utility-maximizing households maximise the expected lifetime utility from a discounted stream of consumption, subject to habit formation. The households own the economy's stock of physical capital. They determine the rate at which the capital stock accumulates and the rate at which it is utilised. Households also own the stock of net foreign assets and deposit money in domestic banks.

Monetary policy is conducted exogenously due to the assumption that our small economy is a member of a monetary union. The foreign economy is modelled as a structural vector autoregression (henceforth, SVAR) in EA output, EA inflation, EA nominal interest rate, and EA unit-root technology growth, as well as foreign demand, competitors' export price, and nominal effective exchange rate. The model economy has one source of exogenous trend growth, which is the neutral technology growth, and it is identified using euro area data in the foreign economy block. Besides this, there is also a stationary domestic technology process. Several fixed share parameters are subject to technology diffusion as in Schmitt-Grohé and Uribe (2012) and Christiano *et al.* (2010).

The financial frictions block adds Bernanke *et al.* (1999) (henceforth, BGG) financial frictions to the aforementioned core model. Financial frictions allow for borrowers and lenders to be different agents that have different sets of information. Thus, this block introduces "entrepreneurs" who are agents with special skills in the operation and management of capital. Their skill in operating the capital is such that it is optimal for them to operate more capital than their own resources can support by borrowing additional funds. There is a financial friction because managing capital is risky, i.e. entrepreneurs can go bankrupt, and only entrepreneurs observe their own idiosyncratic productivity without costs. In this model, households deposit their money in banks. The interest rate on household deposits is nominally non-state-contingent. Banks (present only implicitly) then lend funds to entrepreneurs using a standard nominal debt contract, which is optimal given the asymmetric information.[14] The amount that banks

[14]Namely, the equilibrium debt contract maximises the expected entrepreneurial welfare, subject to the zero profit condition on banks and the specified return on household bank liabilities.

are willing to lend to an entrepreneur under this debt contract is a function of entrepreneurial net worth. This is how balance sheet constraints enter the model. When a shock occurs that reduces the value of entrepreneurs' assets, this cuts into their ability to borrow. As a result, entrepreneurs acquire less capital and this translates into a reduction in investment and leads to a slowdown in the economy. Although individual entrepreneurs are risky, banks are not.

The labour market block adds the labour market search and matching framework of Mortensen and Pissarides (1994), Hall (2005a,b), Shimer (2005, 2012), and Christiano *et al.* (2016). There is no exogenously imposed wage rigidity, and all changes in the total hours worked are attributed to the extensive margin of labour supply. The addition of the labour market block splits the production of all three types of intermediate goods into wholesaler and retailer blocks as in Christiano *et al.* (2016) and Bušs (2017). The wage bargaining process takes place between wholesaler firms and workers via Nash bargaining. Firms are subject to a hiring fixed cost. Wholesalers produce the intermediate good using labour which has a fixed marginal productivity of unity. This product of wholesalers is then purchased by retailers to produce specialised inputs for the production of the homogeneous domestic good. We allow for a procyclical labour cost, as outlined in Bušs and Grüning (2020).

3.2 The fiscal block of the model

The fiscal block of the model comprises the following elements: public investment, public consumption, import content of public investment and consumption, asymmetric government transfers, separately modelled unemployment benefits, public debt, foreign ownership of public debt, taxes, and eight fiscal rules that determine fiscal policy. Specifically, public investment is used in building the public capital stock that is bundled together with private capital in a CES aggregate before being used in the production of intermediate goods. Building the public capital stock is subject to a time-to-build friction. However, in contrast to building private capital there are no adjustment costs for building public capital. Households obtain utility from a CES aggregate of public and private consumption. A fraction of both public investment and public consumption is imported from abroad. Hence, a fraction of total expenditure on public investment and public consumption is used to buy imported goods from specialised retailers. These government retailers are different from the retailers for private investment and private consumption, with potentially different Calvo price stickiness parameters and market power. The imported goods are bundled in CES fashion with the domestic goods to form the usable public investment and public consumption goods. Furthermore, we add another variety of households to the model: restricted (hand-to-mouth) households. These households just consume their disposable income and do not have access to any (financial or real) asset in the economy. Their income consists of private labour income, unemployment benefits, and other government transfers. The government transfers are asymmetric so that a larger share of them is received by the restricted households. Unemployment benefits are modelled separately from the rest of transfers, as the former are cyclical and affect the worker outside option directly. In the steady state, we fix the shares of public consumption expenditure, public investment expenditure, and government transfers to households as fractions of total government expenditure. Dynamically, these shares adjust according to the three expenditure fiscal rules in the model. Regarding taxes, labour income taxes are paid by households, while social security contributions are paid partly by households and partly by firms. The respective tax rates are taken into account in the wage bargaining process. Furthermore, the government operates a fiscal deficit in the steady state that constitutes a steady-state debt level which is used as a target value in the fiscal rules. The government collects labour taxes, social security contributions, and consumption taxes from both types of households, as well as capital income taxes from entrepreneurs. With these revenues and a lump-sum tax levied on the optimizing households, the government finances the expenditure – public investment, public consumption, government transfers, unemployment benefits, and debt interest payments.[15] To operate the fiscal debt, short-term domestic government bonds are issued that are held by both the domestic optimizing households[16] and the rest of the world. As a result, a part of the domestic debt is held abroad, which is taken into account by the current account equation in the model. Thus, interest payments on debt held abroad are lost to the domestic economy.

4 Fiscal Rules

This section describes the operational fiscal rules used in this paper that are different from the generic ones implemented in Bušs and Grüning (2020).

4.1 Structural balance rule

The nominal budget deficit is given by total government expenditure G_t net of government revenues T_t,

$$\text{Deficit}_{g,t} = G_t - T_t,$$

and the deficit-to-GDP ratio dy_t is defined by

$$dy_t = \frac{\text{Deficit}_{g,t}}{Y_t}. \tag{1}$$

Note that the steady state of the deficit-to-GDP ratio is pinned down by the steady-state (target) debt-to-GDP ratio.

Given our model is calibrated to a quarterly frequency, we will target the quarterly structural balance, as targeting the annual structural balance on a quarter by quarter basis may yield some seasonality in impulse responses. (However, we keep reporting the annual balance-to-GDP ratio in the tables below for the reader's convenience.) For the structural balance rule we need a model-based measure of the output

[15] Additionally, there is wasteful spending, which is constant and exogenous, and has the role of a residual in the steady state.

[16] They need to pay quadratic adjustment costs for holdings in excess of an amount they can hold for free.

gap. By default, we are using output deviation from its steady state:

$$\text{ygap}_t = \ln\left(\frac{\text{output}_t}{\text{potential output}_t}\right) = \ln\left(\frac{y_t\mu_{z,1}\mu_{z,2}\ldots\mu_{z,t}}{y_0\mu_{z,1}\mu_{z,2}\ldots\mu_{z,t}}\right) = \ln\left(\frac{y_t}{y_0}\right) = \ln\left(\frac{y_t}{y}\right), \tag{2}$$

where a lowercase denotes a variable normalized by the unit-root technology process with a gross quarter-on-quarter growth rate $\mu_{z,t}$ at time t.[17]

Having an output gap measure, our definition of the structural deficit is given by

$$sdy_t = dy_t + \theta_{ygap,t} \cdot \text{ygap}_t, \tag{5}$$

where $\theta_{ygap,t}$ is the sensitivity parameter of the structural balance with respect to the output gap.[18]

In order to target the structural balance, we include it into the fiscal rules from the expenditure side by targeting the structural deficit level. Therefore, the structural balance rule is as follows:

$$\ln(x_t) = (1-\rho_x)\ln(x) + \rho_x \ln(x_{t-1}) + (1-\rho_x)\theta_{x,sdy}(sdy_t - dy), \tag{6}$$

where $x \in \{g_{c,t}^{exp}; g_{i,t}^{exp}; \text{tr}_t\}$ (i.e. normalized public consumption expenditure, public investment expenditure, and government transfers, respectively), $\theta_{x,sdy}$ controls for the tightness of the structural balance rule with respect to the structural balance target, and ρ_x controls the persistence of government expenditure adjustments. We assume that the tax rules that are present in the original model of Bušs and Grüning (2020) are inactive in our simulation exercise below.

As mentioned in the introduction, several references suggest having a debt-correction term in the operational rule, especially in the expenditure growth rule, as otherwise the capability of the expenditure growth rule to stabilize the public debt is hindered both by expenditure exclusions and sensitivity to the initial level of public expenditure. For comparability purposes, we therefore introduce a debt-correction

[17] The alternative measures we consider are: the employment gap

$$\text{ygap}_t = \ln(L_t/L), \tag{3}$$

where L_t is total labour supply and L its value in the deterministic steady state, a measure based on capital and labour utilization rates

$$\text{ygap}_t = \ln\left[\left(\frac{u_t}{u}\right)^{\alpha}\left(\frac{L_t}{L}\right)^{1-\alpha}\right] \tag{4}$$

and their time-varying equilibria specifications where u_t and u is the capital utilization rate at time t and the steady-state capital utilization rate, respectively. However, we find that specifications (2) and (3) match the data the best, since the capital utilization rate is trending in our data sample (Appendix A.2 reports our output gap estimates).

[18] We adopt this rather simple approach to model the structural deficit and the output gap, as reported in Equation (2), as a benchmark measure since this is a popular one used in practice (for example, also in simpler semi-structural models) and it performs nevertheless very well empirically when compared to the real data, as visible in Appendix A.2, Figure A.2. A popular approach in DSGE models is also to use the level of output relative to the flexible price output level as the output gap; however, this is more difficult to use in practice and since our paper tries to answer the research question from an applied perspective, we stick to this definition of the output gap.

term[19] in both fiscal rules. The structural balance rule then becomes

$$\ln(x_t) = (1-\rho_x)\ln(x) + \rho_x \ln(x_{t-1}) \\ + (1-\rho_x)\theta_{x,sdy}\left(sdy_t - \left(dy - \phi_{x,d}\left(\frac{D_{g,t}}{Y_t + Y_{t-1} + Y_{t-2} + Y_{t-3}} - \overline{dgy}\right)\right)\right), \tag{7}$$

where $\phi_{x,d}$ controls the strength of the correction term with respect to debt-to-GDP ratio deviation from target and $\overline{dgy}$ is the steady-state or target debt-to-GDP ratio. From Equation (7), it can be realized that the debt correction term affects the structural balance target.

4.2 Government expenditure growth rule

In our model, total government expenditure is given by

$$G_t = G^{exp}_{c,t} + G^{exp}_{i,t} + \mathrm{TR}_t + (1-L_t)D_{b,t} + \ln(R_{g,t-1})/\pi_t \cdot D_{g,t-1} + Z, \tag{8}$$

where $G^{exp}_{c,t}$ is public consumption expenditure, $G^{exp}_{i,t}$ is public investment expenditure, TR_t is government transfers (without unemployment benefits), $(1-L_t)D_{b,t}$ are (cyclical) unemployment benefits, $\ln(R_{g,t-1})/\pi_t \cdot D_{g,t-1}$ are the interest payments on public debt, and Z is wasteful spending (a constant residual).

According to the EU fiscal framework, we define 'modified expenditure' by removing the cyclical component of unemployment benefits, interest payments on public debt, and public investment expenditure, as well as adding past 16-quarter average investment expenditure as follows:

$$G^{mod}_t = G^{exp}_{c,t} \cancel{+ G^{exp}_{i,t}} + \mathrm{TR}_t \cancel{+ (1-L_t)D_{b,t} + \ln(R_{g,t-1})/\pi_t \cdot D_{g,t-1}} + Z + (1-L)D_b \\ + \left[G^{exp}_{i,t} + G^{exp}_{i,t-1} + G^{exp}_{i,t-2} + G^{exp}_{i,t-3} + \cdots + G^{exp}_{i,t-13} + G^{exp}_{i,t-14} + G^{exp}_{i,t-15})\right]/16. \tag{9}$$

We define the expenditure growth target as the 40-quarter symmetric average unit-root growth rate

$$\mathrm{ggtarget}_t = \frac{\left[\ln(\mu_{z,t+20}) + \ln(\mu_{z,t+19}) + \cdots + \ln(\mu_{z,t+1}) + \ln(\mu_{z,t}) + \ln(\mu_{z,t-1}) + \cdots + \ln(\mu_{z,t-19})\right]}{40}, \tag{10}$$

and the quarter-on-quarter modified expenditure growth rate as

$$gg_t = \ln(g^{mod}_t) + \ln(\mu_{z,t}) - \ln(g^{mod}_{t-1}). \tag{11}$$

As with the structural balance rule, we also add a debt-correction term. Therefore, the modified govern-

[19] Note that the debt-correction term depends on the deviation of the annual debt-to-GDP ratio from its target for simplicity. Moreover, we have also experimented with using three-year averages of the debt-to-GDP ratio in these fiscal rules. The results reported below remain basically unaltered. See also Footnote 23, as well as Figure A.4 and Table A.1 in Appendix A.3.

ment expenditure growth rule is as follows:

$$\ln(x_t) = (1-\rho_x)\ln(x) + \rho_x \ln(x_{t-1}) + (1-\rho_x)\theta_{x,ggap}\left(gg_t - \left(\text{ggtarget}_t - \phi_{x,d}\left(\frac{D_{g,t}}{Y_t + Y_{t-1} + Y_{t-2} + Y_{t-3}} - \overline{dgy}\right)\right)\right), \quad (12)$$

where $x \in \{g^{exp}_{c,t}; g^{exp}_{i,t}; \text{tr}_t\}$ (i.e. normalized public consumption expenditure, public investment expenditure, and government transfers, respectively), ρ_x controls the persistence of government expenditure adjustments, $\theta_{x,ggap}$ is the parameter controlling for the tightness of the expenditure growth rule, and $\phi_{x,d}$ controls the strength of the correction term with respect to debt-to-GDP ratio deviation from target. Again, we assume that the tax rules are inactive. From Equation (12) it can be seen that although the medium-term growth itself is a (slowly-moving) time-varying process, the debt correction term introduces yet another dimension via which the expenditure growth target is affected.

5 The Case of a Small Country in a Monetary Union

In this section, we use the model to investigate the performance of the two fiscal rules for a small country in a monetary union. First, we discuss the calibration of the fiscal rules (Section 5.1). Second, we delve into the analysis of our simulation results (Section 5.2).

5.1 Calibration of fiscal rules

We calibrate the model to Latvia, a small open economy in the euro area. Except for the fiscal rules, we are using the estimated fiscal DSGE model's parameters and shock standard deviations from Bušs and Grüning (2020).

Regarding the fiscal rules, we set the sensitivity parameter of the structural balance with respect to the output gap in line with the European Commission's estimates for Latvia, $\theta_{ygap,t} = 0.38$. We calibrate the public debt-to-GDP ratio target at $\overline{dgy} = 0.3$, since this yields a steady-state deficit-to-GDP ratio of $dy = 0.9\%$, close to the maximum MTO target for Latvia and roughly equal to the historic average deficit-to-GDP ratio observed for Latvia in recent years before the Covid-19 pandemic.

Regarding the calibrated speed of convergence for the debt-to-GDP ratio, as a benchmark case, we choose $\phi_{x,d}$ such that it would represent a meaningful adjustment comparable to what the European Commission currently uses. For the structural balance rule, the benchmark value of $\phi_{x,d}$ would result in a 0.1 percentage point (pp) reduction in an annual structural deficit-to-GDP ratio for each 10pp deviation of the debt-to-GDP ratio from its target ($\phi_{x,d} = 1/100$). This would mean that, for a highly indebted country running a debt-to-GDP ratio 50pp above its target, the structural deficit target would be corrected by 0.5pp. This is comparable to the current EU fiscal rules stating that countries running debt above the target have a medium-term structural deficit target of 0.5%, while those below the debt target have a medium-term structural deficit target of 1%. Also, absent reaction of deviations of structural balance from its target, our calibration implies the rate of 1/25th of debt-to-GDP gap correction per annum, close to the one specified by the European Commission (1/20), and stronger than those of 1/50 and 1/75 considered by Christofzik *et al.* (2018). As alternatives, we also consider both weaker and stronger debt correction terms.

For the expenditure growth rule, we implement the rule used by the European Commission relating the necessary adjustment in the structural deficit to the necessary adjustment in the expenditure growth (Box 1.10 in European Commission, 2019). The rule states that the necessary adjustment in the expenditure growth must be equal to the required adjustment in the structural balance-to-GDP ratio divided by the share of government primary expenditure share in GDP. For Latvia, we set the primary expenditure share in GDP to 0.38, which is not far from the euro area average of 0.45. Therefore, the adjustment in the expenditure growth rate is about 2.5 times larger than that in the structural balance-to-GDP ratio.[20] This implies a 0.2pp reduction in the annual expenditure growth rate for every 10pp deviation of the debt-to-GDP ratio. So, for a highly indebted country running its debt-to-GDP ratio 50pp above its target, the correction to the annual expenditure growth rate would amount to 1.25pp. This is a relatively sizable yet a reasonable correction for a European country having an average annual potential growth rate of about 1.5–2%.

To better understand how the debt-to-GDP correction term affects the debt-to-GDP ratio stabilization for both fiscal rules, we simulate a deterministic increase in public consumption for two consecutive years, while having fiscal rules deactivated for three consecutive years, that is, we keep fiscal rules deactivated for an extra year after the fiscal stimulus ends. The increase of public consumption is such that it yields an increase of the debt-to-GDP ratio by about 30pp above its target at its peak. Then, fiscal rules ensure a gradual return of the debt-to-GDP ratio to its targeted level.

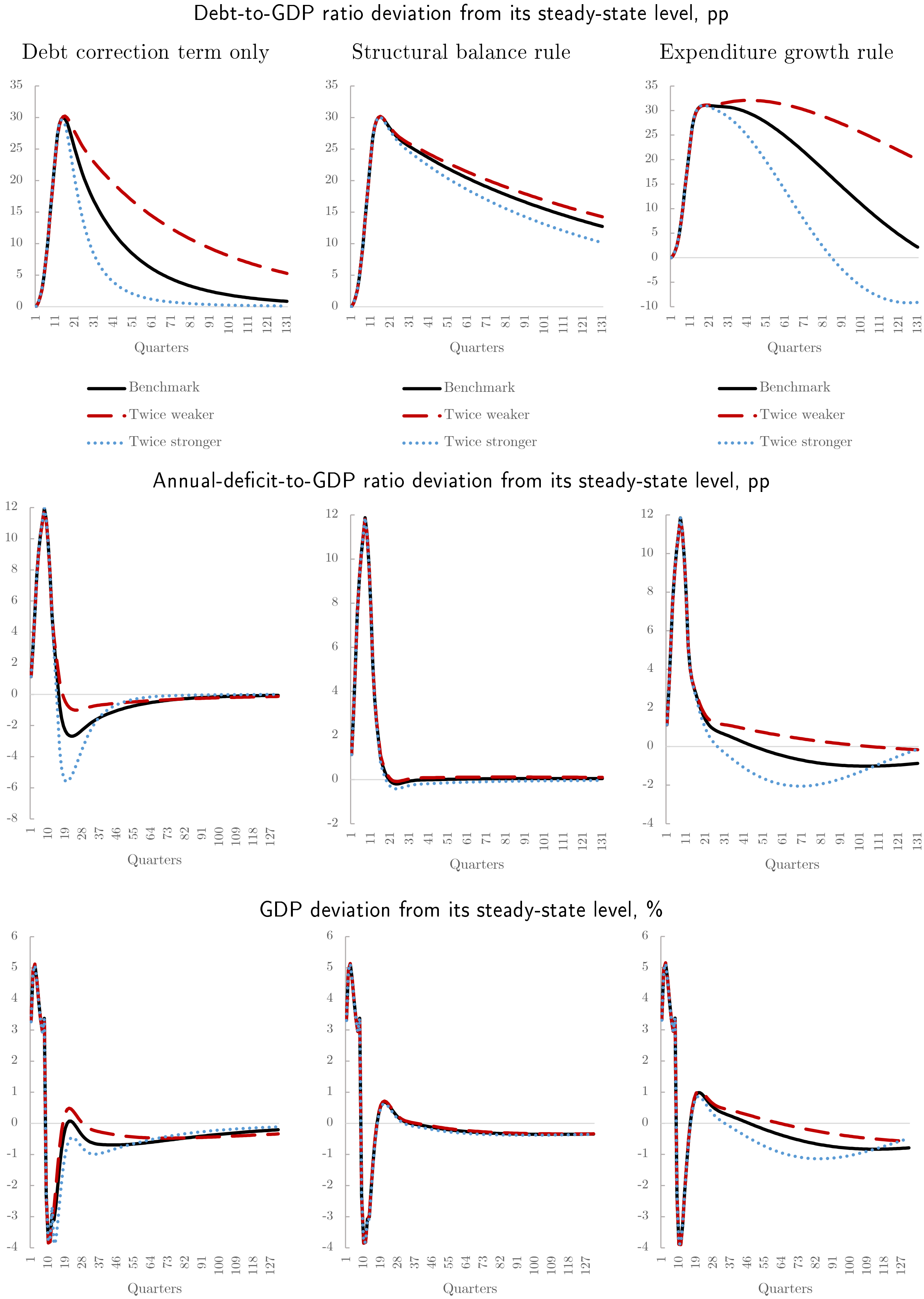
Figure 1 depicts how the debt-to-GDP ratio responds to alternative strengths of the debt-to-GDP correction term in the fiscal rules.

For clarity, we add a debt rule as the third fiscal rule, which contains only the debt correction term that is common to both rules. The results suggest that the behaviour of the debt-to-GDP ratio in case of the expenditure growth rule is more sensitive to the strength of the debt-to-GDP ratio correction term, compared to that of the structural balance rule, since the expenditure growth rule does not ensure debt-to-GDP ratio convergence without the debt correction term, while the structural balance rule does so. Also, the structural balance rule dampens the effect of the debt correction term on the debt-to-GDP ratio. For the benchmark calibration, the half-life of debt correction is similar across the two rules.

Looking at the deficit-to-GDP ratio behaviour (the middle panel of Figure 1), the debt rule imposes rapid fiscal tightening immediately after the fiscal rules are re-activated, while the expenditure growth rule postpones fiscal consolidation towards the future periods; the structural balance rule's behaviour fits in between these two cases. A slower fiscal consolidation yields faster GDP growth in the short term at the expense of slower economic growth in the future (the bottom panel of Figure 1).

[20] For the expenditure growth rule, our benchmark calibration implies $\phi_{x,d} = (1/100)/(4 \cdot 0.38)$ where 4 is used to convert to the quarterly expenditure growth rule and 0.38 is our calibrated government expenditure share in GDP.

Figure 1: **Strength of the debt-to-GDP correction term and debt-to-GDP stabilization, after a government consumption shock**



We set the persistence parameters ρ_x to 0.5.[21] As a benchmark, we prefer to assume the government meets the fiscal rules relatively diligently, so that any differences in outcomes would be accounted for solely by the differences in the rules, and not by differences in how the government is following them. Therefore, we impose relatively tight fiscal rules. In order to calibrate their values, we simulate the model on a grid of their values for 10 thousand quarters, and observe the amplitudes of the deviations of the fiscal outcomes from their targets (the term inside the large parenthesis in the fiscal rules), as well as the deviations of the debt-to-GDP ratio from its target.

We then set the fiscal tightness parameter such that the deviation from the fiscal target is within 0.3pp in 90% of time (which yields $\theta = -50$, see Figure 2). The simulated deviation of the debt-to-GDP ratio from its target is not very sensitive to the calibrated tightness parameter for the structural balance rule.[22] However, for the expenditure growth rule, the debt-to-GDP ratio volatility shows a non-linear pattern, first shrinking with the tightening of the fiscal rule, then increasing (in our case, starting at about $\theta = -50$).[23] We contemplate that the government would not choose an extremely tight expenditure growth rule that would actually make its debt-to-GDP ratio volatility worse, thus we consider that setting $\theta = -50$ is about optimal for stabilizing the debt-to-GDP ratio in the case of the expenditure growth rule for our model.

Having selected relatively tight fiscal rules, we now proceed by inspecting how the structural balance and expenditure growth rules differ in stabilizing macroeconomic and fiscal variables.[24]

5.2 Results

We stochastically simulate the first-order approximation of the model by drawing from the estimated shock distributions.[25] We are fixing the random number generator's seed so that our simulation results are replicable and comparable across alternative rules. We are simulating the model economy for a sufficiently long period (10 thousand quarters), so that the statistics are relatively stable, as public debt cycles in our simulations can spread over many decades.

[21] We have not found much sensitivity of our key results to the calibration of this persistence parameter.

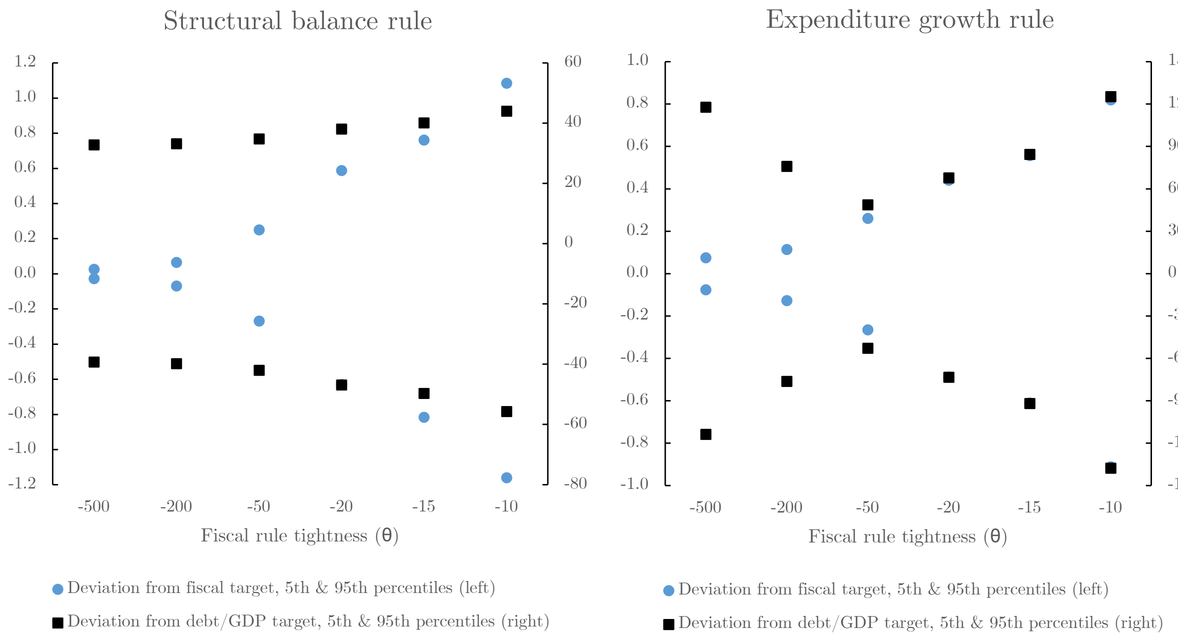
[22] About up to a 40pp deviation across all calibrations.

[23] This non-linear behaviour is robust to an alternative fiscal rule specification with a 3-year average debt-to-GDP targeting (as practised by the European Commission), instead of targeting the particular period's debt-to-GDP deviation; see Figure A.4 in Appendix A.3. A minor twist in the behaviour is the need for a stronger debt correction with a longer averaging window.

[24] Note that in the model and thus also in the results discussed below we always have three fiscal rules active: one for public consumption expenditure, one for public investment expenditure, and one for government transfers. One might suspect that the results can be different if only one of these rules is active at a time. In particular, it might be argued that public investment expenditure should not be touched in order not to harm future growth prospects and the amount of government transfers cannot be easily or quickly changed, when a government faces political or economic pressure to reduce total government spending, so that it could only adjust government consumption expenditure effectively. However, it turns out, using unreported results available from the authors upon request, the outcomes we are going to discuss below are qualitatively robust and quantitatively not much different from the number and kind of fiscal rules active in the model (we do not consider public investment as a single rule, as it is unlikely in policy practice). One just has to adjust the fiscal rule parameters (by making them larger in absolute value) in order to keep the volatility of the public debt-to-GDP ratio unchanged, relative to the benchmark calibration with all three fiscal rules.

[25] Relative to the estimated shocks, we are downscaling all the estimated shock standard deviations by 20% (or variance by 36%), as the shocks are estimated to the Latvian data, and Latvia experienced an exceptionally large boom-bust cycle in the first decade of this century, so that the simulation results would be more tailored to the post-2009 recession period (and to more stable economies).

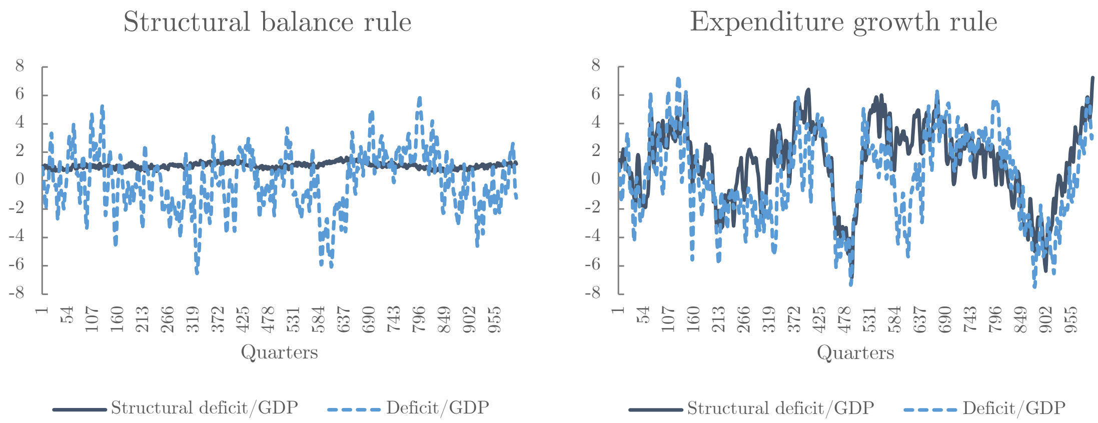
Figure 2: **Calibration of the fiscal rule tightness parameter**



First, we visually compare government deficit with regard to the two rules. Figure 3 depicts simulated deficit and structural deficit, both in terms of per cent shares in GDP, for the two rules. For visibility purposes we constrain the plotted sample for the first 1000 quarters.

Inspecting Figure 3 demonstrates that the two rules yield different deficit behaviour. The structural balance rule ensures that the structural deficit is stable around the target (in our case, 0.9% of GDP), with minor deviations coming mainly from the correction for debt deviations. Meanwhile, the structural balance is drifting in a relatively wide interval for the expenditure growth rule, as this rule does not target the stability of the structural balance. Also, the volatility of deficit is visibly larger in the case of the expenditure growth rule.

Figure 3: **Comparison of deficit behaviour for the two fiscal rules**



Figures 2 and 3 indicate that the expenditure growth rule yields more volatile public finances, compared to the structural balance rule. This result could have been expected, as the expenditure growth rule is designed with a focus of stable public expenditure growth (apart from the term for the debt-to-GDP ratio correction, which leads to adjustments in the medium term). Therefore, over the business cycle, stable public expenditure growth and procyclical public revenues (due to the procyclical size of the tax base) result in more volatile public finances relative to GDP. Next, we will inspect how well the expenditure growth rule performs in terms of stabilizing the economy, as well as the role of key modifications of the public expenditure definition entering the expenditure growth rule.

Table 1 reports the simulated standard deviations of several public finance and macroeconomic series for the expenditure growth rule, relative to the structural balance rule.[26] That is, a number above unity means higher volatility of a particular variable in case of the expenditure growth rule, relative to the structural balance rule, and vice versa. Column 1 of Table 1 shows that the volatility of public finances is larger in case of the expenditure growth rule, compared to the balance rule, while the volatility of macroeconomic variables tends to be lower. In order to understand the differences, in what follows, we will study the role of expenditure modification in the expenditure growth rule.

Table 1: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	1.53	1.51	1.21	1.19	1.37	1.17
Debt/GDP	1.23	1.23	0.99	0.99	1.07	0.83
Unemployment	0.95	0.98	0.96	0.98	0.96	0.96
GDP	0.98	1.00	0.99	1.00	0.98	0.99
Private consumption	0.94	0.95	0.95	0.96	0.95	0.95
Consumption of restricted households	0.87	0.90	0.89	0.91	0.88	0.88
Total investment	1.01	1.01	1.01	1.01	1.01	1.01
Government investment	0.92	0.92	0.94	0.94	0.93	0.93
Inflation	0.99	0.99	0.99	0.99	0.99	0.99

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption and investment are in annual growth terms, and inflation is in annual terms.

Role of cyclical unemployment benefits. For understanding the differences between the expenditure growth and structural balance rules, we start by undoing some of the modifications of public expenditure that enters the expenditure growth rule. As a first step, we add cyclical unemployment benefits back to modified expenditure:

$$G_t^{mod} = G_{c,t}^{exp} \cancel{+ G_{i,t}^{exp}} + \mathrm{TR}_t + (1 - L_t)D_{b,t} \cancel{+ (1 - L_t)D_{b,t} + \ln(R_{g,t-1})/\pi_t \cdot D_{g,t-1}} + Z$$
$$+ \left[G_{i,t}^{exp} + G_{i,t-1}^{exp} + G_{i,t-2}^{exp} + G_{i,t-3}^{exp} + \cdots + G_{i,t-13}^{exp} + G_{i,t-14}^{exp} + G_{i,t-15}^{exp})\right]/16. \quad (13)$$

[26] As a robustness check, Table A.1 in Appendix A.3 reports the results for the alternative specification of fiscal rules, where the government is targeting a 3-year average debt-to-GDP deviation from its target, instead of the particular period's debt-to-GDP targeting. The results are similar.

The results are reported in column 2 of Table 1. Comparing the results of the original expenditure growth rule with those of column 2 demonstrates that removing cyclical unemployment benefits from the public expenditure does not increase public debt volatility but (slightly) stabilizes macroeconomic volatility, as the public expenditure becomes less procyclical. Thus, our results support the choice of removing cyclical unemployment benefits in public expenditure.

Role of interest payments. Next, to see the effect of the exclusion of debt service payments, we add interest payments back to the modified expenditure of the original expenditure growth rule:

$$G_t^{mod} = G_{c,t}^{exp} \cancel{+ G_{i,t}^{exp}} + \mathrm{TR}_t \cancel{+ (1 - L_t) D_{b,t}} + \log(R_{g,t-1})/\pi_t D_{g,t-1} + Z + (1 - L) D_b \\ + \big[G_{i,t}^{exp} + G_{i,t-1}^{exp} + G_{i,t-2}^{exp} + G_{i,t-3}^{exp} + \cdots + G_{i,t-13}^{exp} + G_{i,t-14}^{exp} + G_{i,t-15}^{exp})\big]/16. \tag{14}$$

The resulting volatility is reported in column 3 of Table 1. Comparing column 3 (interest payments included) to column 1 (the original rule) we can see that having interest payments in the modified expenditure reduces the public debt volatility considerably, as now changes in debt service payments are taken into account by the fiscal rule. Also, the effect of having debt service payments in the expenditure growth rule increases the macroeconomic volatility only slightly, hence having more balance between the stability of public finances and the stability of macroeconomic quantities. These results suggest that the choice of excluding the entire interest payments from the expenditure growth rule cannot be unequivocally supported; that is, there is evidence of only a marginal benefit in terms of macroeconomic stabilization in a monetary union context, while we see a relatively more pronounced deterioration of public finance volatility.

Constant interest rate in the expenditure growth rule. Interest payments are excluded from the expenditure growth rule based on the considerations that governments cannot fully control them. Therefore, governments should not be penalized for any ex post interest payments deviation from their ex ante estimate. In order to isolate the effect of changes in the interest rate (which the government cannot fully control) from changes in public debt, we consider including interest payments in the expenditure growth rule with a fixed interest rate. In the model, we set it to its steady state value:

$$G_t^{mod} = G_{c,t}^{exp} \cancel{+ G_{i,t}^{exp}} + \mathrm{TR}_t \cancel{+ (1 - L_t) D_{b,t}} + \log(R_g)/\pi_t D_{g,t-1} + Z + (1 - L) D_b \\ + \big[G_{i,t}^{exp} + G_{i,t-1}^{exp} + G_{i,t-2}^{exp} + G_{i,t-3}^{exp} + \cdots + G_{i,t-13}^{exp} + G_{i,t-14}^{exp} + G_{i,t-15}^{exp})\big]/16, \tag{15}$$

while, in practice, the governments could use the projected long-run level. Column 5 of Table 1 demonstrates that having a constant interest rate in the expenditure growth rule reduces the public finance volatility, relative to the benchmark expenditure growth rule. Therefore, accounting at least for some part of debt service payments (the debt part) may help stabilize public finances. Another option for stabilizing public finances is raising debt correction strength, as we well show later on.

Total effect of expenditure modification. In order to assess the total effect of expenditure modification, we enter non-modified government expenditure in the expenditure growth rule. Essentially, the total effect is a sum of the effects from having cyclical unemployment benefits, interest payments, and averaging investment. The results are reported in column 4 of Table 1. Without any expenditure modification, and for a comparable public finance volatility (which is subject to the choice of debt correction strength), the relative volatility of macroeconomic variables for the expenditure growth rule tends to be lower than that for the structural balance rule.

Role of government risk premium. In the model, there are both exogenous shocks to government risk and the endogenous risk premium due to deviations of public debt from its target. During the estimation sample, in particular during the 2009 bust period, the government risk premium shocks were sizeable. Also, in simulations, due to debt deviations from its target, the endogenous risk premium affects the size of interest payments and thus further amplifies volatility of public debt. In order to control for the effect of the government risk premium channel, we shut off all exogenous shocks to government risk premium, as well as remove the endogenous government risk premium channel. In this case, changes in the government bond yield are solely due to changes in the ECB policy rate, which fluctuates in a relatively narrow interval. We redo simulations for both the expenditure growth and structural balance rule and report the results in column 6 of Table 1. As expected, nullifying the government risk premium reduces the public finance volatility in case of the expenditure growth rule relatively more than in case of the structural balance rule.

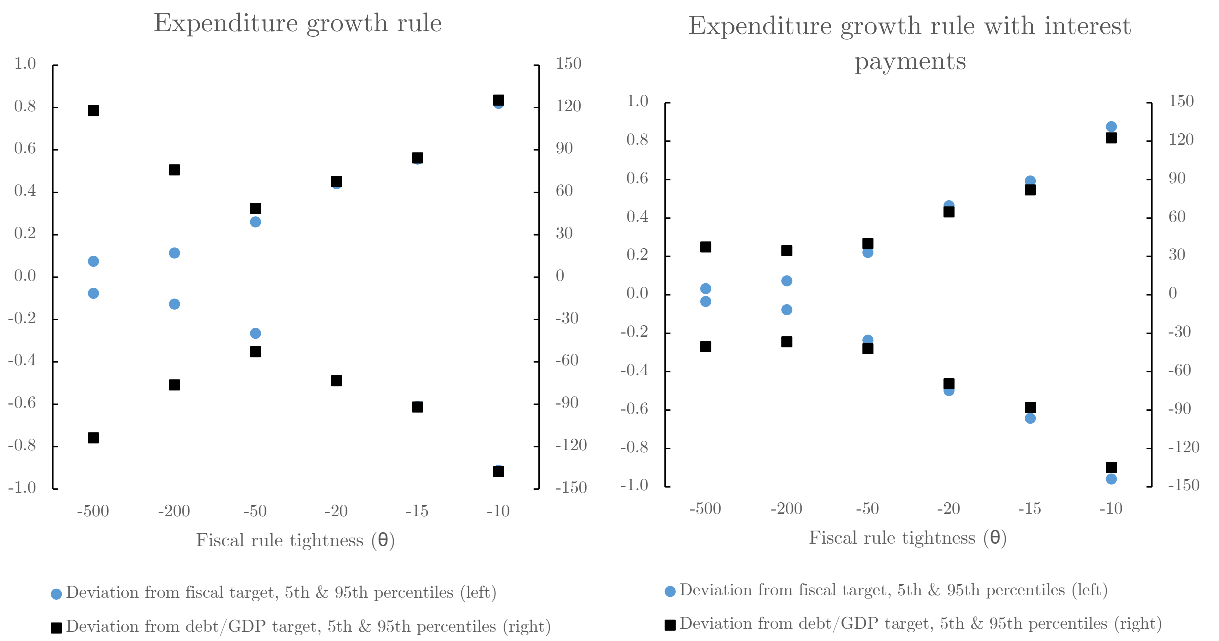
Stability of public investment. Much of the discussion on fiscal rules in the EU involves considerations of the stability of public investment, as it is seen as a contributing factor to long-run growth. It is also argued that, during recessions and in order to meet their fiscal constraints, governments are prone to cut, first and foremost, public investment. Our comparison of the structural balance and the expenditure growth rules in stochastic simulations (in Table 1) demonstrates that public investment is more stable under the expenditure growth rule, compared to the structural balance rule. This is because the expenditure growth rule i) does not react to windfalls and shortfalls in government revenue, ii) ignores the short-term economic fluctuations by targeting long-run growth, iii) excludes interest payments from the modified expenditure definition, and iv) uses a four-year average public investment in the modified expenditure definition.[27] Thus, the expenditure growth rule is more friendly to the stability of public investment, in line with economic reasoning.

Dichotomy between the stabilization of expenditure growth and public debt – the role of interest payments. Now, we return to discussing the role of interest payments in the ability of debt stabilization in the case of the expenditure growth rule. For that, we reconsider the calibration of tightness of the expenditure growth rule with versus without interest payments. In Figure 2, which

[27]Public investment averaging yields small improvements in public investment stability in stochastic simulations for typical public investment shocks. We return to this topic during the discussion of the golden rule below.

we replot in Figure 4 (left panel) for convenience, we can see that the benchmark expenditure growth rule without interest payments, if tight enough, is incongruent to the stabilization of public debt; that is, after some turning point, the tighter the government follows the expenditure growth target, the higher the volatility of public debt. However, if interest payments are included in the expenditure definition, the inconsistency between expenditure growth targeting and public debt stabilization essentially disappears (Figure 4, right panel).

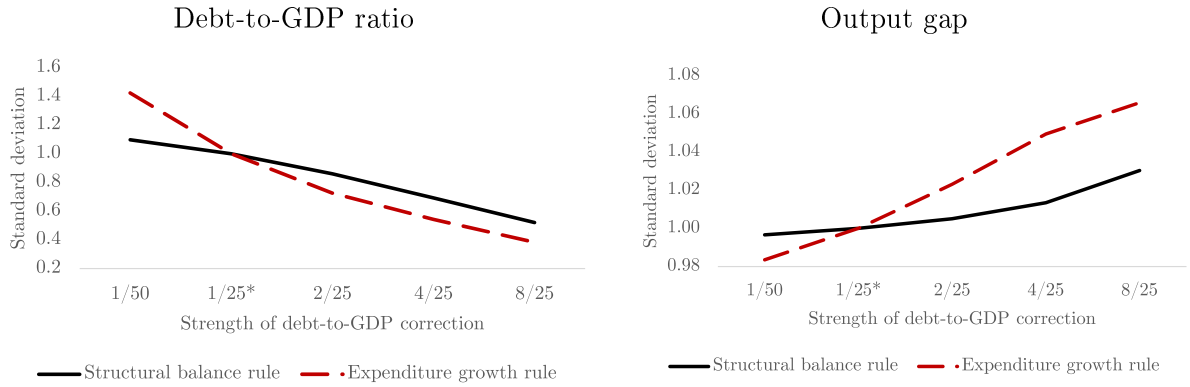
Figure 4: **Calibration of the fiscal rule tightness parameter, revisited**



Alternative strength of debt-to-GDP correction. As discussed in Section 5.1, we select a meaningful strength of debt-to-GDP correction in both fiscal rules, that is, reducing the annual structural deficit to GDP ratio by 0.1pp for each 10pp deviation of the debt-to-GDP ratio from its target. This corresponds to a 0.25pp reduction in the annual expenditure growth rate for every 10pp deviation of the debt-to-GDP ratio from its target for the expenditure growth rule. Absent structural deficit or modified expenditure growth targeting, this implies a reduction of 1/25th fraction of debt-to-GDP per annum, but as shown above, structural deficit or modified expenditure growth targeting affects the debt-to-GDP convergence trajectory. In this paragraph we consider alternative strengths of correction for the debt-to-GDP deviation from its target in both fiscal rules.

First, the left panel of Figure 5 highlights our above findings that the expenditure growth rule's ability to stabilize public debt is more sensitive to the strength of the debt-to-GDP correction than the structural balance rule. This is especially so for weak enough debt-to-GDP correction terms. Second, both fiscal rules are able to contain debt-to-GDP volatility effectively if the debt-to-GDP correction term is strong enough. Third, a tighter debt-to-GDP targeting implies a more volatile real economy, as measured by a standard deviation of the output gap (right panel), as the government loses some of its ability to stabilize output with a tighter debt targeting. Finally, the slope of an increase of volatility of the real economy

Figure 5: **Effects of alternative strengths of debt-to-GDP correction**



Notes: The asterisk * denotes the benchmark calibration. The standard deviation of a variable is normalized to unity at the benchmark calibration.

is by an order of magnitude smaller than the slope of the reduction of debt-to-GDP volatility.[28] These results suggest that having a a strong-enough debt-to-GDP correction for either fiscal rule contains public debt volatility at a relatively minor cost to the real economy in the long run.[29] Speedy debt-to-GDP correction may nevertheless involve practical costs in the near term, as was shown in Figure 1.

Role of the size of the public debt target. As a benchmark, we calibrate the public debt-to-GDP target to 30%, if not specified otherwise. Alternatively, we consider higher debt targets. Figure 6 demonstrates that the volatility of public debt increases with the debt target, if everything else, including the debt correction strength, is kept constant. This is due to shocks to the bond yield that affect a larger amount of debt as the stock of debt increases. The volatility slope is steeper for the expenditure growth rule than for the structural balance rule. As discussed above, the exclusion of the debt service payments from the modified expenditure definition is the key driver of the wedge between the two fiscal rules. For both rules, the heightened debt volatility feeds in to the real economy.

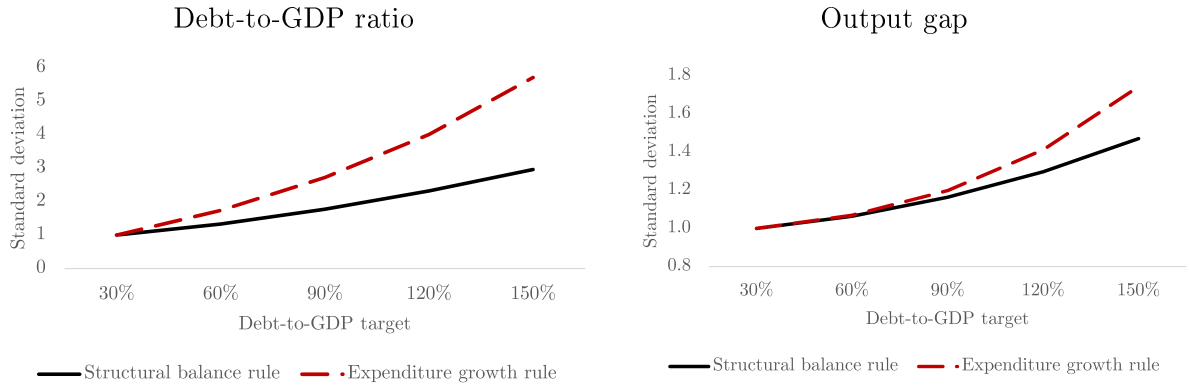
The government should take these effects into account if it for some reason decides to raise its debt levels and sustain the heightened debt levels in the medium to long run. A naive solution for the heightened volatility of public finances could be hoping for a lower bond yield in the future. But the interest rate that the government pays on its debt is not fully under control by the government, and it may be subject to sudden spikes during the times the government needs to borrow the most.

A safer solution for the government would be to consider strengthening the debt correction term to contain the debt volatility. Our back-of-the-envelope calculation suggests the debt correction term should move more than one-to-one with the change in the debt-to-GDP target to limit the debt-to-GDP

[28]This result is robust to alternative calibrations (including absence) of import content in government and private expenditure, as well as to alternative weights of government expenditure in private utility.

[29]A note of caution is warranted: our simulation ignores potential non-linearities, such as a series of bankruptcies (beyond those that can be captured by the Bernanke-Gertler-Gilchrist financial accelerator mechanism in our model) and protracted demand-supply doom loops that may occur in deep crises absent adequate government support. For the sake of balance of risks though, this simulation ignores also sudden debt crises (beyond those that can be captured by a linear risk premium on debt in our model) that may occur for large-enough debt levels.

Figure 6: **Effects of alternative debt-to-GDP targeted levels**



Notes: The standard deviation of a variable is normalized to unity at the benchmark 30% debt-to-GDP ratio calibration.

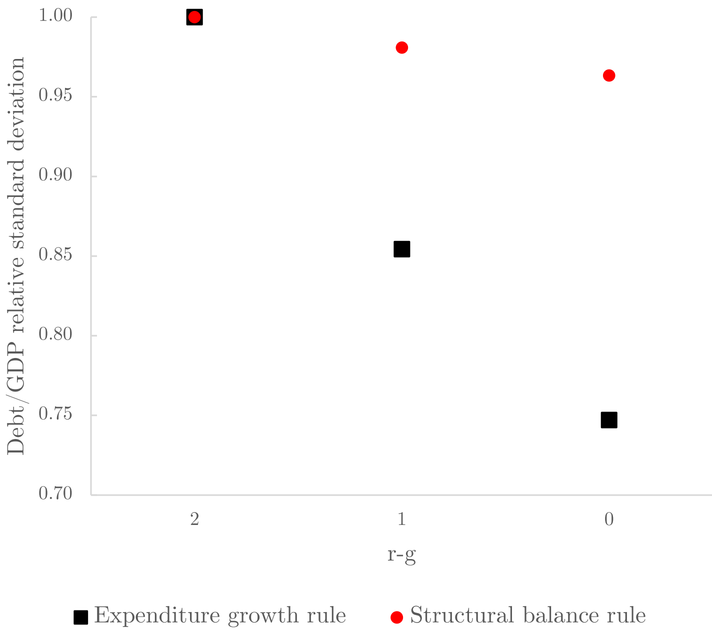
volatility. A rough rule of thumb would be: change the debt correction strength by 1.5–2 times the change in debt to GDP target. Our unreported results indicate that bringing debt volatility back to its initial level may turn challenging under the expenditure growth rule for elevated debt levels, for any strength of the debt correction term; nevertheless, the above rule of thumb would help limiting debt volatility for both fiscal rules. Strengthening the debt correction term, however, comes with even (moderately) more volatile output, as seen in Figure 5. In this respect, a higher debt level is no 'free lunch'.

Secular trend in the interest rate. There are considerations in both academic and policy circles that the low interest rate environment may allow sustaining public debt at a higher level. A lower bond yield for a prolonged time raises fiscal space via i) lowering the mean debt service payments, and ii) narrowing the distribution of public debt. The first channel characterizes the first moment of the debt distribution and, in the medium term, the created fiscal space is unaffected by a fiscal rule. In this paragraph, we consider the second channel – the distributional aspect of changes in (real annual interest rate, r)−(real annual growth rate, g) level. We tweak the $r - g$ levels by adjusting the modelled discount factor. We simulate the model using the first-order approximation; therefore, we do not consider the effects of changes in the perception of risk due to changes in the real interest rate. We stochastically simulate the model economy for 10 thousand quarters, dropping the first 500 quarters as burn-in. We set the debt-to-GDP target to 60%.

Our results indicate that the volatility of the debt-to-GDP ratio shrinks with $r - g$ noticeably for the expenditure growth rule, but not much for the structural balance rule. This is so because the expenditure growth rule, unlike the structural balance rule, excludes the interest payments from the expenditure definition. Quantitatively, a reduction of $r - g$ by one percentage point reduces the standard deviation of the debt-to-GDP ratio under the expenditure growth rule by about 15% (Figure 7).

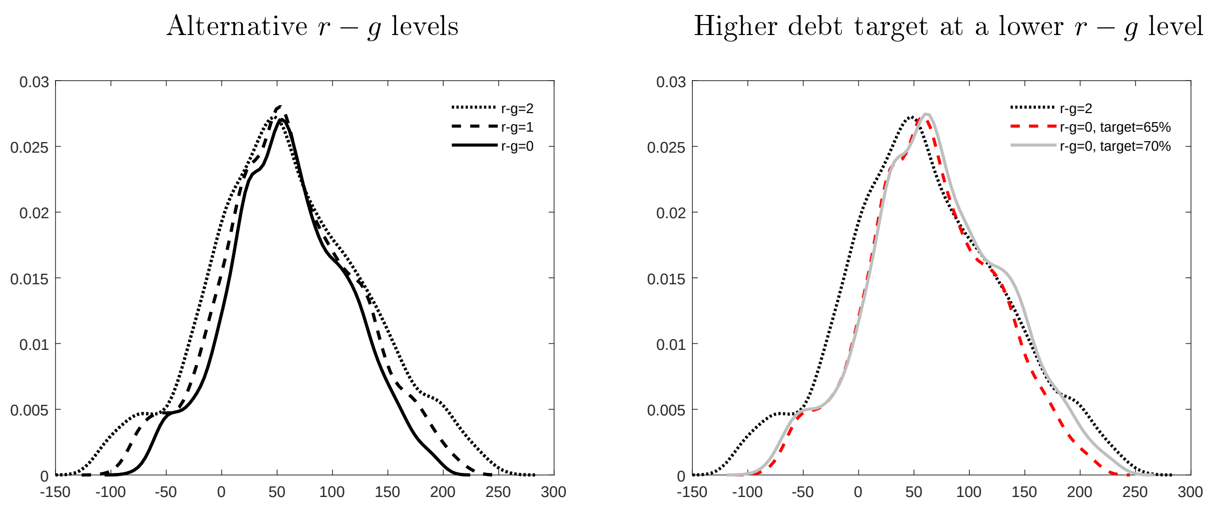
The probability density function drawn from the simulated debt-to-GDP ratio and approximated by a normal kernel function evidently narrows with lower $r - g$ under the expenditure growth rule (Figure 8, left panel), potentially allowing for maintaining a higher debt level without having excessive tail risks.

Figure 7: **Debt-to-GDP ratio relative standard deviation under alternative r − g levels**



Notes: The standard deviation of the debt-to-GDP ratio is normalized to unity at $r - g = 2$pp.

Figure 8: **Debt-to-GDP distribution under alternative r − g levels and debt targets**



Particularly, our results indicate that under the expenditure growth rule, a decrease of $r - g$ by 1pp allows for increasing the debt-to-GDP level by 8.3 percent (or 5pp if the debt-to-GDP ratio is about 60%) without raising tail risks (Figure 8, right panel). This process works the other way around, too – the debt volatility will increase faster under the expenditure growth rule than under the structural balance rule, if $r - g$ rises.

The golden rule. Several advanced economies have recently experienced a decline in public investment growth, which may have deteriorated the state of public infrastructure. Also, tackling the emerging issues related to climate change, digital transformation of the European economy, and post-Covid recovery would benefit from a boost in public investment. To improve the quality of public finances and foresee some fiscal space for these emerging issues, public investment could receive a special treatment. Such an approach, in particular an exclusion of growth-enhancing expenditure from fiscal rules – the so-called 'golden rule' – was proposed by European Fiscal Board (2019).

In order to model the golden rule, we amend the fiscal rules as follows. First, we replace public investment by its steady-state level in the expenditure definition used in the respective fiscal rules. So, for the structural balance rule, this modifies the government deficit definition, which now does not react to changes in public investment. For the expenditure growth rule, the resulting change in the expenditure definition is less striking, as the benchmark specification is less sensitive to changes in the public investment by using a four-year average of public investment; in the case of the investment golden rule, the modified expenditure does not react to changes in public investment at all.

Second, we suspend the public investment fiscal rule in line with the idea in the literature that public investment in the case of the golden rule is not used as an instrument for fiscal adjustment. Therefore, we allow only for two active fiscal instruments to achieve the fiscal targets – government consumption and government transfers.

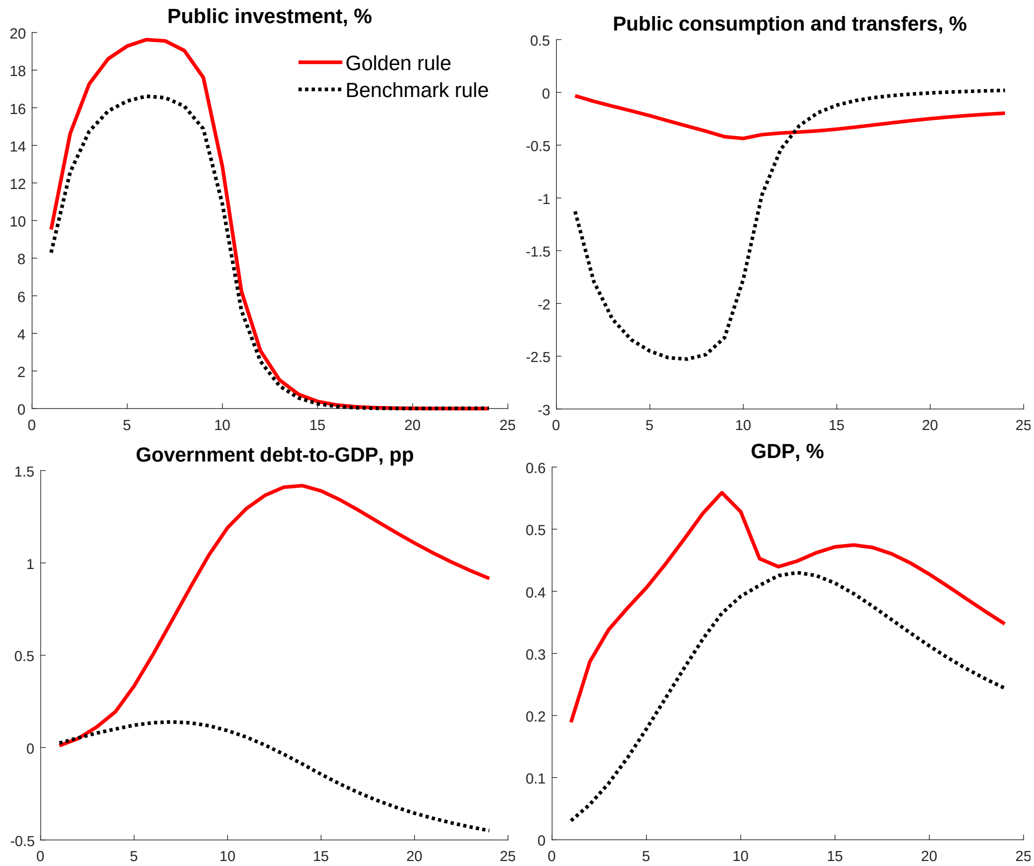
We still allow for the reaction to public investment indirectly via the public debt correction term; but this channel is slower than the direct channels via public deficit or expenditure growth.

Next, we perform a deterministic simulation of a persistent increase in public investment for a few years, with a peak increase in public investment of up to 20%. This simulation is broadly in line with the above idea that large public investment projects, such as the Next Generation EU investment plans (European Commission, 2021; Bankowski *et al.*, 2021), require special care of the way the public investment is accounted for in the fiscal rules.

Figure 9 compares the results of the structural balance golden rule with the benchmark structural balance rule. In the case of the golden rule, public investment increases by up to 20% for a period of about 2.5 years. The public consumption and transfers fiscal rules do not react to the increased public deficit, and only slowly counter-react to the increased public debt. The increase in public debt is sustained in the medium term, as our calibrated benchmark debt correction strength is modest (and the same as in the previous sections). Consequently, there is an investment-supported sustained expansion in GDP by up to 0.5%.

In comparison, the benchmark structural balance rule reacts to the deteriorating government balance by both cutting public consumption, transfers, and decelerating public investment growth. As a result, there is a smaller increase in public investment. On the positive side, there is also a much smaller build-up of public debt. Essentially, there is a partial public expenditure switching from consumption and transfers to investment, thereby raising potential output, causing more favourable terms of trade and boosting net exports. As a result, GDP increases by less than in the case of the golden rule; nevertheless, its increase is notable and sustained, given the fact that this is due in particular to budget-neutral growth-friendly expenditure switching. A note of caution is warranted here. It is not clear in practice by how much the

Figure 9: **Structural balance golden rule**



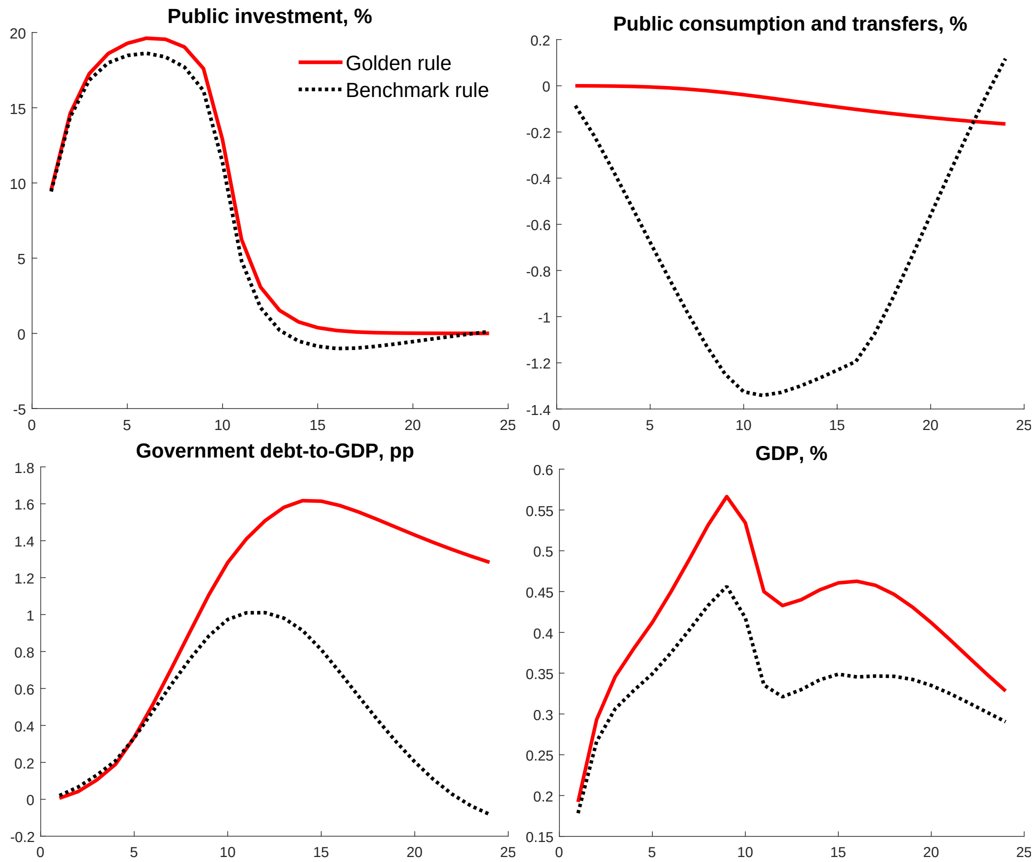
government would be able to cut consumption and transfers until it faces backlash; in the latter case, it would then need to proceed by cutting down on public investment disproportionately.

Figure 10 depicts the results in the case of the expenditure growth golden rule. An increase of public investment raises the government expenditure but this increase is not taken into account by the golden rule. Public consumption and transfers decrease only modestly via the debt correction term due to the persistent increase in public debt. Consequently, and similar to the structural balance golden rule, there is a persistent expansion of GDP by up to 0.5%.

In contrast, the benchmark expenditure growth rule reacts to the growth of public expenditure by both cutting public consumption and transfers, which limits the expansion of public investment. Therefore, public investment growth is lower compared to the one under the golden rule. The decrease in public consumption and transfers is slower but more persistent than in the case of the structural balance rule. As a result, there is a build-up in public debt during the fiscal expansion but it moves towards its initial level considerably faster than under the golden rule. Consequently, GDP grows less, compared to the golden rule.

To summarize, our results demonstrate that taking special care of public investment in fiscal rules, as in the golden rule, may help achieve growth objectives during significant and persistent public investment projects. Yet, it is uncertain whether the golden rule in practice would apply to all public investment or

Figure 10: **Expenditure growth golden rule**



only to a subset of it; for example, green public investment. Also, it is not clear whether such golden rules should be used permanently or rather only during specific investment projects. The caution arises as the golden rule brings about the motivation for governments to misclassify public investment. This issue in real life may overwhelm the benign original purpose of the golden rule. Investment averaging as in the expenditure growth rule may be an alternative. We perform also a stochastic simulation of the model economy using our estimated shocks, including the shocks to public investment (the estimates are for Latvia). Our results indicate that there is a small difference, on average, between the expenditure golden rule and benchmark expenditure growth rule, as the typical public investment shocks historically were small, compared to the aggregate demand level.

6 Sovereign Monetary Policy Case

Governments might prefer a fiscal rule embracing the interaction of fiscal policy and monetary policy, not counter-acting it. In order to assess this dimension, we now consider the case in which our model economy has its own currency and monetary policy characterized by inflation targeting. Therefore, we endogenize the nominal exchange rate, add the Fisher equation, as well as introduce a standard Taylor rule for the monetary authority

$$\ln\left(\frac{R_t}{R}\right) = \rho_r \ln\left(\frac{R_{t-1}}{R}\right) + (1-\rho_r)\left(r_\pi \ln\left(\frac{\pi_t^{c,yoy}}{\pi^{c,yoy}}\right) + r_y \ln\left(\frac{y_t}{y}\right)\right) + \epsilon_{R_t}, \tag{16}$$

where $\pi_t^{c,yoy}$ is the annual inflation rate, the persistence parameter ρ_r is set to 0.8, the parameter controlling the reaction to CPI inflation deviation from its target r_π is set to 1.5, and the reaction to the output gap is controlled by $r_y = 0.125$.

Also, for symmetry, we replace the government bond yield specification with the one where the government bond yield is linked to the domestic monetary policy rate

$$R_{g,t} = \Phi_{g,t} R_t, \tag{17}$$

$$\Phi_{g,t} = \tilde{\phi}_{g,r}\left(\frac{D_{g,t}}{Y_t + Y_{t-1} + Y_{t-2} + Y_{t-3}} - \overline{dgy}\right) + \varepsilon_{g,t}^{rp}. \tag{18}$$

Then, we repeat the comparison of fiscal rules in terms of their implied fiscal and macroeconomic volatility, as reported in Table 2.

First, we see that the results broadly hold for a sovereign monetary policy, that is, the expenditure growth rule stabilizes macroeconomic quantities relatively more, but public finances – relatively less. For the benchmark specifications, the effects with a sovereign monetary policy are even more pronounced, as visible in Table 2, first column.

Table 2: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – the sovereign monetary policy case**

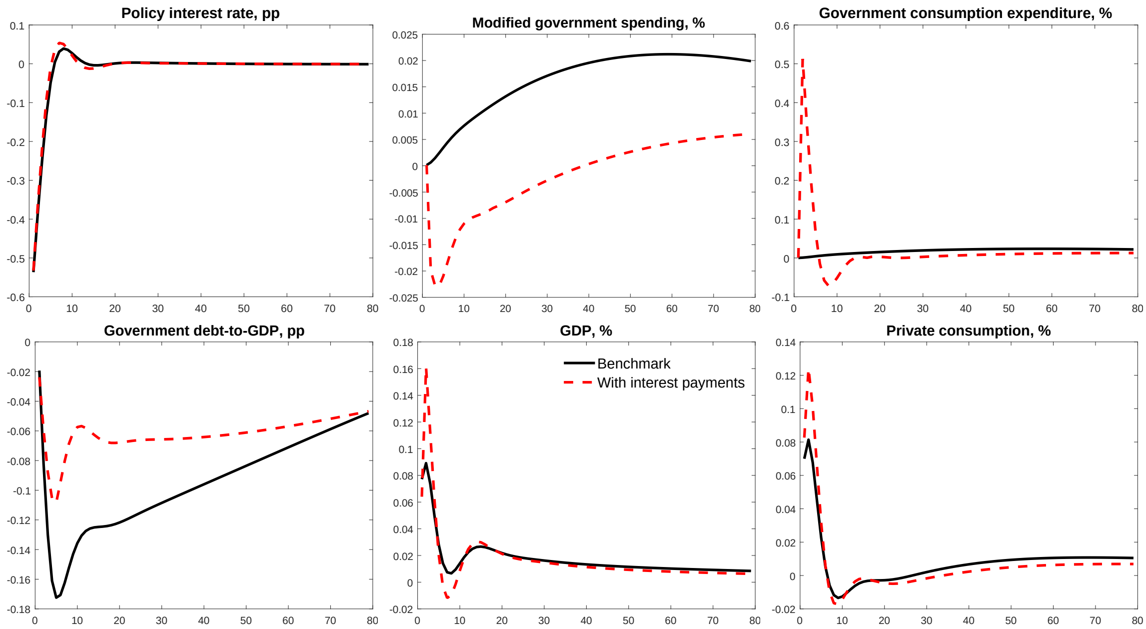
	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	2.04	2.02	1.11	1.13	1.95	1.85
Debt/GDP	1.39	1.39	1.06	1.07	1.22	1.08
Unemployment	0.83	0.86	1.00	1.00	0.83	0.84
GDP	0.86	0.88	1.01	1.01	0.86	0.87
Private consumption	0.89	0.90	1.00	0.99	0.89	0.90
Consumption of restricted households	0.61	0.63	0.99	0.97	0.61	0.62
Total investment	1.00	1.00	1.00	1.00	1.00	1.00
Government investment	0.74	0.74	1.00	0.96	0.74	0.76
Inflation	0.98	0.98	0.99	0.99	0.98	0.98

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

Second, including the interest payments back to the expenditure growth rule, volatility of public finances falls, as seen in the monetary union case, but, distinctively, also the relative ability of the expenditure growth rule to stabilize macroeconomic volatility decreases considerably (Table 2, third column). This result turns out to be robust for alternative specifications of the Taylor rule, including the suspension of monetary policy shocks. Therefore, in a sovereign monetary policy environment, unlike a monetary union environment, exclusion of interest payments helps stabilize macroeconomic variables. This result is linked to changes in the interest rate, as using a constant long-run interest rate in interest payments calculations re-establishes the benchmark results (Table 2, fifth column).

Debt service payments channel. To understand what is going on with the interest payments mechanism under an endogenous interest rate rule, we employ deterministic simulations. First, we simulate a negative shock to the monetary policy rate, so that the policy rate decreases by 50 basis points (Figure 11).

Figure 11: **Interest payments channel, sovereign monetary policy case – monetary policy shock**

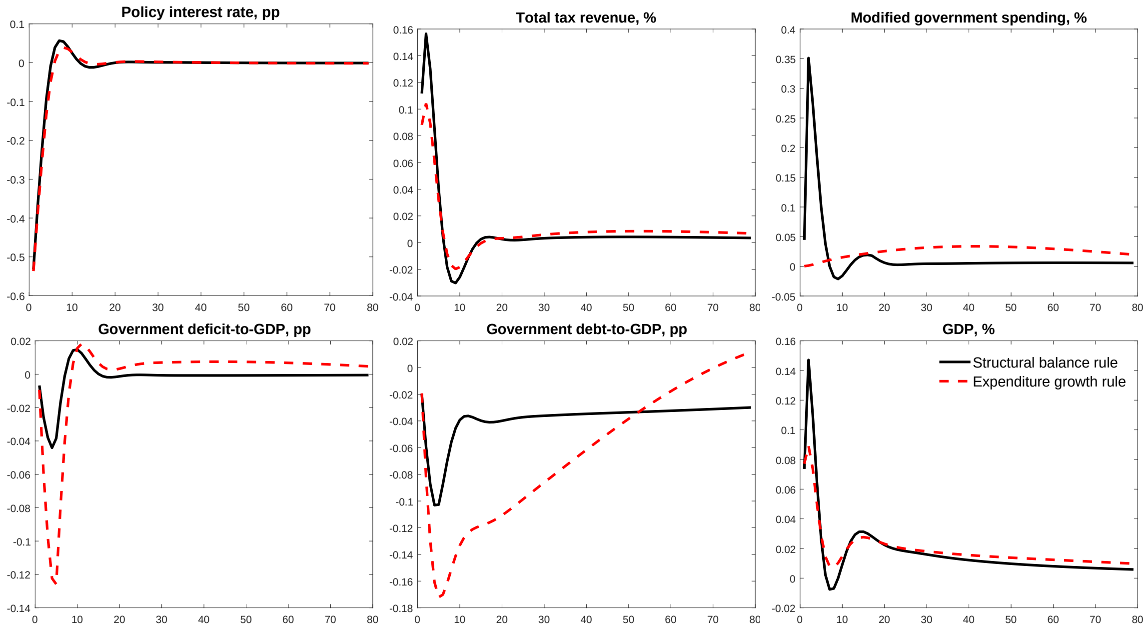


We compare the economic reaction under the expenditure growth rule with and without interest payments. The results show that a comovement between monetary and fiscal policies is considerably stronger if interest payments are taken into account in the expenditure growth rule. Otherwise, if interest payments are excluded from the expenditure growth rule, fiscal policy is broadly unaffected by the monetary policy stance in the near term.

Next, we repeat the above exercise to compare the structural balance rule and the benchmark expenditure growth rule. Figure 12 depicts comovement of the structural balance rule and monetary policy, while the fiscal response under the expenditure growth rule is muted.

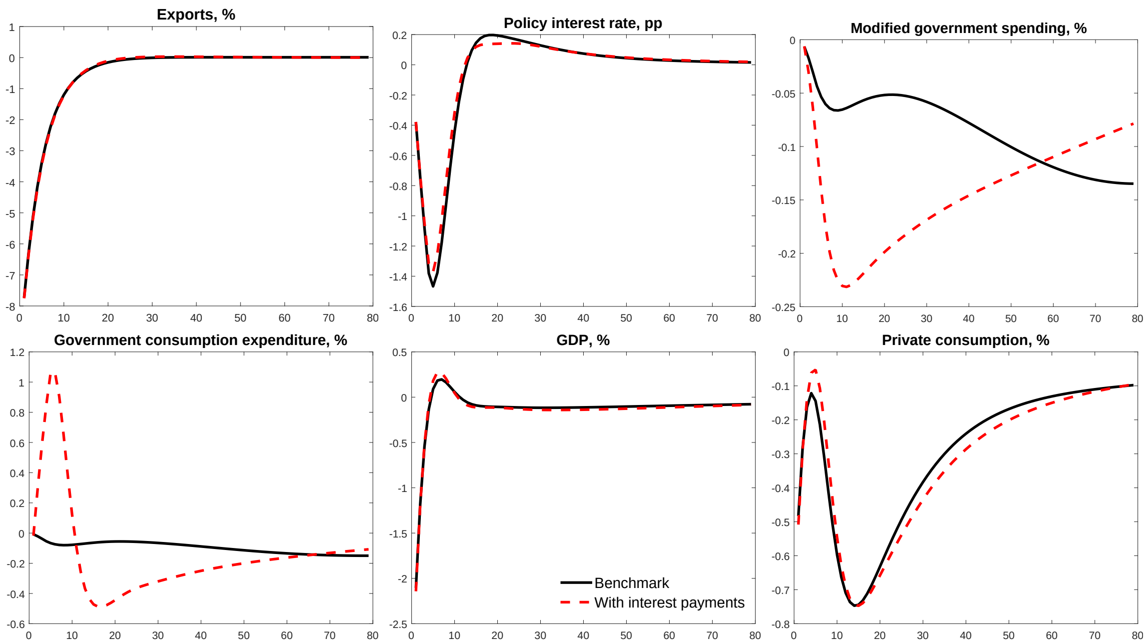
There are (at least) three channels at play that can explain the different behaviour of the two fiscal rules. First, and as discussed above, a lower policy rate induces lower public debt service payments which improves the balance (but these payments are excluded from the benchmark expenditure growth rule). Second, a lower policy rate increases demand, thereby increasing the tax base and tax revenues. These (revenue windfall) effects improve the balance, but they are not taken into account by the expenditure growth rule. Third and minor, an increase in demand raises GDP, thus improving the government

Figure 12: **Structural balance rule versus expenditure growth rule, sovereign monetary policy case – monetary policy shock**



balance-to-GDP ratio. In contrast, short-term changes in growth have a muted effect in the case of the expenditure growth rule.

Figure 13: **Interest payments channel, sovereign monetary policy case – foreign demand shock**



Finally, to see an endogenous response of monetary and fiscal policies to a macroeconomic shock, we perturb foreign demand such that exports decrease (Figure 13), and compare the expenditure growth rule with versus without interest payments. In response to this shock, the monetary policy interest rate is reduced. In the case of interest payments included in the fiscal rule, a lower interest rate creates fiscal space, thus allowing the government to increase its spending on other items. Yet, the fiscal stimulus affects the macroeconomic quantities with some time lag, thus failing to reduce the depth of the recession but merely boosting the recovery phase. Also, as the policy rate returns to its normal level, fiscal space shrinks thereby forcing the government to cut spending. As a result, the macroeconomic variables are at a lower level for a longer period during the recovery phase.[30]

It appears a robust feature[31] that accounting for interest payments in the fiscal rule fails stabilizing macroeconomic growth at typical business cycle frequencies, although it helps stabilizing the trajectory of public debt. As the structural balance rule takes into account debt service payments but the benchmark expenditure growth rule does not, the interest rate channel explains much of the superiority of the benchmark expenditure growth rule in stabilizing macroeconomic variables in a sovereign monetary policy regime.[32] These results suggest that the interest payments channel may create the monetary-fiscal policy interaction vicious to macroeconomic stability over a normal business cycle, and thus may support removing debt service payments from a fiscal rule.

7 Welfare Analysis

In this section, we first define our measures of welfare and how we compute welfare costs in terms of lifetime consumption equivalents (Section 7.1). Then we analyse the welfare implications by comparing simulated values of welfare under the expenditure growth rule to that under the structural balance rule. We do this for both the monetary union case and the sovereign monetary policy case (Section 7.2).

7.1 Computation of welfare

We define our measure of welfare for the two types of households largely following Ascari *et al.* (2015) and Tsiaras (2020). A slight difference from their setup is that, in our model, there is no disutility from supplying labour in the households' utility functions. The following exposition of how to define welfare and welfare gains/losses is similar to the one Ascari *et al.* (2015) provided in the Appendix to their paper. The exposition below is written for a generic household and can be applied to both types of households in our model.

Welfare is defined as the lifetime utility function of a household. Using trending variables, this implies the following definition for welfare:

$$V_t = \zeta_t^c \ln(\widetilde{C}_t - b\widetilde{C}_{t-1}) + \beta \mathbb{E}_t[V_{t+1}]. \tag{19}$$

[30] The timing of the fiscal policy may be crucial here. In the model, an interest rate enters the interest payments with a lag of one period (quarter), thus merely amplifying the monetary policy effects with some lag. In practice, it can be argued that, due to fiscal policy implementation lags, there may be even longer lags of fiscal stimulus, thus implying asynchronicity with the business cycle.

[31] We have experimented with both alternative Taylor rule specifications and alternative macroeconomic shocks, including their assumed persistence parameters.

[32] We confirm this result also by excluding interest payments from the structural balance rule and verifying that in this case much of the superiority of the expenditure growth rule in stabilizing macroeconomic outcomes disappears.

Normalizing variables in the period utility terms, this can be written as follows:

$$V_t = \zeta_t^c \ln(\widetilde{c}_t - b\mu_{z+,t}^{-1}\widetilde{c}_{t-1}) + \ln(z_t^+) + \beta\mathbb{E}_t[V_{t+1}]. \tag{20}$$

We define the following variable ($\hat{V}_t$) to account for the normalized consumption bit of welfare in aggregate welfare:

$$\hat{V}_t := \zeta_t^c \ln(\widetilde{c}_t - b\mu_{z+,t}^{-1}\widetilde{c}_{t-1}) + \beta\mathbb{E}_t[\hat{V}_{t+1}]. \tag{21}$$

Moreover, we define a variable Ψ_t as follows:

$$\Psi_t = \mathbb{E}_t\left[\sum_{s=0}^{\infty}\beta^s \ln(z_s^+)\right] = \sum_{s=0}^{\infty}\beta^s\mathbb{E}_t[\ln(z_s^+)]. \tag{22}$$

Let us set the initial level of technology to 1, i.e. $z_1^+ = 1$, to find $\mathbb{E}_t[\ln(z_s^+)] = s\ln(\mu_{z+})$ where μ_{z+} is the growth rate of technology, z_t^+/z_{t-1}^+, in the deterministic steady state. With this we find

$$\Psi_t = \frac{\beta\ln(\mu_{z+})}{(1-\beta)^2}. \tag{23}$$

Therefore, we can write aggregate welfare as follows:

$$V_t = \hat{V}_t + \Psi_t. \tag{24}$$

Welfare gain in consumption equivalent units. Measuring welfare in lifetime consumption equivalent units is convenient as it reveals the amount of consumption a household would require to be indifferent between the two regimes. The welfare gain is defined as the lifetime consumption equivalent in percentage terms and denoted by λ, following the exposition of Tsiaras (2020). Specifically, it is defined as the additional fraction of consumption that a household would require each period under the structural balance (SB) rule to reach the same welfare as under the expenditure growth (EG) rule. Therefore, a positive value of λ indicates higher welfare under the expenditure growth rule, and a negative value of λ indicates higher welfare under the structural balance rule. Define the welfare function under the SB rule, V_t^{SB}, as follows:

$$V_t^{SB} = \mathbb{E}_t\left[\sum_{s=0}^{\infty}\beta^s U(\widetilde{C}_{t+s}^{SB})\right]. \tag{25}$$

Similarly, define the welfare function under the EG rule, V_t^{EG}, as follows:

$$V_t^{EG} = \mathbb{E}_t\left[\sum_{s=0}^{\infty}\beta^s U(\widetilde{C}_{t+s}^{EG})\right]. \tag{26}$$

Then λ solves the following equation:

$$V_t^{EG} = \mathbb{E}_t\left[\sum_{i=0}^{\infty}\beta^i[\zeta_{t+i}^c \ln((\widetilde{C}_{t+i}^{SB} - b\widetilde{C}_{t+i-1}^{SB})(1+\lambda))]\right] = \frac{\ln(1+\lambda)}{1-\beta} + V_t^{SB}. \tag{27}$$

Solving this equation leads to (also by substituting the welfare variable with the unconditional expectations of the welfare functions from the stochastic simulations in the last step in order to quantify the expected welfare gain/loss for our results below):

$$1 + \lambda = e^{(1-\beta)(V_t^{EG} - V_t^{SB})} \Rightarrow \hat{\lambda} = e^{(1-\beta)(\mathbb{E}[V_t^{EG}] - \mathbb{E}[V_t^{SB}])} - 1. \tag{28}$$

The exposition above is written for a generic household. However, we have two types of households in our model, optimizing households and restricted (hand-to-mouth) households. Optimizing households' welfare measure will be denoted by $V_{o,t}$ and restricted households' welfare measure – by $V_{r,t}$. The calculations above can be applied in the same way for both types of households.

Finally, we define aggregate welfare as the population share-weighted average of the two welfare measures as follows:

$$V_{aggr} = \lambda_r V_{r,t} + (1 - \lambda_r) V_{o,t}. \tag{29}$$

Welfare gain as a percentage difference. The above lifetime consumption equivalent measure is sensitive to the calibration of the discount factor. Given the recent ultra-low interest rates globally and in the euro area that may or may not be representative of a discount factor in an individual member country and the presence of hand-to-mouth households whose discount factor may or may not coincide with that of the optimizing household, it is advisable to come up with an alternative welfare gain measure for robustness purposes.

Therefore, we also compute the welfare percentage difference between having the expenditure growth rule as opposed to the structural balance rule. Specifically, we compute this welfare gain simply as

$$100 \cdot \left(\frac{\mathbb{E}[V_t^{EG}] - \mathbb{E}[V_t^{SB}]}{\mathbb{E}[V_t^{SB}]} \right). \tag{30}$$

7.2 Welfare Results

In this section, we simulate the two considered monetary regimes, the case of a small country within a monetary union and the case of a country with sovereign monetary policy, with either the structural balance rule or the expenditure growth rule active, using stochastic simulations to the second-order approximation with pruning in `Dynare` for 4000 quarters with a burn-in period of 500 quarters to give the model sufficient time to converge to the new stochastic steady state before using the simulated data (i.e. the remaining 3500 quarters) in the computation of moments needed for the welfare analysis, as detailed in Equation (28).

Note that, for these simulations, we slightly adapt the definitions of two gaps in our model. Given that the stochastic steady states in a higher order approximation may differ markedly from their deterministic steady states, the gaps, which fluctuate around zero under a first-order perturbation, may exhibit a long-run value that substantially differs from zero under a second-order perturbation. For example, the output gap variable entering the structural balance definition may no longer have a mean of zero. In order to retain their economic meaning, we redefine the two major gaps in our model, the output gap and the unemployment gap, as follows:

$$\text{ygap}_t = y_t - y, \tag{31}$$

$$\text{lgap}_t = \ln(1 - L) - \ln(1 - L_{t-1}) \tag{32}$$

by replacing the deterministic steady state of output and employment with a long-run average of their stochastic values

$$\text{ygap}_t = y_t - \frac{1}{T}\sum_{s=1}^{T} y_{t-s}, \tag{33}$$

$$\text{lgap}_t = \ln\left(1 - \frac{1}{T}\sum_{s=1}^{T} L_{t-s}\right) - \ln(1 - L_{t-1}), \tag{34}$$

where we set $T = 40$ for a 40-quarter (10-year) average. We choose 40 quarters to account for typical business cycle lengths in the data. For robustness, we supply the results also for 80-quarter (20-year) averages.

Table 3 reports the welfare gain, both as a percentage difference (Δ) and in lifetime consumption equivalent units (CE) from having the expenditure growth rule instead of the structural balance rule.

Table 3: **Welfare gain from having the expenditure growth rule instead of the structural balance rule**

	Monetary union		Sovereign monetary policy	
	Welfare, Δ	Welfare, CE	Welfare, Δ	Welfare, CE
T=40				
Optimizing households ($\mathbb{E}[V_o]$)	2.51%	0.72%	3.10%	0.93%
Restricted households ($\mathbb{E}[V_r]$)	9.16%	0.76%	11.25%	1.00%
Both households ($\mathbb{E}[V_{aggr}]$)	4.00%	0.74%	4.94%	0.97%
T=80				
Optimizing households ($\mathbb{E}[V_o]$)	2.53%	0.71%	3.12%	0.92%
Restricted households ($\mathbb{E}[V_r]$)	9.20%	0.75%	11.30%	1.00%
Both households ($\mathbb{E}[V_{aggr}]$)	4.02%	0.73%	4.97%	0.96%

In the previous sections we documented that private consumption volatility is lower under the expenditure growth rule, compared to the structural balance rule. Since households dislike consumption volatility, we expect to see this reflected in a higher welfare of households under the expenditure growth rule. Therefore, it is not surprising that the expenditure growth rule yields higher household welfare, especially for the restricted households. In the case of a small country in a monetary union, the aggregate household welfare gain from having the expenditure growth rule is 4%, or 0.7% in lifetime consumption equivalent units. For a country with a sovereign monetary policy regime, the aggregate household welfare gain is slightly larger and equals 5% or 1% in lifetime consumption equivalent units. The results are relatively robust to the choice of the length of the averaging window in the computation of the two gaps.

8 Conclusion

There is an ongoing discussion about the European Union's fiscal framework, with the aim of simplifying it. This paper compares two benchmark operational fiscal rules used by the European Commission and discussed in several fora – the structural balance rule and the expenditure growth rule. The main innovation of this paper is the detail in which we consider the fiscal rules, and using both stochastic and deterministic simulations of a fiscal DSGE model to evaluate each fiscal rule's performance, including the analysis of expenditure modifications. We also consider the golden rule versions of the fiscal rules. We consider both a case of a small open economy in a monetary union and a sovereign monetary policy case.

Our main results are as follows. First, the expenditure growth rule tends to yield somewhat more stable macroeconomic outcomes than the structural balance rule. This is because the expenditure growth rule does not react to revenue windfalls and shortfalls and excludes cyclical items, such as cyclical unemployment benefits, from the modified expenditure definition.

Second, the expenditure growth rule dampens the public investment volatility, compared to the structural balance rule. This is done mainly via three channels. The first channel is the one mentioned above, namely, the expenditure growth rule does not react to revenue windfalls and shortfalls. Second, the expenditure growth rule ignores the short-term economic fluctuations by targeting long-run growth. Third, the expenditure growth rule dampens its reaction to shocks via the modification of expenditure definition, such as the removal of debt service payments and investment averaging.

Third, and for comparable calibration of both rules, the expenditure growth rule yields considerably more volatile public debt than the structural balance rule. The main channel for the discrepancy between the expenditure growth targeting and the public debt-to-GDP stabilization objective is the removal of interest payments from the modified expenditure definition, as is done by the European Commission and proposed in the literature.

Fourth, the expenditure growth rule is more sensitive to the strength of the debt-to-GDP correction term than the structural balance rule, as the former is unable to stabilize debt without a debt anchor.

Fifth, keeping everything else unchanged, a higher public debt target yields more volatile public debt. This is due to shocks to the bond yield that affect a larger amount of debt, as the stock of debt rises. The volatility curve is steeper for the expenditure growth rule than the structural balance rule, due to the interest payments channel. For both fiscal rules, the larger volatility of public debt is carried to the real economy via a fiscal rule.

Sixth, after a build-up of public debt, the expenditure growth rule tends to postpone fiscal consolidation to the future periods, compared to the structural balance rule; this means that the resulting growth under the expenditure growth rule is larger in the short term but lower in the future.

Seventh, both fiscal rules are able to contain public debt volatility effectually if the debt correction term is strong enough. A stronger debt correction term yields more volatile economy, as the government gives away some of its ability to stabilize the economy. Notwithstanding, the slope of the volatility of output is much flatter than the slope of the public debt volatility. Hence, having a strong-enough debt correction for either fiscal rule contains public debt volatility at a relatively minor cost to the economy in the long run. A fast debt reduction may still be economically painful in the near term.

Eighth, accounting for interest payments in fiscal rules amplifies the co-movement between monetary and fiscal policies, as the monetary policy easing reduces debt service payments, thus creating fiscal space. Nevertheless, this interaction may turn vicious for the economy at a typical business cycle frequency. As the extra fiscal stimulus influences the economy with a time lag, its peak effect may be overdue, failing to soften the recession but rather amplifying the recovery phase. In addition, a subsequent monetary policy normalization shrinks the fiscal space resulting in a slower growth in the medium term. Over the business cycle, the debt service payments channel may produce higher (rather than lower) economic fluctuations. This can be another reason for supporting the exclusion of debt service payments from the modified expenditure definition of the expenditure growth rule.

Ninth, a negative trend in the bond yield helps control the public debt both because of the decrease in the mean interest payment and because of the narrowing of the debt distribution. The debt volatility curve is notably steeper under the expenditure growth rule than the structural balance rule due to the interest payments channel. This means that, under the expenditure growth rule and with a secular decline in the bond yield, the government may increase its debt level without raising tail risks. However, this effect may turn the other way around with an increase in bond yield.

Tenth, the exclusion of public investment from fiscal rules, like in the case of the golden rule, helps safeguard public investment and attains higher growth outcomes during the period of considerable and persistent boost in public investment, such as the Next Generation EU programme. Yet, the differences between the golden rule and the benchmark rule are less remarkable for typical public investment shocks. Given that the golden rule causes incentives for the governments to misclassify public investment, the merit of using the golden rule on a permanent basis is unclear.

Lastly, the household welfare gain from having the expenditure growth rule rather than the structural balance rule is 4% (0.7% in lifetime consumption equivalent units) for a small open economy in a monetary union and 5% (1% in lifetime consumption equivalent units) for a small open economy with its own monetary policy. These numbers would be smaller if the interest payments were taken into account in the expenditure growth rule.

Overall, our results indicate that the expenditure growth rule with a sufficiently strong debt correction term may be a proper candidate for the fiscal rule in Europe.

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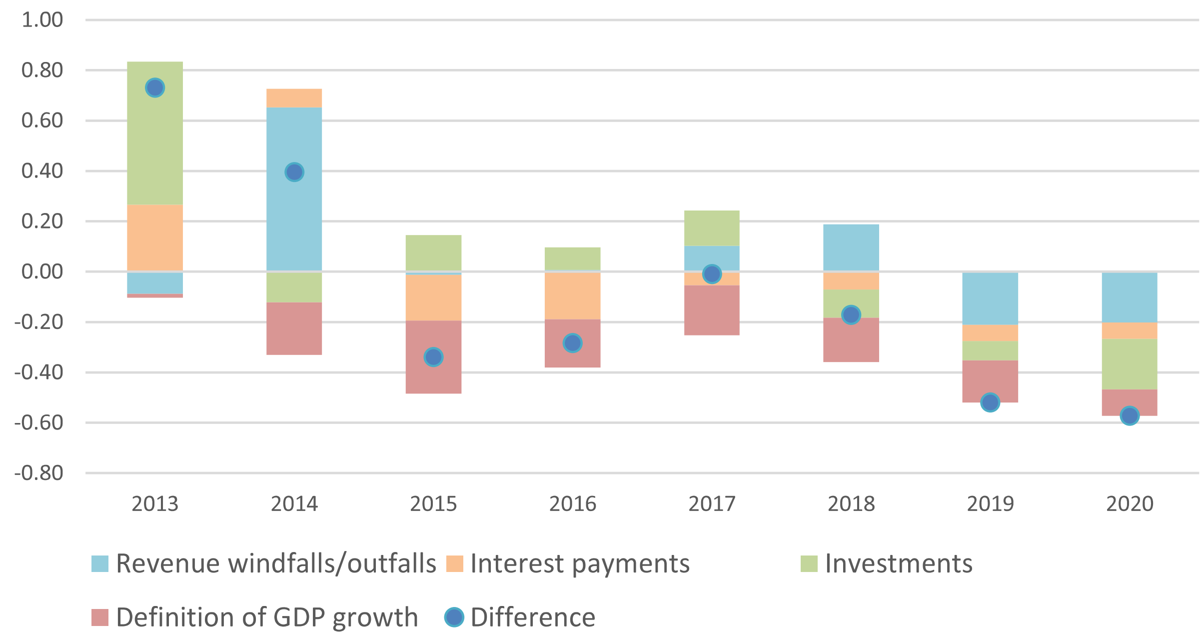
Appendix A

A.1 Empirical differences between the structural balance and expenditure growth rules

These two operational fiscal rules tend to result in contradictory outcomes. Differences arise due to a number of reasons. First, the applied public expenditure modification excludes several items that are included in the assessed level of the structural balance. Second, while the structural balance rule rests on the current estimate of potential output, the expenditure benchmark is generated using the smoothed ten year average potential output level. Third, when a government benefits from revenue windfalls (i.e. an increase in structural revenue in excess of discretionary measures), it improves its structural balance, but it does not affect the compliance with the expenditure benchmark. Taking Latvia as an example, the expenditure growth rule has provided stricter outcomes than the structural balance rule throughout the last five years (Figure 1), due mostly to the fact that potential GDP growth has been slowly recovering after the crisis. This is reflected in the expenditure benchmark, but only with a time lag.

Figure A.1: **Decomposition of the discrepancy between the expenditure growth rule and the structural balance rule in 2012–2019 for Latvia (*ex ante* analysis)**



Notes: These calculations are indicative as they are based on Latvijas Banka's spring fiscal projections and do not reflect the official figures that are part of the European Commission's assessment of Latvia's stability and convergence programmes.

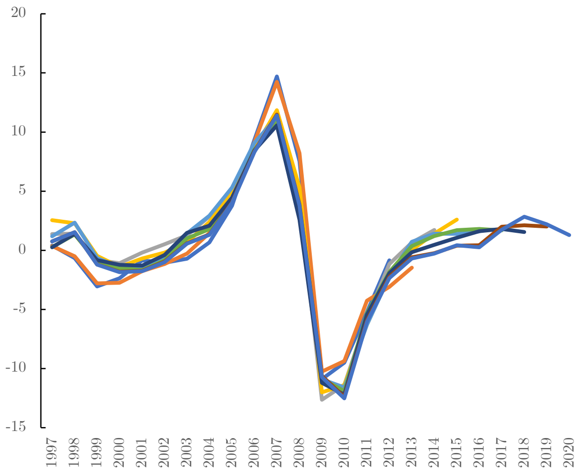
Another component that has persistently made the expenditure benchmark stricter is the exclusion of interest payments from the modified public expenditure. Besides providing contradicting evidence, current rules allow for a number of escape clauses that could be considered when a country does not comply with targets. These are related to unusual events, as well as structural reforms and/or investment that are expected to bring about significant cost savings in the future.

A.2 Output gap estimates

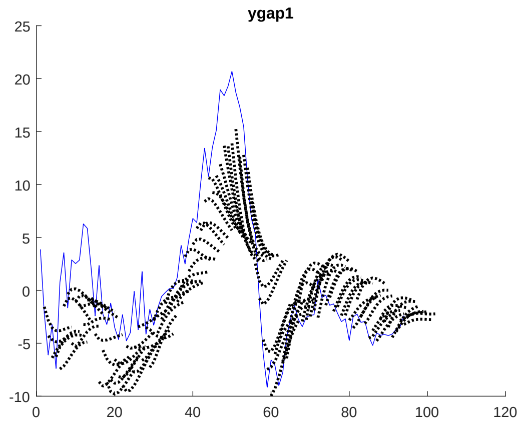
Our measure of the output gap should be realistic. As the model is estimated for Latvia, Figure A.2 depicts the output gap estimates for Latvia: a Hodrick-Prescott (HP) filter-based measure (top left), Latvijas Banka's official estimate based on the production function approach (bottom left), our DSGE model-based benchmark based on equation (2) (top right), our DSGE model-based alternative using the measure of employment gap in equation (3) (bottom right). The figure depicts that our DSGE-based output gap measures mimic closely those calculated using both the HP filter and the production function approach in sign, magnitude, and real-time uncertainty.

Figure A.2: **Output gap estimate for Latvia**

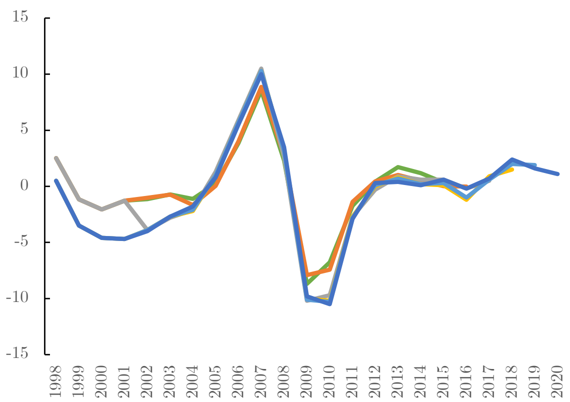
Hodrick-Prescott filter-based measure



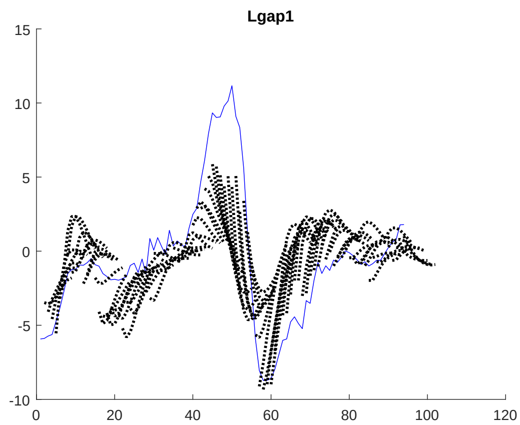
DSGE, benchmark



Latvijas Banka's official estimate



DSGE, employment gap



A.3 Robustness checks

Figure A.3: **Tightness of the debt-to-GDP ratio correction term and debt-to-GDP ratio stabilization – consumption tax shock**

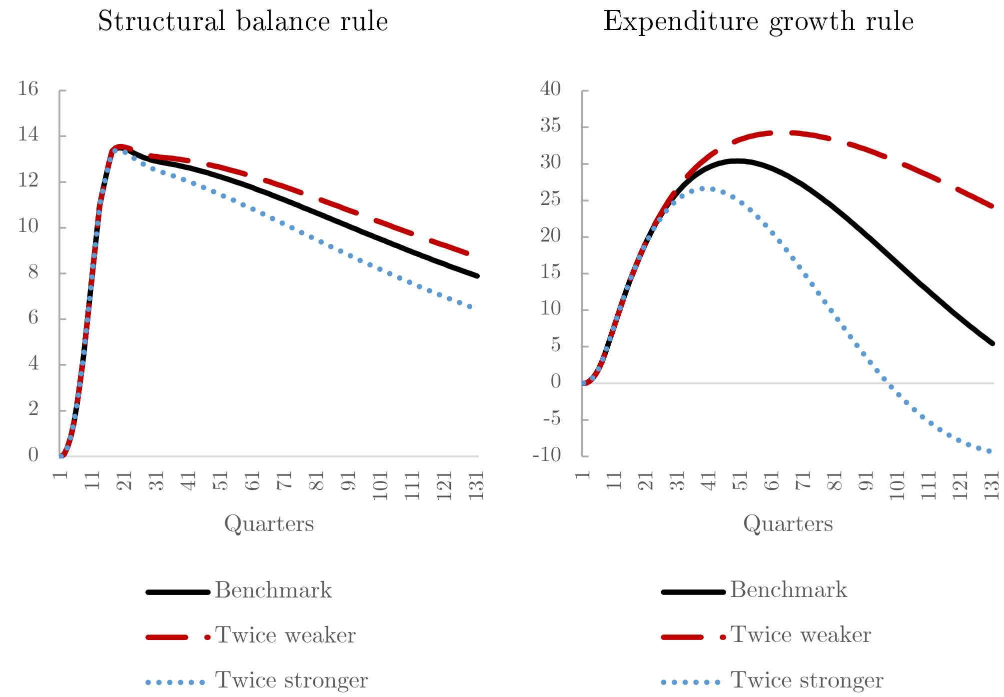


Figure A.4: **Calibration of the fiscal rule tightness parameter, with 3-year average debt targeting**

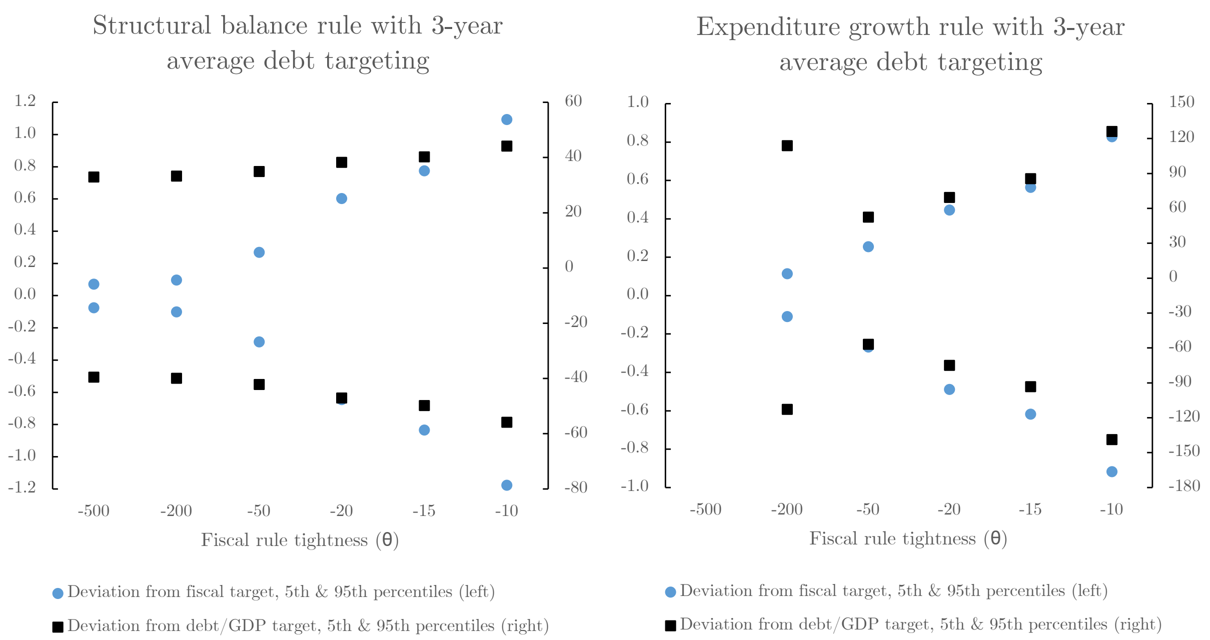


Table A.1: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule, with 3-year average debt targeting**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	1.60	1.59	1.24	1.23	1.41	1.20
Debt/GDP	1.32	1.32	1.04	1.04	1.13	0.88
Unemployment	0.96	0.98	0.96	0.98	0.96	0.96
GDP	0.98	1.00	0.99	1.00	0.98	0.99
Private consumption	0.95	0.95	0.95	0.96	0.95	0.95
Consumption of restricted households	0.87	0.90	0.89	0.92	0.88	0.89
Total investment	1.01	1.01	1.01	1.01	1.01	1.01
Government investment	0.92	0.92	0.94	0.94	0.93	0.93
Inflation	0.98	0.98	0.99	0.99	0.99	0.99

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption and investment are in annual growth terms, and inflation is in annual terms.

Table A.2: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – twice stronger debt correction**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	1.55	1.53	1.21	1.20	1.39	1.21
Debt/GDP	1.04	1.04	0.81	0.82	0.91	0.69
Unemployment	0.95	0.98	0.96	0.98	0.95	0.96
GDP	0.98	1.00	0.98	1.00	0.98	0.98
Private consumption	0.94	0.95	0.95	0.96	0.95	0.95
Consumption of restricted households	0.86	0.89	0.88	0.91	0.87	0.88
Total investment	1.01	1.01	1.01	1.01	1.01	1.01
Government investment	0.92	0.92	0.94	0.94	0.93	0.93
Inflation	0.99	0.99	0.99	0.99	0.99	0.99

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

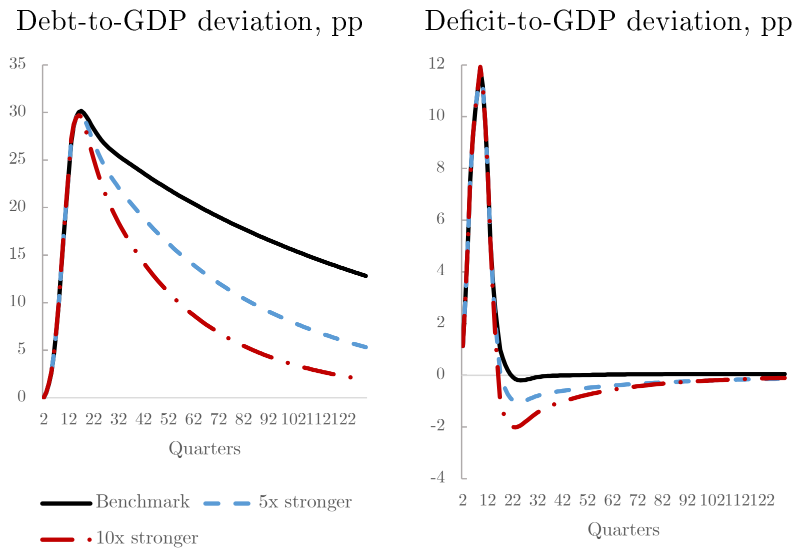
Considerably stronger debt correction for the structural balance rule. In Figure 1, we saw that the baseline structural balance rule produces a somewhat slow deleveraging process, suggesting the potential need for a much stronger debt correction term in the structural balance rule in practice. Figure A.5 depicts that public debt is reduced markedly faster if the debt correction term is five or ten times stronger than in the benchmark calibration, meaning that for each 10pp deviation of the public debt-to-GDP ratio the structural balance target is reduced by 0.5pp or 1pp, respectively.

Table A.3: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – twice weaker debt correction**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	1.52	1.50	1.24	1.22	1.38	1.19
Debt/GDP	1.59	1.59	1.37	1.37	1.43	1.11
Unemployment	0.95	0.98	0.96	0.98	0.96	0.96
GDP	0.98	1.00	0.99	1.00	0.98	0.99
Private consumption	0.94	0.95	0.95	0.96	0.95	0.95
Consumption of restricted households	0.87	0.90	0.89	0.91	0.88	0.88
Total investment	1.01	1.01	1.01	1.01	1.01	1.01
Government investment	0.92	0.92	0.94	0.94	0.93	0.93
Inflation	0.99	0.99	0.99	0.99	0.99	0.99

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

Figure A.5: **Strength of the debt-to-GDP correction term and debt-to-GDP stabilization, after a government consumption shock – considerably stronger debt correction in the structural balance rule**



Namely, if a country runs its debt-to-GDP ratio 50pp above its target, it needs to reduce its deficit-to-GDP ratio by up to 2.5pp or 5pp, respectively, with respect to its long-run average deficit-to-GDP target. A country targeting its debt-to-GDP ratio at 30% (that is, its deficit-to-GDP target is at about 0.9%) but running its public debt-to-GDP ratio 50pp higher than that might need to run a surplus of up to 1.6% or 4.1%, respectively. However, a country targeting its debt-to-GDP ratio at 60% (that is, its deficit-to-GDP target is at about 1.8%) might need to run a surplus of up to 0.7% or 3.2%, respectively. Evidently,

Table A.4: **Public finances and macroeconomic quantities standard deviation for the structural balance rule with much stronger debt correction relative to the benchmark structural balance rule**

	5x stronger debt correction	10x stronger debt correction
	[1]	[2]
Deficit/GDP	0.91	0.85
Debt/GDP	0.64	0.47
Unemployment	1.01	1.01
GDP	1.00	1.01
Private consumption	1.00	1.01
Consumption of restricted households	1.02	1.04
Total investment	1.00	1.00
Government investment	1.01	1.02
Inflation	1.01	1.01

Notes: Each number is a relative standard deviation of a particular variable for the structural balance rule with much stronger debt correction, compared to the benchmark structural balance rule. A number below unity means that the standard deviation of a series is smaller with a stronger debt correction, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

the highly indebted European countries are not running such large surpluses. Nevertheless, we consider the potential implications on the volatilities of macroeconomics quantities and public finances of a much stronger debt correction for the structural balance rule in stochastic simulations. Table A.4 reports that a much stronger debt correction implies considerably less volatile debt dynamics but marginally higher macroeconomic volatility, confirming our findings in the main text.

Asymmetric debt targeting. Our benchmark fiscal rules are symmetric with respect to deviations from the targeted debt-to-GDP level, so that the same rule applies for deviations both from above and from below the targeted level. This is for simplicity of the modelling setup. Also, one can argue that the government might have its implicit long-term debt target, so that it would not deviate too much on either side and thus in practice it would appear as if it reacts to deviations in more or less symmetric fashion.

However, the legal fiscal frameworks typically set the upper bar of the debt to GDP level (though not physically binding) without specifying its lower limit, thus potentially creating asymmetric debt targeting. It can be modelled by adding a quadratic term in the fiscal rule, so that, for example, the expenditure growth rule becomes

$$\begin{aligned} \ln(x_t) = (1-\rho_x)\ln(x) + \rho_x \ln(x_{t-1}) \\ + (1-\rho_x)\theta_{x,ggap}\Bigg[gg_t - \Bigg(\text{ggtarget}_t - \phi_{x,d}\left(\frac{D_{g,t}}{Y_t+Y_{t-1}+Y_{t-2}+Y_{t-3}} - \overline{dgy}\right) \\ - \phi_{x,dd}\left(\frac{D_{g,t}}{Y_t+Y_{t-1}+Y_{t-2}+Y_{t-3}} - \overline{dgy}\right)^2\Bigg)\Bigg]. \end{aligned} \tag{A.1}$$

Having the same (negative) sign of $\phi_{x,dd}$ as for $\phi_{x,d}$ yields a larger adjustment if debt exceeds the target and a smaller adjustment if debt is below the target, resulting in an asymmetric response to debt deviations.

Figure A.6: **Debt and output behaviour under asymmetric debt targeting**

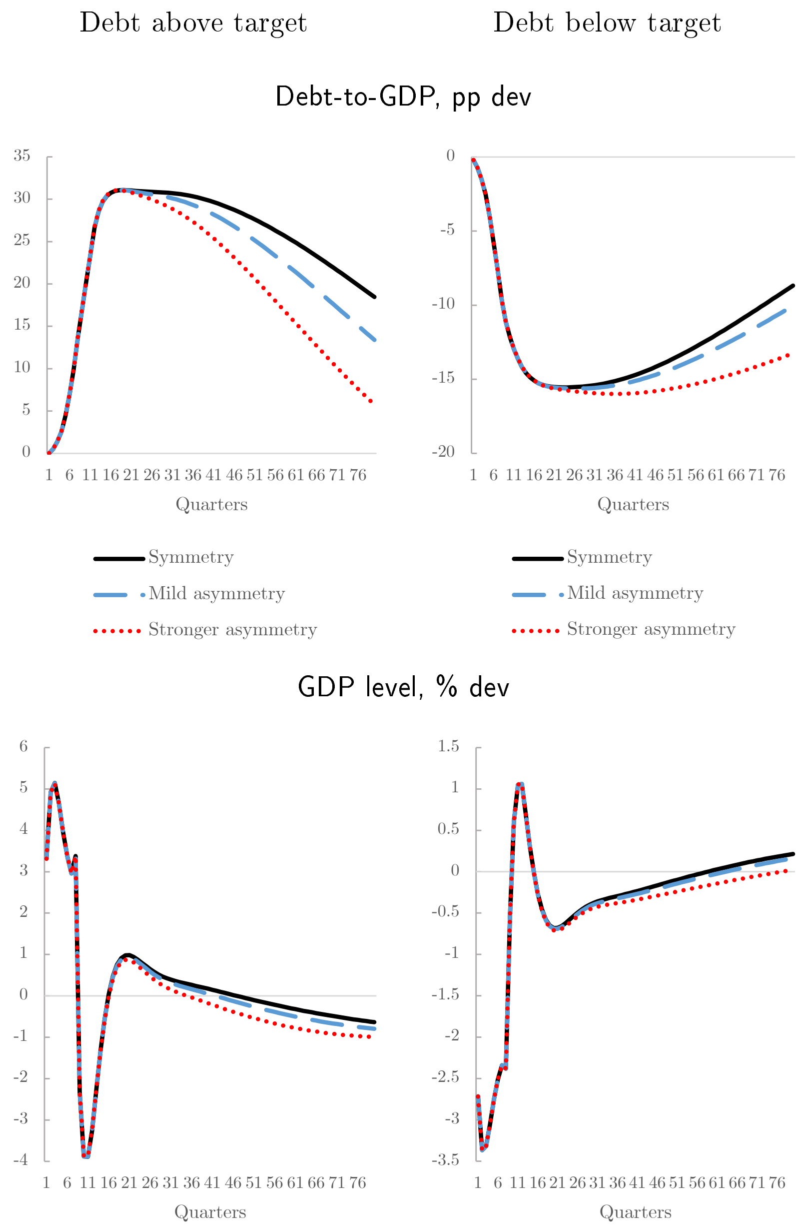


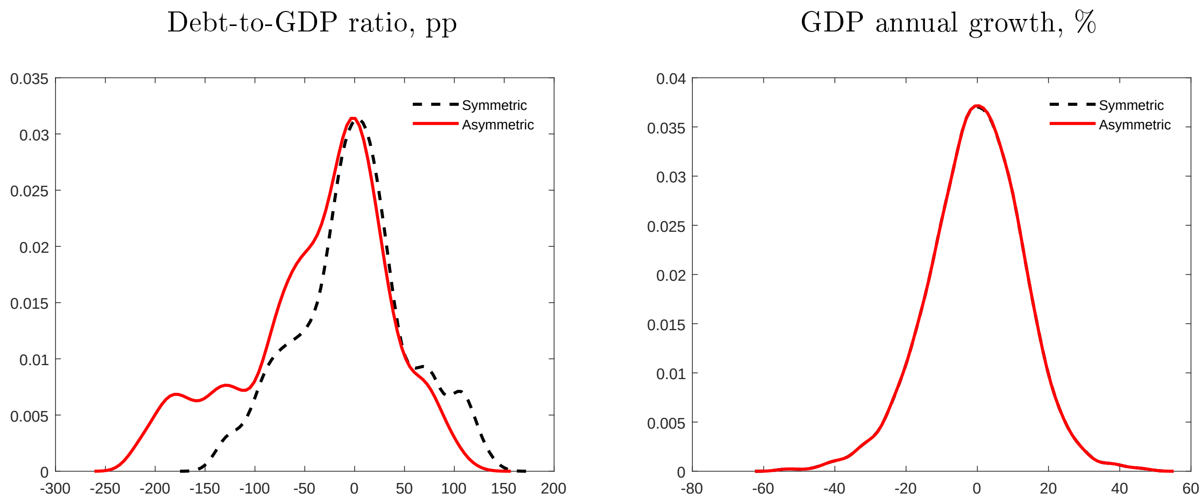
Figure A.6 depicts the behaviour of the debt-to-GDP ratio for the government consumption increase/decrease exercise, similar to the one performed in Section 5.1 (that is, there is a 2-year long government consumption shock with a 3-year-long fiscal rules' suspension period), for the expenditure growth rule with alternative strengths of the asymmetry. Besides a symmetric case ($\phi_{x,dd} = 0$), we consider a mild case of asymmetry ($\phi_{x,dd} = \phi_{x,d}$) and a strong case of asymmetry ($\phi_{x,dd} = 3\phi_{x,d}$). Clearly, for the asymmetric debt targeting, there is a weaker convergence if debt is below the target and a stronger convergence if debt exceeds the target.[33] In the case of debt being above its target, stronger

[33]Apart from the asymmetric fiscal rule, the model exhibits strong asymmetry, as fiscal expansion results in

debt adjustment under asymmetric debt targeting yields stronger downward pressure on output during the adjustment period.

To see if asymmetric debt targeting has distributional effects on economic growth in the long run, we stochastically simulate the model to its 2nd order approximation.[34] Although the mass of the probability density function of the debt-to-GDP ratio under asymmetric debt targeting (with a relatively strong asymmetry, $\phi_{x,dd} = 3\phi_{x,d}$) is skewed to the left from the 50th percentile of the debt-to-GDP ratio distribution formed with a symmetric fiscal rule, there is almost no effect on the distribution of the GDP growth rate (Figure A.7).

Figure A.7: **Distributional effects under asymmetric debt targeting**



Notes: The probability density functions are obtained using the expenditure growth rule with both symmetric and asymmetric debt targeting. The probability density function is calculated around the 50th percentile of the variable's distribution drawn under a symmetric fiscal rule, and smoothed using a normal kernel function.

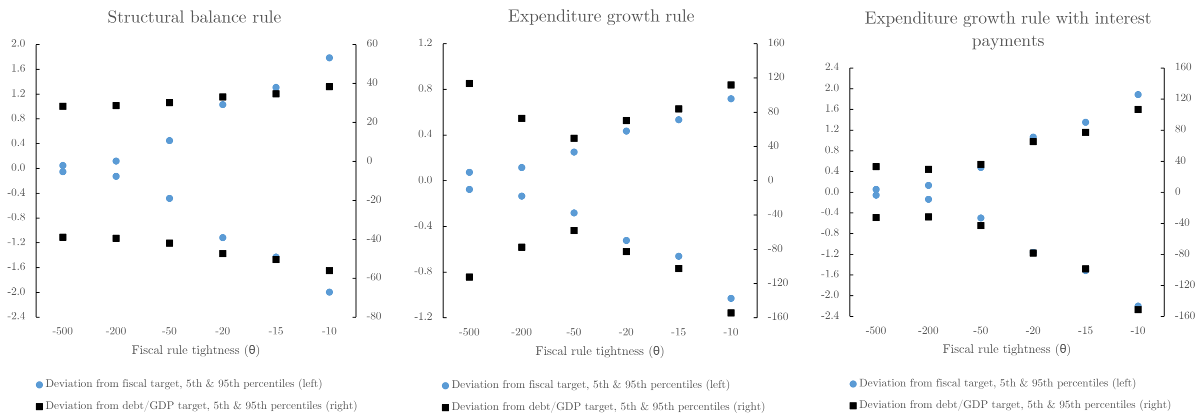
Similar results are obtained by simulating a (fully) non-linear model using the extended path method[35] (Fair and Taylor, 1983). Therefore, we *cannot* conclude that asymmetric debt targeting would have a substantial effect on the distribution of economic growth in the long run.

an almost twice as large debt deviation than for a fiscal contraction for the same shock size. This asymmetry is exacerbated by the (temporary) suspension of fiscal rules.

[34]Simulation length 4000 quarters, among which 500 quarters dropped as burn-in.

[35]For numerical convergence purposes, we reduced the shock size, the extent of the asymmetry (to $\phi_{x,dd} = \phi_{x,d}$), and set the simulation length to 1600 quarters. The results are available upon request.

Figure A.8: **Calibration of the fiscal rule tightness parameter, sovereign monetary policy case**



Alternative strength of debt-to-GDP correction. We also check the sensitivity of our results with respect to the strength of debt-to-GDP ratio correction in fiscal rules. Table A.5 reports the results for a twice stronger debt correction, while Table A.6 reports the results for a twice weaker debt correction. Similar to the monetary union case, we conclude that a strong enough debt correction helps stabilizing public finances in the case of the expenditure growth rule, without significant deterioration in stabilizing macroeconomic variables. Thus, our results suggest that using a strong enough debt correction[36] would not materially hurt the macroeconomic stabilization objective for either fiscal rule.

Table A.5: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – sovereign monetary policy case, twice stronger debt correction**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	2.08	2.05	1.08	1.11	1.99	1.91
Debt/GDP	1.13	1.13	0.81	0.82	1.01	0.94
Unemployment	0.83	0.85	1.00	1.00	0.83	0.84
GDP	0.86	0.88	1.01	1.01	0.86	0.87
Private consumption	0.89	0.90	1.00	0.99	0.89	0.90
Consumption of restricted households	0.61	0.63	0.99	0.97	0.61	0.62
Total investment	1.00	1.00	1.00	1.00	1.00	1.00
Government investment	0.74	0.74	1.00	0.96	0.74	0.76
Inflation	0.98	0.98	0.99	0.99	0.98	0.98

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

[36] In our case, a strong correction for debt deviation means reducing the annual structural deficit-to-GDP ratio by 0.2pp for each 10pp deviation of the debt-to-GDP ratio from its target for the structural balance rule. This corresponds to a 0.50pp reduction in the annual expenditure growth rate for every 10pp deviation of the debt-to-GDP ratio from its target for the expenditure growth rule.

Table A.6: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – sovereign monetary policy case, twice weaker debt correction**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	2.04	2.01	1.17	1.19	1.95	1.84
Debt/GDP	1.83	1.83	1.51	1.51	1.63	1.39
Unemployment	0.83	0.86	1.00	1.00	0.83	0.84
GDP	0.86	0.88	1.01	1.01	0.86	0.87
Private consumption	0.89	0.90	1.00	0.99	0.89	0.90
Consumption of restricted households	0.61	0.63	1.00	0.97	0.61	0.62
Total investment	1.00	1.00	1.00	1.00	1.00	1.00
Government investment	0.74	0.73	1.00	0.96	0.74	0.76
Inflation	0.98	0.98	0.99	0.99	0.98	0.98

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

Sensitivity to monetary policy tightness. As an additional sensitivity check, we consider alternative tightness parameters in the monetary policy rule. We consider both a weak (the Taylor rule parameter in front of inflation set to $r_\pi = 1.1$) and a tight ($r_\pi = 2.5$) monetary policy regime. Tables A.7 and A.8 report the results, respectively. We conclude that the relative performance of the fiscal rules is broadly robust to monetary policy tightness.

Table A.7: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – sovereign monetary policy case, weak reaction to inflation ($\mathbf{r_\pi = 1.1}$)**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	1.99	1.96	1.13	1.15	1.89	1.81
Debt/GDP	1.46	1.46	1.12	1.12	1.28	1.17
Unemployment	0.84	0.86	1.00	1.00	0.84	0.85
GDP	0.86	0.88	1.01	1.01	0.86	0.87
Private consumption	0.88	0.89	0.99	0.99	0.88	0.89
Consumption of restricted households	0.62	0.65	0.99	0.96	0.63	0.64
Total investment	0.99	1.00	1.01	1.00	0.99	1.00
Government investment	0.76	0.75	0.99	0.96	0.76	0.78
Inflation	0.97	0.97	0.99	0.99	0.98	0.98

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

Public debt deleveraging under sovereign monetary policy. Figure 1 depicts public debt-to-GDP deleveraging trajectories under structural deficit and expenditure growth rules in the case of

Table A.8: **Public finances and macroeconomic quantities standard deviation for the expenditure growth rule relative to the structural balance rule – sovereign monetary policy case, strong reaction to inflation ($r_\pi = 2.5$)**

	Benchmark	With cyclical unemployment benefits	With interest payments	Without expenditure modification	With constant interest rate in interest payments	Without government risk premium
	[1]	[2]	[3]	[4]	[5]	[6]
Deficit/GDP	2.16	2.13	1.08	1.11	2.07	1.98
Debt/GDP	1.35	1.35	1.02	1.02	1.18	1.02
Unemployment	0.83	0.85	1.01	1.00	0.83	0.84
GDP	0.85	0.87	1.02	1.01	0.85	0.86
Private consumption	0.90	0.91	1.00	1.00	0.90	0.91
Consumption of restricted households	0.58	0.60	1.01	0.98	0.58	0.59
Total investment	1.00	1.00	1.00	1.00	1.00	1.00
Government investment	0.69	0.68	1.02	0.97	0.69	0.71
Inflation	0.99	0.98	0.99	0.99	0.99	0.99

Notes: Each number is a relative standard deviation of a particular variable for the expenditure growth rule, compared to the structural balance rule. A number below unity means that the standard deviation of a series is smaller for the expenditure growth rule, and vice versa. The quantities GDP, consumption, and investment are in annual growth terms, and inflation is in annual terms.

a monetary union. Now, we redo a similar public debt deleveraging exercise for the case of sovereign monetary policy. Here, we simulate shocks to government transfers for the first four quarters with a persistence of 0.85. In our calibration, 70% of transfers go to the restricted hand-to-mouth households, while the rest go to the optimizing households. The monetary policy is co-operative by keeping its policy rate unchanged during these four quarters, after which the standard Taylor rule applies. The fiscal rules are switched off during these four quarters and the next fours quarters, after which fiscal rules are activated. The results for public finances and GDP are shown in Figure A.9. Relative to the structural balance rule, the expenditure growth rule initially postpones debt reduction. Consequently, the expenditure growth rule is more friendly to growth initially but relatively more stringent in the future. Monetary policy accommodation helps containing the public debt to GDP ratio for both fiscal rules mainly due to the reduction of debt service costs (Figure A.10).

Figure A.9: **Public debt deleveraging, sovereign monetary policy case – shock to government transfers**

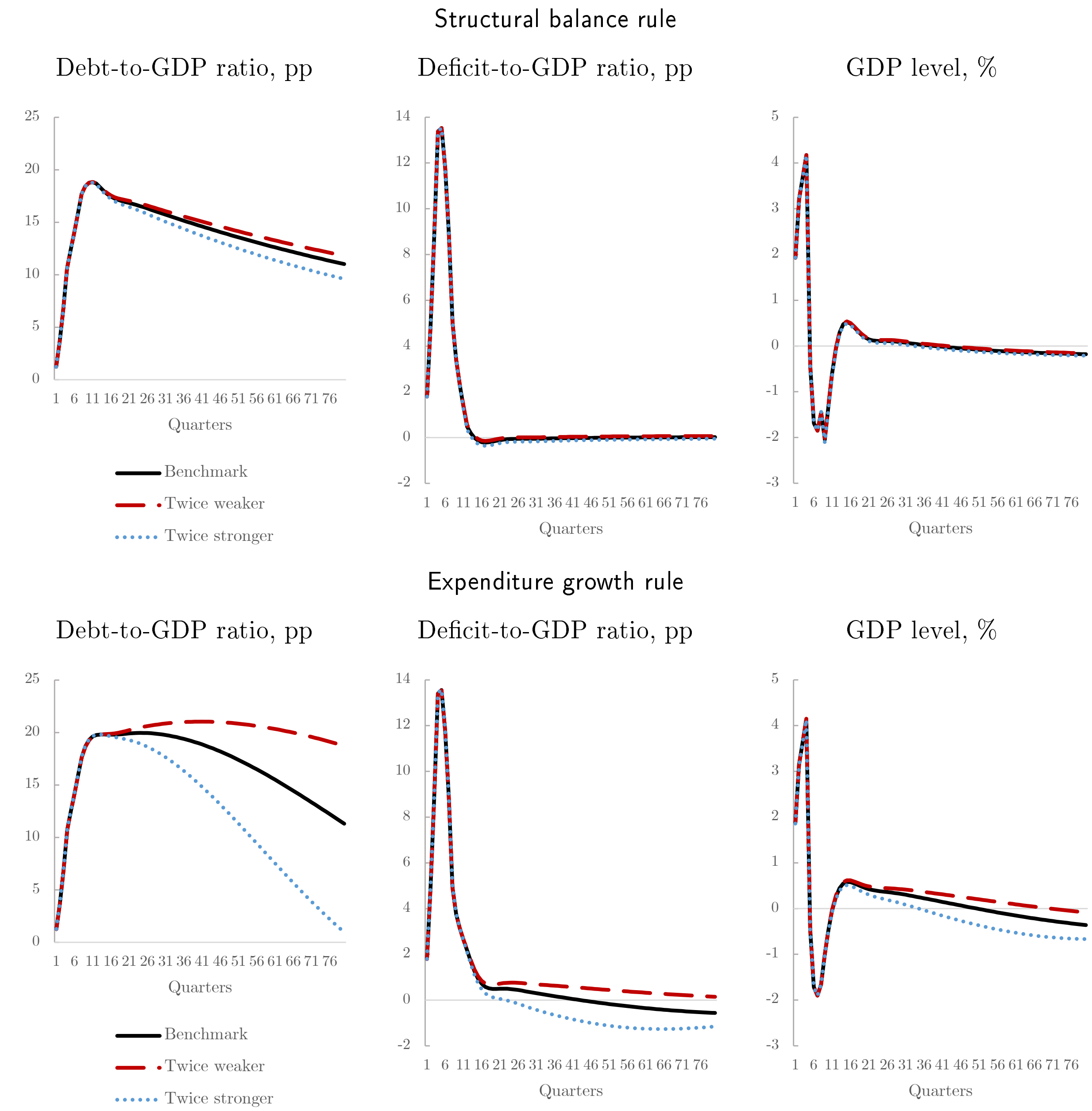


Figure A.10: **Public debt deleveraging and role of monetary policy accommodation, sovereign monetary policy case – shock to government transfers**