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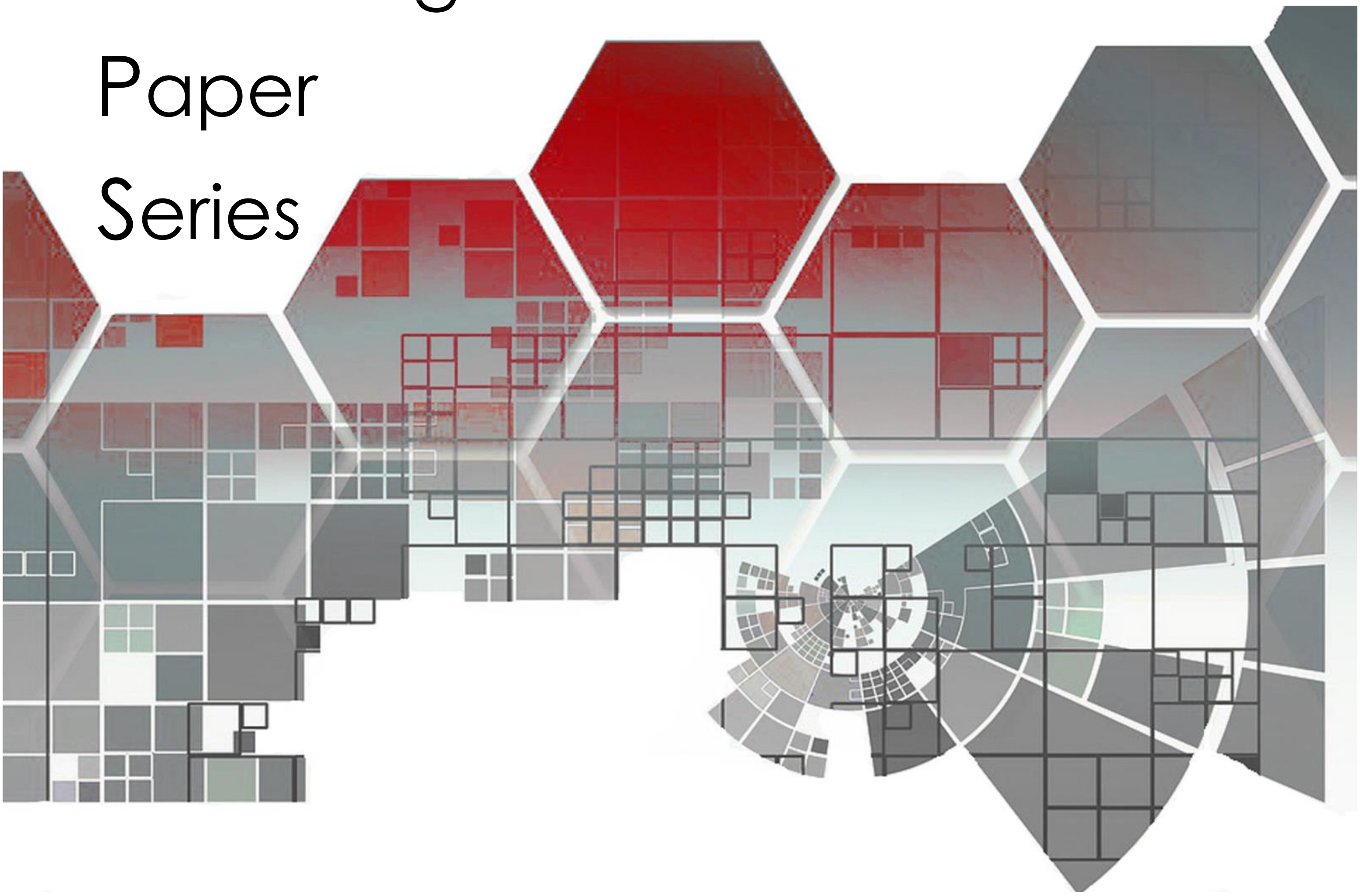

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The role of stabilizing expenditure rule in fostering macro-fiscal stability: simulation-based evidence from Poland

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Abstract

We investigate the properties of the Polish numerical stabilizing expenditure rule (SER) in the context of economic governance review in the EU. To this aim, we use the macroeconometric model NEMPF (Chmura et al., 2024) that offers nuanced, disaggregated mapping between the general government (GG) expenditure categories, the macroeconomic variables (including GDP), and GG revenue categories. This set of detailed links allows for heterogeneous fiscal multipliers by expenditure category, and hence scenario-specific calculation of our categories of interest: the GG revenue, expenditure and balance developments as ratios to GDP. The model-based, endogenous denominator properly accounts for tax base and hence revenue responses to expenditure-side measures. As the Polish SER represents a forward-looking perspective, we propose model solution procedures under model-consistent expectations of policymakers applicable when the perfect foresight assumption is not met. We find that SER generally ensures lower GG deficits (and hence GG debt paths) than policies targeting just-compliance with the Stability and Growth Pact (SGP) thresholds. That results in lower GG debt trajectories, as well as creates room for counter-cyclical responses. We also demonstrate a few specific numerical properties of the Polish SER, including how the correction mechanism encourages a more restrictive fiscal policy to build countercyclical buffers.

1. Introduction

Fiscal rules are designed to impose constraints on fiscal policy variables, and thereby reduce policymakers' deficit bias, limit procyclicality by creating buffers to avoid fiscal contractions in bad times, and generally foster long-term stability of the public finance and macroeconomic performance. Some European Union (EU) Member States implemented various fiscal rules already in 1990s, but the pathbreaking regulations in that area that intensified the use of rules were adopted by the EU in 2011. As a result, starting in 2015, Poland has been using a numerical rule that is explicitly updates the expenditure level on an annual basis.

Although the rule has been used for a decade, except the 1 year suspension during the COVID-19 pandemic, and the underlying legislation has been amended, the academic literature investigating the numerical properties remains limited. This contribution aims to fill in this gap. Specifically, we look at a number of adverse shock scenarios, e.g. global downturn, cost-push shock, interest rate surge, but also at some possibilities of negative developments occurring on the fiscal side (e.g. underperforming revenues), and simulate the reaction of the SER-guided fiscal policy. We also confront it with the benchmark policy of just-compliance with the Stability and Growth Pact limits, i.e. -3% floor on the GG balance and 60% ceiling on the GG debt, in relation to GDP. These shock scenarios enable us to answer the question of whether SER-compliant fiscal policy is more sustainable and better aligned with the EU rules after the recent reform of economic governance framework in the European Union which entered into force on 30th April 2024 (Council of European Union, 2024).

As EU regulations focus on the ratios of GG balance and debt to GDP, it is insufficient to consider the numerical description of expenditure as stipulated by SER. To determine the impact of GG expenditure changes on the nominal GG balance, the resulting GG revenue change needs to be computed. Further, to track the behaviour of GG balance to GDP ratio, the direct and indirect impact of GG expenditure on nominal GDP shall be accounted for. For these reasons, we incorporate the SER into a wider macroeconometric model. We decided to use the NEMPF model (Chmura et al., 2024), used at the Polish Ministry of Finance for forecasting and simulation purposes, as it offers a nuanced set of links between the GG expenditure categories and GDP components on the one hand, and mappings from various National Accounts macroeconomic variables as tax bases to tax revenues on the other one.

The rest of the paper is organized as follows. Section 2 reviews the extant literature on numerical fiscal rules. Section 3 presents the details of the Polish SER and the key properties of the NEMPF model necessary to understand the simulation results. Section 4 formulates the shock scenarios and presents the impact of these shocks on the macroeconomic and fiscal performance, both under SER and without it. In Section 5, the policy implications of the findings are discussed. Section 6 concludes.

2. **Properties of numerical expenditure rules: literature review**

2.1. Theoretical background

Fiscal rules are defined as long-lasting constraints on fiscal policy through numerical limits on budgetary aggregates (Schaechter, 2012). Four main types of fiscal rules can be distinguished based on the type of budgetary aggregate that they seek to constrain:

1. Debt rules set an explicit limit or target for public debt in percent of GDP;
2. Budget balance rules constrain the overall balance, structural or cyclically adjusted balance, or balance “over the cycle”;
3. Expenditure rules set limits on total, primary, or current spending;
4. Revenue rules set ceilings or floors on revenues and are aimed at boosting revenue collection and/or preventing an excessive tax burden.

The main goal in creating and implementing fiscal rules is to limit discretion in fiscal policy and to reduce *deficit bias* phenomena – an inherent tendency of policymakers to create regular excessive budget deficits. One of the first fundamental work about the “rules versus discretion” dilemma in fiscal policy was the article by Kydland and Prescott (1977), who showed that discretionary policy often produces an inefficient equilibrium. Furthermore, as reported by Wyplosz (2002), one of the main objectives of fiscal policy should be to stabilise or reduce the level of public debt to GDP in the long term and to build buffers to be able to use the fiscal impulse as a countercyclical instrument in the short term.

According to Kopits and Symansky (1998), well-defined fiscal rules can help reduce or eliminate the impact of political tendencies that lead to deficit bias. They also increase the government's credibility, which facilitates access to financing on financial markets at a lower cost and can provide support and greater public trust. Fiscal rules can be seen as a catalyst for fiscal reforms, which would be necessary to ensure stability and provide better time consistency in decision-making.

According to the authors, an ideal fiscal rule should be:

- well defined as to the indicator to be constrained, the institutional coverage, and specific escape clauses,
- transparent in government operations, including accounting, forecasting, and institutional arrangements,
- adequate to the specified proximate goal,
- consistent internally, as well as with other macroeconomic policies or policy rules,
- simple to enhance their appeal to the legislature and the public,
- flexible to accommodate exogenous shocks beyond the control of the authorities,
- enforceable and effective.

When designing fiscal rules one should also consider extreme situations when other priorities dominate and fiscal rules could be suspended to achieve non-fiscal goals. The so-called escape clauses allow for this kind of flexibility, i.e. increasing the expenditure limit, without harming the credibility of fiscal policy. Such an extreme situation took place in the COVID-19 pandemic when the General Escape Clause was implemented at the EU level to combat fiscal implications of that challenging period (see Box 1 for additional information).

Box 1. Escape clauses in the EU

Apart from the EU framework common for all Member States, each country may have a national escape clause that can be triggered when the occurring shock is country-specific and not necessarily of global nature. Properly designed escape clauses should precisely define the potential circumstances when they can be triggered, the procedure of activation as well as the mechanism to return to the previously indicated expenditure path.

Usually the escape clauses are activated in the case of exceptional situations such as natural disasters, wars, epidemics or severe economic slowdowns. Each of them should be either officially announced by the authorities based on existing regulations, e.g. wars, epidemics, or precisely defined in the law, e.g. the magnitude of economic slowdown by 2 p.p. lower than the medium-term average pace of economic growth.

For transparency reasons, escape clause should be activated with the support of democratically elected authorities or non-government institutions, e.g. with approval of the parliament majority or independent fiscal institution. The duration of suspension shall be defined in the law and monitored.

The return to the fiscal rule requires the timeframe to be set as well as the mechanism to correct the deviation from the previously indicated expenditure path. If the scale of possible deviation in extreme circumstances is not defined, the return may be more challenging and sustained. In some cases, preferable adjustment measures can be also outlined, e.g. wage freeze in the public sector.

None of the rules fully combines desirable attributes, partly because of the inevitable trade-offs among some of them (for example simplicity and flexibility), but it is worth considering the above features when creating, modifying, or evacuating the fiscal rules.

2.2. Brief history of fiscal rules in the EU

The years 1975-1995 were characterised by significant budget deficits and rising public debt in most countries of the then European Economic Community and later the European Union. Similar developments took place in other developed economies. In the 1990s, fiscal rules began to be seen as a remedy for a perceived fiscal policy stance consistent with the deficit bias (Krogstrup & Wyplosz, 2009).

The history of fiscal rules in the European Union begins in the early 1990s with the establishment of the Maastricht Treaty, which founded the first, and most basic, fiscal rules. Its main objectives were confirmed by the Stability and Growth Pact in 1997 (Council of the European Union, 1997a; Council of the European Union, 1997b), which was a set of principles on coordinating national budgetary policies in EU countries. With the subsequent introduction of the euro, it was decided to use this opportunity also to introduce fiscal constraints at the European level (Calmfors, 2005).

In 2011 the EU continued the process of strengthening the fiscal framework after the great financial crisis and the debt crisis, the intensification of which took place as a result of 2011/85/EU directive (Council of European Union 2011), which tightened the rules of the Stability and Growth Pact. With the directive, new standards for creating national budgetary frameworks were introduced, including numerical fiscal rules imposing top-down numerical restrictions on categories such as debt, deficit or expenditure. Since 2015, in line with the new regulation, Poland has effectively started to use SER in its budgetary policy.

After the shock test by COVID-19 that caused large increase in debt ratio, the reform of the EU rules became necessary. The new approach is based on country-specific debt sustainability analysis (DSA), which – in particular – monitors the drivers and trajectory of the public debt of each EU Member State. Under the new rules, all countries have to commit to a multi-year net expenditure path and explain how they will deliver investments and reforms that respond to the main country-specific challenges.

Currently, fiscal rules are commonly used by all Member States – both those at the EU level and those at the national level. According to the EC Fiscal Rules database[1], in 2023, there were 116 national numerical fiscal rules in force in the EU countries, most of which most cover the general government. Of these 116 rules, 64 are budget balance rules (of which 25 structural balance rules for the general government), 28 debt rules, 20 expenditure rules and four revenue rules. Poland is one of the two exceptions that does not have a national budget balance rule at the general government level. The main operational rule in Poland is the abovementioned SER, which sets an expenditure limit consistent with the medium-term GDP growth rate, adjusted by inflation rate, discretionary revenue measures and correction mechanism. In addition, the long-term debt anchor in Poland is the debt rule enshrined in the Constitution. The open question now is whether these rules are compatible with the new EU framework and sufficient to achieve their new objective of medium-term debt sustainability, what part of them will be amended in the coming years and how many new national fiscal rules will be introduced in the nearest future.

[1] https://economy-finance.ec.europa.eu/economic-research-and-databases/economic-databases/fiscal-governance-database_en

2.3. Literature review

The literature on fiscal rules is very extensive – both theoretical and empirical. Focusing on empirical studies, the most popular research concerning fiscal rules is about their impact on the budget balance and the fiscal stance. One of the first articles in this area for the EU countries is Debrun et al. (2008). They created panel models based on data from 1990 to 2005 and investigated the impact of fiscal rules in general, as well as their types, on fiscal aggregates. According to the authors, budget balance rules had a particularly strong impact on improving the fiscal stance. Further articles in this field are i.a. Nerlich and Reuter (2013), Maltritz & Wüste (2015), Caselli & Reynaud (2020), and Heinemann et al. (2018). The last position summarises in a meta-regression analysis many previous econometric studies concerning the period 1985-2012. It points to a statistically significant and constraining impact of fiscal rules on fiscal aggregates. These results hold particularly strong for deficits but less so for debt, expenditure or revenue. Concerning the effect size, measurable only for a small subset of studies, the results show that budget balance rules, on average, reduce the primary deficit between -1.5 and -1.2 percent of GDP. For expenditure rules, such generalized estimates of the effects on deficits have not yet been analysed in the literature.

The impact of fiscal rules on public investment stands for another extensively analysed topic, especially in recent years. Several empirical studies have emerged on the relationship between fiscal rules and public investment (Ardanaz et al., 2021, Delgado-Téllez, M. 2022, Chmura, 2023a), summarised by Blesse et. al (2023). In general, they find no systematic evidence for a negative effect of fiscal rules on public investments. The design of fiscal rules appears to be crucial for higher or lower public investments. This is especially important in the context of the recent reform of fiscal rules in the EU and the challenges posed to Member States – energy transformation, aging, or digitalisation.

Another strand in the literature concerns the impact of fiscal rules on the volatility of economic growth. Some works show that under certain circumstances, fiscal rules may decrease the pro-cyclicality of fiscal policy and lead to a more stable GDP (Fatás & Mihov, 2006, Badinger & Reuter, 2017, Chmura, 2023b). Brzozowski and Siwińska-Gorzelak (2010) argue that the effect of rules on fiscal policy volatility depends on their type – budget balance rules may amplify spending volatility, while debt rules may mute it. Combes et al. (2017) investigated that the reaction of fiscal policy to the business cycle depends on the level of public debt-to-GDP and fiscal rules. They revealed a non-linear response of fiscal policy to the business cycle, conditional upon the level of debt – when the public debt-to-GDP ratio goes beyond the threshold (estimated at 87% of GDP), fiscal policy turns pro-cyclical. To tackle this effect, they explored the role of fiscal rules – only some of them may mitigate fiscal policy procyclicality in high-debt environment (golden rules[2] and national rules, especially those targeting deficits). On the other hand, there are articles insisting that fiscal rules, by "tying the hands" of policymakers and not allowing them to respond adequately to external shocks, can increase the pro-cyclicality of fiscal policy (Levinson, 1998).

3. Using NEMPF model with the Polish SER: key simulation properties

[2] The golden rules stipulate that over the economic cycle, the government should borrow only to invest and not to fund current spending (Honjo 2007).

The assessment of the economic design of the SER takes into account four features that should characterise effective fiscal rules. These include:

A. **Safeguarding debt sustainability**. The rule should support public debt sustainability by introducing appropriate corrective mechanisms after periods of high deficits. This approach allows for sustainable management of public finances and minimises the risk of a fiscal crisis.
B. **Allowing necessary flexibility.** Ensure that fiscal policy can respond flexibly to the occurrence of major unexpected shocks and can cope with deviations. In such a situation, escape clauses and so-called 'bad times' clauses should apply. The rules should therefore provide flexibility to respond to exceptional events outside the control of the government (such as an epidemic or a massive financial crisis).
C. **Appropriate coverage**. In line with EU requirements for budgetary frameworks of the Member States, the scope of rule should cover the widest possible number of general government expenditure. The scope of the rule should be as broad as possible in order to control the aggregate fiscal developments, while keeping it operational.
D. **Counter-cyclicality and ensuring stability in times of economic shocks**. SER should protect the state budget from excessive imbalances caused by business cycle fluctuations and unexpected events. The task of an effective expenditure rule during an economic upturn is therefore to limit excessive expenditure growth (built fiscal buffers), and during a recession to limit excessive reductions in the expenditure limit to allow a flexible response to changing economic conditions.

Based on the above features, a shock analysis was carried out, which examined whether the SER formula, including the correction mechanism and the bad times clauses, exhibit the desired properties [A]-[D], also taking into account the EU economic governance reform, which entered into force on 30 April 2024.

When alternative fiscal policy scenarios are investigated, the ratios of General Government (GG) deficit or debt to GDP are the most frequently considered outcomes. Changing the GG expenditure level shall therefore be treated as an impulse that initiates a sequence of adjustments in variables of interest. The impact of GG expenditure shift on GDP deserves special attention, for at least two reasons: (i) GDP level is the denominator of the discussed ratios, (ii) GDP level is related to the GG revenues, which impacts on the deficit (numerator) alongside the expenditure.

One simple approach might assume that a major part of GG expenditure is a component of GDP in National Accounts (European System of Accounts 2010). That would be equivalent to positing a fiscal multiplier of 1 in the same period, and the absence of dynamic effects propagated to the following periods. This sharply contradicts the extant empirical evidence of fiscal multipliers materially exceeding unity (e.g. due to positive supply-side spillovers) or being significantly lower than unity (e.g. due to the crowding out effect), which is explainable by the theory and widely observed (see Ramey, 2019, for an overview). The empirical studies also confirm non-negligible dynamic effects of expenditure-side (de)stimulation throughout the business cycle.

For these reasons, the literature sometimes prefers to use Dynamic Stochastic General Equlibrium (DSGE) models, which are calibrated or estimated (mostly with Bayesian methods) based on specifications rigorously derived from decision problems of economic agents. This attractive option has two practical drawbacks. Firstly, the structure of GG expenditures is subject to necessary simplifications, in the form of a single expenditure variable or a simple breakdown into e.g. government consumption, investment and transfers (Stähler and Thomas, 2012; Bušs and Grüning, 2023; Herranz and Turino, 2023). The actual breakdown of expenditure categories under ESA10 is more nuanced, and the policy-relevant analysis must reflect this appropriately. Secondly, a number of established, simple models including fiscal policy (e.g. Orsi et al., 2014) assume a balanced GG budget, without any GG deficit or surplus. As a consequence, in such cases, no disequilibrium in terms of GG debt can be considered to build up over a long period of time.

Bearing that in mind, our ultimate choice is to use a hybrid econometric model that strikes a balance between theoretical underpinning of the specification and empirical fit achieved in the course of econometric analysis. We simulate the economic performance in the aftermath of a number of adverse shocks under SER using the NEMPF model developed by the Polish Ministry of Finance. A comprehensive description of this model can be found in Chmura et al. (2024), whereas some blocks are further discussed in Kelm & Sobiech Pellegrini (2023) and Kelm & Fabiański (2023).

The model determines real GDP in a bottom-up manner, adding the private and GG consumption and investment, as well as net exports. Consumption is determined by both labour income and wealth. Exports and imports are modelled separately, and depend i.a. on the level of activity in the aggregate foreign economy and the exchange rate. Prices and labour costs in the domestic economy vary endogenously, following cost-push and demand-pull triggers. An array of short- and long-term interest rates determine both real consumption and investment, and are determined themselves by both monetary policy and foreign developments.

The core version of the model determines the GG expenditure in a bottom-up manner as well, comprising 11 main categories of expenditures as endogenous or exogenous variables (see Appendix A for details). The sum of these categories is relevant from the macro perspective as it further feeds into the deficit level, which accumulates into debt. However, the individual categories also feed back into the economy through heterogeneous channels, e.g. social spending increases the tax base and investment spending builds capital and strengthens the supply side of the economy. This implies a bottom-up approach to fiscal multiplier derivation.

In line with the handbook intuition, the GG revenues are even more strongly linked to the macroeconomic position, and the relationship is also detailed and disaggregated in NEMPF. VAT-related revenues depend on private consumption (just as the excise tax revenues), as well as investment. CIT revenues are linked to the gross operating surplus, whereas PIT revenues and social security contributions – to the wage fund. Some other, minor revenue categories also depend on the aggregate value added. There is also a noteworthy, direct link between GG revenues and expenditure: as GG revenues grow, public investment projects become more affordable to policymakers.

The simulation scenarios considered in this paper are confronted by two kinds of fiscal policy, each one under a different constraint. In the first, the GG expenditure shall be equal to the value computed according to the SER. In the second, SER is treated as binding, but nonetheless the GG expenditure level shall not lead to a violation of the standard European Stability and Growth Pact constraints, i.e. GG deficit of 3% GDP and GG debt of 60% GDP (‘NO SER’). Given the SER formula presented below, the former one shall be considered as more restrictive.

The inclusion of SER equation, in which aggregate GG spending *G* becomes directly determined as an endogenous variable, violates the bottom-up scheme. A potential discrepancy arises between the SER-determined expenditure level and the sum of individual expenditure categories, and hence the model closure needs to be modified as appropriate: at least one expenditure category shall be determined as residual rather than following its own behavioural equation (if endogenous) or set as exogenous. In practice, exploiting a single category for developing a new closure might violate the non-negativity constraints, and hence an algorithm has been proposed that sequentially reduces the following categories: (i) the public investment, (ii) *other* [than social] *current transfers*, (iii) *Other taxes on output and current taxes on income and wealth* (see Appendix B for details).The GG expenditure equation has been implemented in line with the Polish SER adopted in 2023 and read at that time as follows:

$$G_t = G_{t-1} \cdot I_t^{\Pi} \cdot I_t^{Y} + \tilde{G}_t + E_{t-1}[\Delta DD_t] \tag{1}$$

where

$$I_t^Y = \sqrt[8]{\frac{Y_{t-2}}{Y_{t-8}} \cdot E_{t-1}\left[\frac{Y_{t-1}}{Y_{t-2}}\right] \cdot E_{t-1}\left[\frac{Y_t}{Y_{t-1}}\right]} \tag{2}$$

$$I_t^{\Pi} = \frac{\Pi_{t-2}}{E_{t-2}[\Pi_{t-2}]} \cdot \frac{E_{t-1}[\Pi_{t-1}]}{E_{t-2}[\Pi_{t-1}]} \cdot E_{t-1}[\Pi_t] \tag{3}$$

$$\tilde{G}_t = \begin{cases} -0.005 \cdot Y_t \cdot P_t^Y & E_{t-1}\left[\frac{Y_t}{Y_{t-1}}\right] \geq I_t^Y - 0.02 \ \wedge \left(E_{t-1}\left[\frac{debt_t^{GG}}{Y_t \cdot P_t^Y}\right] > 0.6 \ \vee \ E_{t-1}\left[\frac{def_t^{GG}}{Y_t \cdot P_t^Y}\right] > 0.03 \ \vee \right. \\ & \left. E_{t-1}\left[\frac{debt_{t-1}^{GG}}{Y_{t-1} \cdot P_{t-1}^Y}\right] > 0.6 \ \vee \ E_{t-1}\left[\frac{def_{t-1}^{GG}}{Y_{t-1} \cdot P_{t-1}^Y}\right] > 0.03 \right) \\ 0 & otherwise \end{cases} \tag{4}$$

G_t denotes GG expenditure in year *t*, Π_t – gross CPI inflation rate (average annual price dynamics) or 1 in the case of deflation, Y_t – real GDP with price index P_t^Y as GDP deflator, $Y_t \cdot P_t^Y$ – the respective nominal GDP, ΔDD_t – the expansion of revenues due to discretionary measures on the revenue side (beyond the scope of this analysis and henceforth assumed as 0), $debt^{GG}$ and def^{GG} – general government debt and deficit, respectively. Appendix C specifies how formulae (1)-(4), defined at annual frequency at policymaking level, have been translated into the quarterly framing of the NEMPF model.

Special attention needs to be paid to the reading of the terms $E_{t-1}[\ldots]$ and $E_{t-2}[\ldots]$. G_t is in fact a predetermined variable at *t*, with its value set at *t-1*, within the annual budgeting procedures. For this reason, all endogenous variables subscripted with *t* in (1) or (3) - Y_t, $Y_t \cdot P_t^Y$, Π_t, $debt_t^{GG}$ or def_t^{GG} – shall be treated as leads or conditional expectations based on the information set available in period *t-1*. Moreover, as opposed to the notation and assumptions commonly exploited in DSGE models, this set does not include values subscripted as *t-1* because they are officially published no sooner than at *t*. Consequently, terms such as $E_{t-1}[\mathrm{x}_{t-1}]$ (for any x) shall be regarded as nowcasting results in the year when G_t is determined, $E_{t-1}[\mathrm{x}_t]$ as next year forecasts, $\frac{E_{t-1}[\mathrm{x}_{t-1}]}{E_{t-2}[\mathrm{x}_{t-1}]}$ as a factor updating a 1-year-ahead forecast made at *t-2* to a nowcast made at *t-1*, whereas $\frac{\mathrm{x}_{t-2}}{E_{t-2}[\mathrm{x}_{t-2}]}$ as a factor updating a nowcast into realization which becomes known one period later.

The specification above poses two main modelling challenges: it contains forward-looking components, non-observable at the moment when the left-hand side variable is determined, and a considerable degree of nonlinearity in the form of conditional application of the correction $\tilde{G}_t$.

The presence of forward-looking components impacts the solution algorithm as it requires setting terminal conditions for the endogenous, forward-looking variables that go beyond the simulation horizon as far as the lead length. One could potentially solve this problem by choosing a specific value (e.g. external forecast), which is inconsistent with the purpose of the study to evaluate the degree of macroeconomic stability fostered by SER, and with the model construction itself as it is capable of forecasting the future value in question. The external forecast is potentially inconsistent with the model, hence we decided to apply model-consistent (or rational, as introduced by Muth 1961) expectations.

The resulting alternative approach is to assume constant levels, differences or growth rates of endogenous variables that can be extrapolated beyond the simulation horizon. The second solution, in turn, requires that the simulation horizon be long enough for endogenous variables to stabilize around the steady state values. The model hence needs to be long-run stable, rather than meant for short-term forecasting, and paths of exogenous variables need to be extended as appropriate. For this reason, we solved the model up to 2100, even though the time window of direct interest ends around 2035, and the illustrations in the empirical section assume 2050 as the horizon.

Bearing that in mind, the exogenous paths until 2100 have been established. Interest rate variables for the euro area, United States and Poland are assumed to converge to an equal level. The same applies to all exogenous sources of price dynamics (euro area HICP, US CPI, euro area GDP deflator, food and energy prices worldwide) that stabilize at 2.5% per year, converging from the last observed sample levels. Quantity variables (potential output, euro area GDP) converge to grow at 2% per year. In the initial years beyond the sample, i.e. from 2023 onwards, these exogenous variables are composed of last sample values and long run values as discussed above, with a declining share of the former. Shares and ratios (e.g. proportion between foreign and domestic debt, nominal tax and social security contribution rates, loan to deposit ratio) are anchored at the last sample levels. Nominal funds grow in the long run at 2.5%+2%=4.5% per year, while unit values at 2.5%, consistently with price indices.

The need to make further assumptions about the predictability of exogenous variables from the perspective of economic agents is another consequence of the presence of forward-looking variables. One simple working assumption ensuring the feasibility of deterministic simulation given the exogenous paths is perfect foresight, i.e. that these paths are known to respective agents in advance and always materialize as expected. However, this allows to analyse only a narrow class of scenarios, excluding ones in which unexpected developments occur once the GG expenditure has already been set and can no longer be updated (e.g. surprisingly high CPI inflation or surprisingly GG low revenues). To simulate the remaining scenarios, the standard perfect-foresight solvers (like Broyden or Gauss-Seidel) were applied sequentially as described in Appendix D.

4. **Simulation results**

Performance of the SER was tested through a series of five scenarios representing different potential adverse economic developments. The scenarios are designed to examine (i) the medium- to long-term implications for debt sustainability; (ii) flexibility of the SER in responding to severe shocks; (iii) sensitivity of selected spending categories such as public investment or social transfers to a change in the SER limit; (iv) the ability to return to the baseline following the shocks; and (v) the countercyclical properties of the SER. We tested the rule using forecasts from the macroeconomic model and applying shocks to the main economic variables.

All shock scenarios have been compared to the Ministry of Finance baseline scenario, with impacts applied in (or around) 2028. The exact timing of shock is just illustrative, except for the fact that it was chosen as a relatively distant moment in time, when the effects of the predicted near-term developments subside and model variables mostly return to long-run equilibrium. Note that, as an implication thereof, the initial fiscal position right before the shock is less favourable in the policy variant without SER.

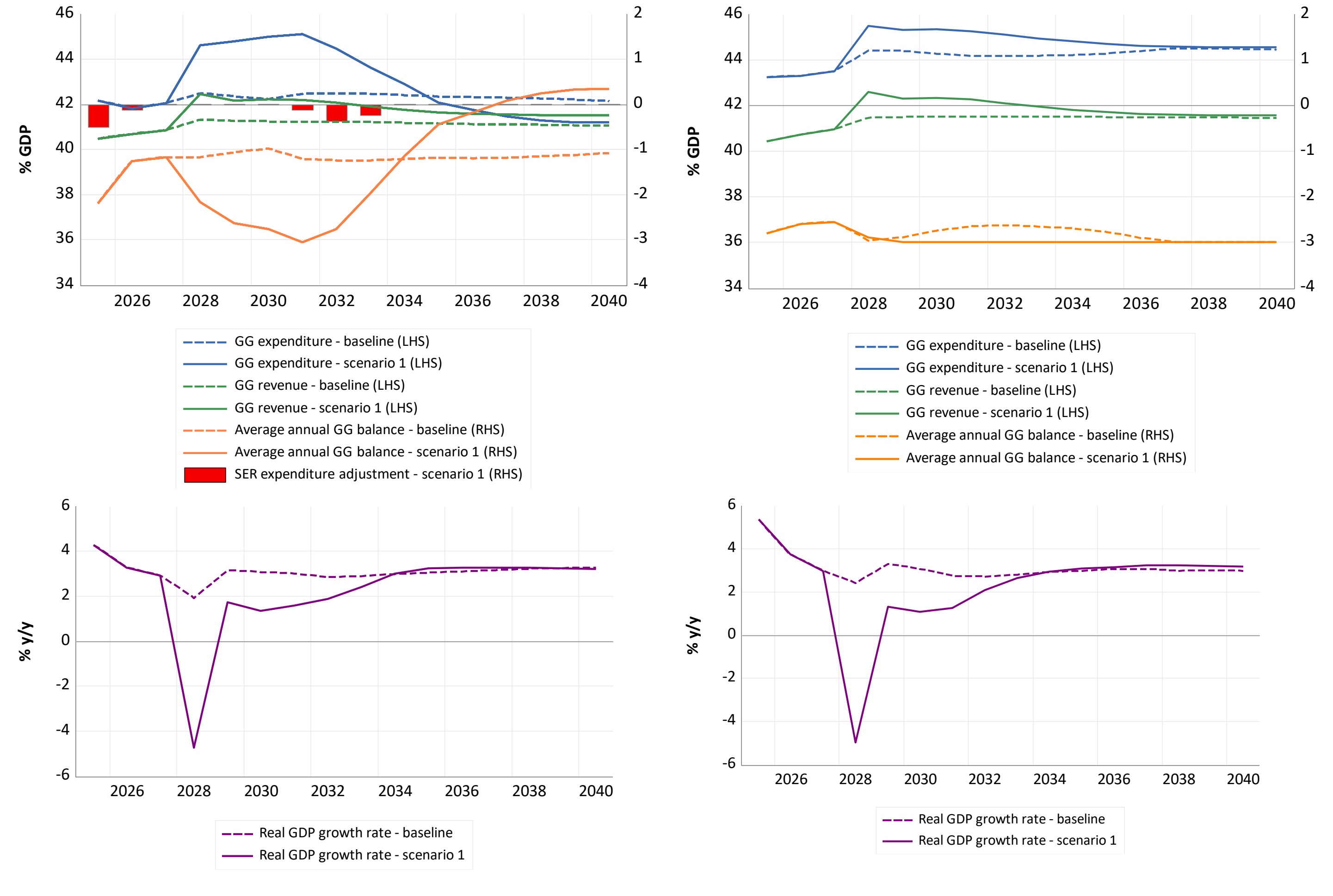
Scenario 1 – global recession. The foreign economy, represented in the model by the eurozone, experiences a negative, transitory shock to its real GDP dynamics, which translates into a recession in Poland. The magnitude of the shock was calibrated so as to trigger a negative shock on Polish GDP dynamics by 2 standard deviations in 2028, which roughly corresponds to a 5% GDP decline in the euro area throughout 2028. The low level of GDP in the euro area persists during 2029, and the GDP dynamics in the euro area returns to baseline in the course of the subsequent 4 years.

As the Polish GDP dynamics is affected by the euro area downturn, both GG revenue and expenditure appear to grow as ratios to GDP. In fact, this change stems entirely from the decline in denominator. In absolute values, both revenue and expenditure fall compared to the baseline scenario, and the decline in revenue is stronger and more rapid than in expenditure. As a result, the positive effect of the shock on the revenue-to-GDP ratio is weaker than on the expenditure-to-GDP ratio, and the GG balance deteriorates considerably as compared to baseline, with a maximum difference of ca. 2% of GDP in 2031. At that moment, as the bad time is over and the fiscal outlook persists, the expenditure correction mechanism as per eq. (8) is triggered (red line in Fig. 1).

A decade after the shock occurred, the GG revenues as percentage of GDP stabilize close to the initial level. However, this is no more the case for the expenditure, and hence the GG deficit. This is due to the incidence of correction, i.e. switch of eq. (8) to the non-zero state in 2031. Given the strongly autoregressive property of eq. (1) (or (5) alike), a one-off shift in $\tilde{G}_t$ brings G_t permanently on a new path. Once a correction is triggered, the adjusted GG expenditure level becomes a reference point for setting expenditure levels in subsequent periods. As a consequence, the expenditure is ultimately settled at a lower level, and the balance – at a higher level (a slight surplus), than in the baseline scenario, where the correction is not triggered.

Figure 1. Stress scenario 1

SER	NO SER

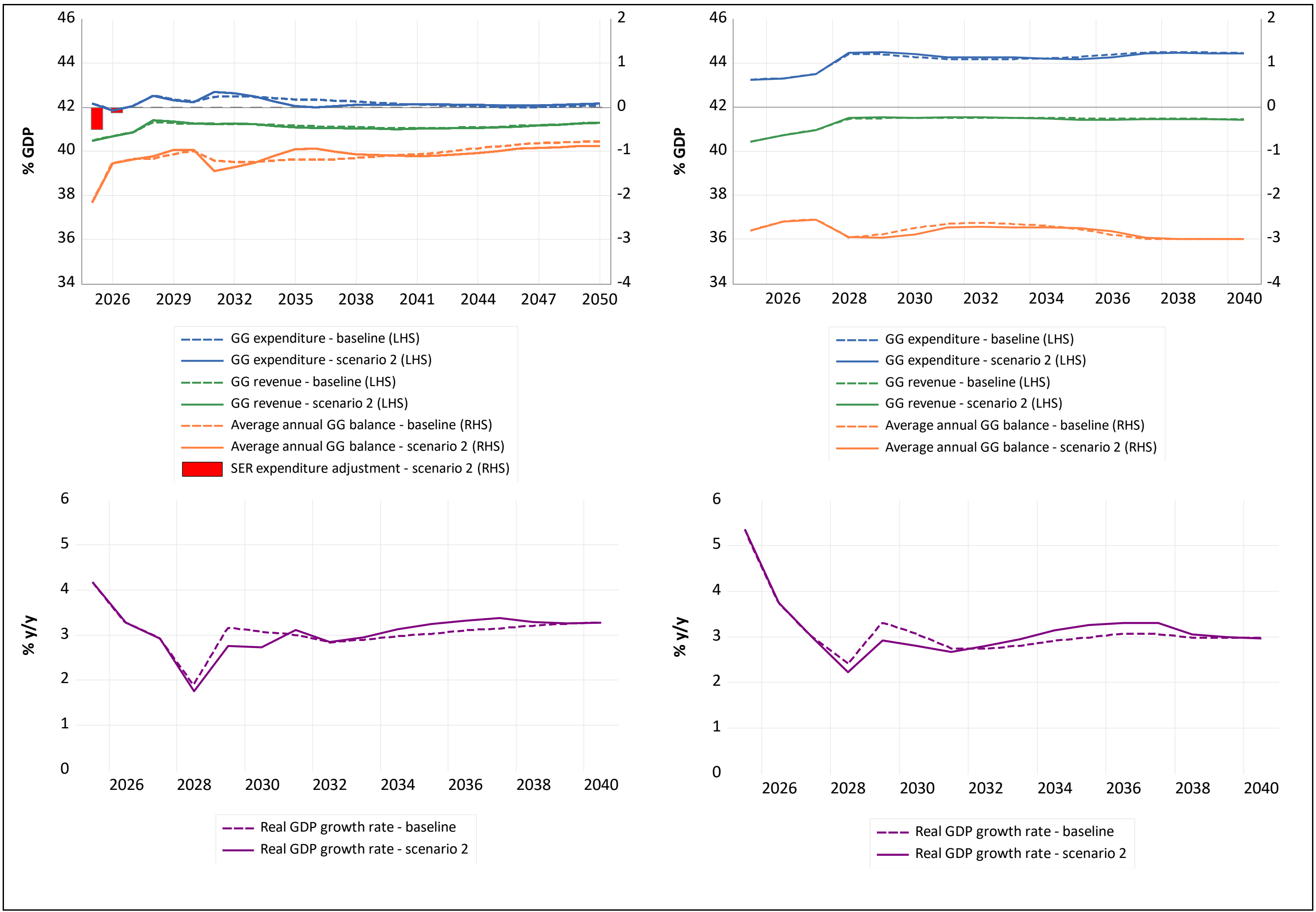


When the fiscal policy is conducted without the SER (right pane of Fig. 1), the difference between the baseline and shock scenario revenues remains similar, and the policymakers struggle to comply with the -3% floor on GG balance. As they quickly hit the constraint, the dynamics on the expenditure side is virtually the mirror image of the revenue side. In the long run, the expenditure stabilizes exactly as required by the constraint. This applies to both the shock and the baseline scenario. The path of GG debt, as a ratio to GDP, is clearly worse – as compared to both the baseline and shock scenario under the SER.

Scenario 2 – unexpected rise in inflation. This scenario aims to examine how an adverse inflation shock affects macroeconomic variables and public finance performance under the SER. The price increase is unanticipated and comes from internal sources, specifically the food prices. The assumed impact on CPI y/y is +2% above the baseline for two consecutive years (labelled 2028 and 2029), and the return to the previous CPI level spreads over the following 6 years.

Figure 2. Stress scenario 2

SER **NO SER**



This scenario reveals an important property of the Polish SER in its current form. The upward surprise in food price dynamic is a negative supply-side shock that manifests itself predominantly in CPI dynamics, as well as nominal values (none of which is demonstrated in Fig. 2). In terms of the ratios of (nominal) GG expenditure to (nominal) GDP, the impact remains quantitatively limited. However, the GG expenditure path (and hence the GG balance path) exhibits a small but lasting deviation from the baseline scenario, which is entirely caused by the numerical construction of the SER. The unexpected negative supply-side shock has some negative impact on GDP dynamics, which has not been taken into account by policymakers in planning the GG expenditure in the year of initial impact (2028). In line with eq. (1), the expenditure grows less than it should as compared to CPI developments, and more than it should as compared to GDP developments, with both effects almost cancelling out. However, the downside effect of CPI surprise is corrected in the next year in line with eq. (3), while the upside effect of GDP surprise is not as no such correction is embedded in the current form of the SER formula. As a result, once an upside (downside) forecast error of GDP dynamics is made, it has a lasting upside (downside) impact on the GG expenditure path and a downside (upside) impact on the GG balance. This has no long-run effect provided that forecast errors average is close to zero, but leaves room for GG balance deterioration if over-optimistic GDP forecast is used repeatedly.

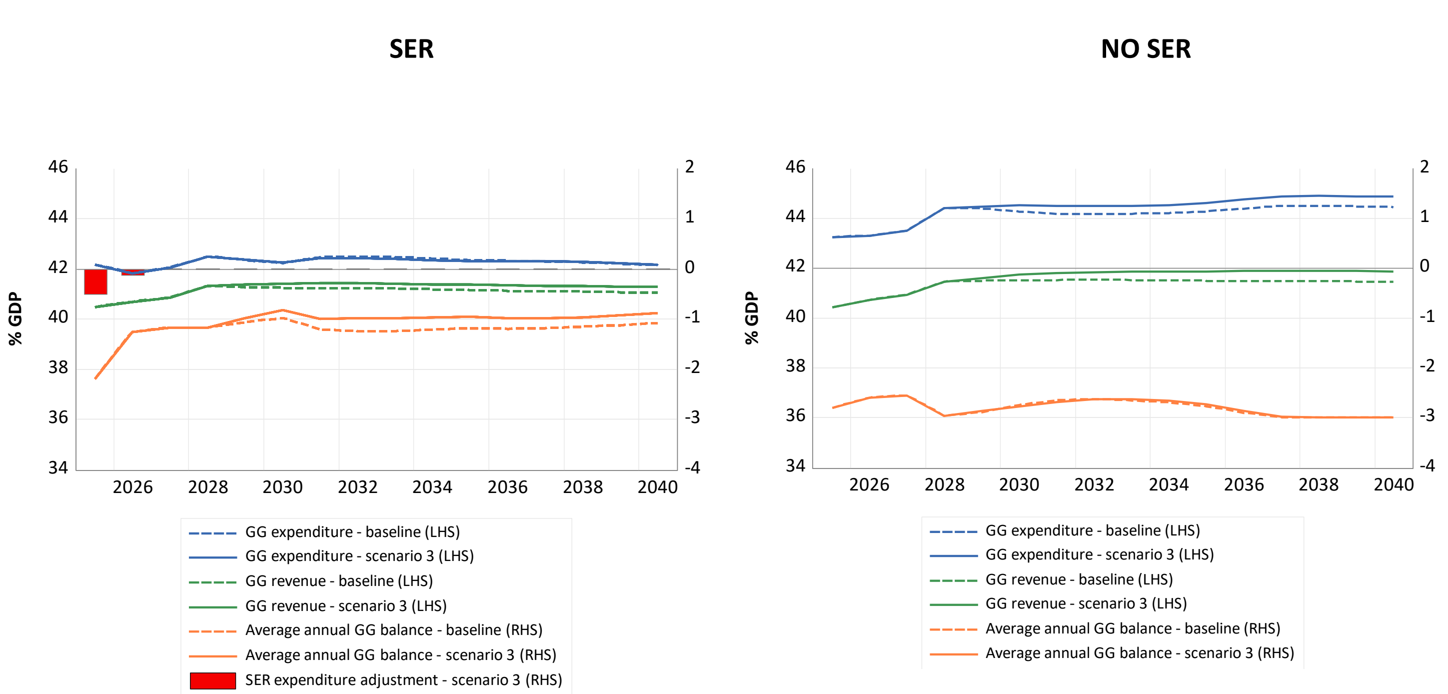
Scenario 3 – tightening of global financing conditions (interest rate shock). The scenario envisages an increase in interest rates, translating into a higher cost of debt servicing and potentially worse economic performance. The scenario considers a permanent 1 pp increase in domestic long-term and short-term interest rates since 2029 as compared to the baseline.

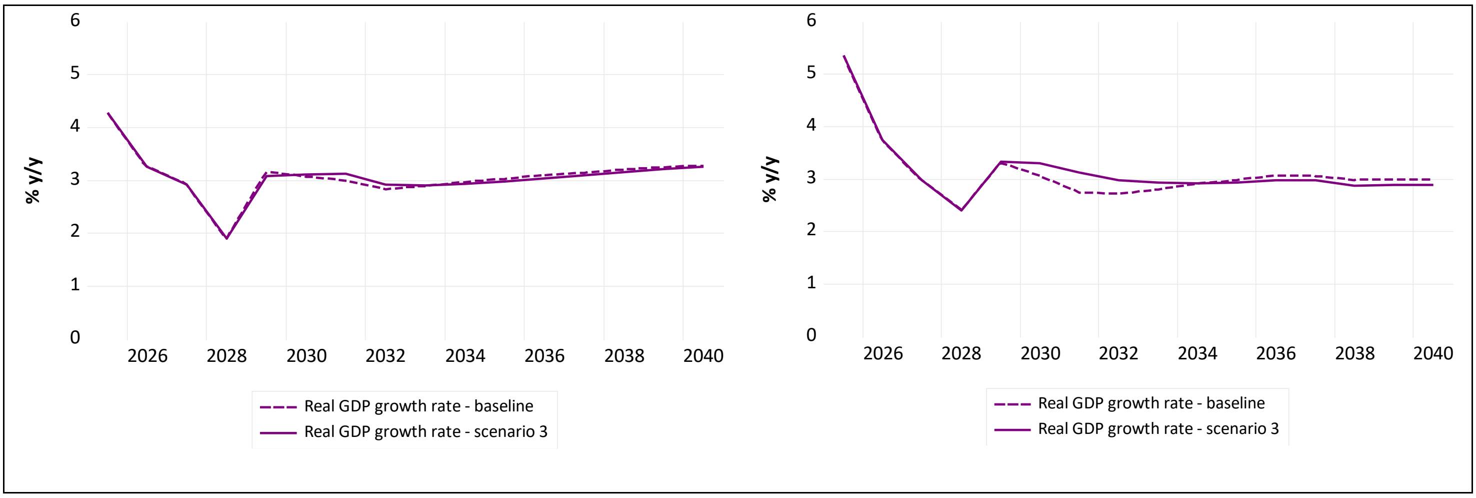
It has surprisingly little impact on the dynamics of the fiscal variables of interest. The GG revenue, expenditure and balance nearly overlap with the baseline scenario, with expenditure only marginally exceeding the baseline. The underlying reason is the historically low sensitivity of debt servicing cost to the short- and long-run interest rates observed otherwise in the national economy. The difference is even lower if foreign rates are a subject to shock, which is due to a low fraction of foreign currency GG debt.

GDP dynamics is slightly reduced by the increase in interest rates under the SER, but not in the policy variant without the SER. This is because of a different reaction of two major GDP components: private consumption and investment. The former is reduced, and this is the main driver of the GDP outcome under the SER. Without the SER, this is more offset by a positive response of investment, including public investment. This positive response is also incorporated in the initially scheduled amount of public investment, but the model implementation of the SER levels off this effect when computing the final, limit-compliant value of public investment (see Section 3 and Appendix A: $GEIT_t^*$ and $GEIT_t$, respectively).

The interest rate shock has been also considered as an increase in credit default swaps and foreign interest rates. This included permanently increasing CDS (both domestic and foreign) and foreign interest rates by 1 pp more than the baseline from 2029. The responses are similar, but weaker in magnitude (see Appendix E).

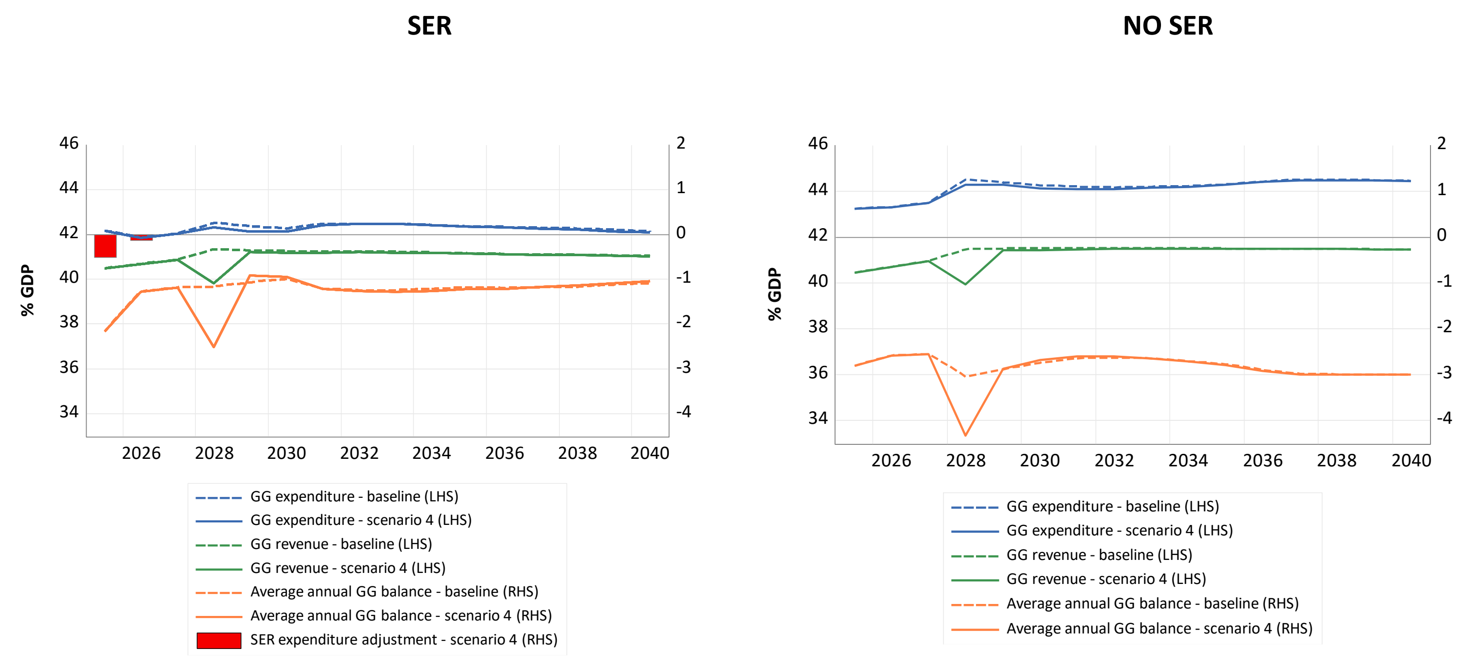
Figure 3. Stress scenario 3 (domestic interest rates)

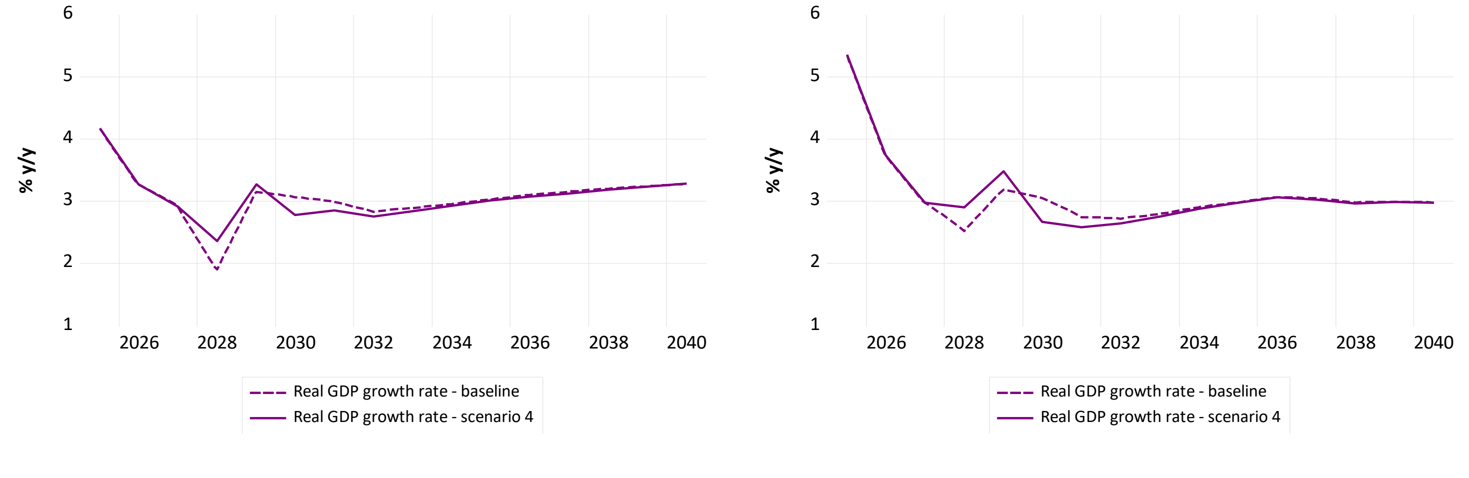




Scenario 4 of a **surprise GG balance deterioration** on the revenue side**.** The scenario considers a temporary (one-year) deterioration of primary balance owing to surprisingly low revenue side performance. The primary balance negative surprise results from an unanticipated drop in PIT revenues caused by a reduction of the effective PIT rate by 75 percent in each quarter of 2028 (Fig. 4) can be regarded either as a sudden decline in tax enforcement (not caused by discretional government intervention) or an unplanned revenue-side fiscal stimulus due to some unanticipated developments, although the latter are relatively unlikely to occur in isolation, without initial macroeconomic deterioration. Whether or not the SER is the prevalent policy regime, the consequences of such a shock depend on its magnitude and the initial position. Under the SER, if the initial balance is good enough (fiscal buffers were built before), no correction is triggered and the GG expenditure and balance paths return to the baseline (see Figure 4). Otherwise their profiles are similar to these under scenario 1, i.e. the expenditure stabilizes on a new, lower path, and the new, better mid-term GG balance follows.

Figure 4. Stress scenario 4



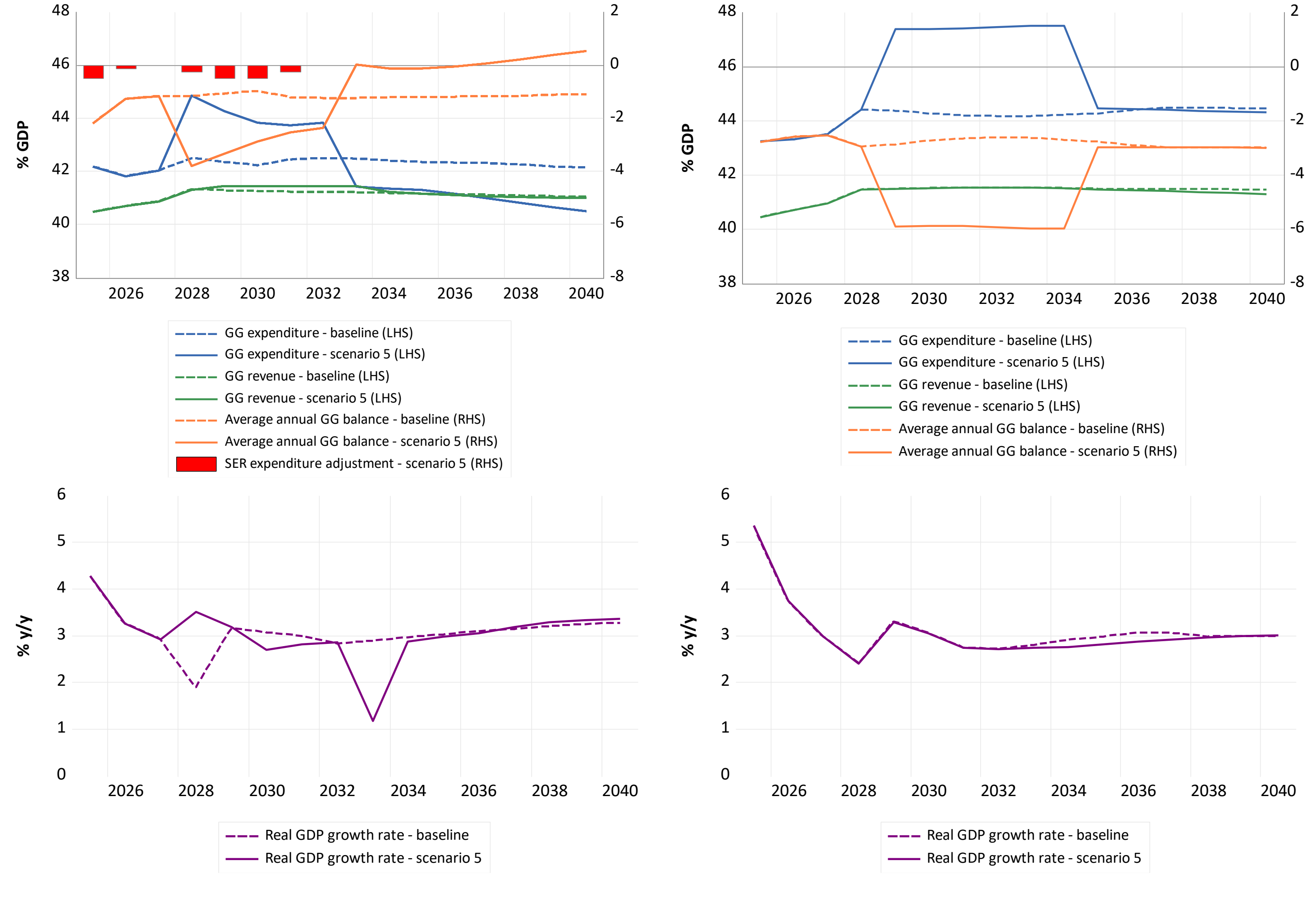


When the SER is not activated, similar reactions occur (however finally they result in less favourable fiscal position). Under the initial condition of the GG balance far enough from the floor of -3% GDP, the consequences would be scarce to a limited upward shift of the debt path due to a one-off decline in GG balance, and the related expenditure on interest payments would grow. Once the lower bound is hit, as in Fig. 4, public investment expenditure is crowded out in subsequent years, lowering GDP dynamics 2-3 years after the shock occurred, and this effect is slightly aggravated by higher debt servicing costs. Bottom line, if the fiscal revenue shock is not a part of a wider macroeconomic downturn, but occurs in isolation and with limited duration and magnitude, the macroeconomic impact shall be limited.

Scenario 5 – SER coverage (expenditure-side fiscal shock). The scenario replicates a situation of a discretionary surge of expenditure for a given period of time. The GG expenditure remaining outside of the SER coverage increases by 3% of GDP for 5 consecutive years. This can be regarded as a **massive fiscal expansion** on the expenditure side, implemented beyond the coverage of the SER, which, in the simulations, covered about 95% of GG expenditure. A sudden and substantial deterioration in GG deficit triggers the SER correction described by eq. (8). GG expenditure within the coverage of the SER needs to be reduced, and a crowding out process begins. While initially supportive to GDP dynamics, the shock has ultimately a negative effect two years after its occurrence. First, the reduced public investment is a drag on GDP both in the short and in the long run. Second, the surge in GG debt increases the interest payments that also crowd out government consumption and investment.

Figure 5. Stress scenario 5

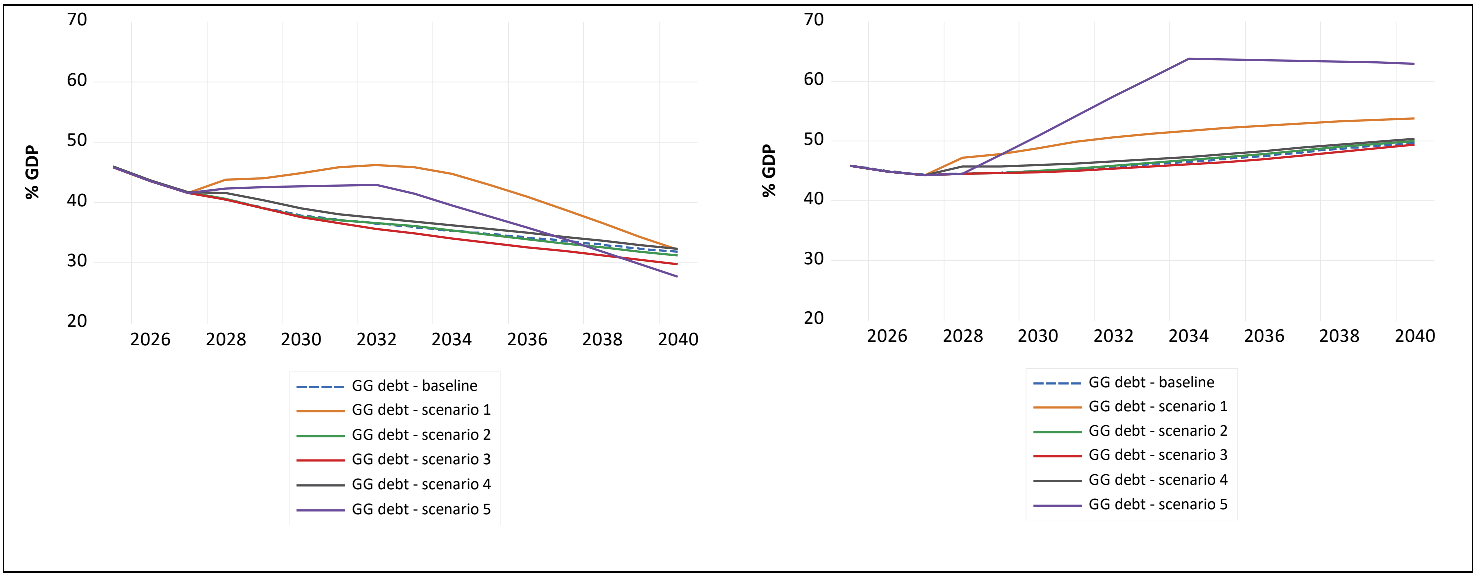
SER **NO SER**



It shall be finally noted that the GG debt to GDP ratio is generally lower under the policy that applies the SER as compared to the alternative policy without the SER, and trends downwards. This difference stems from the persistently lower GG deficits under the SER due to a generally lower level of GG expenditure. Interestingly, the fiscal policy under the SER is strongly disincentivized from operating in the proximity of the -3% GDP threshold for GG balance, since doing so exposes the policymakers to the correction (eq. (8)) being triggered in response to even relatively small shocks. In consequence, the GG expenditure is pulled down to a completely new trajectory, and in the end the GG balance is considerably higher than -3% GDP. The policy of just-compliance with the Stability and Growth Pact threshold hence becomes inoperable in practice. This means that SER even in its original form contributes to building fiscal buffers fir bad times that was a main goal of EU rules reform in 2024.

Figure 6. GG debt in simulated scenarios

SER **NO SER**



5. Discussion of policy implications

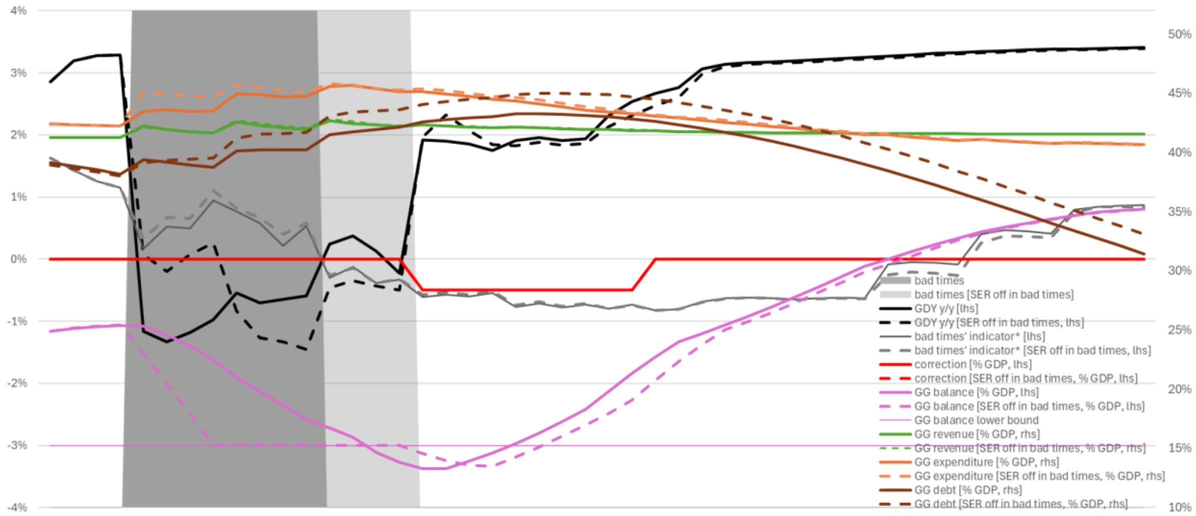
The stress scenarios prove that SER generally exhibits the desired properties. Following SER forces policymakers to restore fiscal **sustainability**. This can be concluded from Figure 6, in which debt levels and dynamics under SER are better than without SER, for all scenarios.

Scenario 5 of a massive fiscal expansion further indicates that the SER **coverage** should be as broad as possible, not only to make its impact on fiscal sustainability more effective, but also to avoid crowding out of the expenditure of public entities covered by the rule.

SER creates room for a credible **countercyclical** reaction of fiscal policy (as shown in Scenario 1 of global recession and Scenario 4 of massive fiscal expansion outside the SER coverage), as the correction is triggered only in relatively favourable macroeconomic context. Note, however, that Scenario 1 suggests that some adjustment of the escape clause seems desirable. Although the escape clauses exist for emergencies (e.g. epidemics or martial law), there is no scope to increase expenditure in the event of an significant economic slowdown. This might require more room for active fiscal policy (increase in the level of public expenditure or discretional tax cuts) than SER fosters on average. Adding an additional trigger in the escape clause in the event of a significant economic downturn, without the occurrence of any enumerated exceptional circumstances, would improve the SER countercyclical features.

To see this point, consider a response to a shock similar to Scenario 1, but with a modified version of the SER. While the solid lines (Figure 7) represent the simulation results under the standard SER parameters, the dashed lines simulate under an alternative, hypothetical setting of SER, in which not only do ‘bad times’ disable triggering the correction mechanism, but also they suspend the SER application SER. Under that circumstances, the expenditure categories declared as flexible in Section 3 (i.a. public investment, some social transfers) are growing so as to exceed the SER-consistent level of aggregate expenditure, up to a level that implies GG deficit of 3% of GDP. Up to a moment when the threshold is hit, this indeed supports the GDP dynamics and helps to mitigate the recession. Note, however, that the aggregate demand cannot be further stimulated once the lower bound is hit, and the dip in GDP dynamics is postponed, and the ‘bad times’ situation – prolonged. We assume that the end of ‘bad times’ automatically restores the applicability of the SER with an initial condition that would have been in place if SER had been applied throughout the 'bad times' episode. Therefore, the long-run level of GG expenditure and deficit remains unchanged in this exercise.

Figure 7. Hypothetical modifications of the SER: disactivation of the SER in bad times

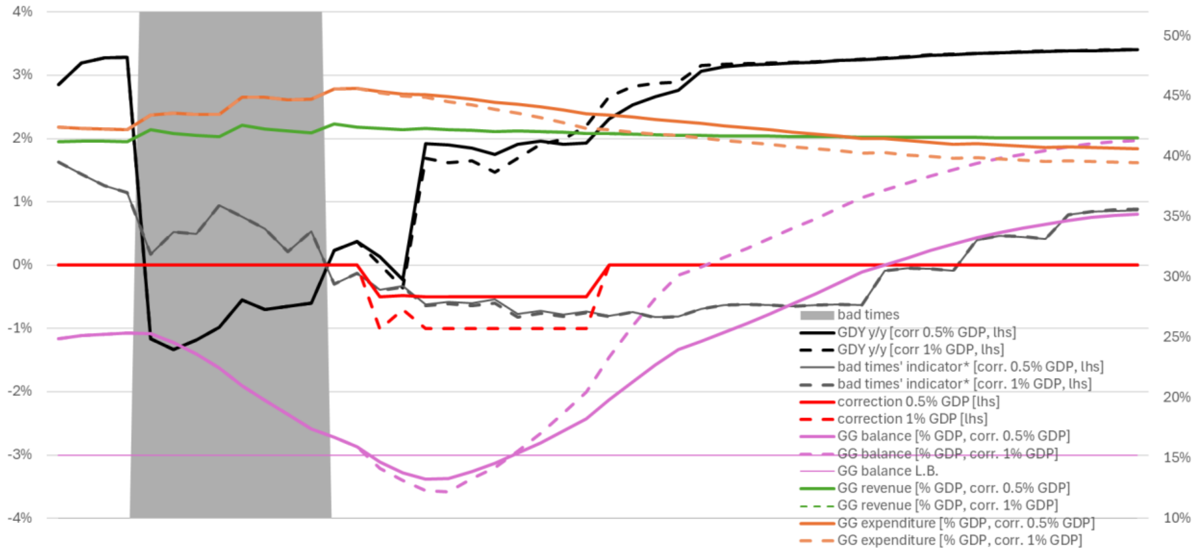


The simulation analysis also points to some challenges around SER, mostly related to **flexibility**. First and foremost, the correction mechanism seems to have too long memory. Its reaction is not strong enough in the case of large shocks or after fiscal expansion period – under such circumstances, correction should be higher than 0.5% of GDP to faster stabilize GG deficit at a safe level and prevent excessive increase in public debt. In the mid-term, the opposite is the case: the correction remains active for too long.

This can be further explored by considering another scenario similar to Scenario 1. Figure 8 compares the response to a large shock under standard SER parameters (solid lines) to a response that would occur if the correction mechanism was stronger, i.e. the definition of $\tilde{G}_t$ in eq. (4) started with -0.01 rather than -0.005 (dashed lines). In the initial period, when the shock negatively affects the GDP dynamics to a highest extent, the 'bad times' condition in (4) prevents the fiscal policy from aggravating the recession by cutting expenditures. The correction mechanism turns on soon after the bad times are over, and a slight fall in GDP dynamics is observed at the same time. Shortly after that, the GDP dynamics and GG balance are worse than under weaker correction, but the differences are minor in quantitative terms. When the correction is disactivated, the GDP dynamics (slightly) accelerates as compared to the standard setup. The major difference is, however, the final level of expenditure and GG balance. A stronger correction certainly increases the pace of restoring sound fiscal position, but from the perspective of this particular goal, and due to inertia, the correction lasts for too long and its impact is bottom line too strong.

More appropriate magnitude of correction and some flexibility in the automatic correction might be engineered by linking SER correction with EU recommendations stemming from new EU rules. Under the new economic governance in the EU, the Member States are obliged to prepare fiscal path in line with all the requirements, including the Debt Sustainability Analysis (DSA). At the same time, the Excessive Deficit Procedure (EDP) aims to set a fiscal path that would reduce the excessive deficit when it occurs. In addition, the economic governance reform in the EU introduced more flexibility to the EDP recommendations, via the so called *relevant factors* that affect the assessment of fiscal sustainability or lower fiscal adjustment in justified cases.

Figure 8. Hypothetical modifications of SER: stronger correction after large shocks

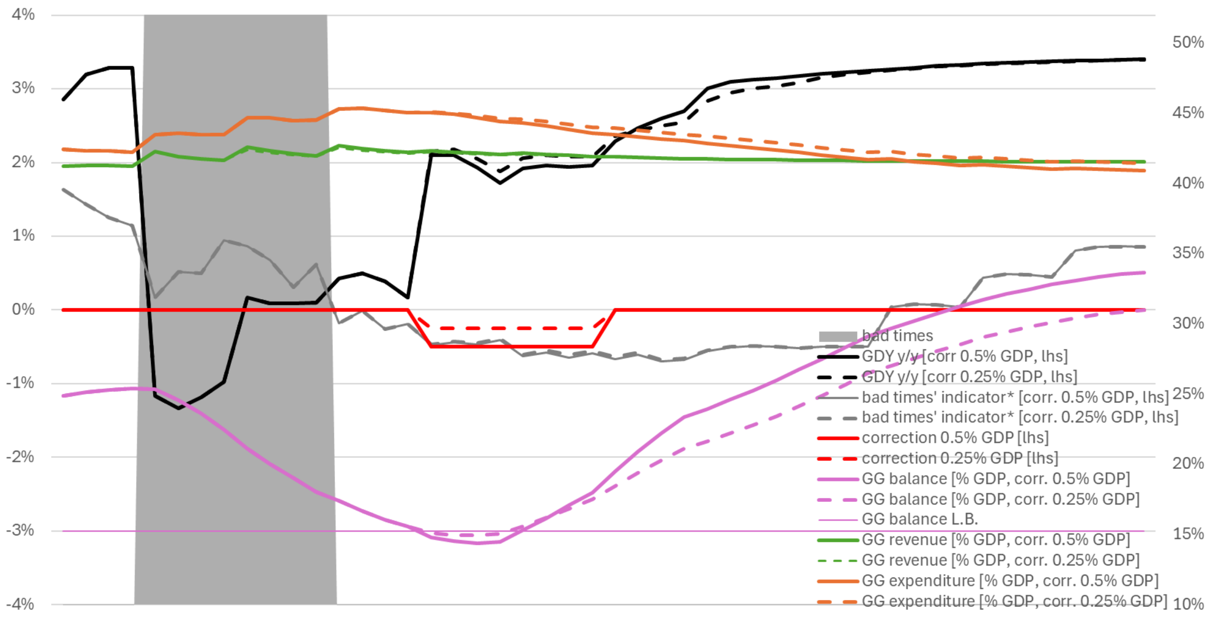


**Bad times (condition in eq. (4)) occur when the black line (GDP y/y dynamics) falls below the grey line. The period is the same in both simulations and is marked with the grey shaded area.*

In new EU framework, the correction of 0.5% of GDP in terms of structural (primary) balance as considered in all simulation scenarios in Section 4 remains a benchmark. Higher yearly correction or frontloaded fiscal effort may be recommended if required by fiscal sustainability. There is also a possibility to reduce the correction or extend the adjustment period in exceptional circumstances (see Box 2). Introduction of such flexibility in the SER would improve its features. Simultaneously, such a change will align SER with the EU fiscal framework and prevent conflicting signals for fiscal policy coming from different rules.

To illustrate the case of such an alleviation, consider a version of Scenario 1 that leads to a soft landing of GG balance slightly below the threshold of -3% of GDP (Figure 9). The dashed lines represent an alternative policy response, based on a correction of -0.25 % of GDP rather than -0.5% (eq. (4) starting with -0.0025 rather than -0.005). In such a situation, not only does the lower correction lead to a slightly better GG balance at the bottom point, but also it moderates the return path of GDP dynamics and, in the end, helps to avoid setting the GG expenditure at an overly restrictive level.

Figure 9. Hypothetical modifications of SER: flexible correction after weaker shocks



**Bad times (condition in eq. (4)) occur when the black line (GDP y/y dynamics) falls below the grey line. The period is the same in both simulations and is marked with the grey shaded area.*

In order to make the rule more effective and reduce the lags in its response to changes in the macroeconomic situation, some other changes seem desirable. As shown in Scenario 2 of an unexpected rise in inflation, a comprehensive correction of forecast errors (including not only inflation but also GDP growth) should be introduced. Although the simulations, and the NEMPF model construction in general, did not confirm a fundamental difference between using CPI and GDP deflator in eq. (1), switching from the CPI to the GDP deflator will make the rule more consistent with signals from EU-level rules, which are based on the GDP deflator, and internally consistent as a tool preserving desired GG expenditure to (nominal) GDP ratios.

Box 2. New European Union Economic Governance Framework

In April 2024, a reformed economic governance framework for European Union came into force. The new framework focuses on medium- to long-term sustainability of public finances and growth friendly fiscal consolidation, instead of rapid corrections of excessive deficit before the reform. In the new framework the fiscal adjustment is to be realistic, while also allowing for countercyclical policy and increasing in public investment in priority areas (such as green transformation or defence). The single operational instrument in the new framework is the nominal net primary expenditure growth (NEG):

$$\textit{Nominal net primary expenditure growth}_t$$

$$= \textit{potential GDP growth}_t + \textit{GDP deflator}_t - \textit{adjustment}_t$$

The framework requires to control net expenditure growth that is to guarantee long-term fiscal sustainability. Securing fiscal sustainability is specified along two dimensions. Public debt should be plausibly placed on a downward path, or—if already low (gg debt below 60% of GDP) — maintained at prudent levels. Fiscal deficits should—if high (gg deficit higher than 3% of GDP) — be reduced by the end of the adjustment period (in the 4-year horizon that may be extended to 7 years under strict conditions), and subsequently sustainably kept below 3% of GDP in the long run – hence the importance of properly designed national fiscal rules. In the adjustment period, the country is required to make a minimum annual improvement of 0.5 percent of GDP in terms of structural balance (in a transition period during 2025–27 structural primary balance, i.e. adjusted to take into account higher interest expenses).

The analysis of debt sustainability is based on debt-sustainability analysis (DSA). The DSA examines the debt dynamics under various pre-specified scenarios and shocks, such as lower GDP-growth or higher fiscal deficits. In the DSA, if debt or deficit are above thresholds the correction is required. The scale of the correction should allow to fulfil above mentioned criteria in t+10 horizon (t equals from 4 to 7 years).

In addition, the framework includes two minimum adjustment safeguards. According to a debt sustainability safeguard, over the adjustment period the debt-to-GDP ratio should fall on average by no less than 1 percentage point of GDP annually if debt is above 90 percent of GDP, and 0.5 percentage points of GDP annually if debt is between 60 and 90 percent of GDP. According to the deficit resilience safeguard, as long as the general government structural balance is less than -1.5 percent of potential GDP, the annual improvement of the structural primary balance should not be less than 0.4 percentage points of potential GDP for countries with a four-year adjustment period, and 0.25 for those with a seven-year adjustment period. However, this second safeguard is not binding if the debt and deficit are below the thresholds.

New framework contains also control account which allows for even greater rule flexibility. The control account will record a debit or credit when the observed net expenditure in a given year is above or below the recommended NEG. Thus, if buffers are built, a less restrictive fiscal policy is possible. And conversely, a delayed adjustment is possible under certain circumstances (deviation from NEG of up to 0.3% of GDP in 1 year or 0.6% of GDP in cumulative terms).

For the purpose of institutional soundness, the role of the independent fiscal institution shall not be undermined. Apart from surveillance and monitoring of fiscal policy both in good and bad times, independent fiscal institutions should play a more active role in turbulent times and support policymakers in the application of discretionary SER elements. For instance, the fiscal watchdogs could be involved in the process of disactivating the escape clause, adjusting the period of return to the fiscal rule compliance or the magnitude of required fiscal impulse. This approach is in line with the new EU economic governance principles which emphasize the completeness of fiscal framework and therefore the role of independent institutions in the budgetary process.

6. **Conclusion**

We investigate the properties of the Polish stabilizing expenditure rule (SER) in handling adverse economic developments. To this aim, we use NEMPF, a macroeconometric model of the Polish economy (Chmura et al., 2024) to simulate a number of adverse policy scenarios under various policy settings related to SER. We are particularly interested in the long-term debt sustainability, flexibility, coverage and countercyclicality.

The Polish SER appears to be well-equipped to handle these scenarios. The 'bad-times' conditionality, disabling the fiscal correction under precisely formulated conditions on GDP dynamics, ensures decent anti-cyclical behaviour: the corrections do not coincide with the periods of most adverse shock impact, and the expenditure reduction does not aggravate the business cycle position in the most critical moments. The escape clause and the potentially varying size of correction ensure the desired flexibility. We find that the SER generally ecourages lower GG deficits (and hence GG debt paths) than policies targeting just-compliance with the Stability and Growth Pact thresholds. The nonlinear correction mechanism encourages policymakers to look for a more restrictive efficient lower bound of GG balance than the legal boundary of -3% GDP.

Some challenges have been identified as well. GDP forecast errors are never corrected in the current version of the SER (unlike inflation forecast errors), which means that a positive bias in the forecasting can lead to excessive expenditure growth. The longer the period when the correction mechanism is activated, the higher the final (persistent) level of GG expenditure, and the final alignment is sometimes overly restrictive. For some specific shocks, a correction of more than 0.5% GDP or higher flexibility in choosing the terminal period of the correction might be required, in particular linking it with DSA implications.

As far as future research is concerned, the use of DSA approach, envisaged by the governance framework mentioned in Section 2, implies methodological challenges of at least two kinds.

First, the DSA toolbox envisages stochastic analysis. For the purpose of stochastic simulations in future applications with the aid of models like NEMPF, it shall be noted that the trigger for the GG expenditure correction is endogenous, and hence the constraint is occasionally binding in a similar sense to what Guerrieri and Iacoviello (2015) develop with reference to the zero lower bound constraint on nominal interest rates. Hence, an application of the OccBin solver or an implementation of a similar algorithm can be an option for stochastic simulations in mid-sized models incorporating SER in a shape adopted in Poland in 2023, although such solvers are less likely to handle large-scale models such as NEMPF effectively.

Second, the attention should be paid to the existence and stability of the long-run solution of models designated to fiscal policy analysis. The architecture of DSA implementation in the EU framework uses the future projected GG debt as a suggestion for the change in the current policy stance. Such a 'message from the future' brings the forward-looking perspective of the SER far beyond what the current SER equations (1)-(4) imply. As the perfect foresight assumption becomes less realistic with growing time horizon (which is more than a decade in DSA), dedicated efficient solvers should be proposed.

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APPENDIX A. Government expenditure composition in NEMPF model

The core version of the model determines the GG expenditure in a bottom-up manner, comprising 11 main categories of expenditures as endogenous or exogenous variables (see Table 1). Labels in Table 1 are consistent with Chmura et al. (2024) for the sake of accessibility for interested Readers.

Table 1. Structure of GG expenditure (G) in NEMPF model

Category	**Label**	**Share in G (2022)**	**Part of GDP?**
Compensation of employees in the GG sector	***GEFW***	22.4%	Yes (public consumption)
Intermediate consumption of the GG sector	***GEIC***	14.4%	Yes (public consumption)
Social transfers in kind	***GESTK***	4.1%	Yes (public consumption)
Public investment	***GEIT***	9.2%	Yes (public investment)
Changes in GG sector inventories	***GEIV***	below 1%	Yes (public investment)
Social transfers	***GES***	35.2%	No (transfers & subsidies)
Other current transfers	***GETRC***	4.9%	No (transfers & subsidies)
Capital transfers	***GETRK***	3.8%	No (transfers & subsidies)
Debt servicing cost	***GEWH***	3.6%	No
Subsidies	***GESU***	2.3%	No (transfers & subsidies)
Other taxes on output and current taxes on income and wealth	***GEOTH***	below 1%	No
Statistical discrepancy	***GE_DIS***	below 1%	No

Source: own elaboration, NEMPF database.

The expenditure categories are either determined by their own behavioural equations or designated as exogenous. GEFW depends on the labour productivity, labour supply and price dynamics. GES is also CPI-dependent, mainly due to pension indexation clauses. GEIC depends on the GDP dynamics, and GESTK is connected to the wage fund developments. GEWH naturally depends on the debt level, as well as domestic and foreign interest rates. This implies that individual expenditure categories can vary in the simulations between the baseline and shock scenarios due to their dependency on macroeconomic developments, although they do not vary along this dimension to an extent that they depend on the exogenous variables (i.e. social transfers other than pensions in GES).

Once determined, both GG expenditure and revenues feed into the macroeconomic block of the model. This ultimately leads to nuanced, category-dependent interactions between *G* and GDP, going beyond the simple inclusion of public consumption (GEIC, GEFW, GESTK) and investment (GEIT) in the calculation of *G*, and even more non-trivial structure behind the GG deficit to GDP ratio. This involves three main channels:

1. **Reinforcement of consumption multiplier.** As a negative shock (of various kinds) reduces output and consequently wages, households' disposable income decreases, which further aggravates the effect on output. If this translates into worse fiscal position, the government may be forced to reduce transfers (GES, GETRC) or wages (GEFW), which aggravates the impact on the disposable income.

2. **Other mechanisms of fiscal multipliers.** In a similar situation, the reduction can also be effected through the GG sector supply chain (GEIC) or reducing the supply of selected public goods (GESTK). This reduces taxed profits of the enterprises and the value of taxed transactions, which also translates into worse fiscal position, with a similar effect of further deterioration in economic activity.
3. **Accelerator.** If a shock reduces GDP through investment, a decline in capital and productivity follows, which further reduces GDP. This differentiates between productivity-deteriorating reductions in GEIT and other channels of potential *G* reduction.

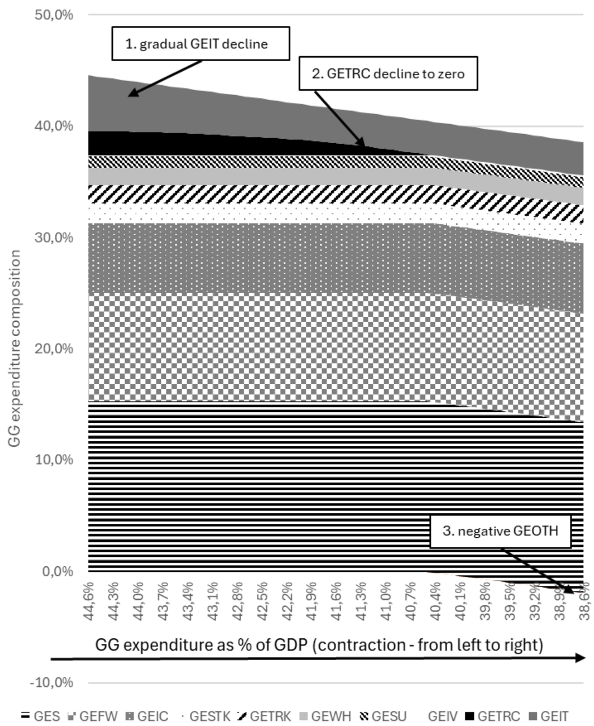
APPENDIX B.

The following algorithm has been proposed to sequentially reduces the following categories: (i) the public investment, (ii) *other* [than social] *current transfers*, (iii) *Other taxes on output and current taxes on income and wealth* if the sum of government spending categories needs to be reduced to the SER-consistent expenditure value. See Appendix A for the explanation of category symbols.

1. Compute
$$G_t^* = GEIT_t^* + GEIV_t + GEIC_t + GEFW_t + GEWH_t + GESU_t + GES_t + GESTK_t + GETRC_t^* + GETRK_t + GEOTH_t^* + GE\_DIS_t$$
where initial values computed from respective component's equations, or initial values of exogenous variables in the scenario, are denoted with asterisks (*).
2. If $G_t^* > G_t$ (the latter as per eq. (1) below), reduce $GEIT_t^*$ until $G_t^* = G_t$, but not below 3% $Y_t \cdot P_t^Y$. Refer to this final value as $GEIT_t$. In practice, a continuous differentiable transformation of $\frac{GEIT_t}{Y_t \cdot P_t^Y}$ as a function of G_t^* is applied that converges to 0.03 as $\frac{GEIT_t^* - (G_t^* - G_t)}{Y_t \cdot P_t^Y}$ decreases below 0.03 and to $\frac{GEIT_t^* - (G_t^* - G_t)}{Y_t \cdot P_t^Y}$ as this value increases above 0.03. This is aimed to ensure numerical stability of the model solver in the presence of an otherwise undifferentiable function.
3. Recompute G_t^* with $GEIT_t$ instead of $GEIT_t^*$. If still $G_t^* > G_t$, reduce $GETRC_t^*$ to equalize both, but not below 0. Refer to this final value as $GETRC_t$.
4. Recompute G_t^* with $GEIT_t$ instead of $GEIT_t^*$ and $GETRC_t^*$ instead of $GETRC_t$. If still $G_t^* > G_t$, replace $GEOTH_t^*$ with $GEOTH_t = GEOTH_t^* - (G_t^* - G_t)$. This equalizes $G_t^* = G_t$ by definition, but potentially implies negative outcomes of $GEOTH_t$ in simulation, hence discretion is required. However, in the simulations described in Section 5, these values have not fallen below historical values as % of GDP.

Note that the expenditure reduction scheme as illustrated in Figure 1 also applies to the 'NO SER' policy.

Figure 1. Structure of fiscal consolidation in NEMPF simulations



Source: own elaboration

APPENDIX C. Polish SER translated into quarterly frequency as part of NEMPF model

It shall finally be noted that SER determines annual GG expenditure, whereas the NEMPF model is specified at quarterly frequency. Hence, eqs. (1)-(4) – stipulated in the Public Finance Act with the annual frequency as the budgetary process – has been implemented in NEMPF as:

$$G_t = 0.25(0.5G_{t-6} + G_{t-5} + G_{t-4} + G_{t-3} + 0.5G_{t-2}) \cdot I_t^{\Pi} \cdot I_t^{Y} + 0.25(\tilde{G}_t + \tilde{G}_{t-1} + \tilde{G}_{t-2} + \tilde{G}_{t-3}) \tag{5}$$

$$I_t^{\Pi} = \frac{\Pi_{t-8}}{E_{t-8}[\Pi_{t-8}]} \cdot \frac{E_{t-4}[\,\widetilde{\Pi}_{t-4}]}{E_{t-8}[\,\widetilde{\Pi}_{t-4}]} \cdot E_{t-4}[\,\widetilde{\Pi}_t], \text{ where } \widetilde{\Pi}_t = min\{0.25 \cdot \textstyle\sum_{i=0}^{3}(\Pi_{t-i})\,;0\} \tag{6}$$

$$I_t^{Y} = \sqrt[8]{\frac{Y_{t-8}}{Y_{t-32}} \cdot E_{t-4}\left[\frac{Y_{t-4}}{Y_{t-8}}\right] \cdot E_{t-4}\left[\frac{Y_t}{Y_{t-4}}\right]} \tag{7}$$

$$\tilde{G}_t = \begin{cases} -0.005 \cdot Y_t \cdot P_t^{Y} & E_{t-4}\left[\frac{Y_t}{Y_{t-4}}\right] \geq I_t^{Y} - 0.02 \;\wedge\; \Bigl(E_{t-4}\left[\frac{debt_t^{GG}}{Y_t \cdot P_t^{Y}}\right] > 0.6 \;\vee\; E_{t-4}\left[\frac{\sum_{i=0}^{3} def_{t-i}^{GG}}{\sum_{i=0}^{3}(Y_{t-i} \cdot P_{t-i}^{Y})}\right] > 0.03 \;\vee \\ & E_{t-4}\left[\frac{debt_{t-4}^{GG}}{Y_{t-4} \cdot P_{t-4}^{Y}}\right] > 0.6 \;\vee\; E_{t-4}\left[\frac{\sum_{i=4}^{7} def_{t-i}^{GG}}{\sum_{i=4}^{7}(Y_{t-i} \cdot P_{t-i}^{Y})}\right] > 0.03\Bigr) \\ 0 & otherwise \end{cases} \tag{8}$$

The above modelling choices are intended to (i) avoid seasonal fluctuations in simulation caused by the initial conditions, i.e. the variation of expenditure between quarters in the first year of the simulation and (ii) preserve the staggered properties of budget planning with one year ahead horizon. For the first purpose, we use as the past reference expenditure level in (5) the annual average of G centered at *t-4*, rather than G_{t-4}.

For the second one, we assume away the possibility introducing a full correction $\tilde{G}_t$ at the quarter when an adverse shock occurs, replacing it with the moving average from t to $t-3$. As a consequence, the target size of correction (if sustained) is achieved after 4 quarters, which can be regarded as an expected value of four scenarios of the quarterly shock incidence, each of them at a different stage of the budgeting process. In formula (6), we also preserve the property of full ex post forecast error correction in CPI being effected in budget planning two years later, although it might be argued that the respective final CPI readings can take place sooner than with a 4-quarter lag. Once again, this is intended to preserve the average lags incorporated into the annual planning process when mapping into the quarterly framework.

APPENDIX D. Model solution under surprise scenarios in exogenous variables (no perfect foresight)

Let us consider the solution horizon in which:

A) From $t = 1$ to $t = T_1$ exogenous variables develop as expected.
B) For $t = T_1 + 1$, at least one exogenous variable takes an unexpected value. This does not change expectations for $t = T_1 + 2$.
C) From $t = T_1 + 2$ to $t = T_2$, (B) is reiterated.
D) From $t = T_2 + 1$ onwards up to simulation horizon T, exogenous variables develop as expected (the paths may potentially be revised).

Bearing this type of scenarios in mind, the following algorithm has been developed and applied on top of the classical Gauss-Seidel or Broyden solvers implemented in EViews:

1. Set the expected path of exogenous variables. Solve the model under perfect foresight $t = 1$ to $t = T$.
    a. Store solution for periods from $t = 1$ to $t = T_1$ as the final solution.
    b. Store solution for periods from $t = T_1 + 1$ to $t = T$ as the initial values for solutions in the next steps.
2. For $t^* = T_1 + 1$ to $t^* = T_2$, period by period:
    a. Replace the previously expected value of the exogenous variable at t^* with the realized value.
    b. Solve from $t = t^*$ to $t = T$ under perfect foresight.
    c. Store solution for period $t = t^*$ as the final solution.
    d. Store solution for periods from $t = t^* + 1$ to $t = T$ as the initial values for solutions in the next steps.
3. Revise the expected paths of exogenous variables for $t = T_2 + 1$ onwards, if applicable. Solve the model under perfect foresight for $t = T_2 + 1$ to $t = T$ and store solution for these periods as final.

The nonlinear correction, designed as a downward correction $\tilde{G}_t$ of GG expenditure conditional on projected values of endogenous variables, goes significantly beyond the analytic linear framework for fiscal rules proposed i.a. by Kliem and Kriwoluzky (2014) and poses numerical difficulties to all deterministic solvers pre-programmed in EViews, i.e. Gauss-Seidel, Newton and Broyden. For the purpose of obtaining a numerically stable, deterministic solution, the following algorithm has been applied. First, the model was solved with a modified version of eq. (1) in which each expectation term $E_{t-1}[x_t]$ has been replaced with x_t, that is under perfect foresight. Second, the solution from point 1 has been used as starting values for endogenous variables when solving the forward looking model including (1) as it reads.

APPENDIX E. Selected further simulation results

Stress scenario 3 – variant with foreign interest rate shock