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Abstract

This paper assesses the economic implications of existing fiscal rules in Poland, Switzerland and Germany. In the analysis we establish economic relationships between output, government revenues and expenditures estimating a VAR model on US data for the years 1960–2015. Imposing fiscal policies implied by a given rule on those relationships, we analyze the consequences for the simulated paths of debts, deficits and expenditures in terms of stability and cyclicality. We find that the Swiss and German rules are strict and stabilize deficits at low levels. However, this may still not be sufficient to stabilize debt, in the long run, in a strict sense. The Polish rule stabilizes the debt level at about $40-50\%$ of the GDP in the long run. All rules imply an anticyclical fiscal policy: an increase of the deficit to GDP ratio implied by changes in the output gap equals, at most, 2.2 pp, 3.3 pp and 3.9 pp over the whole business cycle for the Polish, Swiss and German rules, respectively. These results can be perceived as satisfactory for the Swiss and German rules.

Keywords: fiscal policy, fiscal rules

JEL Classification: C32, E62, H62, H63

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1 Introduction

The Great Recession, together with debt crises in some European countries, has put fiscal policy in the spotlight again and accentuated the significance of sound and sustainable public finance. Wyplosz, 2013 argues that a departure from optimal fiscal policy, due to a deficit bias, results in too high, suboptimal debt levels and is a political failure. Potential causes of such a failure are concisely summarized in Alesina and Passalacqua, 2016. They include fiscal illusion that results in an inability among voters to understand the notion of the intertemporal budget constraint for the government, political budget cycles, delayed stabilizations with 'wars of attrition' preventing smooth fiscal contractions or common pool problems that result in a failure of certain groups of voters to internalize fully fiscal policy costs. The suboptimality of fiscal policy may be also connected with the procyclicality of government expenditures, see e.g. Alesina, Campante, and Tabellini, 2008.

The aforementioned authors summarize potential remedies for the political deficit bias. Firstly, Alesina and Perotti, 1996 argue that an improvement of institutions may restrict the process of budget creation (e.g. an improvement of the voting process on budget amendments in the parliament). Secondly, Wyplosz, 2008 indicates that fiscal councils, i.e. impartial committees may decide on the budget balance of the government or, at least, assess and comment the fiscal policy led by the government. Thirdly, fiscal rules, understood as numerical and formal mechanisms, may restrict budget balances and they are the focus of this paper.

Our research serves two purposes. Firstly, we provide a detailed mathematical description of the fiscal rules existing in Switzerland, Poland and Germany. Secondly, we analyze the behavior of these three rules and compare them with a simple balanced-budget rule. We apply these rules to artificially created series of GDP and government revenues of a benchmark economy. The economy is represented by a VAR model, which is estimated on empirical US data. The actual economic relationships between GDP, government revenues and expenditures, described by the VAR model, interact with the fiscal policy implied by each of the analyzed rules. This in turn results in interdependent time series of output, revenues and expenditure that are analyzed.

Analyzing four rules in a unified Monte Carlo simulational framework enables credible comparison of their implications and effectiveness regarding stabilizing output, reducing procyclicality of fiscal policy and reducing debt levels. There is a wide consensus in the existing literature that these features, together with transparency and simplicity of a rule's mechanism, are the most important merits of an effective fiscal rule. Therefore, the comparison focuses on precisely these features.

We find that the rules are capable of stabilizing deficits at low levels and they imply anticyclical fiscal policy. Nonetheless, the degree of antycyclicality is not uniform: the maximum difference in deficit to GDP ratios, caused by output gap volatility, over a business cycle does not exceed 2.2 pp for the Polish rule, 3.3 pp for the Swiss and 3.9 pp for the German rules.

The Monte Carlo simulation methodology, which we use for our analysis, has been already used in the analysis of fiscal rules. Examples of such research are Geier, 2012, who assesses the Swiss fiscal rule on purely artificial data, and Korniluk, 2016, who analyses the Polish expenditure rule based on time series created by an econometric model using data from EU countries. The research in Landon and Smith, 2017 is closest to our contribution. They use a very similar approach based on time series generated by a VAR model and compare properties of different fiscal rules. While they focus on a synthetic measure of welfare and do not assess in detail other features of the rules, we focus on procyclicality and stabilization of debt, deficits and expenditures. Moreover, they analyze simplified rules that are not part of actual legislation. The major conclusions of their paper are that rules, in general, help in increasing welfare and in decreasing expenditure volatility. Finally, structural deficit rules (like the Swiss or German ones) deliver best results in terms of welfare maximization.

Problems arising with implementation and effectiveness of rules are well-known on theoretical grounds: the 'rules vs. discretion dilemma' may result in time-inconsistency (these issues are analyzed specifically for fiscal rules in Alfaro and Kanczuk, 2016 or Halac and Yared, 2014) with further problems being commitment and self-enforcement issues. Short time series and endogeneity make it difficult to assess the behavior of fiscal rules empirically. Nevertheless, the popularity of this strand of research is increasing together with the rising popularity of rules within the last 25 years. IMF reports, including Schaechter et al., 2012, Eyraud et al., 2018a or Eyraud et al., 2018b, present an encyclopedic overview of countries adopting fiscal rules together with reviewing their types and features. Econometric research (Debrun and Kumar, 2007, Holm-Hadulla, Hauptmeier, and Rother, 2012 or Nerlich and Reuter, 2016) claims that fiscal rules are associated with lower deficits, more fiscal space and lower procyclicality of fiscal policy. Nevertheless, they point out that self-selection may convolute the causal effect of fiscal rules as countries with a better fiscal situation or more willingness to follow a conservative fiscal policy may be more eager to implement rules, which then serve rather as signaling devices than as binding policy constraints. Recent research, which includes Grembi, Nannicini, and Troiano, 2016 and Guerguil, Mandon, and Tapsoba, 2017, using a quasi-experimental setting or propensity-score matching, shows that rules themselves can affect, in the sense of causality, fiscal policy by reducing deficits and procyclicality.

The rest of the paper is organized as follows. Section 2 describes in detail the mechanics of all four analyzed rules. Section 3 presents the framework in which the rules are assessed. Section 4 describes the VAR model generating artificial GDP and revenue time series used in the simulations. Section 5 presents the obtained results and Section 6 concludes.

Finally, Section A of the Appendix presents the modified HP filter used in the calculations of the Swiss and German rule, while Section B summarizes all diagnostic checks of the VAR model used in the paper.

2 Description of the fiscal rules

This section explains the mechanics behind each of the rules analyzed in the paper, together with a review of the respective literature. The focus of the analysis is economic so that we do not address legal details like the degree of enshrinement of each rule in a legal system of each country, potential loopholes, the degree of budget rule coverage, enforcement sanctions, escape clauses etc.

Despite a relatively large, and growing, number of fiscal rules around the world, only a few of them, including the Swiss, German and Polish rule, can be analyzed in a unified, non-discretionary framework. First, many other rules use country-specific benchmarks governing deficit or expenditure limits, which may involve, for example, copper or oil prices, as it is in case of Chile and Norway, respectively. Second, rules aim to restrict and automatize fiscal policy, but some of them still leave a lot of space for fully discretionary decisions.[1] Lastly, many rules lack sufficient, publicly available information on their detailed specification.

Fiscal rules in each of the analyzed countries cover a different amount of public expenditure (understood as general government spending) as, firstly, they differ in their central budget coverage by definition and, secondly, central government spending that is subject to these rules differs significantly because of the federal or centralized nature of Germany, Switzerland and Poland. For example, the Swiss rule does not include expenditure on unemployment insurance and the Polish rule does not encompass 'expenditure generated by institutions incapable of creating large deficits' (e.g. the Polish Academy of Science). According to the Eurostat database, central government expenditures in 2015 encompassed 10.5% of GDP in Switzerland, 22.9% in Poland and 12.6% in Germany, while general government expenditure in these countries was, in terms of the GDP fraction, 33.9%, 41.5% and 44.0%, respectively.

GDP, total government expenditures, i.e. including interest payments on existing debt stock, total government revenues and public debt in a budget period t are called Y_t, G_t, R_t and D_t, respectively. We define public deficit as $R_t - G_t$, which means that a positive deficit is, in fact, a surplus. Debt is defined in the same fashion: positive values of D_t mean an accumulation of assets and negative values of D_t mean liabilities. The variable c_t stands for corrections of some variables to be undertaken in period t and is connected with a state of the correction account CA_t, which is used, in some form, in all rules. Corrections show up in all of the analyzed rules, but the simplified balanced budget rule, and pertain to expenditure or deficit limits. Correction accounts CA_t are defined differently for every rule and are explained in detail below. $E_t[x_{t+1}]$ is an expectation of a variable x_{t+1} in period t. The convention applied in the paper, which is in line with reality and necessary from the technical perspective of the simulation, is that a budget for year $t+1$ is planned in year t and its plan is based on projected values $E_t[x_{t+1}]$. In all rules definitions, government expenditures G and revenues R, as well as values derived from them, are treated as nominal. Nevertheless, the rules operate with real GDP growth rates and trends.

2.1 Swiss rule

The Swiss fiscal rule, which is called 'the debt brake' or 'die Schuldenbremse' in German, is described in Geier, 2011. It was created in 2000 and is operational since 2003, after its three-year vacatio legis.

The main tenet of the rule is to have the budget structurally balanced over the business cycle. The rule is summarized by the following equation:

$$\bar{G}_{t+1} = E_t[k_{t+1}] \cdot E_t[R_{t+1}], \quad \text{with } E_t[k_{t+1}] = \frac{E_t[Y^*_{t+1}]}{E_t[Y_{t+1}]},$$

where $\bar{G}$ is the expenditure limit for the next period's budget and it is equal to expected revenues R multiplied by the expected business cycle adjustment factor k. The adjustment factor k is a ratio between the long-run real trend output Y^* and real actual output Y. The logic behind this adjustment is that when the economy is below its trend, i.e. it is in a slowdown phase: $E_t[Y^*_{t+1}] > E_t[Y_{t+1}]$, the adjustment factor k is larger than one allowing expenditures to be larger than revenues, which results in a (cyclical) deficit. The

[1] The Swedish fiscal rule is an example of a very interesting mechanism stabilizing fiscal policy. Unfortunately, it still allows fiscal authorities to make some discretionary decisions within the limits of a restricted framework. For details, see reports of the Swedish Fiscal Policy Council, 2018 and the Swedish Ministry of Finance, 2018.

opposite happens when the economy is in a boom phase: k is lower than one as the economy is above its trend and the rule requires a (cyclical) surplus.

The expenditure limit $\bar{G}$ is based on expectations, which do not necessarily coincide with their realizations. The discrepancies may come from forecasts errors, as it may be so that $E_{t-1}[R_t] \neq R_t$ or $E_{t-1}[k_t] \neq k_t$, or because initially authorized expenditure may differ from actual spending. In the simulation we abstract from differences between authorized and actual expenditure so the only source of discrepancies are forecast errors. The difference between the expenditure limit and the revised realization of expenditure ceiling $\bar{G}_t - \bar{G}_t^R$ is credited in the compensation account CA in line with the equation:

$$CA_t = CA_{t-1} + (\bar{G}_t - \bar{G}_t^R),$$

where $\bar{G}_t^R$ is a revised expenditure ceiling, i.e. the expenditure limit calculated with realizations of variables Y and R instead of their expectations ($\bar{G}_t^R = k_t \cdot R_t$ with $k_t = Y_t^*/Y_t$).

If the cumulated deficit in the correction account is higher than 6% of the expenditure (i.e. $CA_t/G_t > 0.06$) then the excessive amount must be eliminated by decreasing expenditure limits within next 3 years. The corrective amount is defined as $c = max(0, \frac{CA_t}{G_t} - 0.06)$. The statement that a deficit in the correction account has to be eliminated within 3 years is not precise enough for the simulation algorithm so it is assumed that it is always eliminated in the next year after its occurrence by multiplying $\bar{G}_{t+1}$ with the term $c_{t+1} = (1 - c)$.

An innate feature of the Swiss fiscal rule is its method of trend calculation. The trend Y^* is calculated using a modified HP filter. The modification is presented originally in Bruchez, 2003 and it is explained in detail in Appendix A. The modified HP filter applies different weights for observations at the very end of the rolling window of observations used to calculate the trend. The reason for such a modification is the fact that the standard HP filter does not smooth enough observations at the end of sample. Pigoń and Ramsza, 2016 confirm that the application of this change may also increase the countercyclical properties of the rule. The rolling window consists of 24 GDP observations, which is, to the best of our knowledge, just a discretionary decision of Swiss authorities. The last observation in the rolling sample is a GDP prediction $E_t[Y_{t+1}]$.

The rule is praised (see eg. Beljean and Geier, 2013) for its transparency and simplicity. It is pointed out that it leads to surpluses and decreases in government expenditure, even in nominal terms. It is unknown though if this outcome is caused by the construction of the rule or by favorable conditions in which the Swiss economy is currently operating.

2.2 German rule

The German fiscal rule, often claimed to be inspired by the Swiss rule, bears the name of its Helvetic counterpart and is also called 'the (German) debt brake' or 'die (Deutsche) Schuldenbremse' in German. The rule is best documented by the official paper of Federal Ministry of Finance, Germany, 2015, which serves as a basic reference for the rule's mechanics. The German debt brake entered the German constitution in 2011 with the federal budget in 2016 being the first under the official scope of the rule. Budgets between 2011 and 2016 were subject to transitory constraints.

The rule states that the structural federal budget should be 'nearly' balanced as the maximum allowed structural deficit is set to be 0.35% of GDP. The rule is best specified by the following equation:

$$E_t[R_{t+1}] - \bar{G}_{t+1} = -0.0035 \cdot E_t[Y_{t+1}] + E_t[F_{t+1}] \\ + E_t[\epsilon_{t+1}] \cdot (E_t[Y_{t+1}] - E_t[Y^*_{t+1}]) - c_{t+1} \ ,$$

where $E_t[R_{t+1}] - \bar{G}_{t+1}$ is the maximum permissible projected deficit ($\bar{G}_{t+1}$ is the maximum allowed expenditure), $0.0035 \cdot E_t[Y_{t+1}]$ is the maximum allowed structural deficit equal to 0.35% of GDP, $E_t[F_{t+1}]$ is the balance of financial transactions (i.e. those transactions related to financial assets, e.g. privatization proceeds), $E_t[\epsilon_{t+1}] \cdot (E_t[Y_{t+1}] - E_t[Y^*_{t+1}])$ stands for the cyclical component of the budget balance and c_{t+1} is the correction coming from the stance of the correction account CA_t. The cyclical term is the multiplication of the output gap $E_t[Y_{t+1}] - E_t[Y^*_{t+1}]$, where $E_t[Y^*_{t+1}]$ is the expected potential output, with the semi-elasticity ϵ of federal budget balance with respect to the output gap. The semi-elasticity ϵ measures the impact of a change in economic activity on federal revenues and expenditures, which affect together the budget balance. The correction term c_{t+1} is connected with the compensation account CA_t, whose goal is to make sure the rule works not only with the projected but also with the actual (realized) budget. The state of the correction account is determined as follows:

$$CA_t = CA_{t-1} + (R_t - G_t) - (R_t - \bar{G}^R_t) \ ,$$

where $R_t - G_t$ is the actual deficit[2] and $R_t - \bar{G}^R_t$ is the revised borrowing limit. G_t is the actual expenditure, which is equal in our simulation to $\bar{G}_t$ as there are no unplanned expenditures and all planned ones are undertaken, and $\bar{G}^R_t$ is the maximum allowed expenditure revised with respect to the cyclical component CC^R. The revision means that instead of just output gap projections also the actual realizations of variables are used in the following way:

$$CC^R_t = E_{t-1}[\epsilon_t] \cdot \Big(Y_t - E_{t-1}[Y^*_t]\Big)$$

The rest of the equation for revised expenditure limit is the same as for the expenditure limit before revision, which means that the revision takes into account only an adjustment of cyclical factors. If the accumulated deficits in the correction account are larger than 1% of GDP (i.e. $CA_t < -0.01 \ Y_t$) then the excessive deficit must lower the maximum allowed expenditure as a correction term. The correction cannot be larger than 0.35% of GDP though. Finally, a correction is applied only if the economy is in an upturn. It all means that:

$$c_{t+1} = \max\{CA_t + 0.01 \cdot Y_t \ , \ -0.0035 \cdot Y_t\}$$

if

$$CA_t < -0.01 \cdot Y_t \quad \text{and} \quad E_t[Y_{t+1}] > E_t[Y^*_{t+1}]$$

and 0 otherwise.

The framework of the rule does not provide any special treatment of one-off extraordinary revenues (e.g. auctions of TV frequencies), contrary to the Polish mechanism. The existence of any funds being outside of the scope of the rule's limits is not allowed. The rule pertains also to state ('Bundesländer') budgets with

[2]When $R - G$ is positive it is in fact a surplus.

a difference that their budgets must be structurally fully balanced. The law regarding states starts to be binding in 2020.

The rule involves the necessity of calculating the cyclical component of the government budget. It is stipulated in the law that the method that must be applied in the calculation of this component is the European Commission's production function approach used together with semi-elasticities of the budget balance with respect to the output gap. A detailed exposition of the production function method is presented in the paper by European Commission, 2014b, while the way of obtaining semi-elasticities is given in European Commission, 2014a. In order to get the potential output Y^*, which is needed to calculate the output gap, the Cobb-Douglas production function must be applied with the use of potential values of capital, labor, TFP and capital/labor weights. The projections, made by German fiscal authorities together with calculations of the budget balance semi-elasticities, are subject to many arbitrary decisions and, potentially, give enough degrees of freedom to manipulate effectively the fiscal policy. Being unable to credibly project the potential output using the EU Commission approach, we have decided to apply the modified HP filter, used in the same way as in the Swiss fiscal rule, to calculate the trend output, as a measure for the potential output. This approach makes it possible to focus rather on the comparison of various aspects of fiscal rules than on various trend/potential output calculation methods. The sum of semi-elasticities of the federal budget applied in the rule is equal to 0.205, which is a value obtained empirically by the German Ministry of Finance in 2015.

The German fiscal rule has been criticized in Truger and Will, 2012. The main reason for their critique is the use of the European Commission production function trend calculation method, which is made even more opaque by the allowance in German law to apply any modifications that are 'justified by the newest state of knowledge'. Truger and Will, 2012 point out that the German rule, also through channels other than the trend calculation, is prone to various interpretations and manipulations. Other problems envisaged by these authors are the arbitrariness of the 0.35% structural deficit limit, tendency for procyclicality and high conservativeness of the rule, which are all problems of more subjective nature. It is worth noting that the German fiscal policy after 2011 is even more conservative than it would be when sticking precisely to the rule. Paetz, Rietzler, and Truger, 2016 claim that it is so because of very favorable conditions for the German economy and the fact that the rule itself is procyclical: in good times the rule is not that strict but had the environment been worse the rule would have been binding as the economic conditions would worsen more than the expenditure limit would increase.

2.3 Polish rule

'The stabilizing expenditure rule' in Poland ('stabilizująca reguła wydatkowa' in Polish) is described in Korniluk, 2016. It was added to the Polish legal system in 2013 and the first national budget calculated with its spending limit was in 2015.

The principle of the rule is to let government expenditure grow not faster than the rate of the medium-term real GDP growth. The rule is summarized by the following equation:

$$\bar{G}_{t+1} = G_t \cdot E_t[\Pi^*_{t+1}] \cdot (y^*_{t+1} + c_{t+1}) + E_t[\Delta\ dR_{t+1}],$$

where $\bar{G}$ is the maximum allowed expenditure limit for next period, G is the government expenditure in a given period, $E[\Pi^*]$ is the central bank inflation target, y^* is a medium-term real GDP growth, c is the correction term explained below and $E[\Delta\ dR]$ is a change in 'large discretionary revenue'.[3] The medium-term real GDP growth y^*, which is a geometric mean over 8 years, is given by the following formula:[4]

$$y^*_{t+1} = \Big(\frac{E_t(Y_{t+1})}{Y_{t-7}}\Big)^{\frac{1}{8}}.$$

The Polish rule uses the correction account CA to store deviations of deficits $R-G$, relative to GDP, from the medium-term objective that is set to -1% of GDP:[5]

$$CA_t = CA_{t-1} + \frac{R_t - G_t}{Y_t} + 0.01.$$

Finally, corrections c are given as follows:

- if $\frac{R_t-G_t}{Y_t} < -0.03$ or $\frac{D_t}{Y_t} < -0.55$ then $c_{t+1} = -0.02$;
- if $\frac{R_t-G_t}{Y_t} \geqslant -0.03$ and $-0.55 \leqslant \frac{D_t}{Y_t} < -0.50$ and $E_t[\frac{Y_{t+1}}{Y_t}] \geqslant y^*_{t+1} - 0.02$ then $c_{t+1} = -0.015$;
- if $\frac{R_t-G_t}{Y_t} \geqslant -0.03$ and $\frac{D_t}{Y_t} \geqslant -0.50$ and $CA_t < -0.06$ and $E_t[\frac{Y_{t+1}}{Y_t}] \geqslant y^*_{t+1} - 0.02$ then $c_{t+1} = -0.015$;
- if $\frac{R_t-G_t}{Y_t} \geqslant -0.03$ and $\frac{D_t}{Y_t} \geqslant -0.50$ and $CA_t > 0.06$ and $E_t[\frac{Y_{t+1}}{Y_t}] \leqslant y^*_{t+1} + 0.02$ then $c_{t+1} = 0.015$;
- otherwise, $c_{t+1} = 0$.

The rule does not contain unobservable terms like structural/cyclical balances or trends, whose calculation method can be disputable or opaque. Nonetheless, it is far from being transparent because of the complicated correction mechanism. This mechanism serves the purpose to decrease the growth of expenditure (corrections -2pp and -1.5pp) when the government is heavily indebted, it just ran a high deficit, GDP growth is high or the control account accumulated substantial deficits. In an opposite situation, when the economic growth is low, deficits and debt are low enough and the control account accumulated surpluses, public expenditure is allowed to grow faster than the medium-term economic growth rate as a positive correction applies ($+1.5$pp).

It is worth noting that in the initial formula of the Polish expenditure rule there appeared a projection of CPI dynamics, which was replaced by the central bank (National Bank of Poland - NBP) inflation target in 2015. The NBP inflation target was higher than the actual inflation, which allowed larger expenditure. Clearly, such a change does not instill confidence in the rule, particularly in view of the fact that it is not a part of the constitution but it can be changed as an ordinary law. Additional changes in the rule framework were an

[3] Both $E[\Pi^*]$ and y^* are expressed as factors, not rates.

[4] Empirical research indicates that business cycles in Poland, similarly to other developed countries, have a maximum length of 8 years, for details see Korniluk, 2016. The formula is equivalent to $y^*_{t+1} = \big(\frac{Y_{t-6}}{Y_{t-7}} \cdot \frac{Y_{t-5}}{Y_{t-6}} \cdot \ldots \cdot \frac{E_t[Y_{t+1}]}{Y_t}\big)^{\frac{1}{8}}$.

[5] Recall that a positive deficit $R-G$ is in fact a surplus. The same applies to the debt: a positive value of D means an accumulation of assets.

inclusion of discretionary revenues in the expenditure limit and a change of debt thresholds in the correction definitions from 55% of GDP and 50% of GDP to 48% and 43%, respectively. The last change was implied by a pension system reform and redemption of some pension bonds. In our simulation we use the 'old' debt levels i.e. 50% and 55%.

The results of a simulation in Korniluk, 2016 indicate that the Polish fiscal rule should lead to debt levels around 20% of GDP. Nonetheless, the rule does not imply an anticyclical fiscal policy because the output gap and cyclically adjusted budget balances are not correlated, which suggests acyclicality.

2.4 Balanced budget rule

We define the balanced budget rule in this paper so that government expenditure equals realized government revenue:

$$\bar{G}_{t+1} = R_{t+1}.$$

To the best of our knowledge such a rule is not operational in any developed country at the national level. It is popular though at the US state or Swiss cantonal level. Nevertheless, it must be pointed out that these rules vary considerably as they deal differently with deficits realized ex post. This is so because the balanced-budget rule should be rather written as $\bar{G}_{t+1} = E_t[R_{t+1}]$ with a precise instruction on what to do in case of deviations from the expected values. In order to avoid making fully discretionary decisions on the rule mechanics we have decided to apply its most stringent form: the government cannot run any deficits at all and must equate its spending to its realized revenue all the time.

Although the rule is extremely transparent and simple conceptually because there is no need to calculate unobservable structural or cyclical components, its limited popularity can be traced back to its procyclicality. This rule is treated then in this research as a benchmark. We expect it to be the most procyclical rule among the analyzed rules. Empirical analysis of US state rules (Alesina and Bayoumi, 1996) and Swiss cantonal rules (Luechinger and Schaltegger, 2013) show that variations of balanced budget rules lower deficits and can lead to more accurate revenue projections. Moreover, Alesina and Bayoumi, 1996 show that balanced budgets do not necessarily increase output volatility, yet this claim may be invalid in view of the fact that state governments in the US have little impact on output stability in comparison with the federal government.

3 Simulation methodology

The main component of the simulation framework is a reduced-form VAR(2) model that is explained in detail in Section 4. The econometric model is used on US data from the years 1960 to 2015 and contains the following endogenous variables: output Y, public revenue R and public expenditure G, as well as an exogenous variable '$crisis$', which indicates an occurrence of recessions.

The strategy applied in our simulation is to use the VAR parameter estimates $\hat{\beta}$, based on the empirical data, to compute three endogenous variables Y_{t+1}, G_{t+1} and R_{t+1}, knowing their initial values in periods t and $t-1$, realizations of stochastic shocks e_{t+1} and a value of the exogenous stochastic variable $crisis_{t+1}$.

Then, the value of VAR-generated expenditures in period $t+1$ (i.e. G_{t+1}) is substituted with the value $\bar{G}_{t+1}$, obtained with a given fiscal rule, so that $\bar{G}_{t+1}$ forms the history of expenditures G in the following periods. Fiscal rule expenditure limits, as depicted in Section 2, are functions of past, current and expected future variables:

$$\bar{G}_{t+1} = f(E_t[Y_{t+1}], E_t[R_{t+1}], Y_t, R_t, G_t, Y_{t-1}, R_{t-1}, G_{t-1}, ...),$$

which makes their computation feasible. After the substitution of VAR-generated expenditures G_{t+1} with the rule-generated ones $\bar{G}_{t+1}$, expectations $E_t[Y_{t+1}]$ and $E_t[R_{t+1}]$ are confronted with their realizations Y_{t+1} and R_{t+1} so that correction accounts can be adjusted, in line with the rules' formulations. Finally, we move to a next step of the simulation, in which the new current state variables are output, revenues and expenditures obtained in the previous step using the VAR relationship supplemented with the expenditure policy implied by a fiscal rule.

The simulation approach relies on a series of assumptions, which are summarized and explained below:

- Expenditure limits are binding, i.e. politicians are willing to spend as much as possible and they exploit all the space given by the rules. The purpose of this assumption is that we want to assess the properties of the fiscal policy implied by the rules, i.e. when they are binding.
- Fiscal rules encompass all the public expenditure without any exceptions for any special funds or expenditure types.
- All planned expenditures are incurred and there are no unplanned expenditures. There are no irregular one-off revenues and there are no financial transactions (e.g. privatization), which reduces respective terms in the Polish and German rules: $\forall t \; E_t[F_{t+1}] = 0$ and $\forall t \; E_t[\Delta \; dR_{t+1}] = 0$.
- Revenues are 'exogenous' from politicians' perspective so that all adjustments required to respect rule's limits are made through changing expenditures.
- There is no inflation, which means that nominal variables are equal to real variables. The inflation term in the Polish rule is always equal to one: $\forall t \; E_t[\Pi^*_{t+1}] = 1$.
- The simulation abstracts from default risk and interest payments. The latter assumption, although seemingly strict, is, in fact, fully warranted by the construction of the rules, which specify the maximum allowed *total*, not *primary*, deficits. As government expenditure is equal to primary expenditures plus interest payments, $G = GP + i \cdot D$, an increase in the interest rate i, for a given maximum spending limit G, must lead to lower primary expenditures GP and does not affect total deficit $R-G$ nor debt level D. It is beyond the scope of this text to assess which fraction of the interest payments in total government spending is beyond social acceptance. Furthermore, we assume that the debt level is neutral for output growth. Debt accumulation is defined as $D_t = D_{t-1} + (R_t - G_t)$.
- Computation of expenditure limits for all rules, but the balanced-budget one, involves projecting revenues and output one period (year) ahead. In all places where such a forecast is required the following procedure is used. Firstly, logs of a time series are calculated. The resulting time series is fed into the function that automatically identifies and estimates the best ARIMA model. The function uses a stepwise method based on Akaike information criterion.[6] The length of a time series that is used to make a forecast is equal to 24 for all rules, which coincides with the length of the HP-filter window

[6] http://reference.wolfram.com/language/ref/TimeSeriesModelFit.html

in the Swiss rule. Based on the identified and estimated model a point forecast is created.[7] We apply ARIMA forecast functions because these models have parsimonious specifications and it can be shown (see Favero and Marcellino, 2005) that ARIMA fiscal forecasts perform very well.

- It is important to note that all fiscal rules use projections $E_t[x_{t+1}]$ but also $E_t[x_t]$. This is so because the process of planning a budget for period $t+1$ starts well in the middle of period t so variable x_t is not yet fully realized. In the simulations, variables x_t are assumed to be already known in period t or, equivalently, to be perfectly forecasted. This last assumption seems to be rather innocuous considering the fact that projections of annual GDP or revenues are accurate when the government has partial data from the first or first two quarters of a given year.

- At the time of the introduction of the rules, countries start without any deficits and surpluses on their correction accounts CA. This assumption is realistic because all three rules started with a neutral 'record' when they were introduced.

- The German rule uses the modified HP filter (identical to the one used in the Swiss rule) to calculate the trend/potential output. This modification is due to the arbitrariness and complexity of the production function method specified in the actual German rule. The modified HP filter is described in detail in Appendix A. Moreover, budget semi-elasticity $E_t[\epsilon_{t+1}]$ used in the rule is equal to 0.5 instead of 0.205, which is a value of this variable for the US economy (see OECD, 2015).

- Values of output Y_{t+1}, expenditures G_{t+1} and revenues R_{t+1} are computed using a reduced-form VAR and previous values of Y, G and R, without imposing any structural identification. A substitution of VAR-generated expenditures G_{t+1} with the ones specified by fiscal rule limits (i.e. $\bar{G}_{t+1}$) does not affect VAR-generated contemporaneous output Y_{t+1} nor revenues R_{t+1}.

- In every simulated path for every rule an independent path of exogenous crisis shocks is generated. The binary variable 'crisis' is created using a Markov chain, whose characteristics were calibrated to mimic the actual path of crises in the years 1960-2015 in the US.

- The only source of randomness in the simulations are the VAR error terms and a stochastic occurrence of exogenous economic crises. They are the reason why realizations of output Y_{t+1} and revenues R_{t+1} may differ from their expectations $E_t[Y_{t+1}]$ and $E_t[R_{t+1}]$. Expenditure limits $\bar{G}_{t+1}$, once they are evaluated using a given rule, do not contain any stochastic components.

The simulation uses the VAR model to mimic the economic relationships between output, government revenues and government expenditures in a realistic way. Moreover, the simulation includes an exogenous variable, which describes the impact of economic crises on endogenous variables. The use of this variable lets the VAR model better fit the data and better map the nature of a business cycle impact on budget balances. Binary variables for 'crises' create deeper recessions than just VAR error terms alone as they would average all recessions and would not put enough strain on budget balances. Therefore, the approach we have used makes measuring how fiscal rules react in difficult times more credible.

The framework adopted in this research is subject to the Lucas critique as it imposes new policies on economic relationships estimated on past behavior. It implies that we cannot answer the question 'what would have happened with the US debt and deficits had the American government adopted one of the fiscal

[7] http://reference.wolfram.com/language/ref/TimeSeriesForecast.html

rules at hand?'. In order to answer this question we would have to assume that we hold the behavior of households constant against different government policies, which is an assumption that we do not want to maintain. Alternatively, assuming that the Ricardian equivalence holds would imply that interdependencies between output, government expenditure, government revenues and private consumption stay relatively constant as government expenditures and private consumption are perfect (or, at least, close) substitutes. Leaving aside the empirical validity of the Ricardian equivalence, under such an assumption it would not make sense to assess anticyclicality and volatility of fiscal policy as private consumption would adjust to substitute government expenditures.

Instead, we build a framework that makes it possible to assess the mechanics of some fiscal rules by applying them to realistic, although artificial, economic relationships. Our model credibly mimics the behavior of business cycles, especially with respect to the strain that is put by a recession on the government budget. Most importantly, all rules are compared within a necessarily simplified but an identical framework that allows an impartial comparison of all the rules. Moreover, the use of 'neutral' US data, putting aside the issue of its good quality and availability, reduces the argument that some of the rules may react differently to the data produced by their 'own' economy because of the fact they were calibrated to its specific features.

Such a framework allows us to analyze rules' fundamental characteristics and to draw conclusions about properties of fiscal policies implied by the rules at hand. Finally, we can order the rules with respect to their conservatism, volatility or procyclicality, which can serve as a valuable policy advice.

4 VAR model used for simulations and the data

The basic step of the simulation is based on a reduced-form VAR(2) model. The model takes a standard form:

$$V_t = \beta_0 + \beta_1 \cdot V_{t-1} + \beta_2 \cdot V_{t-1} + \beta_3 \cdot X_t + e_t \ ,$$

where V_t is a vector of endogenous variables, X_t is a vector of exogenous variables, e_t is the vector of error terms and β_0 is a vector of constants. Vector V_t consists of logs of real total output, revenues and expenditures, $V_t = [\ln(Y_t), \ln(R_t), \ln(G_t)]'$. In addition to the endogenous variables, one exogenous variable is used. The exogenous variable is a binary indicator that encodes information about economic crises occurring in a given year, $X_t = [crisis_t]'$.

The endogenous variables are US, annual, real (measured in 2009 US dollars) output, federal revenues and federal expenditures between 1960 and 2015. The source of data is Federal Reserve Bank of St.Louis (FRED). The exogenous variable is a binary indicator for years in which there was an economic recession recorded by NBER, whose origins were deemed to be exogenous to the American fiscal policy. The variable 'crisis' encompasses the economic recessions relate to the 1st and 2nd Oil Crisis, 1st Gulf War, September 11th attack and the Great Recession. It implies values of one for the following years in the data sample: $\{1974, 1975, 1982, 1991, 2001, 2008, 2009\}$.

Based on the mentioned variables a number of lags was selected using information criteria. A lack of any theoretical considerations implying a given number of lags for models using annual data a parsimonious two-lag specification was chosen. The model was then estimated equation by equation with the OLS method (equivalent to conditional maximum likelihood estimation). The estimated model has been put through standard diagnostics including tests for normality, serial correlation etc. The only problematic part is related to the possible heteroskedasticity. Since it does not seem to be severe and the model is estimated using OLS technique, which is robust to heteroscedasticity in view of the model application, the estimated values of parameters are used in further simulations. Details of the VAR model results and its diagnostics are presented in Appendix B.

Figure 1 depicts impulse response function graphs. The IRFs are calculated after imposing structural form restrictions on the VAR model.[8] These are in the form of a Cholesky identification with the following assumptions on contemporaneous interdependencies:

- Expenditures are not affected contemporaneously by GDP nor revenues.
- GDP is affected by expenditures but not by revenues.
- Revenues are affected by both GDP and expenditures.

The structural identification is similar in spirit to Blanchard and Perotti, 2002 by using the institutional framework of fiscal policy to form the restrictions. It is assumed that expenditures are decided before a given fiscal year and, therefore, they are not affected contemporaneously by other variables. They can affect though the level of economic activity and, then, government revenues. Moreover, it is assumed that the level of economic activity affects tax revenues immediately but there is no reverse effect. This is a discretionary, but necessary, assumption that is needed to achieve identification. The structural identification is identical as in Landon and Smith, 2017.

The obtained IRF results indicate insignificant responses of GDP to shocks in expenditures and revenues, which is in line with Landon and Smith, 2017, Burriel et al., 2009 or other authors. This may be resulting from the fact that impulse responses of GDP are deemed to be short-lasting with their positive effects up to 3-5 quarters, which may be hardly visible in annual data.

Exogenous paths of crises are generated to mimic empirical data. The maximum-likelihood estimation with binary variables in years $\{1974, 1975, 1982, 1991, 2001, 2008, 2009\}$ over the whole sample 1960-2015 leads to a Markov chain with the following transition probabilities between crisis (c) and non-crisis (nc) states:

$$\begin{bmatrix} P(nc|nc) & P(c|nc) \\ P(nc|c) & P(c|c) \end{bmatrix} = \begin{bmatrix} 0.896 & 0.104 \\ 0.714 & 0.286 \end{bmatrix}.$$

For every simulation a crisis path is generated independently using the described probability matrix. On average, a crisis occurs every 8.6 years.

[8] The nature of structural form restrictions does not affect simulation results. The IRFs help to understand general properties of the VAR model though.

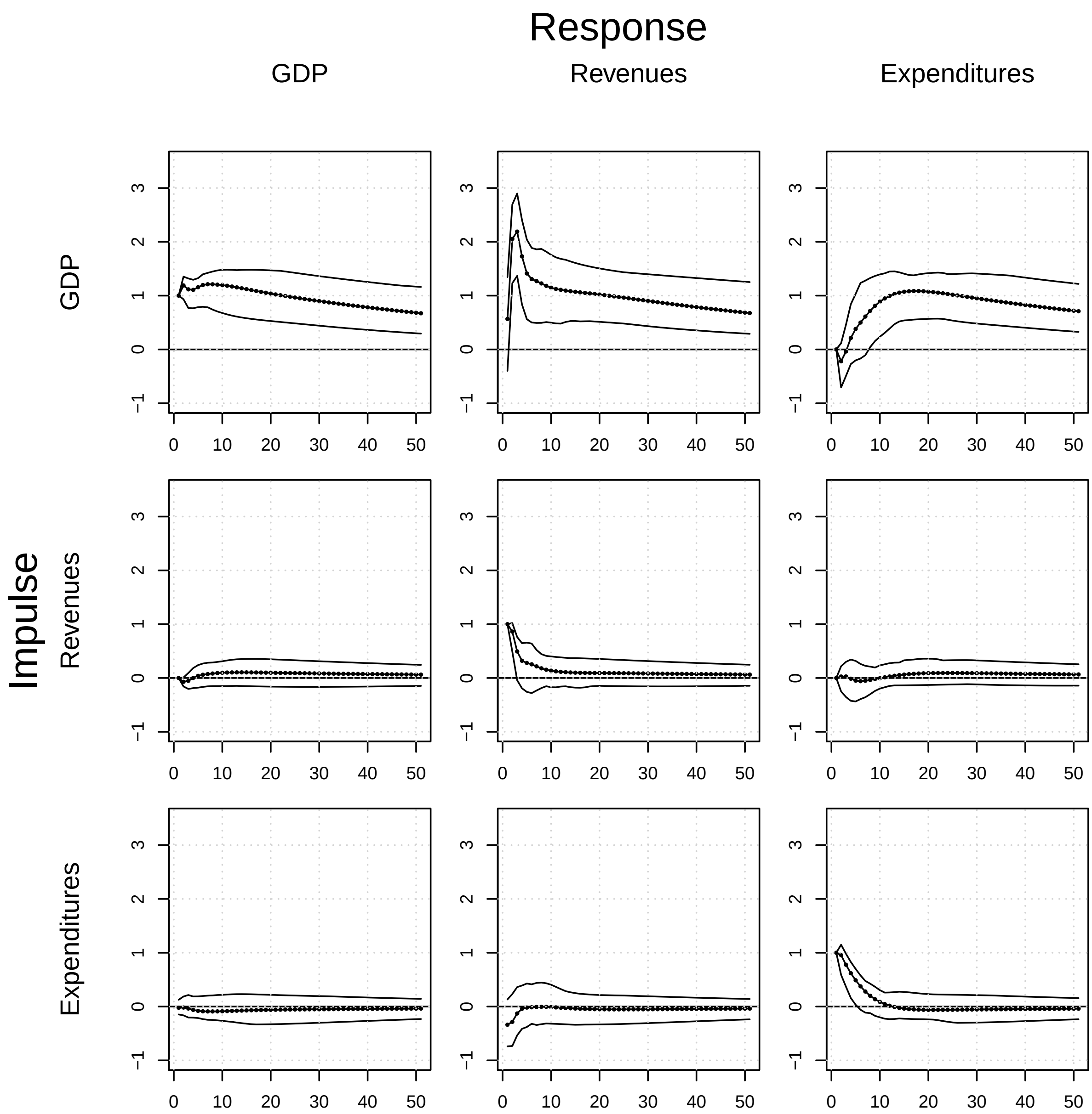


Figure 1. Impulse response functions for a unitary shock in GDP, revenues and expenditures. Confidence intervals are the 5th and 95th percentiles.

5 Results

The simulation serves the purpose to analyze the trajectory of debt and deficit levels implied by the rules and to measure their potential for expenditure stabilization. Moreover, the procyclicality of the induced fiscal policy is assessed.

Each simulation starts with the empirical US values from the years 1960 and 1961 for all endogenous variables and, then, the VAR model without any fiscal rule is run for 50 periods. After 50 periods the fiscal rules are applied and the simulation is run for another 150 periods. The results of these 150 periods are reported in this section. We run 1000 simulations for each rule.

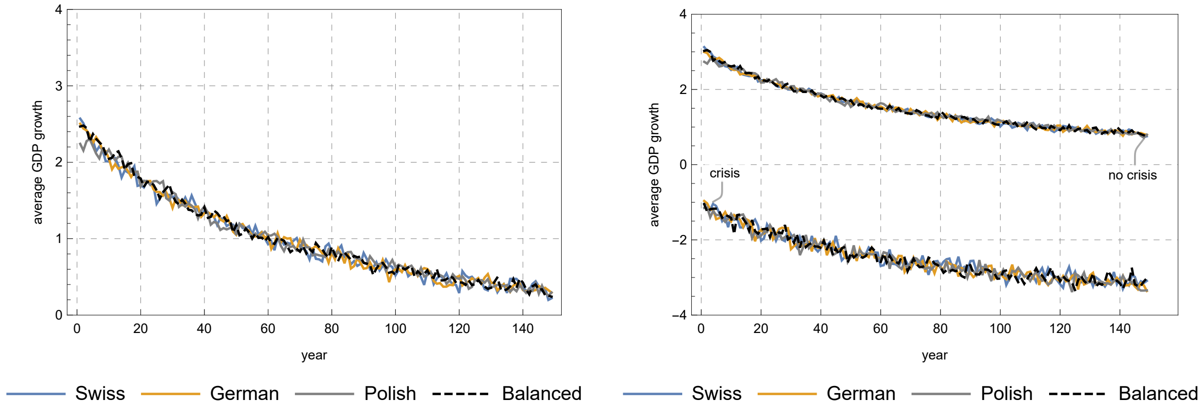
The initial debt level for all rules is set to 0% and 50% of GDP because the Polish rule has a built-in mechanism trying to prevent debt accumulation over 50% and 55% of GDP. An inclusion of 2 starting debt levels serves the purpose to asses if the rule is effective in attaining its goal. Other rules are expected to behave identically in both scenarios as their formulas do not depend on debt levels. In order to conserve space only some of the results with 50% of the initial debt to GDP ratio are shown.

A general result of the simulations, coming directly from the construction of the VAR model, is that the rules do not differ with respect to the output stabilization as the fiscal policy affects the output in a very limited way. It is shown by the size of the output gap, defined as $(Y - Y^*)/Y$, whose values, averaged over all 1000 simulations for each of the rules, are around 0 and differ between the rules by the order of magnitude of tenths of a basis point of GDP.[9] The same applies to average minimum and maximum output gaps, whose values are around -5% and 5% of GDP, respectively.

Finally, the simulations indicate a gradual drop of average GDP growth rates from slightly above 2.5% in the first period to slightly less than 0.5% in the last period of the simulation, see Figure 2a. The depicted paths, suggesting a long-lasting slowdown of economic growth, reflect the idea of secular stagnation.[10] Decreasing growth rates affect debt accumulation processes, particularly the debt to GDP ratios, and put additional pressure on the rules. Figure 2b shows average growth rates in periods in which a crisis occurs and in which there is no crisis. Both graphs indicate no differences between the four assessed rules.

[9] Y^* is the potential output calculated independently for every simulation as a HP trend of the whole 150-year series of GDP.

[10] For a discussion on the secular stagnation see e.g. Gordon, 2015 or Summers, 2015.



(a) Average overall growth rates

(b) Average growth rates for crisis and non-crisis periods

Figure 2. Average growth rates for 0% of initial debt level. Values are averaged across all 1000 simulations of a given rule at given points in time. Note that Figures (a) and (b) have different scales on the vertical axes.

5.1 Stabilization of deficits, expenditures and debt

Figure 3 shows average deficit paths for the Swiss, German and Polish rules.[11] The Swiss and German rules are not affected by the initial debt levels by construction so their results are not reported twice. The average behavior of deficits induced by the Swiss and German 'debt brakes' is stable in the whole simulation period. On the other hand, the trajectory of the Polish rule depends on the debt starting point, which is visible in the graph. A large debt ratio induces more frugal fiscal policy till debt-stabilizing deficit ratios are attained. When the debt levels are below the limit of 50% of GDP and excessive deficits of more than 1% of GDP are not pervasive anymore, the correction account starts to de-accumulate, which leads to larger deficits again.

The incidence of deficit to GDP ratios is summarized in Figure 4, showing the different behavior of the Polish rule across periods. The Swiss rule leads to deficits that are heavily and nearly symmetrically concentrated around zero, while the German rule allows for slightly higher deficits. For the Helvetic rule, deficits and surpluses are almost exclusively between +/- 3% of GDP and its German counterpart allows for bounds larger by around 1 pp. Deficits governed by the Polish rule are centered around their desired level at -1% of GDP in the first 100 periods. Later on, the budgets remain balanced on average. The dispersion of deficits induced by the Polish rule is much more pronounced as they vary between about +/- 6% of GDP.

[11]Median paths would look extremely similar, which applies to all figures presented in the text.

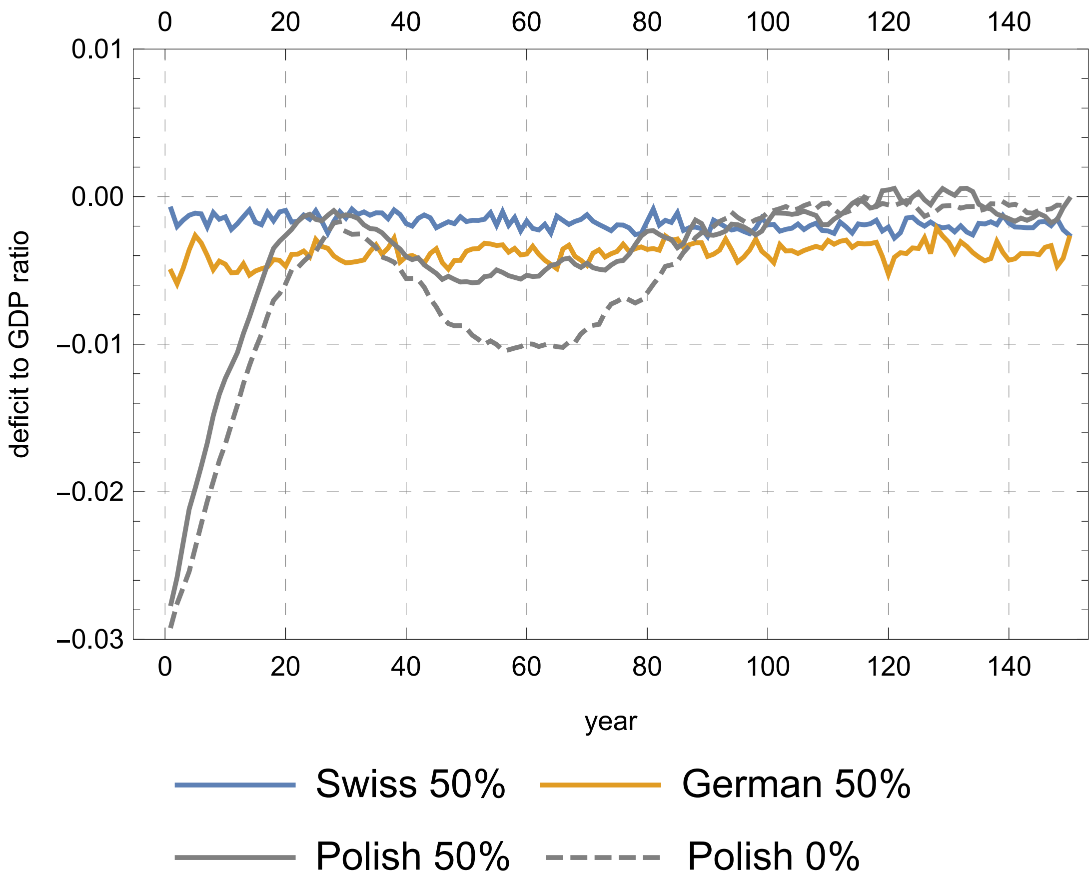
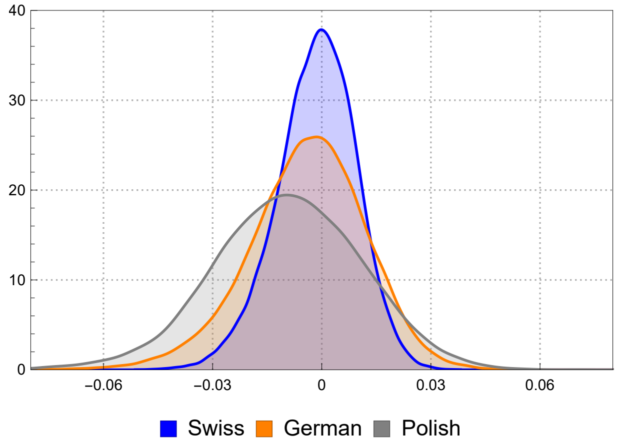
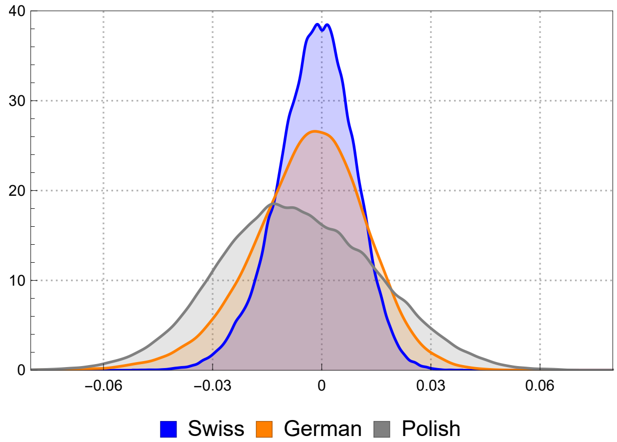


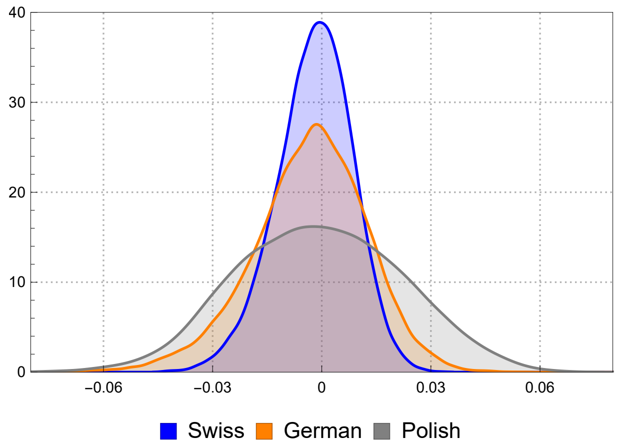
Figure 3. Paths of average deficits for given rules at a given point in time. Values are averaged over all 1000 simulations.



(a) Deficit densities in years 1-50



(b) Deficit densities in years 51-100



(c) Deficit densities in years 101-150

Figure 4. Estimated kernel density functions for all deficit to GDP ratios (computed across 1000 simulated scenarios in a given time period) with 0% of initial debt.

Table 1 sums up basic statistics on deficit and expenditure ratios, measured for each 150-period simulated path and, then, averaged across different simulation scenarios. The average deficit to GDP ratios for the Polish, Swiss and German rule are 0.56%, 0.18% and 0.37%, respectively. These results suggest that only the German rule implies deficits that are of the intended size, which is equal to 0.35% of GDP. The Polish rule implies deficits smaller than planned 1%, while the Swiss ones, although being close to zero, are still not balanced on average. Standard deviations and ranges confirm that the Polish rule is most volatile when it comes to both deficits and expenditures.

Table 1. Descriptive statistics of deficit to GDP ratios and expenditures to GDP ratios 'within' simulated paths for 0% of initial debt.

Deficit to GDP ratios

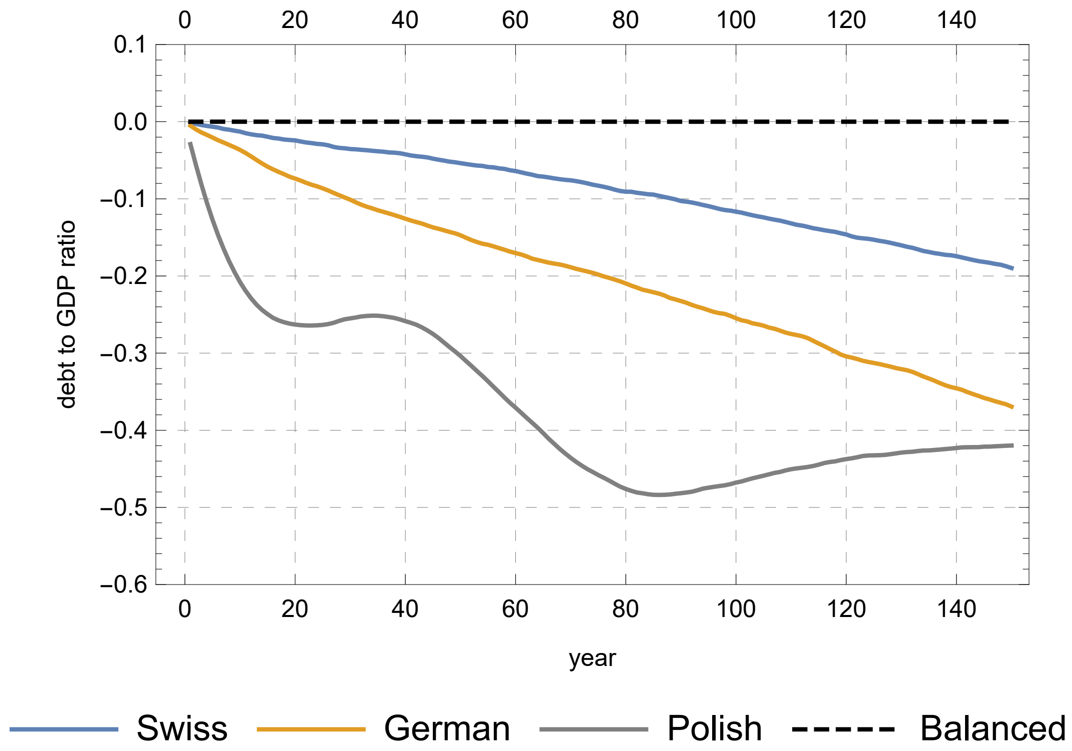
Statistics	Balanced	Polish	Swiss	German
min	$0.$	-0.0596	-0.0335	-0.0541
max	$0.$	0.0453	0.0241	0.0350
mean	$0.$	-0.0056	-0.0018	-0.0037
std. dev.	$0.$	0.021	0.011	0.012
range	$0.$	0.105	0.058	0.089
autocorr(1)	1	0.878	0.163	0.430

Expenditure to GDP ratios

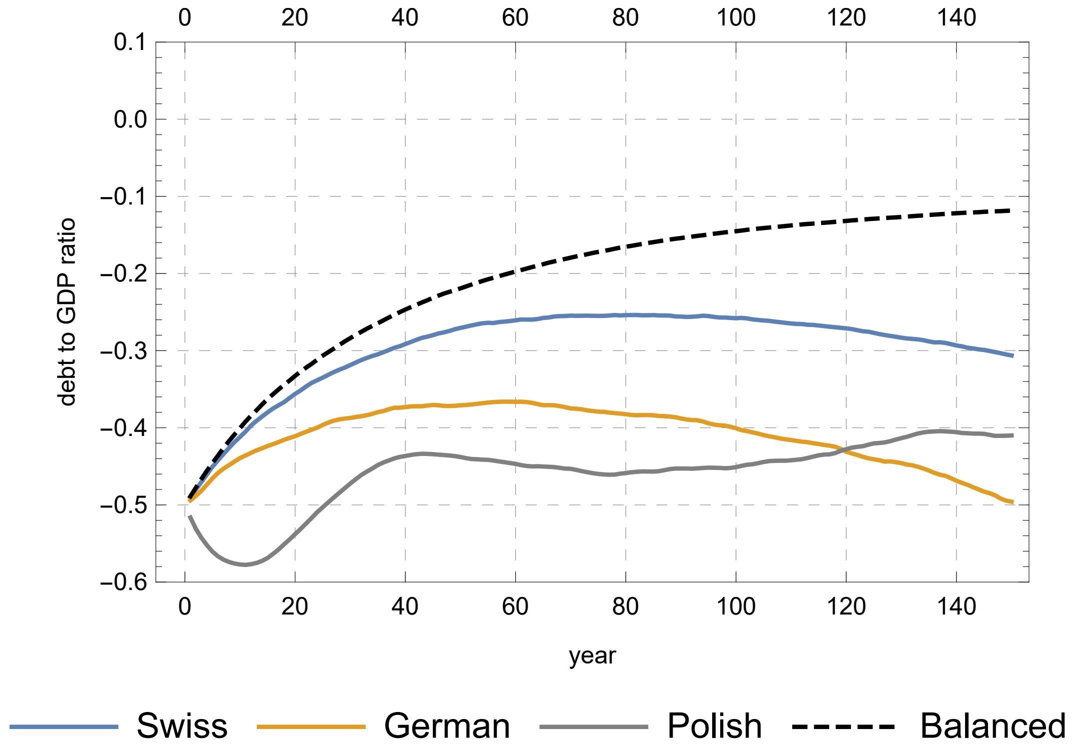
Statistics	Balanced	Polish	Swiss	German
min	0.127	0.121	0.122	0.127
max	0.197	0.216	0.216	0.197
mean	0.162	0.168	0.166	0.162
std.dev.	0.014	0.022	0.018	0.014
range	0.070	0.095	0.093	0.070
autocorr(1)	0.805	0.961	0.690	0.805

The Polish rule offers the highest degree of stabilizing expenditures period to period, which is proved by the value of expenditure autocorrelation measure. The Swiss and the German rules stabilize deficits at the cost of curbing expenditures, which have to vary significantly between years. In case of the Polish rule it is the stabilization of expenditures, which are very persistent year to year, that leads to deficits that are volatile in the long-run, i.e. over the whole 150-period simulation. High persistence of expenditure ratios induced by the Polish rule leads to longer adjustment phases and their large long-run variation, measured by their range or standard deviation.

The reason behind this can be, for example, an introduction of the rule in a long-lasting good phase of the business cycle, which lets expenditure ratios grow to large levels, while their decrease caused by worse economic conditions is slow. Figure 3 shows that it takes the Polish rule even 20 years before the large expenditures, created by the more profligate non-rule VAR model, are lowered enough to match revenues. Swiss and German rules sharply decrease expenditures in such circumstances even by a couple of GDP pp within one period. This implies however that, in practice, the Polish rule can be implemented without any pre-introduction transitory periods, while the other rules may necessitate some fiscal policy adjustments till they can fully shape deficits according to their tenets.

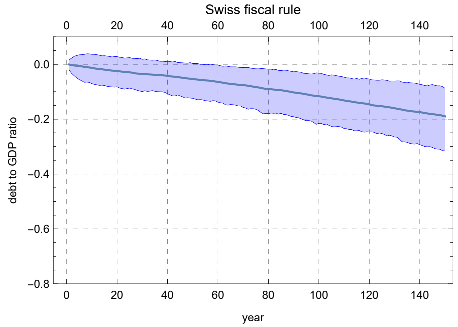


(a) Average debt accumulation, 0% initial debt

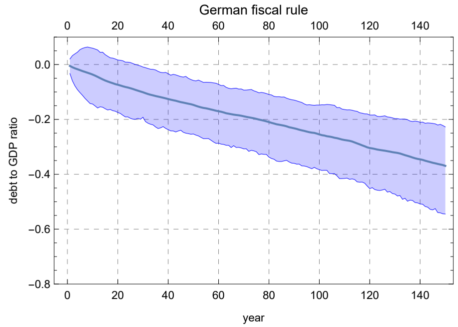


(b) Average debt accumulation, 50% initial debt

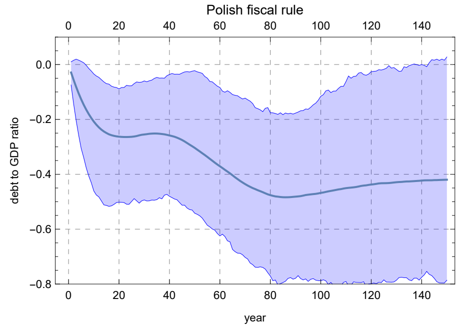
Figure 5. Average paths of debt accumulation for 0% and 50% of initial debt level. Values are averaged across all 1000 simulations of a given rule in a given point in time.



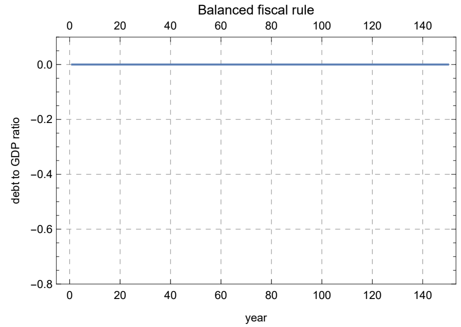
(a) Swiss rule, 0% initial debt



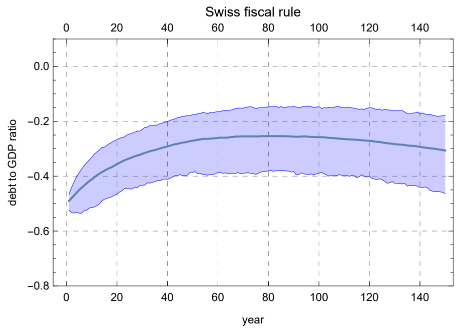
(b) German rule, 0% initial debt



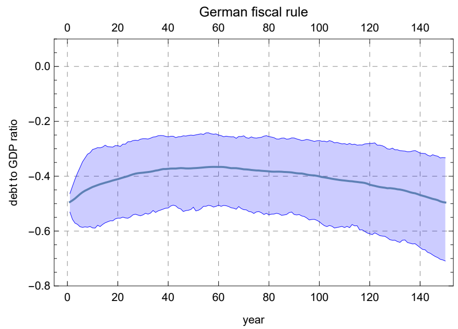
(c) Polish rule, 0% initial debt



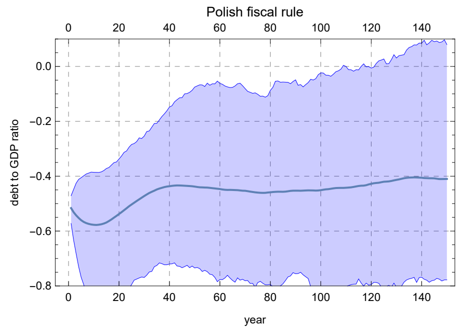
(d) Balanced rule, 0% initial debt



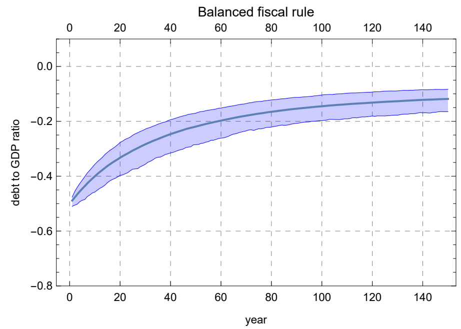
(e) Swiss rule, 50% initial debt



(f) German rule, 50% initial debt



(g) Polish rule, 50% initial debt



(h) Balanced rule, 50% initial debt

Figure 6. Debt accumulation paths for different rules and initial debt levels. Thick lines are average paths over all 1000 simulations in a given time point. Shaded area is the 90% interval between the 5^{th} and 95^{th} percentile values.

Figures 5a and 5b show that the Polish rule differs significantly from the rest when it comes to details of the debt accumulation process. The Swiss and German rules rely on a similar tenet, which is balancing the structural budget. It implies their qualitatively similar behavior that was already shown in case of the deficit behavior. Stable values of deficits lead to a steady debt accumulation in the long run, whose mechanism is explained precisely in the next paragraph. The German rule is less stringent than the Swiss one by construction, i.e. by allowing the structural deficit to be 0.35% of GDP, and it leads to a larger accumulation of debt in the long run. In case of the 50% initial debt, both rules mimic qualitatively the balanced budget rule in terms of the debt (de)accumulation and only the depressing growth rates of the economy prevent them from attaining non-explosive debt paths in the long run. A systematically different result is given by the Polish expenditure rule. The average debt accumulation path is more volatile and not strictly monotonic. Nevertheless, the rule prevents, on average, debt accumulation above 50%, which means that it attains its prescribed goal. Lastly, the Swiss and German rules offer similar, and rather limited, volatility in their debt to GDP paths, which is reflected by Figure 6. The Polish rule proves here to be much less reliable with this respect.

Debt levels converge to equilibria given by the formula $d^* = (r - g)/y$, where $d^* = (D/Y)^*$ is the equilibrium debt to GDP ratio, $r = R/Y$ and $g = G/Y$ are the expenditure and revenue to GDP ratios and y is the GDP growth rate.[12] Taking into account that deficit to GDP ratios $r - g$ implied by the rules oscillate around their long-term average values, at least for the Swiss and German rules, the equilibrium debt ratio d^* is a function of the GDP growth rates that differ across time: $d^*(y_t)$. Because of constantly decreasing GDP growth rates y_t, the long-run debt equilibria $d^*(y_t)$ implied by the Swiss and German fiscal rules also decrease, which is clearly visible in Figures 5a and 5b. It means that these two rules are not sufficient, despite being capable of stabilizing deficits at low levels, to prevent debt explosion in a strict sense.[13]

Expectations regarding the debt stabilisation features of the German and Swiss rules, listed in Truger and Will, 2012 and Beljean and Geier, 2013 respectively, are not based on theoretical nor empirical inference but rather on intuition. In our research we corroborate them formally and confirm that these rules are austere and do not allow for large debt accumulation, unless GDP growth rates decline to very low values. The results we obtain with respect to debt stabilisation properties of the Polish rule are only partially in line with the results of Korniluk, 2016, who projects the debt level to stabilise at around 20% of GDP in the long run. As explained in the previous paragraph, such results rely heavily on the GDP dynamics. In our model the Polish rule allows for larger, but seemingly still stable, debt levels.

5.2 Procyclicality measures

We measure procyclicality as in Alesina, Campante, and Tabellini, 2008 or Guerguil, Mandon, and Tapsoba, 2017. Specifically, we rely on the following regressions:

$$\Delta \frac{G_t}{Y_t} = \beta_0 + \beta_1 \cdot \Delta \frac{Y_t - Y_t^*}{Y_t} + \epsilon_t, \qquad \text{(P1)}$$

[12] It is a formula for an equilibrium of the debt accumulation difference equation $\Delta(D/Y) = R/Y - G/Y - y \cdot (D/Y)$. Interest rate i does not show up in the equation as interest payments are already included in expenditures G.

[13] One has to keep in mind though that this statement may not apply from a practical policy perspective, which is undoubtedly shorter than 150 annual periods.

$$\Delta \frac{R_t - G_t}{Y_t} = \beta_0 + \beta_1 \cdot \Delta \frac{Y_t - Y_t^*}{Y_t} + \epsilon_t, \tag{P2}$$

where G_t/Y_t is a ratio of expenditure to GDP, $(R_t - G_t)/Y_t$ is the deficit to GDP ratio and $(Y_t - Y_t^*)/Y_t$ is the output gap to GDP ratio. Δ indicates a year on year change in the given variables. The trend output Y_t^* is calculated using the standard HP filter on the whole 150-period time sample in which fiscal rules are active. The smoothing parameter is equal to $\lambda = 100$, which is used by, for example, Backhus and Kehoe, 1992. The parameter of interest in both regressions is β_1, which describes a reaction of government expenditure to GDP or deficit to GDP ratios with respect to changes in the output gap.

The above regressions, when used in an empirical setting, are expected to contain an endogenous variable, which is the output gap. The reason for this is the fact that there can be a reverse causality, caused by simultaneous interaction between fiscal policy and output. In order not to include the impact of fiscal multipliers on $\hat{\beta}_1$ instruments are used (e.g. lagged explanatory variables). The reduced-form VAR setting we have adopted precludes endogeneity by assuming no effect of fiscal policy on contemporaneous output. Therefore, no additional modifications are needed to estimate consistently the equations at hand using OLS. Results of the regressions are given in Table 2, which presents estimates of parameters β_1, their p-values and R^2 values for both regressions. All values were calculated as averages of 1000 coefficients, which were in turn calculated on each of the 150-period simulations. As differences between estimates from regressions starting with 0% and 50% of initial debt to GDP ratios are negligible only the former ones are presented.

Table 2. The average procyclicality metrics (0% initial debt).

Statistic	Balanced	Polish	Swiss	German
metric $P1$	0.015	-0.198	-0.302	-0.356
p-value	0.489	0.000	0.000	0.000
R^2	0.007	0.561	0.200	0.207

Statistic	Balanced	Polish	Swiss	German
metric $P2$	–	0.219	0.331	0.388
p-value	–	0.000	0.000	0.000
R^2	–	0.152	0.184	0.164

Table 2 indicates that all three analyzed rules are anticylical as intended, which is proven by negative and positive coefficients of metrics P1 and P2, respectively. The interpretation of the coefficients means that an increase in the output gap by 1 percentage point (i.e. a recovery by 1 pp) decreases the expenditure to GDP ratio by about 0.20 pp, 0.36 pp and 0.30 pp for the Polish, German and Swiss rule, respectively. Metric P1 for the balanced-budget rule is positive but close to zero, suggesting, in fact, acyclicality. This result is driven by a relatively low correlation between the output gap and government revenues in the empirical US data, which implies only slight procyclicality of the revenues to GDP ratio in the VAR model used in simulations. A 1 pp change in the output gap decreases deficits by about 0.02 pp to 0.03 pp more than just a reduction in the expenditure to GDP ratio. No variation of deficits in the balanced-budget case makes it impossible to obtain sensible results of the P2 regression for this rule. Taking into account that the average range of the output gap for all the rules is slightly less than 10 pp, it means that the deficit to GDP ratio should vary with respect to changes of the output gap in the business cycle up to, maximally, 2.2 pp, 3.9 and 3.3 for the Polish, German and Swiss rule, respectively, taking other factors constant.

It is crucial to note that the above results are based on the responsiveness of deficit and expenditure ratios to changes in the business cycle measured by the output gap, which is calculated 'ex post', i.e. using all realized periods. The maximum responsiveness of deficits or expenditures to the business cycle is not to be confused with the actually realized deficit ratios, which are depicted in Figure 4. Discrepancies between these values contain all other factors affecting deficits than the output gap. For example, they include debt levels (in case of the Polish rule) or the fact that rules miscalculate the 'ex post' output gap using projections and only partial time series samples. Moreover, an inclusion of the term $\Delta\ R_t/Y_t$ to the regressions would help explaining a larger portion of expenditure of deficit variation as revenues contain also shocks that are orthogonal to the output gap.[14] Finally, more-than-proportional procyclicality of revenues reduces actual deficits in Switzerland and Germany over the values suggested by output gap multipliers.

The results confirm that all analyzed rules are, in fact, anticyclical. According to the obtained results, the difference in the deficit to GDP ratios implied by differences in output gaps in the whole 150-year period is between the values of 2.2 pp to 3.9 pp, depending on a rule. Such a difference between maximum and minimum deficit ratios could be perceived as satisfactory in 'normal' times, particularly for the more anticyclical Swiss and German rules. It may be, however, inadequate in economic crises equal in magnitude to the Great Recession, which led to deficits of up to 10% of GDP in the US or in the UK.

5.3 Transparency and political issues

Finally, we would like to mention the lack of transparency and proneness to manipulation, from which suffer all analyzed rules. The goal of fiscal rules is to reduce the deficit bias by minimizing politicians' discretionary decisions regarding expenditure limits. Although the rules may, at least to some extent, reduce the discretion with respect to the budget balance, they seem to be far from eliminating it completely. The complication and arbitrariness of measuring potential or trend output and the possibility to bias output or inflation projections leave a lot of space to manipulate with, theoretically impartial, expenditure or deficit limits. The problem is particularly acute because rules' limits are calculated by fiscal authorities, whose direct supervisors are politicians.[15] Rules turn then into 'black boxes' producing some results that are, theoretically, in accordance with the legal framework but, in fact, may be far from their initial economic intentions.

Fiscal rules thus cannot be perceived as substitutes to fiscal councils but they should be rather treated as their complementary elements. In case fiscal authorities depending on politicians cannot credibly calculate their limitations this task should be delegated to some, ideally, impartial institutions.

6 Conclusions

We have analyzed the performance of the Swiss, German, and Polish fiscal rules by comparing them to one another and to the balanced-budget rule that serves as a benchmark.

We find that, firstly, all rules are capable of stabilizing the deficit to GDP ratios. The Swiss rule is very successful in this respect as it nearly mimics, on average, the balanced budget rule. The German rule allows for slightly higher deficits, which is a result of allowing structural deficits of 0.35% of GDP. Nonetheless, both these rules do not guarantee long-run debt stabilization in a strict sense. The Polish rule is the only one that

[14]In case of the balanced budget rule, $\Delta\ R_t/Y_t$ explains obviously 100% of the variance of $\Delta\ G_t/Y_t$.
[15]It is worthy of saying here 'nemo iudex in causa sua' or, simply, 'no-one should be a judge in his own cause'.

stabilizes the debt ratio, which converges, on average, to levels between 40-50% of GDP. It must be pointed out, however, that the Polish rule creates largest bands for debt and deficit paths.

Secondly, stabilization of deficits comes at the cost of increasing the volatility of the expenditure to GDP ratio. Here, the Polish rule performs best in the short run as its character is inherently measured to stabilize expenditures period-to-period.

Thirdly, the rules perform relatively well in terms of implying anticyclical fiscal policy. Although they all seem to show some anticyclical behavior, its magnitude is highest for the Swiss and German rules, for which it could be deemed as satisfactory. Taking into account the output gap volatility, responsiveness of deficits is equal to, at most, 3.3 and 3.9 pp of GDP between peaks of the business cycle for the Swiss and German rules, respectively, and about 2.2 pp for the Polish one.

Finally, the discretionary nature of calculations of trend and projections makes an impartial overseeing of the rules' implementation a necessity. It implies politically independent fiscal councils, which could assess a proper working of rules' mechanisms, being not substitutes but being complementary to rules.

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Appendix

A comparison of German, Swiss and Polish fiscal rules using Monte Carlo simulations: Appendix

A Modified HP filter

Given a time series $\{y_t\}$ for $t = 1, \ldots, T$, a smoothed (filtered) version of the time series, with the use of the standard HP filter, is defined as $\{y_t^*\}$ for $t = 1, \ldots, T$, where values y_t^* are defined as minimizers of the following function:

$$C_{std} = \frac{1}{\lambda} \sum_{t=1}^{T} (y_t - y_t^*)^2 + \sum_{t=2}^{T-1} \left((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*) \right)^2 .$$

The first part of this expression is an 'error' that is made when substituting the original values y_t with smoothed values y_t^*. The second part captures the 'smoothness' of the trend time series. The coefficient $1/\lambda$ balances the two parts.

The Swiss fiscal rule uses a modified version of the HP filter, described by Bruchez, 2003. Trend values y_t^* are defined as minimizers for the following function:

$$C_{mod} = \sum_{t=1}^{T} \frac{1}{\lambda_t} (y_t - y_t^*)^2 + \sum_{t=2}^{T-1} \left((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*) \right)^2 ,$$

where

$$\lambda_t = \begin{cases} 3\lambda & \text{for } t = 1 \text{ and } t = T, \\ 3/2\,\lambda & \text{for } t = 2 \text{ and } t = T-1, \\ \lambda & \text{for other } t. \end{cases}$$

The above modification, which is effectively confined to applying different weights to observations, defines larger values of λ at the boundaries of a sample that leads to a trend part being more linear there. The modification of the filter is introduced in order to increase smoothness of the trend at the end of a sample, which is, in the context of the Swiss fiscal rule, a 24-observation rolling window of GDP values.

B Details of the VAR model

This section presents the VAR model results, lag selection and diagnostics. Coefficients of the estimated VAR model on output ('gdp'), government expenditures ('exp') and government revenues ('rev') with two lags are presented in Table 3.

Four information criteria were calculated and an optimal number of lags according to each information criterion used is given in Table 4. A lag of order 2 was selected in order to keep the model parsimonious. As a result we operate with 46 degrees of freedom for each equation. This choice is identical as in the model by Landon and Smith, 2017.

Table 3. VAR model results

	Dependent variable:		
	gdp	rev	exp
gdp.lag1	1.229^{***}	1.565^{***}	-0.236
	(0.109)	(0.330)	(0.288)
rev.lag1	-0.071^{*}	0.862^{***}	0.027
	(0.042)	(0.127)	(0.111)
exp.lag1	-0.016	0.040	0.959^{***}
	(0.058)	(0.176)	(0.154)
gdp.lag2	-0.257^{**}	-1.354^{***}	0.420
	(0.117)	(0.355)	(0.311)
rev.lag2	0.095^{**}	-0.140	-0.038
	(0.041)	(0.125)	(0.109)
exp.lag2	0.008	0.030	-0.140
	(0.054)	(0.164)	(0.143)
constant	0.163	-0.420	-0.210
	(0.098)	(0.296)	(0.259)
crisis	-0.040^{***}	-0.056^{***}	0.024
	(0.006)	(0.017)	(0.015)
Observations	54	54	54
Adjusted R^2	0.999	0.993	0.995
F Statistic (df = 7; 46)	$9{,}541.442^{***}$	$1{,}055.989^{***}$	$1{,}635.778^{***}$
Note:			*p<0.1; **p<0.05; ***p<0.01

A series of diagnostics tests has been run. They include calculation of roots and tests of normality, homoscedasticity and serial correlation of error terms. The results of diagnostic checks are presented in Table 5. The only potentially worrisome feature is a heteroscedasticity of the error term but the problem does not seem to be of a large magnitude and, in this particular application of the model, does not distort

Table 4. Best lag selections

Citerion	Number of lags
Akaike	9
Hannan-Quinn	2
Schwarz	2
Final Prediction Error	3

the results.

Table 5. VAR diagnostic checks

Roots					
0.986	0.791	0.791	0.469	0.469	0.157

Normality			
JB-Test (multivariate)	χ^2-statistic = 7.711,	df = 6,	p-value = 0.260
Skewness only (multivariate)	χ^2-statistic = 5.313,	df = 3,	p-value = 0.150
Kurtosis only (multivariate)	χ^2-statistic = 2.398,	df = 3,	p-value = 0.494

Homoscedasticity			
ARCH Breusch-Pagan LM (multivariate)	χ^2-statistic = 213.92,	df = 180,	p-value = 0.043

Serial autocorrelation (maximum of 5 lags)			
Portmanteau Test (asymptotic)	χ^2-statistic = 37.252,	df = 126,	p-value = 0.090
Breusch-Godfrey LM test	χ^2-statistic = 49.017,	df = 45,	p-value = 0.315
Edgerton-Shukur F test	F-statistic = 0.869,	df_1 = 45, df_2 = 86,	p-value = 0.694

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