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A Comparison of German, Swiss, and Polish Fiscal Rules Using Monte Carlo Simulations

Porównanie niemieckiej, szwajcarskiej i polskiej reguły fiskalnej przy użyciu symulacji Monte Carlo

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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 based on US data for the 1960–2015 period. We impose on these relationships fiscal policies implied by a given rule and analyse 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 stabilise deficits at low levels. However, this may still not be sufficient to stabilise debt in the long term in the strict sense. The Polish rule stabilises the debt level at about 40% – 50% of the GDP in the long term. All the rules imply an anticyclical fiscal policy: the deficit-to-GDP ratio implied by changes in the output gap increases by up to 2.2 percentage points, 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.

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Streszczenie

W niniejszym artykule oceniamy skutki ekonomiczne istniejących reguł fiskalnych w Polsce, Szwajcarii i Niemczech. W analizie ustalamy związek pomiędzy PKB, dochodami i wydatkami rządowymi, estymując model VAR oparty na danych amerykańskich dla okresu 1960–2015. Nakładamy na te relacje polityki fiskalne implikowane przez daną regułę i analizujemy konsekwencje dla symulowanych ścieżek długu, deficytu i wydatków pod względem stabilności i cykliczności. Stwierdzamy, że reguły szwajcarska i niemiecka są konserwatywne i stabilizują deficyty na niskich poziomach. Może to być jednak niewystarczające do stabilizacji długu w długim okresie w ścisłym sensie. Polska reguła stabilizuje poziom długu na poziomie około 40–50% PKB w długim okresie. Wszystkie reguły implikują antycykliczną politykę fiskalną: relacja deficytu do PKB powodowana zmianami luki PKB wzrasta w całym cyklu koniunkturalnym o maksymalnie 2,2 p.p., 3,3 p.p. i 3,9 p.p. odpowiednio dla reguły polskiej, szwajcarskiej i niemieckiej. Wyniki te można uznać za zadowalające w przypadku reguły szwajcarskiej i niemieckiej.

Słowa kluczowe:
polityka fiskalna, reguły fiskalne

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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 finances. Wyplosz [2013] argues that a departure from an optimal fiscal policy, due to a deficit bias, results in excessive, suboptimal debt levels and is a political failure. Potential causes of such a failure are concisely summarised in Alesina and Passalacqua [2016]. One major cause is "fiscal illusion," which makes voters unable to understand the notion of the intertemporal budget constraint for the government. Other causes include political budget cycles, delayed stabilisation with "wars of attrition," preventing smooth fiscal contractions, and common pool problems that result in a failure by certain groups of voters to fully internalise fiscal policy costs. The suboptimality of fiscal policy may also be connected with the procyclicality of government expenditures, see e.g. Alesina, Campante and Tabellini [2008].

These authors summarise potential remedies for the political deficit bias. First, 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 parliament). Second, 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 on government fiscal policy. Third, fiscal rules, understood as numerical and formal mechanisms, may restrict budget balances. These rules are the focus of this paper.

Our research serves two purposes. First, we provide a detailed mathematical description of the fiscal rules existing in Switzerland, Poland and Germany. Second, we analyse the mechanics 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 estimated on the basis of 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 analysed rules. This, in turn, results in interdependent time series of output, revenues and expenditure.

Analysing four rules in a unified Monte Carlo simulation framework makes it possible to compare their implications and effectiveness in stabilising output, reducing the procyclicality of fiscal policy, and reducing debt levels. There is a wide consensus in the existing literature that these features, together with the 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 stabilising deficits at low levels and imply anticyclical fiscal policy. Nonetheless, the degree of antycyclicality is not uniform: the maximum difference in the 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 one, and 3.9 pp for the German rule.

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

Problems with the implementation and effectiveness of rules are well known on theoretical grounds. The "rules vs. discretion dilemma" may result in time inconsistency. These issues are analysed specifically for fiscal rules in Alfaro and Kanczuk [2016] and Halac and Yared [2014]. Further problems include commitment and self-enforcement issues. Short time series and endogeneity make it difficult to empirically assess the behaviour of fiscal rules. Nevertheless, the popularity of this strand of research has increased with the rising popularity of rules in the last 25 years. IMF reports, including those by Schaechter et al. [2012], Eyraud, Baum, et al. [2018], and Eyraud, Lledo et al. [2018], present an encyclopaedic overview of countries that have adopted fiscal rules together with reviewing their types and features. Econometric research by the likes of Debrun and Kumar [2007], Holm-Hadulla, Hauptmeier and Rother [2012], and Nerlich and Reuter [2016] reveals that fiscal rules are associated with lower deficits, more fiscal space and lower procyclicality of fiscal policy. These researchers 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 that then serve as signalling devices rather than binding policy constraints. Recent research by 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 the causality of fiscal policy by reducing deficits and procyclicality.

The rest of the paper is organised as follows. Section 2 describes in detail the mechanics of all four analysed rules. Section 3 presents the framework in which the rules are assessed. Section 4 describes the VAR model generating artificial GDP and the 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 rules, while Section B summarises all the diagnostic checks of the VAR model used in the paper.

Description of the fiscal rules

This section explains the mechanics behind each of the rules analysed in the paper, together with a review of the respective literature. The focus of the analysis are the rules' technical mechanisms governing the trajectories of the deficits and debts so that we do not address legal details such as the degree of enshrinement of each rule in the legal system of each country, potential loopholes, the degree of budget rule coverage, enforcement sanctions, or escape clauses.

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

Fiscal rules in each of the analysed countries cover a different amount of public expenditure (understood as general government spending) as, first, they differ in their central budget coverage by definition and, second, central government spending that is subject to these rules differs significantly because of the federal or centralised 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) or "investment expenditure." According to the Eurostat database, central government expenditures in 2019 encompassed 10.2% of the GDP in Switzerland, 23.0% in Poland and 12.5% in Germany, while general government expenditure in these countries was 32.8%, 41.8% and 45.0% of the GDP respectively.

1 The discretion is meant here as a feature of a rule when fiscal authorities can freely choose some parameters affecting final expenditures or deficits, within some limits allowed by the rule. It is not meant that the entire rule's framework can be altered because of its weak legal enshrinement. The Swedish fiscal rule is an example of an interesting mechanism that stabilises fiscal policy, but allows fiscal authorities to make some discretionary decisions within the limits of a restricted framework. For details, see the reports of the Swedish Fiscal Policy Council [2018] and the Swedish Ministry of Finance [2018].

GDP, total government expenditures, i.e. including interest payments on existing debt stock, total government revenues and public debt in budget period t are called Y_t, G_t, R_t and D_t respectively. We define the 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 in period t and is connected with the state of correction account CA_t, which is used, in some form, in all the rules. Corrections show up in all of the analysed rules except the simplified balanced budget rule, and pertain to expenditure or deficit limits. Correction accounts CA_t are defined differently for each rule and are explained in detail below. $E_t\,[x_{t+1}]$ is the expectation of variable x_{t+1} in period t. The convention applied in the paper, in line with reality and necessary from the technical perspective of the simulation, is that the 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 the rule definitions, government expenditures G and revenues R, as well as the values derived from them, are treated as nominal. Nevertheless, the rules operate with real GDP growth rates and trends.

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 has been operational since 2003, after a three-year *vacatio legis*.

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

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

where $\overline{G}$ is the expenditure limit for the next period's budget; it is equal to expected revenues R multiplied by the expected business cycle adjustment factor k. The adjustment factor k is the 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: $E_t\left[Y^*_{t+1}\right] > E_t\left[Y_{t+1}\right]$, the adjustment factor k is larger than one allowing expenditures to be larger than revenues, which results in a cyclical deficit. The opposite happens when the economy is in a boom phase: k is lower than 1 as the economy is above its trend and the rule requires a cyclical surplus.

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

$$CA_t = CA_{t-1} + \left(\overline{G}_t - \overline{G}^R_t\right),$$

where $\overline{G}^R_t$ is a revised expenditure ceiling, i.e. the expenditure limit calculated with the actual realisation of variables Y and R instead of their expected values ($\overline{G}^R_t = k_t \cdot R_t$ with $k_t = Y^*_t / Y_t$).[2]

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 the next three years. The corrective amount is defined as $c = \max\left(0, \frac{CA_t}{G_t} - 0.06\right)$. The statement that a deficit in the correction account has to be eliminated within three years is not precise enough for the simulation algorithm so it is

2 It must be noted that, in practice, $\overline{G}^R_t$ is not yet fully known in year t, when the expenditure limit $\overline{G}_{t+1}$ is planned. Therefore, $\overline{G}^R_t$ is substituted with its relatively accurate projection that is available at the end of a year.

assumed that it is always eliminated in the next year after its occurrence by multiplying $\overline{G}_{t+1}$ 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 that the standard HP filter does not smooth enough observations at the end of the 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 by Swiss authorities. The last observation in the rolling sample is the GDP prediction $E_t\,[Y_{t+1}]$.

The rule is praised for its transparency and simplicity; see e.g. **Beljean and Geier [2013]**. It is pointed out that it leads to surpluses and decreases in government expenditure, even in nominal terms. It is not known, however, if this outcome is caused by the construction of the rule or by the favourable conditions in which the Swiss economy is currently operating.

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 the 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:

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

where $E_t\left[R_{t+1}\right]-\overline{G}_{t+1}$ is the maximum permissible projected deficit ($\overline{G}_{t+1}$ is the maximum allowed expenditure), $0.0035 \cdot E_t\left[Y_{t+1}\right]$ is the maximum allowed structural deficit equal to 0.35% of GDP, $E_t\left[F_{t+1}\right]$ is the balance of financial transactions (i.e. those transactions related to financial assets, e.g. privatisation proceeds), $E_t\left[\epsilon_{t+1}\right]\cdot\left(E_t\left[Y_{t+1}\right]-E_t\left[Y^*_{t+1}\right]\right)$ 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 $E_t\left[Y_{t+1}\right]-E_t\left[Y^*_{t+1}\right]$, where $E_t\left[Y^*_{t+1}\right]$ is the expected potential output, with the semi-elasticity ϵ of the 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 together affect 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 (realised) budget. The state of the correction account is determined as follows:

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

where $R_t - G_t$ is the actual deficit[3] and $R_t - \overline{G}^R_t$ is the revised borrowing limit. G_t is the actual expenditure, which is equal in our simulation to $\overline{G}_t$ as there are no unplanned expenditures and all planned ones are undertaken, and $\overline{G}^R_t$ is the maximum allowed expenditure revised with respect to the cyclical component CC^R. The revision means that, instead of just output gap projections, the actual realisations of variables are also used in the following way:

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

3 When $R - G$ is positive it is in fact a surplus.

The rest of the equation for the revised expenditure limit is the same as for the expenditure limit before revision, which means that the revision only takes into account an adjustment of cyclical factors. If the accumulated deficits in the correction account are larger than 1% of GDP (i.e. $CA_t < -0.01Y_t$) 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:

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

if

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

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), unlike in the Polish mechanism. The existence of any funds being outside of the scope of the rule's limits is not allowed. The rule also pertains to state (*Bundesländer*) budgets with a difference that their budgets must be structurally fully balanced. The law regarding states took effect 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 the 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 the **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, labour, TFP and capital/labour 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 offer enough freedom to effectively manipulate fiscal policy. Being unable to credibly project the potential output using the European 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 on the comparison of various aspects of fiscal rules rather than on various trend/potential output calculation methods. The sum of the 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 criticised 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, including through channels other than trend calculation, is prone to various interpretations and manipulation. Other problems envisaged by these authors are the arbitrariness of the 0.35% structural deficit limit, and a tendency for procyclicality and high conservativeness of the rule. These are all problems of a more subjective nature. German fiscal policy after 2011 has been even more conservative than it would be when sticking precisely to the rule. **Paetz, Rietzler and Truger** [**2016**] claim that this is so because of highly favourable conditions for the German economy and the fact that the rule itself is procyclical: in good times the rule is not that strict, but it would kick in if the environment deteriorated.

Polish rule

"The stabilising 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 the spending limit was in 2015.

The rule aims to let government expenditure grow no faster than the rate of medium-term real GDP growth. The rule is summarised by the following equation:

$$\overline{G}_{t+1} = \overline{G}_t \cdot E_t \cdot \left[\boldsymbol{\pi}^*_{t+1}\right] \cdot \left(y^*_{t+1} + c_{t+1}\right) + E_t\left[\Delta dR_{t+1}\right],$$

where $\overline{G}_{t+1}$ is the maximum allowed expenditure limit for the next period, $\overline{G}_t$ is the maximum allowed expenditure in a given period, $E\left[\boldsymbol{\pi}^*\right]$ is the central bank inflation target, y^* is medium-term real GDP growth, c is the correction term explained below, and $\mathrm{E}\left[\Delta dR\right]$ is a change in "large discretionary revenue" or "one-off revenue".[4] The medium-term real GDP growth rate y^*, which is a geometric mean over eight years, is given by the following formula:[5]

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

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 at 1% of GDP:[6]

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

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

The rule does not contain unobservable terms such as structural/cyclical balances or trends, whose calculation method can be disputable or opaque. Nonetheless, it is far from transparent because of the complicated correction mechanism. This mechanism is designed to decrease the growth of expenditure (corrections –2 pp and –1.5 pp) when the government is heavily indebted, it ran a high deficit, GDP growth is high, or the control account accumulated substantial deficits. In the opposite situation, when 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).

The initial form of the Polish expenditure rule contained a projection of the CPI inflation, which in 2015 was replaced by the inflation target of the National Bank of Poland (NBP), the country's central bank. The NBP inflation target, which was set at 2.5% beginning in 2004, was higher in 2015 than the actual inflation rate, which allowed larger expenditure. Additional changes in the rule framework included an inclusion of one-

4 Both $E\left[\boldsymbol{\pi}^*\right]$ and y^* are expressed as factors, not rates.

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

6 Recall that the 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.

off and temporary revenues in the expenditure limit, including in 2015, and a change of the debt thresholds in the correction definitions in 2014, from 55% of GDP and 50% of GDP to 48% and 43% respectively. That change followed a pension system reform and redemption of some pension bonds.[7] In our simulation, we use the "old" debt levels, i.e. 50% and 55%. Lastly, in 2020, investment expenditure was exempted from the expenditure limits. Clearly, such changes do not instil confidence in the rule, particularly because it is not a part of the constitution and can be changed like an ordinary law.

The results of a simulation in **Korniluk** [**2016**] indicate that the Polish fiscal rule should lead to debt levels of 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.

Balanced budget rule

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

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

To the best of our knowledge, such a rule is not in operation in any developed country at the national level. However, it is popular at the US state and Swiss cantonal level. Overall, these rules vary considerably as they deal differently with deficits ex post. This is so because the balanced-budget rule should rather be written as $\overline{G}_{t+1} = E_t[R_{t+1}]$ with precise instructions 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, although socially and politically infeasible, form: the government cannot run any deficits and must equate its spending to its actual 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 popularity is limited. This is in part due to its procyclicality. It is consequently treated in this research as a benchmark. We expect it to be the most procyclical rule among those studied. Empirical analyses of US state rules [**Alesina, Bayoumi, 1996**] and Swiss cantonal rules [**Luechinger, 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 United States have little impact on output stability in comparison with the federal government.

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 estimated 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 called "crisis" to indicate an occurrence of recession.

The strategy applied in our simulation is to use the VAR parameter estimates $\hat{\beta}$, based on 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 $t-1$, actual stochastic shocks e_{t+1} and 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 $\overline{G}_{t+1}$, obtained with a given fiscal rule, so that $\overline{G}_{t+1}$, reflects 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:

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

[7] The limits in the rule's framework were lowered by only 7 pp, whereas the redemption of the pension bonds was equal to around 9 pp.

which makes their computation feasible. After the substitution of the VAR-generated expenditures G_{t+1} with the rule-generated ones $\overline{G}_{t+1}$, expectations $E_t[Y_{t+1}]$ and $E_t[R_{t+1}]$ are confronted with the actual values of Y_{t+1} and R_{t+1} so that correction accounts can be adjusted in line with the rules' formulations. Finally, we move to the 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 summarised 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. privatisation), which reduces the respective terms in the Polish and German rules: $\forall t \ E_t\left[F_{t+1}\right]=0$ and $\forall t \ E_t\left[\Delta \ dR_{t+1}\right]=0$.
- Revenues are exogenous from the politicians' perspective so that all adjustments required to respect a 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: $\forall t \ E_t\left[\pi^*_{t+1}\right]=1$. The assumption on price stability may seem rather restrictive, but this is due to technical reasons. The aim is to avoid either increasing the dimensionality of the VAR model or adopting an arbitrary process generating inflation.
- The simulation abstracts from default risk and interest payments. This assumption, though 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 the total deficit $R - G$ or the debt level D. It is beyond the scope of this text to assess what proportion of 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 $D_t = D_{t-1} + (R_t - G_t)$.
- Computing expenditure limits for all the rules except 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. First, the logs of a time series are calculated. The resulting time series is fed into the function, which automatically identifies and estimates the best ARIMA model. The function uses a stepwise method based on the Akaike information criterion.[8] The length of a time series used to make a forecast is equal to 24 for all the rules, which coincides with the length of the HP-filter window in the Swiss rule. Based on the identified and estimated model, a point forecast is created.[9] 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.
- All the 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 realised. In the simulations, the 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 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.

8 http://reference.wolfram.com/language/ref/TimeSeriesModelFit.html (accessed on 4.12.2022)

9 http://reference.wolfram.com/language/ref/TimeSeriesForecast.html (accessed on 4.12.2022)

- At the time of introducing 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 a modified HP filter (identical to that 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 $E_t\left[\epsilon_{t+1}\right]$ used in the rule is equal to 0.5 instead of 0.205, which is the value of this variable for the US economy (see [**OECD, 2015**]).
- The 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. Substituting VAR-generated expenditures G_{t+1} with those specified by fiscal rule limits (i.e. $\overline{G}_{t+1}$) does not affect VAR-generated contemporaneous output Y_{t+1} or revenues R_{t+1}. Although this assumption may seem restrictive, it is also dictated by technical reasons because including contemporaneously output-affecting expenditures would complicate the model significantly.
- In each simulated path for each 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 1960–2015 period in the United States.
- The only sources of randomness in the simulations are VAR error terms and a stochastic occurrence of exogenous economic crises. They are the reason the actual output Y_{t+1} and revenues R_{t+1} may differ from their expected levels $E_t[Y_{t+1}]$ and $E_t[R_{t+1}]$. Expenditure limits $\overline{G}_{t+1}$, 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 that 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 the 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 behaviour. This implies that we cannot answer the question of "what would have happened with the US debt and deficits had the American government adopted one of the fiscal rules at hand?" In order to answer this question we would have to assume that we hold the behaviour 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 the 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 behaviour 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 data produced by their "own" economy because they were calibrated to its specific features.[10]

[10] The use of the US data also implies the adoption of structural features of the American economy such as the ratio of public (federal) revenues and expenditures to the GDP of around 15%–20%, instead of the much higher figures recorded in Germany or Poland.

Such a framework allows us to analyse the fundamental characteristics of the rules and draw conclusions about the 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 valuable policy advice.

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:

$$V_t = \beta_0 + \beta_1 \cdot V_{t-1} + \beta_2 \cdot V_{t-2} + \beta_3 \cdot X_t + e_t,$$

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 the 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 the NBER, whose origins were deemed to be exogenous to American fiscal policy. The variable "crisis" encompasses the economic recessions related to the 1st and 2nd Oil Crises, the 1st Gulf War, the 9/11 attack and the Great Recession. This implies values of one for the following years in the data sample: {1974, 1975, 1982, 1991, 2001, 2008, 2009}.

Based on these variables, a number of lags were selected using information criteria. Due to a lack of 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 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 the 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.[11] These are in the form of a Cholesky identification with the following assumptions on contemporaneous interdependencies:

- Expenditures are not affected contemporaneously by GDP or 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. But they can affect 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 to that 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**] and other authors. This may result

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

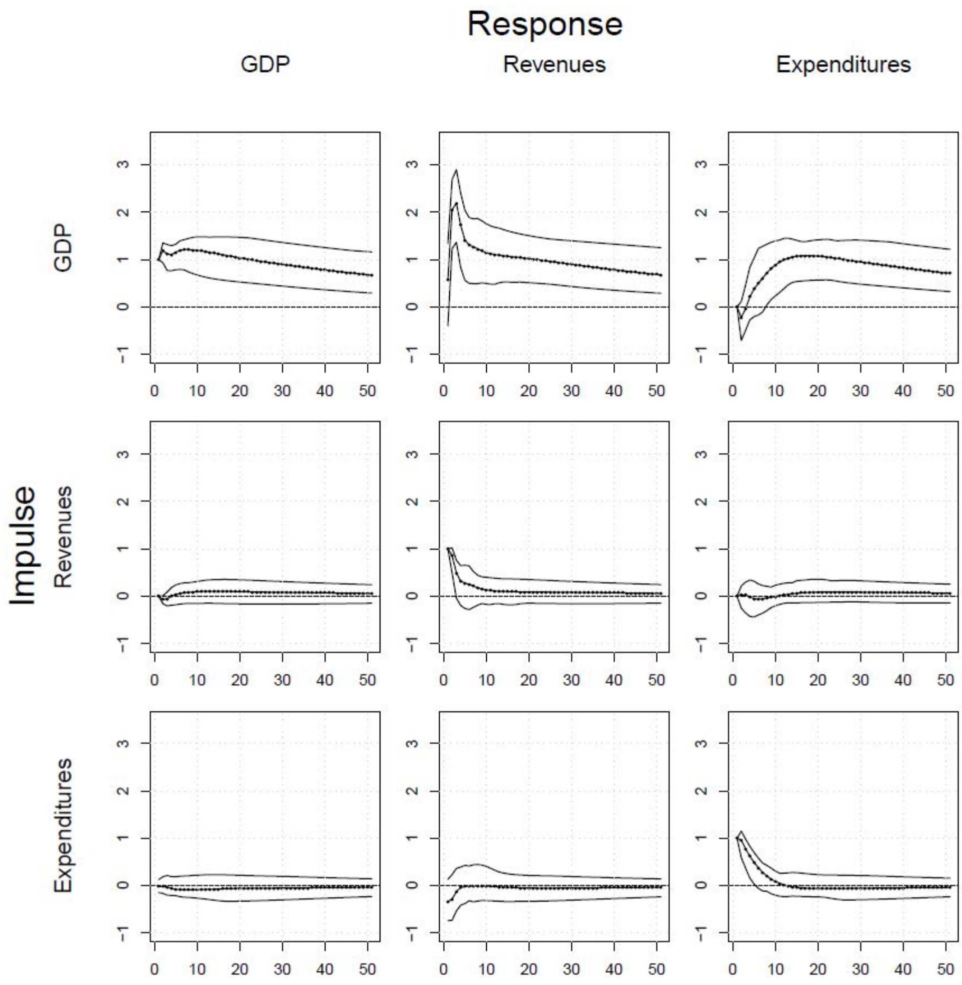
from the fact that the impulse responses of GDP are deemed to be short-lasting with their positive effects up to three to five quarters, which may be hardly visible in annual data.

Exogenous paths of crises are generated to mimic empirical data. The maximum-likelihood estimation with binary variables in the 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.

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



Source: Authors' own elaboration.

Results

The simulation aims to analyse the trajectory of the debt and deficit levels implied by the rules and to measure their potential for expenditure stabilisation. Moreover, the procyclicality of the induced fiscal policy is assessed.

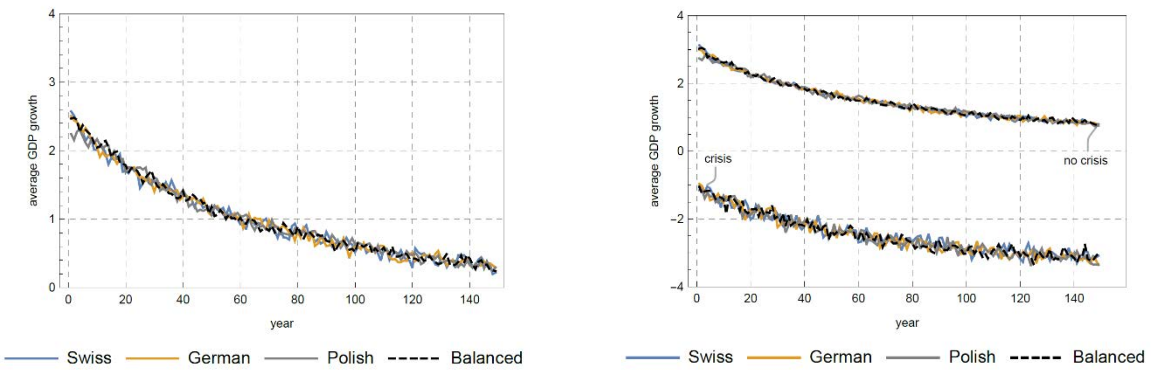
Each simulation starts with empirical US values from the years 1960 and 1961 for all the endogenous variables, and then the VAR model without any fiscal rule is run for 50 periods. After 50 periods the fiscal rules are applied and the simulation is run for a further 150 annual periods.[12] The results of these 150 periods are reported in this section. We run 1,000 simulations for each rule.

The initial debt level for all the rules is set to 0% and 50% of GDP because the Polish rule has a built-in mechanism to prevent debt accumulation over 50% and 55% of GDP. An inclusion of two starting debt levels serves the purpose to assess if the rule is effective in attaining its goal.[13] Other rules are expected to behave identically in both scenarios as their formulas do not depend on the 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 output stabilisation as 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 1,000 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.[14] The same applies to the average minimum and maximum output gaps, whose values are around 5% and 5% of GDP respectively.

Finally, the simulations indicate a gradual drop in the average GDP growth rates from just over 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.[15] The decreasing growth rates affect debt accumulation processes, particularly the debt-to-GDP ratios, and put additional pressure on the rules. Figure 2b shows the 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.

Figure 2. Average growth rates for 0% of initial debt level. Values are averaged across all 1,000 simulations of a given rule at given points in time. Note that Figures (a) and (b) have different scales on the vertical axes



(a) Average overall growth rates

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

Source: Authors' own elaboration.

Stabilisation of deficits, expenditures and debt

Figure 3 shows the average deficit paths for the Swiss, German and Polish rules.[16] The Swiss and German rules are not affected by the initial debt levels by construction so their results are not reported twice. The average behaviour of the 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

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12 The perspective of 150 years may seem irrelevant from the political, or policy, point of view. But it makes it possible to analyse the long-term properties of the rules' mechanisms and to observe some convergence to potential equilibria in particular.

13 The value of 0% is set in order to simulate the trajectory of debt, when the initial value is certainly lower than the potential equilibrium debt level.

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

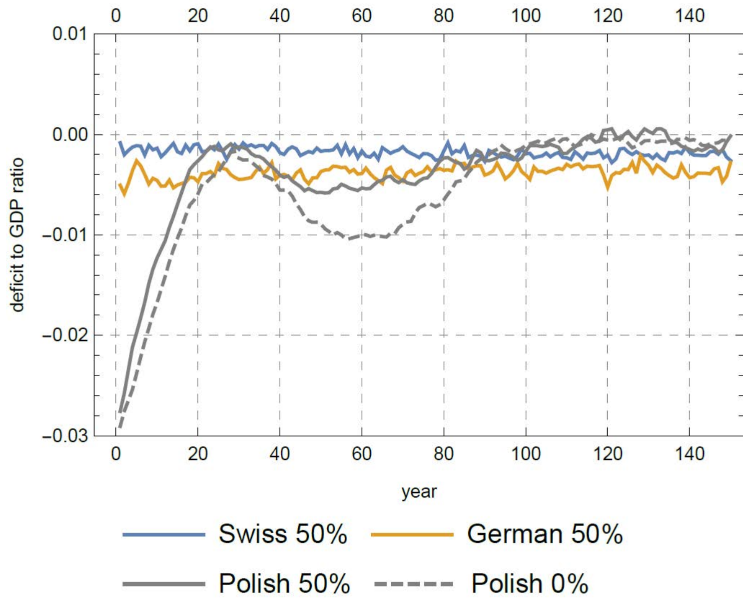
15 For a discussion on the secular stagnation, see e.g. Gordon [2015] or Summers [2015].

16 The median paths would look extremely similar, which applies to all the figures presented in the text.

in the graph. A large debt ratio induces more frugal fiscal policy until debt-stabilising deficit ratios are attained. When the debt levels are not below the limit of 50% of GDP and excessive deficits of less than 1% of GDP are not pervasive anymore, the correction account starts to de-accumulate, which leads to larger deficits again.

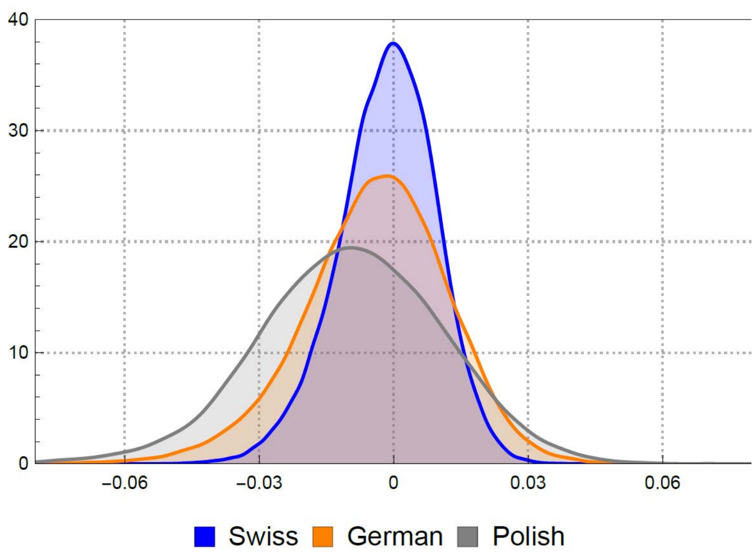
The incidence of the deficit-to-GDP ratios is summarised in Figure 4, showing the different behaviour of the Polish rule across periods. The Swiss rule leads to deficits that are heavily and nearly symmetrically concentrated around zero, while the German rule allows for slightly higher deficits. For 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 centred around their desired level at 1% of GDP in the first 100 periods. Later on the budgets remain balanced on average. The dispersion of the deficits induced by the Polish rule is much more pronounced as they vary between about +/– 6% of GDP.

Figure 3. Paths of average deficits for given rules at a given point in time. Values are averaged over all 1,000 simulations

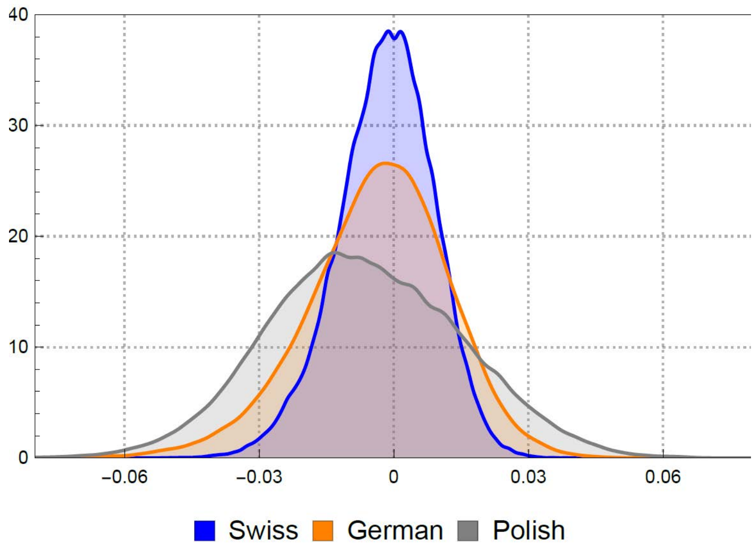


Source: Authors' own elaboration.

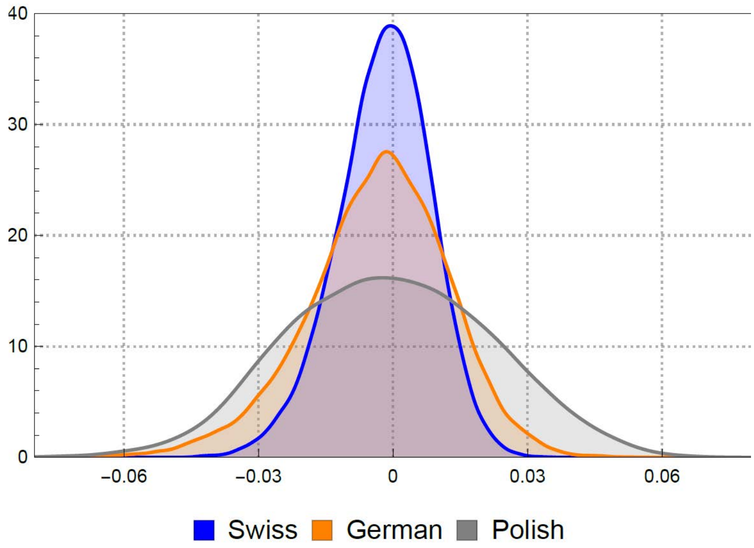
Figure 4. Estimated kernel density functions for all deficit-to-GDP ratios (computed across 1,000 simulated scenarios in a given time period) with 0% of initial debt



(a) Deficit densities in years 1–50



(b) Deficit densities in years 51–100



(c) Deficit densities in years 101–150

Source: Authors' own elaboration.

Table 1 sums up basic statistics on the 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 rules 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 budgetary balances larger than the 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

Statistics	Balanced	Polish	Swiss	German
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

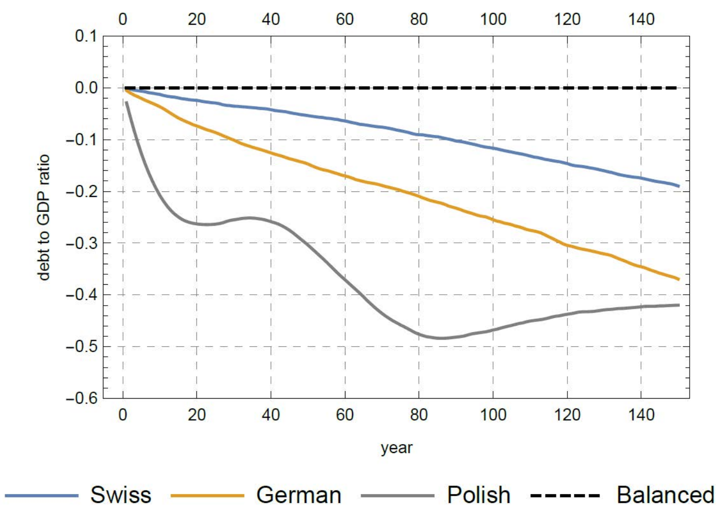
Statistics	Balanced	Polish	Swiss	German
min	0.127	0.121	0.122	0.127
max	0.197	0.216	0.216	0.197
mean	0.162	0.168	0.166	0.162
std.dev.	0.014	0.022	0.018	0.014
range	0.070	0.095	0.093	0.070
autocorr (1)	0.805	0.961	0.690	0.805

Source: Authors' own elaboration.

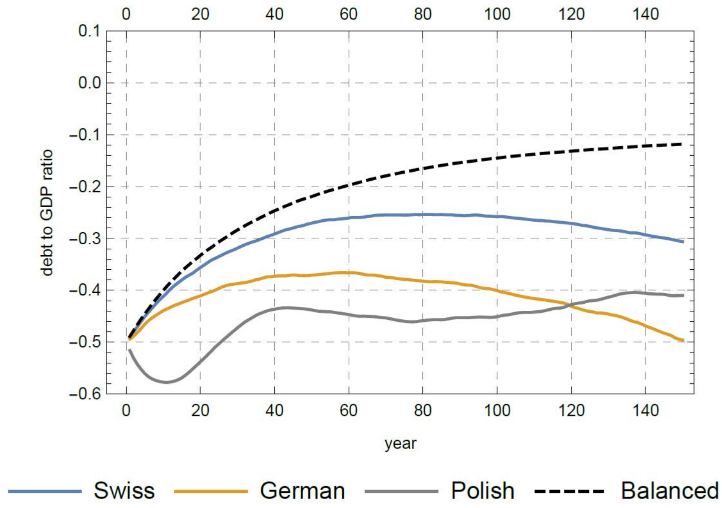
The Polish rule offers the highest degree of stabilising expenditures period to period, which is proved by the value of the expenditure autocorrelation measure. The Swiss and German rules stabilise deficits at the cost of curbing expenditures, which have to vary significantly between years. In the case of the Polish rule, it is the stabilisation 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. The 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, the 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. The Swiss and German rules sharply decrease expenditures in such circumstances, even by a few percentage points of GDP 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 until they can fully shape deficits according to their tenets.

Figure 5. Average paths of debt accumulation for 0% and −50% of initial debt level. Values are averaged across all 1,000 simulations of a given rule in a given point in time



(a) Average debt accumulation, 0% initial debt



(b) Average debt accumulation, – 50% initial debt

Source: Authors' own elaboration.

Figures 5a and 5b show that the Polish rule differs significantly from the rest when it comes to the details of the debt accumulation process. The Swiss and German rules rely on a similar tenet of balancing the structural budget. This implies their qualitatively similar behaviour as already shown in the case of the deficit behaviour. Stable deficit values lead to 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 the case of the 50% initial debt, both rules mimic qualitatively the balanced budget rule in terms of 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 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 to be much less reliable in this respect.

The debt levels converge to the 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-to-GDP and revenue-to-GDP ratios, and y is the GDP growth rate.[17] Since the deficit-to-GDP ratios $r - g$ implied by the rules hover 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. This means that these two rules are not sufficient despite being capable of stabilising deficits at low levels, to prevent debt explosion in the strict sense.[18]

The expectations about 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 or 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 the GDP growth rates decline to very low levels. The results we obtain with respect to the 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 apparently still stable, debt levels.

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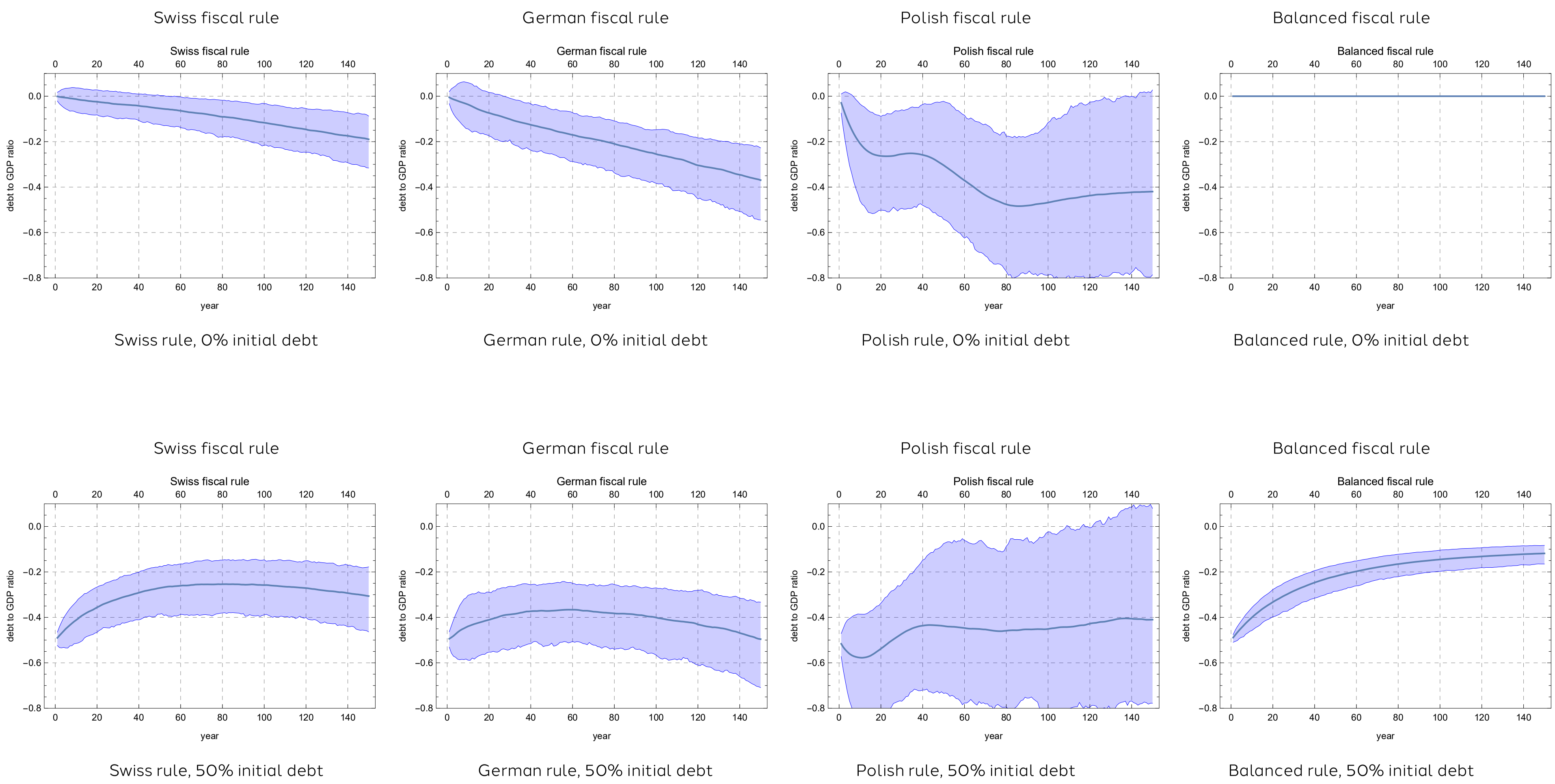
17 It is a formula for an equilibrium of the debt accumulation difference equation $\Delta(D / Y) = R / Y - G / Y - y \cdot (D / Y)$. Interest rate i does not show up in the equation as interest payments are already included in expenditures G.

18 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.

Figure 6. Debt accumulation paths for different rules and initial debt levels. Thick lines are average paths over all 1,000 simulations in a given time point. Shaded area is the 90% interval between the 5th and 95th percentile values



Source: Authors' own elaboration.

Procyclicality measures

We measure procyclicality as in **Alesina et al. [2008]** or **Guerguil et al. [2017]**. Specifically, we rely on the following regressions:

$$\Delta \frac{G_t}{Y_t} = \beta_0 + \beta_1 \cdot \Delta \frac{Y_t - Y_t^*}{Y_t} + \epsilon_t \tag{P1}$$

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

where G_t/Y_t is the ratio of expenditure to GDP, $(R_t - G_t)/Y_t$ is the deficit-to-GDP ratio and $\left(Y_t - Y_t^*\right)/Y_t$ 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 the ratio of government expenditure to GDP, or the deficit-to-GDP ratio, with respect to changes in the output gap.

The above regressions, when used in an empirical setting, are expected to contain an endogenous variable. The output gap is such a variable. The reason is that there can be reverse causality resulting from simultaneous interaction between fiscal policy and output. In order not to include the impact of fiscal multipliers on $\hat{\beta}_1$, instruments such as lagged explanatory variables are used. 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 consistently estimate the equations at hand using OLS. The results of the regressions are given in Table 2, which presents the estimates of parameters β_1, their p-values and R^2 values for both regressions. All the values were calculated as averages of 1,000 coefficients, which were in turn calculated on each of the 150-period simulations. As the differences between the estimates from the regressions starting with 0% and 50% of the initial debt-to-GDP ratios are negligible, only the former ones are presented.

Table 2. 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
R2	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
R2	–	0.152	0.184	0.164

Source: Authors' own elaboration.

Table 2 indicates that all three analysed rules are anticyclical as intended, which is proven by the 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 rules 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 the simulations. A 1 pp change in the output gap decreases the 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. Considering that the average range of the output gap for all the rules is slightly less than 10 pp, 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 pp for the Polish, German and Swiss rules respectively, assuming that all other factors are constant.

These results are based on the responsiveness of the deficit and expenditure ratios to changes in the business cycle measured by the output gap, which is calculated *ex post*, i.e. using all available data. The maximum responsiveness of the deficits and expenditures to the business cycle is not to be confused with the actual deficit ratios, which are depicted in Figure 4. The discrepancies between these values are caused by various factors affecting deficits other than the output gap. For example, they include the debt levels (in the case of the Polish rule) or the fact that the rules miscalculate the *ex post* output gap using projections and only partial time series samples. Moreover, including the term $\Delta R_t/Y_t$ in the regressions would help explain a larger portion of expenditure (or deficit) variation as revenues also contain shocks that are orthogonal to the output gap.[19] Finally, the more-than-proportional procyclicality of the revenues reduces the actual deficits in Switzerland and Germany over the values suggested by output gap multipliers.

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

Transparency and political issues

Finally, we would like to mention the lack of transparency and proneness to manipulation, from which all the analysed rules suffer. The goal of fiscal rules is to reduce the deficit bias by minimising politicians' discretionary decisions about expenditure limits. Although the rules may, at least to some extent, reduce the discretion with respect to the budget balance, they cannot eliminate it completely. The complexity and arbitrariness of measuring potential or trend output and the possibility of bias in output or inflation projections leave a lot of space to manipulate with theoretically impartial expenditure and deficit limits. The problem is particularly acute because fiscal rule limits are calculated by fiscal authorities, whose direct supervisors are politicians.[20] Rules therefore turn into "black boxes" producing some results that are theoretically in accordance with the legal framework but may in fact be far from their initial economic intentions.

Fiscal rules thus cannot be perceived as substitutes to fiscal councils, but should rather be treated as their complementary elements. If fiscal authorities dependent on politicians cannot credibly calculate their limitations, this task should be delegated to some ideally impartial institutions. Nonetheless, other problems would arise then, including, first, how to effectively choose members of these institutions without the involvement of politicians. Second, these institutions would most probably lack a broad democratic mandate, as in the case of the European Central Bank or the European Commission, for example.

Conclusions

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

We find that, first, all the rules are capable of stabilising the deficit-to-GDP ratios. The Swiss rule is very successful in this respect as it nearly mimics the balanced budget rule on average. The German rule allows for

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19 In the case of the balanced budget rule, $\Delta R_t / Y_t$ explains obviously 100% of the variance of $\Delta G_t / Y_t$.

20 It is worth pointing out here that *nemo iudex in causa sua*, or "no one should be a judge in his own cause".

slightly higher deficits as a result of allowing structural deficits of up to 0.35% of GDP. But neither of these rules guarantees long-run debt stabilisation in a strict sense. The Polish rule stabilises the debt ratio, which converges to levels between 40% and 50% of GDP on average. However, the Polish rule creates the largest bands for the debt and deficit paths.

Second, the stabilisation 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 term as its characteristics are inherently measured to stabilise expenditures period to period.

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

Finally, the discretionary nature of trend calculations and projections makes it necessary to ensure impartial monitoring of how the rules are implemented. This implies the existence of politically independent fiscal councils that would oversee the proper use of specific mechanisms as an additional safeguard to complement fiscal rules.

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Appendix

A. Modified HP filter

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

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

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]. The trend values y_t^* are defined as minimisers for the following function:

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

where

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

This modification, which is effectively confined to applying different weights to observations, defines larger values of λ at the boundaries of a sample, which leads to a trend part being more linear there. The modification of the filter is introduced to increase the smoothness of the trend at the end of the sample. In the context of the Swiss fiscal rule, the sample is 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. The 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		

Source: Authors' own elaboration.

Table 4. Best lag selections

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

Source: Authors' own elaboration.

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 the diagnostic checks are presented in Table 5. The only potentially worrisome feature is the heteroscedasticity of the error term, but the problem does not seem to be serious and does not distort the results in this particular application of the model.

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

Source: Authors' own elaboration.