International Entrepreneurship Review

2024, Vol. 10, No. 1

10.15678/IER.2024.1001.03

Selected method for determining fiscal targeting rules: Results for Poland

Agnieszka Przybylska-Mazur

ABSTRACT

Objective: The objective of the article is the presentation of a selected method for determining fiscal targeting rules. The proposed fiscal rules make it possible to achieve the intended goals. In this article, the main goal of fiscal policy was the minimisation of deviations of the general government debt-to-GDP ratio from the target value. In the proposed method for determining fiscal targeting rules, we also considered the minimalisation of deviation of the inflation rate and output gap from their target values. We present the results of the empirical analysis for Poland.

Research Design & Methods: The main design was quantitative. We used the modelling method. We applied the dynamic optimisation method for determining fiscal targeting rules. The fiscal targeting rule was the solution of selected dynamic optimisation problems with an infinite time horizon and discounting. We used the minimisation problem of the intertemporal loss function. We performed empirical analysis for quarterly data from the first quarter of 2011 to the third quarter of 2022 for Poland. We used the Bellman equation and the envelope theorem.

Findings: In this article, we determined the fiscal targeting rule. This rule, determined as a solution to the minimisation problem of the intertemporal loss function, allows for the calculation of optimal values of the general government debt-to-GDP ratio while also considering the minimisation of deviations of the inflation rate and the output gap from their target values. We could observe the same direction of the optimal values of the debt-to-GDP ratio in different considered cases, but there is a different shift along the axis of ordinates. We could observe that reducing debt during good economic times allows for achieving an acceptable level of the debt-to-GDP ratio during a crisis.

Implications & Recommendations: To minimise the intertemporal loss function, a portion of the financial resources accumulated during non-exceptional periods should be utilised during crises and shock events. Considering other variables such as inflation and the output gap when deciding on the value of the debt-to-GDP ratio, we noted that the fiscal convergence criterion for debt was not always fulfilled.

Contribution & Value Added: In this article, we present a method of determining fiscal rules not only considering the general government debt-to-GDP ratio, but also considering such variables as the inflation rate and the output gap, as well as other variables such as general government balance to GDP ratio and the monetary policy instrument – the interest rate. The novelty of the article is also the determination of the fiscal targeting rule as a solution to the minimisation problem of intertemporal loss function. Thus, they make it possible to determine the optimal general government debt-to-GDP ratio, considering also the minimisation of deviations from the inflation rate and the output gap from their target values.

Article type:	research article
Keywords:	public debt; fiscal targeting rule; intertemporal loss function; minimisation problem; Bellman equation
JEL codes:	C54, C60, E62

Received: 11 July 2023 | Revised: 28 November 2023 | Accepted: 1 December 2023

Suggested citation:
Przybylska-Mazur, A. (2023). Selected method for determining fiscal targeting rules: Results for Poland. *International Entrepreneurship Review,* 10(1), 37-54. https://doi.org/10.15678/IER.2024.1001.03

INTRODUCTION

The topic addressed in this article is important because one of the ways of decision-making involves rule-based decisions, which can enhance prudence and objectivity in the implementation of fiscal and monetary policy (see *e.g.* Barbier-Gauchard *et al*., 2021; Wieland, 1996). Moreover, numerical fiscal rules help achieve the objectives deriving from the Treaty Establishing the European Community (Protocol 20) and the Treaty on the Functioning of the European Union (Protocol 12) in the area of budgetary policy.

Based on Regulation (EU) No 1175/2011 of the European Parliament and of the Council of 16 November 2011 amending Council Regulation (EC) No 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies, for activating the general escape clause the following premises must be satisfied:

1. exceptional events beyond the control of the Member State which significantly impact the financial position of the general government

or

2. serious economic downturn in the euro area or the Union as a whole.

Exceptional events are situations beyond the control of the Member State. These situations significantly impact the financial position of the general government. Examples of exceptional events that negatively impact the financial position include wars, natural disasters, and epidemics. The COVID-19 pandemic was an exceptional situation enabling the activation of the general escape clause and allowing the suspension of fiscal rules in European Union Member States. Therefore in 2020, due to a significant economic downturn caused by the pandemic across the EU, the Ecofin Council agreed to temporarily depart from the EU Council's fiscal policy recommendations for the countries of the European Union, provided that this did not endanger the sustainability of public finances in the medium term. Thanks to the EU escape clause, the requirements regarding fiscal criteria contained in the Treaty on the Functioning of the European Union do not have to be met. This enabled the suspension of fiscal rules in individual EU countries and gave European Union Member States budgetary flexibility to deal with the COVID-19 crisis.

The Act of May 28, 2020, amending the Public Finance Act (Journal of Laws 2020, item 1175, article 1, point 3), adopted in 2020, extends the list of events that enable the temporary suspension of the application of the stabilising expenditure rule to include the state of the epidemic. Therefore, based on the Public Finance Act amended in 2020 (Journal of Laws 2009, No. 157, item 1240), consistent with the EU legal act – the Treaty on the Functioning of the European Union, the application of the stabilising expenditure rule (Journal of Laws 2009, No. 157, item 1240, Article 112aa) has been suspended due to the state of the epidemic. Moreover, Article 112d point 4 of the Public Finance Act (Journal of Laws 2009, No. 157, item 1240) specifies the path of automatic return to the application of the stabilising expenditure rule.

Considering the activated escape clause concerning the stabilising expenditure rule, in the years 2020-2023 in Poland, the stabilising expenditure rule was not applied. This allows for taking measures to minimise the negative effects of the crisis and increase necessary spending to support healthcare systems, the population, and the economy. In this article, we propose various types of fiscal rules applicable even in exceptional situations, which distinguishes it from previous literature.

The article aims to present a selected method for determining fiscal targeting rules. The proposed fiscal rules make it possible to achieve the intended goals. In this article, the main goal of fiscal policy is the minimisation of deviations of the general government debt-to-GDP ratio from the target value. The proposed method for determining fiscal targeting rules considers the minimalisation of deviation of the inflation rate and output gap from their target values. We present the results of the empirical analysis for Poland.

The research attempts to answer the following research question. What forms of fiscal rules are applicable in exceptional situations when making optimal decisions regarding the value of a selected macroeconomic fiscal instrument, which in this study is the general government debt-to-GDP ratio, while also considering the minimisation of deviations of other variables such as the inflation rate and GDP dynamics from their target values?

The novelty of the article is the determination of the fiscal targeting rule as a solution to the minimisation problem of intertemporal loss function. Thus, they make it possible to determine the optimal general government debt-to-GDP ratio, considering also the minimisation of deviations of the inflation rate and the output gap from their target values.

In the subsequent part of the article, after the literature review, the research methodology is presented, including the types of fiscal policy rules and the selected method of determining fiscal targeting rules as a solution to the intertemporal loss function minimisation problem. Then, based on the obtained theoretical results, an empirical analysis is conducted for Poland to determine the optimal values of the general government debt-to-GDP ratio. The article ends with conclusions formulated based on the obtained research results.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The EU fiscal rules aim to maintain the stability of public finances (see Larch *et al*., 2023). In the literature on fiscal rules, we observed two main approaches.

The first approach is to establish ad hoc simple rules to constrain fiscal policies, such as a 3% ceiling on budget deficits and the 60% debt/GDP rule, which were introduced at the European level in 1992 with the ratification of the Maastricht Treaty (European Communities 1992, 92/C 191/01, Treaty on European Union). Moreover, fiscal rules contained in the Stability and Growth Pact (European Union 2011, Regulation 1175/2011 & 1177/2011) were also implemented to limit the tendency for indebtedness and promote fiscal stability. The introduction of such rules also aimed to strengthen policy coordination at the European level. In 2013, based on the Stability and Growth Pact ratified by member states, the EU Member States were obligated to implement structural balanced budget rules at the national level. However, in the face of various exceptional situations and crises, different exemptions were added to the Stability and Growth Pact. Based on Article 3 Paragraph 1 point c of the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union, the Member States 'may temporarily deviate from their respective medium-term objective or the adjustment path towards it only in exceptional circumstances, as defined in point (b) of paragraph 3.' Furthermore, the UE Member States may be temporarily exempted from the balanced budget rule and the stabilising spending rule in exceptional circumstances.

The second approach involves deriving fiscal rules based on a specific model (see Halac & Yared, 2014; Yared, 2019; Halac & Yared, 2022; Danninger, 2002; Przybylska-Mazur, 2017) at the national level, and Beetsma and Jensena (2005); Pappa and Vassilatos (2007); Gali and Monacelli (2008) for the Economic and Monetary Union).

Many researchers (see Wyplosz, 2012; Fatás *et al.,* 2019; Eyraud *et al*., 2018; Caselli & Reynaud, 2020; Valencia *et al.*, 2022) have analysed fiscal rules that can be used to control debt and thereby provide greater fiscal discipline and reduce high levels of public debt. The appropriate type of fiscal rules that allow for the limitation of public debt, is of significant importance in situations of unfavourable shocks, such as financial crises, pandemics, natural disasters or wars (Obstfeld, 2013; Battaglini & Coate, 2016; Romer & Romer, 2018). Gómez-González *et al*. (2022) provide evidence of the positive and significant impact of implementing fiscal rules on the accessibility of public debt in both developed and emerging countries.

Noteworthy, while European countries have engaged in a debate on fiscal policy rules, little is known about the ability of these rules to ensure stable debt and output paths when taxes are distortionary, particularly in a small open economy. In this context, it turns out that the interaction between fiscal rules and the output may show what type of equilibrium we have: stabilising or passive. To achieve a stabilising equilibrium, public expenditures and public revenues should be adjusted to the level of economic activity to mitigate the fluctuations of the business cycle, while in the case of passive equilibrium, public expenditures and public revenues are not adjusted to the level of economic activity, *i.e.* fiscal policy decisions are not made to mitigate the fluctuations of the business cycle.

Several researchers have examined the significance of fiscal rules and the fiscal multiplier in various aspects (see Barnichon *et al*., 2022; Caselli & Wingender, 2021; Canzoneri *et al*., 2016; Corsetti *et al.*,

Debrun & Jonung, 2019; Przybylska-Mazur, 2016; Woodford, 2011). After analysing these articles, we may formulate the following general conclusion: the fiscal rules that limit the size of the general government deficit or general government debt may reduce the fiscal multiplier.

Furthermore, to determine targeting fiscal rules, as analyzed by Barnichon and Mesters (2021), the maximisation problem can be applied, as studied by Reicher (2014), or the intertemporal loss function minimisation problem, which is the objective of this article.

Moreover, we should not forget how important the interaction between monetary and fiscal policy is in conducting macroeconomic policy. Stawska and Miszczyńska (2022), Chugunov *et al.* (2021), Monamodi (2019) analyze the impact of variables in the area of monetary and fiscal policy on the economies of EU countries.

In a combination of monetary and fiscal policy *i.e.* in the traditional policy mix, monetary policy is important in stabilising economies, while the interest rate is the basic stabilisation instrument. While, in the new policy mix (see Klucznik *et al*., 2021), fiscal policy has a significant role in stabilising and stimulating the economy, and fiscal policy instruments are the main instruments for stimulating the economy. In the new policy mix, monetary policy has a supporting role in the effectiveness of fiscal policy. Stawska *et al.* (2023) consider the cooperative game between the central bank and the government.

In the model presented in this article when we determined fiscal targeting rules, we considered the output gap. This is because there exists a relationship between output growth, productivity, and public debt, as demonstrated by Afonso and Jalles (2013) and Auerbach and Gorodnichenko (2012) in their research. The negative impact of debt on economic growth and investment has also been studied by Fatas *et al*. (2020) and Yared (2019). Salmon and de Rugy (April 5, 2020) demonstrate also the existence of a negative impact of public debt on the growth rate of the economy.

Aimola Akingbade and Odhiambo (2020) presented a review of the literature showing the research results on the relationship between general government debt and inflation. They noted that the positive relationship between public debt and inflation dominates in the reviewed studies. Moreover, considering the studies cited in the other literature, which present inflation targeting (*e.g.* Ciżkowicz-Pękała *et al.*, 2019; Hammond, 2012) and which indicate the impact of general government debt on inflation (see Romero & Marín, 2017; Bon, 2015; Faraglia *et al*., 2013), in the model presented in this article we also include inflation. Moreover, a high level of general government debt also increases inflation expectations in society. Furthermore, the relationship between general government debt and inflation is discussed in the literature in the context of the debate on using fiscal policy to support economic development.

These prior empirical results allowed us to assume the following research hypotheses:

H1: Fiscal rules that take into account the inflation rate and GDP cyclical dynamics allow for minimising deviations of the general government debt-to-GDP ratio, inflation rate, and output gap from their target values.

H2: Fiscal targeting rules can be applied in exceptional situations without the need for activating an escape clause.

RESEARCH METHODOLOGY

In the study, we used a quantitative design.

To determine fiscal targeting rules, we utilised the selected problem of dynamic optimisation with an infinite time horizon and discounting.

We determined the optimal values of macroeconomic fiscal instruments, such as the general government debt-to-GDP ratio while considering deviations from the target values of other variables, such as the inflation rate and output gap. Since the fiscal targeting rule is a solution to the minimisation problem of the intertemporal loss function, according to the classification of research methods provided by Sudoł (2007), we applied the following research method: quantitative (mathematical) method and modelling method.

Minimisation Problem of Intertemporal Loss Function

In the intertemporal loss function, deviations between the values of target variables and their target levels are taken into account. Therefore, to determine the optimal values of the target variables, the following minimisation problem had to be solved:

$$\min_{b_t} E_t \sum_{\tau=0}^{\infty} \delta^{\tau} \cdot L_{t+\tau} \quad (1)$$

subject to the constraints defined by the considered model.

In the above problem: $\sum_{\tau=0}^{\infty} \delta^{\tau} \cdot L_{t+\tau}$ represents the intertemporal loss function in period t; δ is the discount factor, $0 < \delta < 1$; E_t denotes the expected value symbol determined based on the available information in period t; L_t is the period loss function.

The period loss function can take various forms. Svensson (1996) proved that the accuracy of decisions in targeting rules also depends on the form of the decision-maker's period loss function. The other forms of the period loss function can be considered. One of the other forms of the period loss function is presented by Ruge-Murcia (2003) noting that positive deviations from the target can be weighted more, or less, severely than negative ones.

Considering the stability of public finances and fiscal convergence criteria, we can adopt the fiscal policy instrument b_t – the general government debt-to-GDP ratio as one of the target variables, $b_t > 0$ for earch $t = 1,2,3, \ldots$

Considering the premises presented in the literature review justifying the selection of other target variables that affect the debt, the inflation rate and output gap are also considered when making decisions. Thus, $x_t = (\pi_t, y_t)$, where π_t represents the inflation rate in period t and y_t represents the output gap in period t. The output gap y_t is defined as the relative deviation of GDP Y_t from potential GDP $\bar{Y}_t$, *i.e.* $y_t = \frac{Y_t - \bar{Y}_t}{\bar{Y}_t}$.

Furthermore, a quadratic form of the loss function is assumed. Thus,

$$L_t = L(x_t, b_t) = L(\pi_t, y_t, b_t) = w_1(\pi_t - \pi_t^*)^2 + w_2(y_t - y_t^*)^2 + w_3(b_t - b_t^*)^2 \quad (2)$$

in which:

w_1, w_2, w_3 are parameters representing weights assigned to the squares of deviations of individual target variables from their target values.

The loss function (2) differs from the loss function considered in the literature on the inflation targeting rule (see *e.g.* Svensson, 1999). In the inflation targeting rule (Svensson, 1999) and in the standard Taylor rule (Taylor, 1993), researchers considered the output gap and the deviation of the inflation rate from the inflation target. In the presented period loss function (2), we took into account the deviations of all three variables, such as the debt-to-GDP ratio, the inflation rate, and the output gap, from their target values. This is a modification and extension to analyses conducted by other researchers (*e.g.* Svensson, 1999; Taylor, 1993).

We adopted the three-equation model as a limiting condition. This model considers the multiplier effect because the trade-off between debt stability and output or inflation stability is likely if fiscal policy operates with a multiplier effect, for example, due to distortionary taxes or Keynesian consumption behaviour. The presence of distortionary taxation can affect the interactions between monetary and fiscal policy rules.

Thus, the model that is limiting condition in the optimisation problem consists of the following three equations:

1. An equation describing the inflation changes depending on the output gap and the general government debt – this relationship comes from the accelerating New Keynesian Phillips curve supplemented by the general government debt-to-GDP ratio. This equation presents the formation of the inflation rate and eliminates the assumption present in the literature on fiscal targeting rules (see *e.g.* Reicher, 2014) that monetary policymakers in a given country have no influence on price formation in the country and that prices follow a constant path. Moreover, this equation includes the general government debt-to-GDP ratio, because it can impact inflation through aggregate de-

mand, the transfer of wage growth from the public to the private sector, the effect of taxes on marginal costs, and society's expectations regarding the repayment capacity of the general government debt in the future. Thus, the first equation of the model is of the following form:

$$\pi_{t+1} = \alpha_1\pi_t + \alpha_2 y_t + \alpha_3 b_t + \varepsilon_{t+1} \tag{3}$$

in which:

π_{t+1} - inflation rate in period *t*+1;
π_t - inflation rate in period *t*;
y_t - output gap in period *t*;
b_t - general government debt-to-GDP ratio in period *t*;
ε_{t+1} - a random term that is a supply shock.

2. An equation describing the relationship between the output gap and the lagged output gap by one period, as well as the real interest rate calculated based on the lagged Fisher equation. This relationship is the modification of the IS curve, in which we take into account a multiplier effect that links the primary surplus with production.

$$y_{t+1} = \beta_1 y_t - \beta_2(i_t - \pi_t) - \beta_3 \cdot s_{t+1} + \eta_{t+1} \tag{4}$$

in which:

y_{t+1} - output gap in period *t+1*;
y_t - output gap in period *t*;
i_t - interest rate in period *t*;
π_t - inflation rate in period *t*;
$s_{t+1} = \frac{S_{t+1}}{Y_{t+1}}$ - general government balance to GDP ratio in period *t+1*;
S_{t+1} - general government balance in period *t+1*;
Y_{t+1} - GDP in period *t+1*;
η_{t+1} - a random term that is a demand shock.

3. The law of motion for general government debt presenting budgetary constraints considering public finances shocks.

$$b_{t+1} = \gamma_1 b_t + s_{t+1} + \delta_{t+1} \tag{5}$$

in which:

b_{t+1} - general government debt-to-GDP ratio in period *t+1*, $b_{t+1} = \frac{B_{t+1}}{Y_{t+1}}$;
B_{t+1} - general government debt in period *t+1*;
Y_{t+1} - GDP in period *t+1*;
b_t - general government debt-to-GDP ratio in period *t*;
s_{t+1} - general government balance to GDP ratio in period *t+1*;
δ_{t+1} - a random term that is a public finance shock.

Often in the literature (see, *e.g.* Reicher, 2014), the law of motion for the general government debt includes a variable coefficient:

$$\gamma_{1t+1} = \frac{1+i_t}{1+g_{t+1}} \tag{6}$$

in which:

i_t - is the interest rate in period *t*;
g_{t+1} - is the GDP growth rate in period *t*+1, $1 + g_{t+1} = \frac{Y_{t+1}}{Y_t}$;
Y_{t+1} - GDP in period *t+1*;
Y_t - GDP in period *t*.

Solution of the Minimisation Problem of Intertemporal Loss Function

To solve the problem (1), which is the discounted dynamic programming problem with a discrete infinite time horizon, we use the theory presented by Woźny (2006) concerning the Bellman equation and the envelope theorem. We present this theory below.

The Bellman equation for the discounted dynamic programming problem with a discrete infinite time horizon is of the following form (Woźny, 2006):

$$V(x_t) = \min_{b_t \in B(x_t)} \{E_t L(x_t, b_t) + \delta E_t V(x_{t+1})\} \tag{7}$$

or equivalent

$$V(x_t) = \min_{b_t \in B(x_t)} \{L(x_t, b_t) + \delta E_t V(x_{t+1})\} \tag{8}$$

in which:

$V(x_t)$ is a value function for the discounted dynamic programming problem with a discrete infinite time horizon. It is a mapping that assigns to each state x_t the minimum achievable payout.

The policy equation is the following form:

$$b_t^*(x_t) = arg \min_{b_t \in B(x_t)} \{L(x_t, b_t) + \delta E_t V(x_{t+1})\} \tag{9}$$

The envelope theorem can be formulated as presented below.

Assume that the function $f(x_t, b_t)$ is differentiable with respect to x_t and b_t and for each b_t there exists $\min_{b_t} f(x_t, b_t)$.

Then:

$$\frac{d}{dx_t} V(x_t) = \frac{\partial}{\partial x_t} f(x_t, b_t^*(x_t)) \tag{10}$$

in which:

$$(x_t) = \min_{b_t} f(x_t, b_t), \text{ whereas } b_t^*(x_t) = arg \min_{b_t} f(x_t, b_t).$$

Therefore, to solve the problem

$$\min_{b_t} E_t \sum_{\tau=0}^{\infty} \delta^{\tau} [w_1(\pi_t - \pi_t^*)^2 + w_2(y_t - y_t^*)^2 + w_3(b_t - b_t^*)^2] \tag{11}$$

subject to the constraints of the model described by equations (3) – (5), we consider the Bellman equation (7) for $x_t = (\pi_t, y_t)$ of the form

$$V(\pi_t, y_t) = \min_{b_t \in B(\pi_t, y_t)} \{w_1(\pi_t - \pi_t^*)^2 + w_2(y_t - y_t^*)^2 + w_3(b_t - b_t^*)^2 + \delta E_t V(\pi_{t+1}, y_{t+1})\} \tag{12}$$

In the above equation, the control variable is the general government debt-to-GDP ratio.

The value function for the problem with discounting and an infinite time horizon, also known as the intermediate loss function, is as follows:

$$V(\pi_t, y_t) = k_0 + k_1(\pi_t - \pi_t^*)^2 + k_2(y_t - y_t^*)^2 \tag{13}$$

in which:

k_0, k_1, k_2 are the coefficients that need to be calculated. The first-order condition for problem (12) is the following form:

$$\frac{\partial}{\partial b_t} V(\pi_t, y_t) = 0 \tag{14}$$

in which:

$$\frac{\partial}{\partial b_t} V(\pi_t, y_t) = 2\, w_3(b_t - b_t^*) + \delta E_t \left(\frac{\partial}{\partial \pi_{t+1}} V(\pi_{t+1}, y_{t+1}) \frac{\partial \pi_{t+1}}{\partial b_t} + \frac{\partial}{\partial y_{t+1}} V(\pi_{t+1}, y_{t+1}) \frac{\partial y_{t+1}}{\partial b_t}\right)$$

$$V(\pi_{t+1}, y_{t+1}) = k_0 + k_1(\pi_{t+1} - \pi_t^*)^2 + k_2(y_{t+1} - y_t^*)^2 \Rightarrow \frac{\partial}{\partial \pi_{t+1}} V(\pi_{t+1}, y_{t+1})$$

$$= 2k_1(\pi_{t+1} - \pi_{t+1}^*) \wedge \frac{\partial}{\partial y_{t+1}} V(\pi_{t+1}, y_{t+1}) = 2k_2(y_{t+1} - y_{t+1}^*)$$

and

$$\frac{\partial \pi_{t+1}}{\partial b_t} = \alpha_3, \frac{\partial y_{t+1}}{\partial b_t} = \beta_3 \gamma_1.$$

Therefore, we obtained the following equation:

$$2\, w_3(b_t - b_t^*) + 2\delta k_1 \alpha_3(\pi_{t+1} - \pi_{t+1}^*) + 2\delta k_2 \beta_3 \gamma_1 (y_{t+1} - y_{t+1}^*) \tag{15}$$

The solution of this equation is the decision rule for the general government debt-to-GDP ratio that is the following form:

$$b_t = b_t^* - \frac{\delta k_1 \alpha_3}{w_3}(\pi_{t+1} - \pi_{t+1}^*) - \frac{\delta k_2 \beta_3 \gamma_1}{w_3}(y_{t+1} - y_{t+1}^*) \tag{16}$$

Considering the constraints, the value of the general government debt-to-GDP ratio is a solution of the following first-order differential equation with a constant coefficient and a variable constant term:

$$\begin{aligned} -\frac{\delta k_2 \beta_3^2 \gamma_1}{w_3} b_{t+1} + \left(1 + \frac{\delta k_1 \alpha_3^2}{w_3} + \frac{\delta k_2 \beta_3^2 \gamma_1^2}{w_3}\right) b_t \\ = b_t^* + \frac{\delta k_1 \alpha_3}{w_3}\pi_{t+1}^* + \frac{\delta k_2 \beta_3 \gamma_1}{w_3} y_{t+1}^* + \left(-\frac{\delta k_1 \alpha_1 \alpha_3}{w_3} - \frac{\delta k_2 \beta_2 \beta_3 \gamma_1}{w_3}\right) \pi_t \\ + \left(-\frac{\delta k_1 \alpha_2 \alpha_3}{w_3} - \frac{\delta k_2 \beta_1 \beta_3 \gamma_1}{w_3}\right) y_t + \frac{\delta k_2 \beta_2 \beta_3 \gamma_1}{w_3} i_t \end{aligned} \tag{17}$$

We can rewrite this equation in the following equivalent form

$$b_{t+1} = A\, b_t + W_t \tag{18}$$

in which:

$$A = \frac{1 + \frac{\delta k_1 \alpha_3^2}{w_3} + \frac{\delta k_2 \beta_3^2 \gamma_1^2}{w_3}}{\frac{\delta k_2 \beta_3^2 \gamma_1}{w_3}} \tag{19}$$

$$\begin{aligned} W_t = -\frac{1}{\frac{\delta k_2 \beta_3^2 \gamma_1}{w_3}} [b_t^* + \frac{\delta k_1 \alpha_3}{w_3}\pi_{t+1}^* + \frac{\delta k_2 \beta_3 \gamma_1}{w_3} y_{t+1}^* + \left(-\frac{\delta k_1 \alpha_1 \alpha_3}{w_3} - \frac{\delta k_2 \beta_2 \beta_3 \gamma_1}{w_3}\right) \pi_t \\ + \left(-\frac{\delta k_1 \alpha_2 \alpha_3}{w_3} - \frac{\delta k_2 \beta_1 \beta_3 \gamma_1}{w_3}\right) y_t + \frac{\delta k_2 \beta_2 \beta_3 \gamma_1}{w_3} i_t \end{aligned} \tag{20}$$

Assuming the initial condition for general government debt-to-GDP ratio b_1, the solution of equation (18) can be written in the form:

$$b_{t+1} = A^t\, b_1 + \sum_{k=1}^{t} A^{t-k}\, W_k \quad \text{for } t = 1,2,3,\ldots \tag{21}$$

Therefore, considering the assumption that the debt-to-GDP ratio is a positive value, we adopted the value calculated based on formula (21) as the optimal value of the debt-to-GDP ratio when it was a positive value. If the value of the debt-to-GDP ratio calculated based on formula (21) was non-positive, then the optimal value of the debt-to-GDP ratio could be taken a positive value close to 0 or it can be assumed debt-to-GDP ratio equalled 0 *i.e.* no general government debt but this does not occur in practice. In practice, periods in which the debt-to-GDP ratio calculated on the basis of formula (21) was non-positive could be considered as periods in which part of the budget revenues should be allocated to repaying a larger amount of debt or should be accumulated for use in exceptional situations.

We can note that the general government debt-to-GDP ratio which is determined on the basis of the presented model, depends on the inflation rate and the output gap. When we determined the value of the general government debt-to-GDP ratio, the target values of the considered variables, such as the debt-to-GDP ratio, inflation and output gap, were also considered. Furthermore, the monetary policy instrument – the interest rate, also affects the value of the debt-to-GDP ratio. When we determined the fiscal targeting rule, which is a solution to the presented minimisation problem, we observed that the coordination of fiscal and monetary policies helps achieve the target.

To determine the coefficients k_1, k_2, we applied the envelope theorem to the Bellman equation (12) and utilise equation (13).

Supposing that $x_t = (\pi_t, y_t)$ i $f(\pi_t, y_t, b_t) = L(\pi_t, y_t, b_t) + \delta E_t V(\pi_{t+1}, y_{t+1})$ we needed to solve the equation system as follows:

$$\begin{cases} \frac{\partial}{\partial \pi_t} V(\pi_t, y_t) = \frac{\partial}{\partial \pi_t} f(\pi_t, y_t, b_t^*(\pi_t, y_t)) \\ \frac{\partial}{\partial y_t} V(\pi_t, y_t) = \frac{\partial}{\partial y_t} f(\pi_t, y_t, b_t^*(\pi_t, y_t)) \end{cases} \tag{22}$$

i.e. the following equation system

$$\begin{cases} (k_1 - w_1)(\pi_t - \pi_t^*) = \delta k_1 (\pi_{t+1/t} - \pi_{t+1}^*) \\ (k_2 - w_2)(y_t - y_t^*) = \delta k_2 (y_{t+1/t} - y_{t+1}^*) \end{cases} \tag{23}$$

Assuming the constant trends of deviations of inflation rate from the inflation target and the constant output gap from the target, denoted as T$inf = \frac{\pi_{t+1/t} - \pi_{t+1}^*}{\pi_t - \pi_t^*}$ and T$gap = \frac{y_{t+1/t} - y_{t+1}^*}{y_t - y_t^*}$, respectively, we calculated the coefficients k_1 and k_2 using the following formulas:

$$k_1 = \frac{w_1}{1 - \delta \cdot Tinf} \tag{24}$$

and

$$k_2 = \frac{w_2}{1 - \delta \cdot Tgap} \tag{25}$$

In the analysis, we considered the quarterly data for Poland from the first quarter of 2011 to the third quarter of 2022. We considered the inflation rate data and the GDP growth rate data published by Statistics Poland (www.stat.gov.pl), the general government debt-to-GDP ratio data published by the Ministry of Finance (https://www.gov.pl/web/finanse/zadluzenie-sektora-finansow-publicznych) and also the reference interest rate data (end-of-quarter values) published by the National Bank of Poland (www.nbp.pl). We establish b_t^*= 0.55 for each $t = 1,2,3, \ldots$ (which corresponds to 55% – the upper limit of the first prudential threshold for debt in Poland; this limit was suspended in 2013) as the target values for the general government debt-to-GDP ratio. Based on the Resolution No. 2/2003 of the Monetary Policy Council of February 25, 2003 on the 'Strategy of Monetary Policy after 2003,' since 2004, in Poland a continuous inflation target of 2.5% is implemented with an acceptable range of fluctuations of +/- 1 percentage point. Therefore, initially, we assumed inflation target 2.5% *i.e.* π_t^*=0.025 on a year-on-year, the lower bound of acceptable deviations of inflation from the inflation target equals to 1.5% and the upper bound of acceptable deviations of inflation from inflation target equals to 3.5% for each *t* = 1, 2, 3,… For the purpose of this study, initially, we set also $y_t^* =$ = 0 for each *t* = 1, 2, 3,… as the target value for the output gap, *i.e.* we assume that the GDP growth is equal to the potential GDP growth.

Noteworthy, there are two groups of methods for estimating potential GDP. The first group are structural methods. This group of methods includes the method based on the production function and the method using Okun's law The second group are non-structural methods, *i.e.* methods of statistical trend elimination. Examples of these methods are the method using the trend function and the method using the Hodrick-Prescott filter. The most frequently used method for estimating potential GDP is the method using the Hodrick-Prescott filter (HP filter). Thus, we calculated the potential GDP growth values using the HP filter.

RESULTS AND DISCUSSION

In the Figures 1 to 3, we present the actual values of the variables that we take into account in the loss function. These are the actual values of the general government debt-to-GDP ratio, the actual values of inflation compared to the inflation target and the lower and upper bounds of acceptable deviations of inflation from the target as well as the actual values of the output gap. For the purposes of this study, the output gap target was initially assumed to be 0.

We present these values for Poland for periods from 2011Q1 to 2022Q3.

From the above Figures, we can see that over the whole analyzed period in Poland, the actual values of the general government debt-to-GDP ratio were lower than 60%, which is the value adopted as the threshold that EU countries should not exceed based on the fiscal convergence criterion for the

general government debt-to-GDP ratio. Therefore, we can observe that in Poland, the fiscal convergence criterion for the debt-to-GDP ratio was fulfilled over the whole analyzed period.

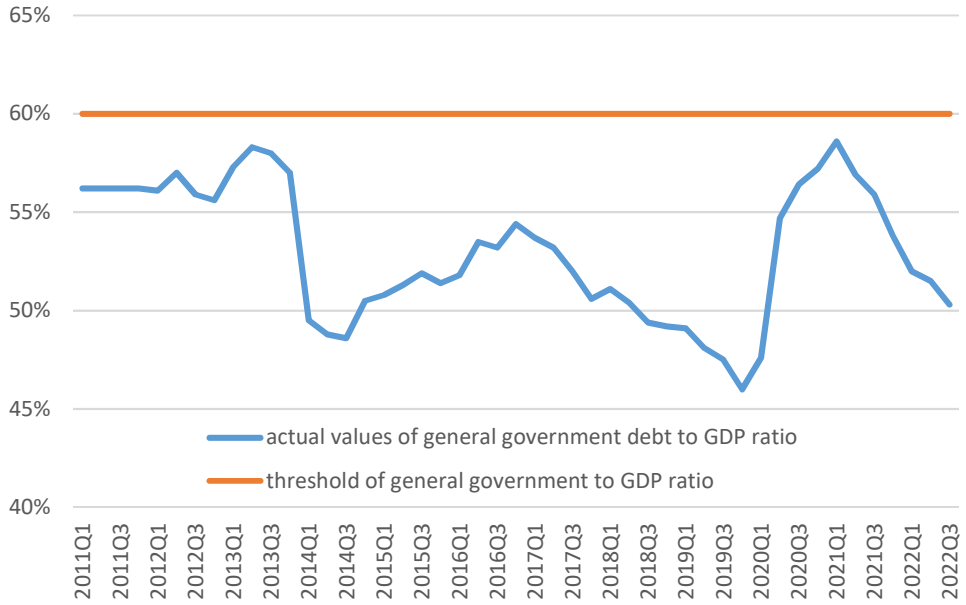

Figure 1. The actual values of the general government debt-to-GDP ratio and threshold of general government debt-to-GDP ratio in Poland
Source: own elaboration of data from the Ministry of Finance.

However, we can also observe that the other considered variables, the inflation rate and the output gap, deviated significantly from their assumed targets in many quarters. Particularly in the recent period, the non-fulfillment of targets for these variables is evident. Inflation has deviated significantly from the inflation target since the second quarter of 2021, while the output gap has deviated since the first quarter of 2020. Moreover, in the period from 2020Q1 to 2021Q1, the output gap was negative, whereas from 2021Q2 to 2022Q3, it was positive.

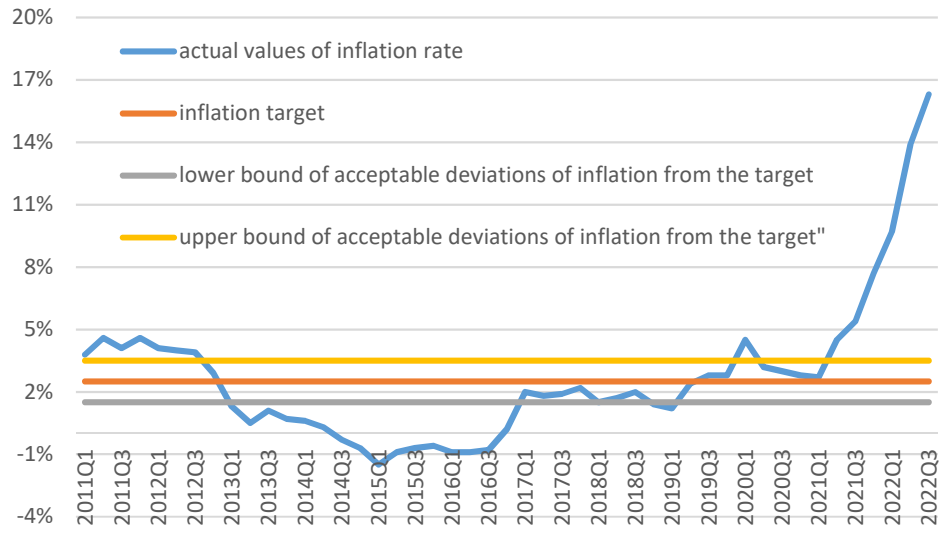

Figure 2. The actual values of inflation rate, the inflation target, the lower and the upper bounds of acceptable deviations of inflation from the target in Poland
Source: own elaboration of data from Central Statistical Office and Narodowy Bank Polski.

To take into account not only the achievement of the fiscal convergence criterion for the debt-to-GDP ratio but also the minimisation of deviations in inflation and the output gap from their target values, it is worth considering the solutions of the minimisation problem of intertemporal loss function. We present the results of this analysis below.

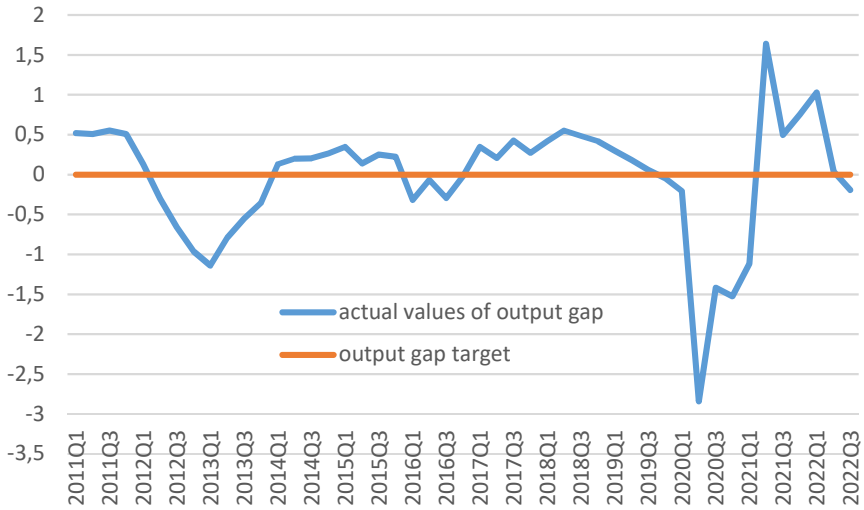

Figure 3. The actual values of the output gap and the output gap target
Source: own elaboration of data from Central Statistical Office.

We calculated the optimal values of the general government debt-to-GDP ratio based on the minimisation problem of intertemporal loss function. These calculated values take into account the minimisation of deviations in inflation from the inflation target and the output gap from the output gap target.

Using the formula for the solution of the presented minimisation problem, we obtained the values of the general government debt-to-GDP ratio for the following different cases:

1. Assuming different weights assigned to the deviation in inflation from the inflation target, the deviation in the output gap from the output gap target, and the deviation in the debt-to-GDP ratio from the target value.
2. Assuming different target values for inflation rate and the output gap, with a constant target for the debt-to-GDP ratio set at 55%.
3. Assuming different discount factors.
4. Assuming different values for the coefficient of constant trend in deviations of the inflation rate from the inflation target and the coefficient of constant trend in deviation of the output gap from the output gap target.

The obtained values of the general government debt-to-GDP ratio are presented in Figures 4 to 7 as obtained in the different cases. Our estimates are compared with the actual values.

Moreover, we could observe that only a change of coefficient of constant trend in deviations in inflation from the inflation target affects the optimal values of the debt-to-GDP ratio. A change in the coefficient of constant trend in deviations in the output gap from the output gap target has no significant impact on the optimal value of the debt-to-GDP ratio.

In all cases, we can observe the same direction of the optimal values paths of the debt-to-GDP ratio, but there is a different shift along the axis of ordinates.

Figure 5 shows that, assuming the fixed values of the debt-to-GDP ratio target and the output gap target, even increasing the value of the inflation target from 2.5% (inflation target of the National Bank of Poland since 2004) to 5%, which does not occur in practice, does not change the path of the optimal debt-to-GDP ratio.

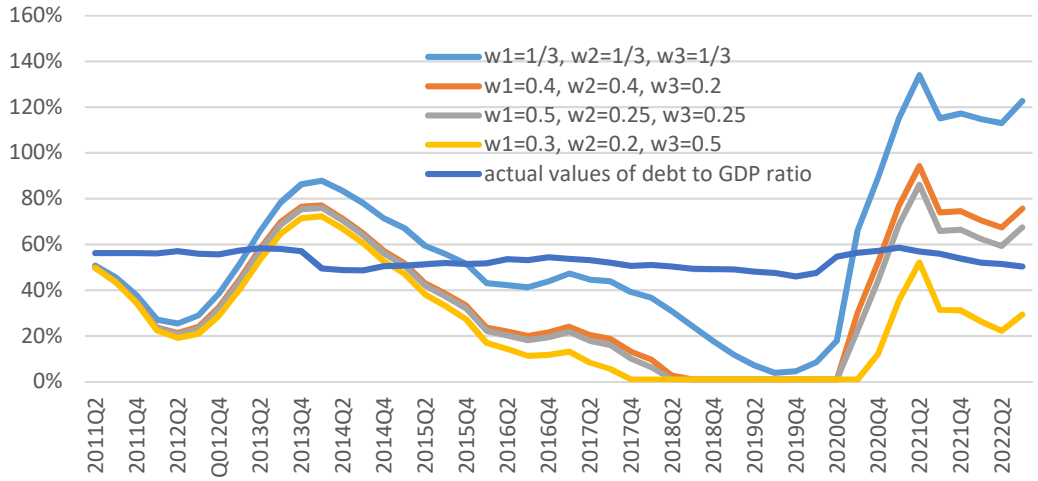

Figure 4. The optimal and actual values of the general government debt-to-GDP ratio in Poland: Case 1
Source: own elaboration.

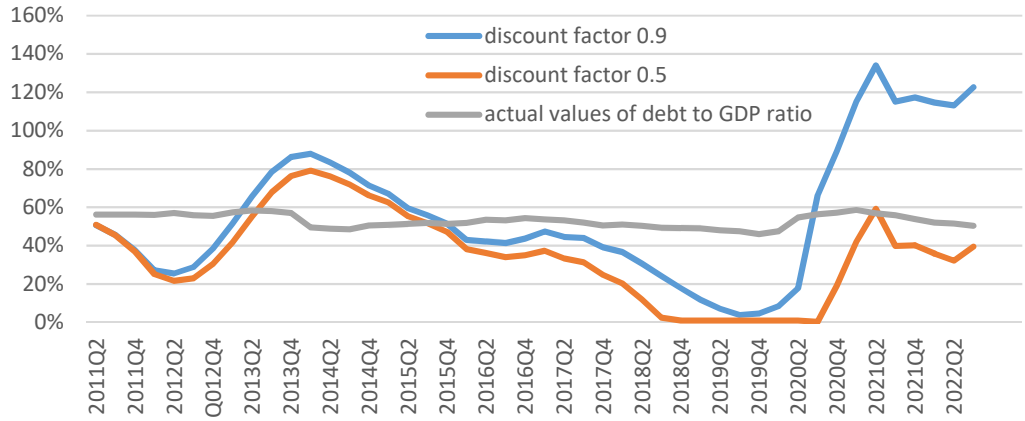

Figure 5. The optimal and actual values of the general government debt-to-GDP ratio in Poland: Case 2
Source: own elaboration.

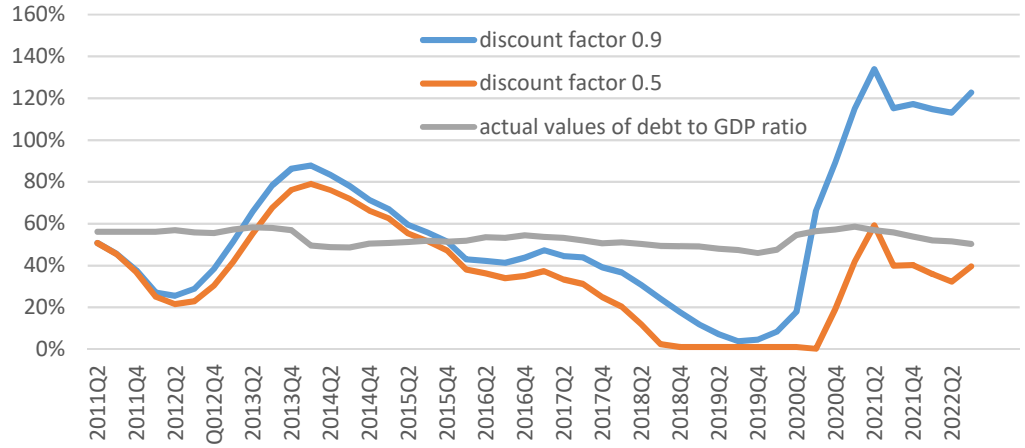

Figure 6. The optimal and actual values of the general government debt-to-GDP ratio in Poland: Case 3
Source: own elaboration.

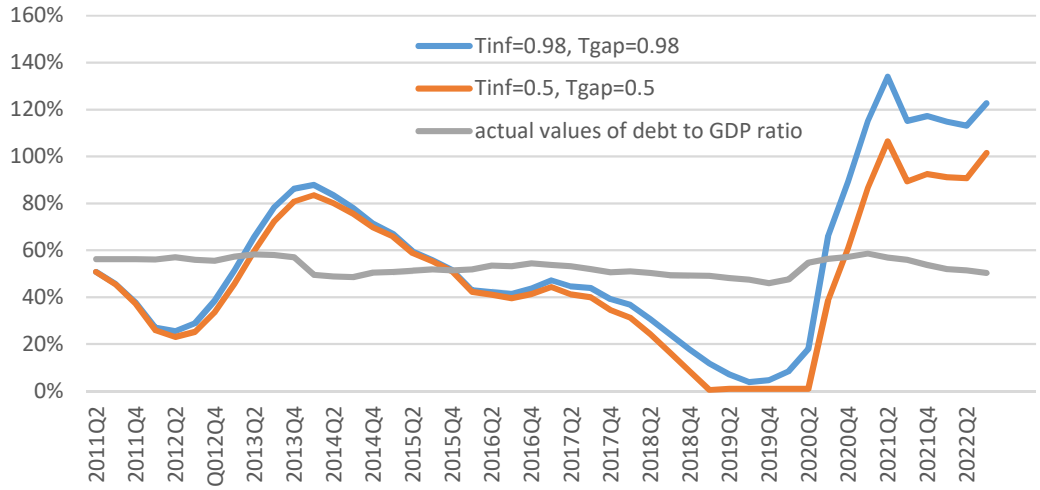

Figure 7. The optimal and actual values of the general government debt-to-GDP ratio in Poland: Case 4
Source: own elaboration.

Supposing lower values of discount factors and wanting to achieve all the predetermined goals, namely, minimising the deviations of the considered variables (debt-to-GDP ratio, inflation rate and output gap) from their target values during various exceptional situations and shocks, a debt-to-GDP ratio close to zero should be maintained during periods of recovery and economic boom. Furthermore, greater values of weight assigned to the debt-to-GDP ratio and greater surplus of financial resources should be generated to achieve the assumed targets in case of exceptional situations.

Considering the optimal values of the debt-to-GDP ratio, we found that assuming a constant value of the debt-to-GDP ratio target of 55%, the achievement of the assumed targets is also influenced by the values of the inflation rate target, the output gap target and the value of the constant trend coefficient in deviations of inflation rate from the inflation target and the constant trend coefficient of output gap from the target. We can note that in these cases and assuming equal weights assigned to individual variables, the fiscal convergence criterion is not possible to fulfill. Then, different values of weights in the loss function should be assigned to individual variables, or an alternative solution would be to replace the constant values in the fiscal convergence criterion with variable values considering the phase of the business cycle or the occurrence of shocks.

CONCLUSIONS

Changing economic conditions and the exceptional situation forced the need for interaction of monetary and fiscal policies (see *e.g.* Chugunov *et al*., 2021; Corsetti *et al*., 2019; Monamodi, 2019). As researchers (*e.g.* Stawska & Miszczyńska, 2022) prove, the monetary and fiscal policy have a significant impact on the economy.

One type of monetary or fiscal policy rules are targeting rules. All researchers determining targeting rules must give an objective function and limiting conditions. Ruge-Murcia (2003) determines the inflation targeting rule as a solution of a game-theoretical model, considering the preferences of monetary policy makers in the objective function. When determining the fiscal targeting rule Reicher (2014) takes into account that consumers seek to maximise the present discounted value of utility subject to a budget constraints.

In this article, we present one of the problems on the basis of which we determine the fiscal targeting rule. We present the results of research in which the determination of fiscal targeting rules was approached using the minimisation problem of intertemporal loss function. The solution presented in the article allows for the determination of the optimal values of macroeconomic fiscal instrument (in this article the general government debt-to-GDP ratio). These values minimise deviations this fiscal

instrument from the target value while also achieving other set goals, such as minimising deviations of the inflation rate and the output gap from their target values.

Based on the obtained results of empirical analysis, we can observe that reducing debt or even maintaining a debt close to zero during good economic times allows for achieving an acceptable, *i.e.* not exceeding 60%, level of the debt-to-GDP ratio during a crisis. This ratio is a measure whose values minimise the deviation from the target value while considering the minimisation of deviations of inflation rate and the output gap from their target values.

The determined optimal values of debt-to-GDP ratio take into account the interactions between macroeconomic fiscal instruments such as the general government debt-to-GDP ratio, the general government balance to GDP ratio, the inflation rate, the output gap, and the monetary policy instrument – the interest rate. The presented findings allow for a positive verification of the first formulated research hypothesis. Therefore, we can control the debt-to-GDP ratio while considering the values of other variables such as the inflation rate and GDP dynamics.

Furthermore, when we incorporated various variables in the fiscal targeting rule that influence the decision to activate the general escape clause in the fiscal rule we eliminated this necessity. That allows for the application of the determined fiscal targeting rule even in exceptional situations and a positive verification of the second hypothesis. If the presented fiscal targeting rule is applied, it is possible to obtain the debt-to-GDP ratio close to zero in times when there are not exceptional situations and the economic situation is good. Therefore, it would not be necessary to activate a general escape clause making it possible to increase general government expenditures to eliminate the negative effects of exceptional situations. Moreover the budget surpluses may be used to at least partially cover the costs resulting from the exceptional events.

However, it is important to note certain limitations in the research resulting from the schedule of quarterly data publications regarding the inflation rate and GDP dynamics, and thus the availability of real data concerning these variables necessary for determining the optimal values of the debt-to-GDP ratio. Therefore, to determine the optimal value of the general government debt-to-GDP ratio in the current quarter, preliminary the estimates of the inflation rate and GDP dynamics must be utilised. On the other hand, when we can calculate the forecasts of optimal values of debt-to-GDP ratio, we have to consider the forecasts of the inflation rate, GDP dynamics and interest rate, which are burdened with a certain error affecting the optimal value of the considered macroeconomic fiscal instrument.

The research led to the following implication for policy makers. To minimise the intertemporal loss function, a portion of the financial resources accumulated during non-exceptional periods should be utilised during crises and shock events. To achieve the lowest possible optimal value of the debt-to-GDP ratio that minimises – in addition to the deviation of the debt-to-GDP ratio from the target of 55% – the deviation of the inflation rate from the target of 2.5% and the output gap from the target of 0%, the deviation of the debt-to-GDP ratio should be assigned the highest weight. If we assume equal weights for all variables, the optimal values of the debt-to-GDP ratio have the highest values. Policy makers should consider that the value of the assumed output gap target have a significant role in determining the optimal value of the debt-to-GDP ratio. The lowest optimal values of the debt-to-GDP ratio can be achieved if the objective is GDP equal to potential GDP, *i.e.* output gap equals to 0%. Moreover, there is no need to discuss changing the inflation target in the context of determining the optimal value of the debt-to-GDP ratio because changing the value of the inflation target does not lead to significant changes in the optimal value of the debt-to-GDP ratio. Moreover, the optimal values of the debt-to-GDP ratio are the smallest when policy makers consider the lowest possible value of the discount factor. To obtain the lowest possible optimal values of the debt-to-GDP ratio, policy makers should assume the lowest possible values of the constant trends of deviations of inflation rate from the inflation target and values of the constant output gap from the target.

We can also observe that in certain cases, the fiscal convergence criterion may not be fulfilled. Therefore, this research allows decision-makers to assess whether the objective of achieving fiscal convergence regarding the general government debt-to-GDP ratio is achievable at a given point in time.

Thus, it seems advisable to conduct research to examine whether changing the constant value into the variable value in the convergence criteria, considering the phase of the business cycle, allows for

the fulfillment of the fiscal convergence criterion during different phases of the business cycle. Moreover, suggestion for future research is the determination of fiscal target rules considering another model as a constraint in the optimisation problem or another objective function. Other mathematical optimisation methods can be used to determine fiscal targeting rules.

REFERENCES

Afonso, A., & Jalles, J.T. (2013). Growth and productivity: The role of government debt. *International Review of Economics & Finance*, *25*(C), 384-407. https://doi.org/10.1016/j.iref.2012.07.004

Aimola Akingbade, U., & Odhiambo, N.M. (2020, June). Public Debt and Inflation: A Review of International Literature. *Folia Oeconomica Stetinensia*, *20*(1), 9-24. https://doi.org/10.2478/foli-2020-0001

Auerbach, A.J., & Gorodnichenko, Y. (2012). Measuring the Output Responses to Fiscal Policy. *American Economic Journal: Economic Policy*, *4*(2), 1-27. https://doi.org/10.1257/pol.4.2.1

Barbier-Gauchard, A., Baret, K., & Minea, A. (2021). National fiscal rules and fiscal discipline in the European Union. *Applied Economics*. *Taylor & Francis Journals*, *53*(20), 2337-2359. https://doi.org/10.1080/00036846.2020.1859453

Barnichon, R., Debortoli, D., & Matthes, C. (2022, January). Understanding the size of the government spending multiplier: It's in the sign. *The Review of Economic Studies*, *89*(1), 87-117. https://doi.org/10.1093/restud/rdab029

Barnichon, R., & Mesters, G. (2021). Fiscal targeting. *(Economics Working Papers No. 1793).* Department of Economics and Business, Universitat Pompeu Fabra. Retrieved from https://econ-papers.upf.edu/papers/1793.pdf on May 2, 2023.

Battaglini, M., & Coate, S. (2016). A political economy theory of fiscal policy and unemployment. *Journal of the European Economic Association*, *14*(2), 303-337. https://doi.org/10.1111/jeea.12136

Beetsma, R.M.W.J., & Jensen, H. (2005). Monetary and fiscal policy interactions in a micro-founded model of a monetary union. *Journal of International Economics*, *67*(2), 320-352. https://doi.org/10.1016/j.jinteco.2005.03.001

Bon, N.V. (2015). The Effects of Public Debt, Inflation, and their Interaction on Economic Growth in Developing Countries: Empirical Evidence Based on Difference Panel GMM. *Asian Journal of Empirical Research*, *5*(11), 221-236. Retrieved from https://archive.aessweb.com/index.php/5004/article/view/3868 on May 4, 2023.

Caselli, F., & Reynaud, J. (2020). Do fiscal rules cause better fiscal balances? A new instrumental variable strategy. *European Journal of Political Economy*, Elsevier, *63*(C). https://doi.org/10.1016/j.ejpoleco.2020.101873

Caselli, F., & Wingender, P. (2021). Heterogeneous effects of fiscal rules: The Maastricht fiscal criterion and the counterfactual distribution of government deficits. *European Economic Review*, 136. https://doi.org/10.1016/j.euroecorev.2021.103748

Canzoneri, M., Collard, F., Dellas, H., & Diba, B. (2016). Fiscal Multipliers in Recessions. *Economic Journal*, *26*(590), 75-108. Retrieved from http://www.jstor.org/stable/24738145 on May 2, 2023.

Chugunov, I., Pasichnyi, M., Koroviy, V., Kaneva, T., & Nikitishin, A. (2021). Fiscal and monetary policy of economic development. *European Journal of Sustainable Development*, *10*(1), 42. https://doi.org/10.14207/ejsd.2021.v10n1p42

Ciżkowicz-Pękała, M., Grostal, W., Niedźwiedzińska, J., Skrzeszewska-Paczek, E., Stawasz-Grabowska, E., Wesołowski, G., & Żuk, P. (2019). Three decades of inflation targeting (NBP Working Paper No. 314). Narodowy Bank Polski, Warsaw.

Corsetti, G., Dedola, L., Jarocinski, M., Maćkowiak, B., & Schmidt, S. (2019). Macroeconomic stabilization., monetary-fiscal interactions, and Europe's monetary union. *European Journal of Political Economy*, *57*, 22-33. https://doi.org/10.1016/j.ejpoleco.2018.07.001

Danninger, S. (2002). A New Rule: "The Swiss Debt Brake" (IMF Working Paper No. 02/18). Retrieved from https://ssrn.com/abstract=879354 on April 2, 2023.

Debrun, X., & Jonung, L. (2019). Under threat: Rules-based fiscal policy and how to preserve it. *European Journal of Political Economy*, *57,* 142-157. https://doi.org/10.1016/j.ejpoleco.2018.09.001

European Union. (1992). Treaty on European Union, 92/C 191/01, European Communities. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AC%3A1992%3A191%3ATOC on April 3, 2023.

European Union. (2006, December 29). Consolidated versions of the Treaty on European Union and of the Treaty Establishing the European Community, Official Journal of the European Union, CE 321, *49*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=OJ%3AC%3A2006%3A321E%3ATOC on April 3, 2023.

European Union. (2012, October 26). Consolidated version of the Treaty on the Functioning of the European Union, Official Journal of the European Union, 2012/C 326/01, 47-390. Retrieved from http://data.europa.eu/eli/treaty/tfeu_2012/oj on April 3, 2023.

European Union. (2011). Regulation, 1175/2011. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32011R1175 on April 3, 2023.

European Union. (2011). Regulation, 1177/2011. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32011R1177 on April 3, 2023.

European Union. (2011, November 23). Regulation (EU) No 1175/2011 of the European Parliament and of the Council of 16 November 2011 amending Council Regulation (EC) No 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies. *Official Journal of the European Union*, L 306/12. Retrieved from http://data.europa.eu/eli/reg/2011/1175/oj on April 3, 2023.

European Union. (2012). Treaty on Stability, Coordination and Governance in the Economic and Monetary Union. Document 42012A0302(01). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A42012A0302%2801%29 on April 3, 2023.

Eyraud, L., Debrun, M.X., Hodge, A., Lledo, V.D., & Pattillo, M.C.A. (2018). Second - generation fiscal rules: Balancing simplicity, flexibility, and enforceability. (IMF Staff Discussion Notes No. 2018/04). International Monetary Fund. Retrieved from https://www.imf.org/external/datamapper/fiscalrules/sdn1804-on-second-generation-fiscal-rules.pdf on April 3, 2023.

Faraglia, E., Marcet, A., Oikonomou, R., & Scott, A. (2013). The impact of debt levels and debt maturity on inflation. *The Economic Journal*, *123*(566), F164-F192. Retrieved from http://www.jstor.org/stable/23470573 on April 3, 2023.

Fatás, A., Ghosh, A.R., Panizza, U., & Presbitero, A.F. (2019, May). The motives to borrow. (IMF Working Paper No WP/19/101). Retrieved from https://www.imf.org/-/media/Files/Publications/WP/2019/WPIEA2019101.ashx on April 3, 2023.

Gali, J., & Monacelli, T. (2008). Optimal monetary and fiscal policy in a currency union. *Journal of International Economics*, *76*(1), 116-132. https://doi.org/10.1016/j.jinteco.2008.02.007

Halac, M., & Yared, P. (2014). Fiscal rules and discretion under persistent shocks. *Econometrica*, *82*(5), 1557-1614. https://doi.org/10.3982/ECTA11207

Halac, M., & Yared, P. (2022). Fiscal rules and discretion under limited enforcement. *Econometrica*, *90*(5), 2093-2127. https://doi.org/10.3982/ECTA16962

Hammond, G. (2012, April). State of the art. Inflation targeting. Handbooks. Centre for Central Banking Studies, Bank of England, 29.

Klucznik, M., Marczewski, K., Rybacki, J., & Sawulski, J. (2021). Nowy policy mix. Relacje między polityką pieniężną i fiskalną – wnioski po kryzysie (Policy Paper No. 6). Polski Instytut Ekonomiczny, Warszawa.

Larch, M., Malzubris, J., & Santacroce, S. (2023). Numerical Compliance with EU Fiscal Rules: Facts and Figures from a New Database. *Intereconomics Review of European Economic Policy*, *58*(1), 32-42. https://doi.org/10.2478/ie-2023-0008

Monamodi, N. (2019). The Impact of Fiscal and Monetary Policy on Economic Growth in Southern African Custom Union (SACU) Member Economies between 1980 and 2017: A Panel ARDL Approach. https://doi.org/10.2139/ssrn.3480082

Obstfeld, M. (2013). On keeping your powder dry: Fiscal foundations of financial and price Stability (IMES Discussion Paper Series No. 13-E-08). Institute for Monetary and Economic Studies, Bank of Japan.

Pappa, E., & Vassilatos, V. (2007). The unbearable tightness of being in a monetary union: Fiscal restrictions and regional stability. *European Economic Review*, *51*(6), 1492-1513. https://doi.org/10.1016/j.euroecorev.2006.10.006

Poland. (2003. February 25). Resolution No. 2/2003 of the Monetary Policy Council of February 25, 2003 on the "Strategy of Monetary Policy after 2003". *Journal of Laws of Narodowy Bank Polski* 2003.4.4.

Poland. (2009). Ustawa z dnia 27 sierpnia 2009 r. o finansach publicznych. Dz. U. 2009 Nr 157 poz. 1240. Retrieved from https://eli.gov.pl/eli/DU/2009/1240/ogl on April 3, 2023.

Poland. (2020). Ustawa z dnia 28 maja 2020 r. o zmianie ustawy o finansach publicznych. Dz.U. 2020 poz. 1175. Retrieved from https://eli.gov.pl/eli/DU/2020/1175/ogl on April 3, 2023.

Przybylska-Mazur, A. (2016). Fiscal Rules as Instrument of Economic Policy. In: *Wrocław Conference in Finance: Contemporary Trends and Challenges* (Research Papers of Wrocław University of Econmics No. 428), 207-216. https://doi.org/10.15611/pn.2016.428.18

Przybylska-Mazur, A. (2017). The brake public debt rule as an instrument to stabilize the debt – results for Poland. In A. Gardoń, C. Kozyra, & E. Mazurek (Eds.). Conference Proceedings Application of Mathematics and Statistics in Ecoomics. Publishing House of Wrocław University of Economics, *428*, 365-372. https://doi.org/10.15611/amse.2017.20.30

Reicher, C.A. (2014). Fiscal targeting rules and macroeconomic stability under distortionary taxation (Kiel Working Papers No. 1968).

Romero, J.P.B., & Marin, K.L. (2017). Inflation and public debt. *Monetaria*, *5*(1), 39-94.

Romer, C.D., & Romer, D.H. (2018). Why some times are different: Macroeconomic policy and the aftermath of financial crises. *Economica*, *85*(337), 1-40. https://doi.org/10.1111/ecca.12258

Ruge-Murcia, F.J. (2003). Inflation Targeting under Asymmetric Preferences. *Journal of Money, Credit and Banking*, *35*(5), 763-785. Retrieved from http://www.jstor.org/stable/3649827 on April 3, 2023.

Salmon, J., & de Rugy, V. (2020, April 5). Debt and Growth: A Decade of Studies. (Mercatus Research Paper). https://doi.org/10.2139/ssrn.3690510

Stawska, J., & Miszczyńska, K. (2022). The impact of monetary and fiscal policy variables on the EU economic growth. Panel data analysis. *Entrepreneurship and Sustainability Issues, 9*(4), 380-395. https://doi.org/10.9770/jesi2022.9.4(20)

Stawska, J., Malaczewski, M., Malaczewska, P., & Stawasz-Grabowska, E. (2023). The central bank or the government – who really dictates the terms of the policy-mix cooperation in economies with an independent monetary policy?. *Economic Research-Ekonomska Istraživanja*, *36*(2). https://doi.org/10.1080/1331677X.2022.2142258

Sudoł, S. (2007). Nauki o zarządzaniu. Węzłowe problemy i kontrowersje. Dom Organizatora TNOiK Toruń, 70-72. https://doi.org/2007.10/2014/188

Svensson, L.E.O. (1996). How should monetary policy respond to shocks while maintaining longrun price sability?. *Conceptual issues (commentary). Proceedings – Economic Policy Symposium -Jackson Hole. Federal Reserve Bank of Kansas City*, 209-227. Retrieved from http://www.kansascityfed.org/PUBLICAT/SYMPOS/1996/pdf/s96sven.pdf on April 3, 2023.

Svensson, L.E.O. (1999, June). Inflation targeting as a monetary policy rule. *Journal of Monetary Economics*, *43*(3), 607-654. https://doi.org/10.1016/S0304-3932(99)00007-0

Taylor, J.B. (1993, December). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, *39*, 195-214. https://doi.org/10.1016/0167-2231(93)90009-L

Wieland, V. (1996). Monetary Policy Targets and the Stabilization Objective: A Source of Tension within the EMS. *Journal of International Money and Finance*, *15*(1), 95-116. https://doi.org/10.1016/0261-5606(95)00047-X

Woodford, M. (2011). Simple Analytics of the Government Expenditure Multiplier. *American Economic Journal Macroeconomics*, *3*(1), 1-35. https://doi.org/10.1257/mac.3.1.1

Woźny, Ł. (2006). *Handout z dynamicznej optymalizacji*. Retrieved from e-sgh.pl/niezbednik/plik.php?id=715&pid=171 on April 3, 2023.

Wyplosz, C. (2012). Fiscal rules: Theoretical issues and historical experiences. NBER Chapters, in: Fiscal policy after the financial crisis, National Bureau of Economic Research, Inc, 495-525.

Valencia, O.M., Gómez-González, J.E., & Sánchez, G.A. (2022, May). Debt affordability in developed and emerging market economies: The role of fiscal rules (IDB Working Paper Serie No. 1344). Inter - American Development Bank. https://doi.org/10.18235/0004267

Yared, P. (2019). Rising Government Debt: Causes and Solutions for a Decades-Old Trend. *Journal of Economic Perspectives*, *33*(2), 115-40. https://doi.org/10.1257/jep.33.2.115

Author

Agnieszka Przybylska-Mazur
Associate Professor at Department of Statistical and Mathematical Methods in Economics, University of Economics in Katowice (Poland). Her research interests include quantitative methods in economics and finance, fiscal policy, monetary policy, forecasting inflation.
Correspondence to: Dr hab. Agnieszka Przybylska-Mazur, prof. UE, University of Economics in Katowice, Faculty of Economics, Department of Statistical and Mathematical Methods in Economics, ul. 1 Maja 50, 40-287 Katowice, Poland, e-mail: agnieszka.przybylska-mazur@ue.katowice.pl
ORCID http://orcid.org/0000-0001-6889-0060

Acknowledgements and Financial Disclosure

This article has been presented as the paper at the scientific conference LIX Konferencja Statystyków, Ekonometryków i Matematyków Polski Południowej (SEMPP) organised on 21-23 March 2023 by Krakow University of Economics.

Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright and License

Published by Krakow University of Economics – Krakow, Poland

Ministry of Education and Science
Republic of Poland

The journal is co-financed in the years 2022-2024 by the Ministry of Education and Science of the Republic of Poland in the framework of the ministerial programme “Development of Scientific Journals” (RCN) on the basis of contract no. RCN/SP/0251/2021/1 concluded on 13 October 2022 and being in force until 13 October 2024.