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ANALYSIS OF THE INFLUENCE OF SELECTED MACROECONOMIC VARIABLES ON THE PUBLIC DEBT OF SERBIA

Abstract: Controlling public debt is one of the most significant challenges faced by contemporary states. The aim of this study is to examine the relationship between the level of public debt and selected macroeconomic variables in the Republic of Serbia. The empirical analysis, based on annual data from 2006 to 2023, includes, in addition to the public debt as a percentage of gross domestic product as a dependent variable, four selected macroeconomic indicators incorporated into the model as independent variables. For the purpose of the analysis, E-views and Stata software were used. Descriptive statistics were initially presented, followed by a series of diagnostic tests such as unit root test and the derivation of the correlation matrix to reject hypotheses of non-stationarity and multicollinearity. Finally, the Ordinary Least Squares (OLS) method was applied to interpret the effects of independent variables on the dependent variable. The research results can be significant for policymakers in defining activities aimed at maintaining the stability of public debt.

Keywords: public debt, Serbia, macroeconomic variables.

1. INTRODUCTION

Controlling public debt is one of the most significant challenges faced by contemporary states. Therefore, an evaluation of factors affecting debt dynamics and debt sustainability is vital for designing prudent macroeconomic policy for any economy. There is no country whose fiscal stability is not affected by the geopolitical and economic crisis, especially underdeveloped and developing countries. The Republic of Serbia, like most countries in the region, is a developing country that was affected by the crisis caused by the COVID-19 pandemic as well as the war in Ukraine. Crises result in the destabilization of public finances, where most often there is a decrease in state income with an increase in state expenditures and the need for public borrowing. In the last few years, the issue of the level and sustainability of public debt in Europe has been raised because it is extremely important in the context of achieving and maintaining macroeconomic stability. Public debt in the Republic of Serbia reached its peak of 70% of gross domestic product (GDP) in 2015, after which it declined due to fiscal consolidation. By the end of 2019, public debt amounted to 51.9% of GDP. In 2020, once again, there was an increase in the debt-to-GDP ratio, followed by its stabilization and a more moderate decline over the period 2021–2023.

The aim of this study is to examine the relationship between the level of public debt and selected macroeconomic variables in the Republic of Serbia.

The paper is constructed as follows: After the introduction, the second part of the paper provides an overview of the literature, which presents research on the influence of various macroeconomic variables on public debt. The third part gives a description of the methodology and data used to examine the relationship between public debt, primary balance, interest rate, GDP growth, and stock-flow adjustment in the Republic of Serbia. The fourth and most important part of

the paper includes the results of the econometric models. The paper ends with a summary containing the main conclusions of the research and considerations for future research on this topic.

2. LITERATURE REVIEW

The existing literature on public debt determinants shows that the factors that can affect public debt are macroeconomic, political, institutional, and structural variables. The empirical studies estimating the main determinants of public debt remain scarce and limited. In this context, Pirtea, Nicolescu, and Mota (2013) analyze the factors that influence the debt-to-GDP ratio in Romania. They found that the primary fiscal balance, the real interest rate, the real GDP growth rate, and the exchange rate are significant factors. The same results were found by Dumitrescu (2014). A study conducted by Belguith and Omrane (2019) revealed that Tunisia`s state debt is mostly determined by the primary deficit. Abdul (2006) used an econometric approach to analyze the domestic debt of Pakistan by determining various factors responsible for the growth of domestic debt. The sample period for estimation was from 1991 to 2002. The ordinary least squares (OLS) method was used to estimate the parameters of the equation. The results of the study confirmed that the primary balance and interest rate payments were relevant in explaining the accumulation of domestic debt in Pakistan during the period under study. Abbas et al. (2013) suggest that the structural primary budget balance and economic growth are the key determinants of large previous public debt reductions in the analyzed advanced economies. The research by Gargouri and Ksantini (2016) was conducted on a sample of 12 European countries and indicated a statistically significant and negative impact of GDP growth on public debt. Pegkas, Staikouras, and Tsamadias (2020) use AMECO data and find that there is a negative long-run effect of public debt on growth. The results indicate that there is long-run bidirectional causality between public debt and growth. The sample includes twelve Eurozone countries. The authors recommend that Eurozone countries base their growth strategies on fiscal consolidation. Abubakar and Mamman (2020) use a two-stage least squares regression to estimate a model analyzing the effects of public debt on economic growth in 37 OECD countries. The authors examine the permanent versus transitory effects of public debt on GDP growth. The findings reveal that public debt exerts a significant negative permanent and positive transitory effect on GDP growth. The magnitude of the negative permanent effect of public debt was found to be larger than the positive transitory effect. In addition, while all country groups experienced negative permanent effects, not all country groups experienced positive transitory effects. Employing the two-stage least squares methodology, Ghourchian and Yilmazkuday (2020) compare the effects of public debt on economic growth in 83 countries from 1960 to 2014. The results reveal that a 1% increase in the debt-to-GDP ratio would reduce real GDP growth by about 0.01%, on average across countries. Checherita-Westphal and Rother (2012) use a two-stage least squares regression model with a control variable for fiscal balance and long-term real interest rates, among other factors. The authors analyze the impact of public debt on per capita GDP growth in 12 Euro Area countries from 1970 to 2011. They find a nonlinear impact of public debt on GDP growth with a turning point—beyond which the debt-to-GDP ratio has a deleterious impact on long-term growth—at about 90 to 100 percent of GDP. Eberhardt and Presbitero (2015) use OLS regressions to model the potential nonlinearity within and across countries in the debt-growth relationship. Observing a large dataset of 118 countries from 1961 to 2012, the authors find some support for a negative relationship between public debt and long-run growth across countries but no evidence for a similar, let alone common, debt threshold within countries. The properties of stock-flow adjustments have been studied in an early strand of literature, finding that they are nearly always and everywhere of relevant size. Campos, Jaimovich, and Panizza (2006) found that stock-flow adjustments are as important as government deficits in explaining fluctuations in government debt. Similar results were found by Abbas et al. (2011). Afonso and Jalles (2020) assess how stock-flow adjustments affect the debt-to-GDP ratio in 65 countries between 1985 and 2014. They found that stock-flow adjustments positively contribute to the change in the debt-to-GDP ratio with a coefficient close to one. So far, the literature has provided strong evidence that stock-flow adjustments are not purely erratic processes, being influenced by several macroeconomic variables such as output, inflation, and debt.

3. MATERIAL AND METHODS

As previously emphasized, the aim of this study is to examine the relationship between public debt, primary balance, GDP growth, interest rate, and stock-flow adjustment in the Republic of Serbia. In this chapter, the authors define the dependent and independent variables used in this study and state the hypotheses and main models that are the subject of testing, as well as the formulas of the diagnostic test used.

3.1. Data description

The empirical analysis, based on annual data from 2006 to 2023, includes, in addition to the public debt as a percentage of gross domestic product as a dependent variable, four selected macroeconomic indicators incorporated into the model

as independent variables. All the data used was downloaded from the website of the Ministry of Finance of the Republic of Serbia. The description of variables is provided in Table 1.

Table 1: Description of the researched variables

Variable name	Notation	Calculation	Role of variable
Public debt	PD	% of GDP	Dependent
Primary balance	PB	% of GDP	Independent
GDP growth rate	GDP	Annual %	Independent
Interest rate	IR	Annual %	Independent
Stock-flow adjustment	SFA	% of GDP	Independent

Source: Authors

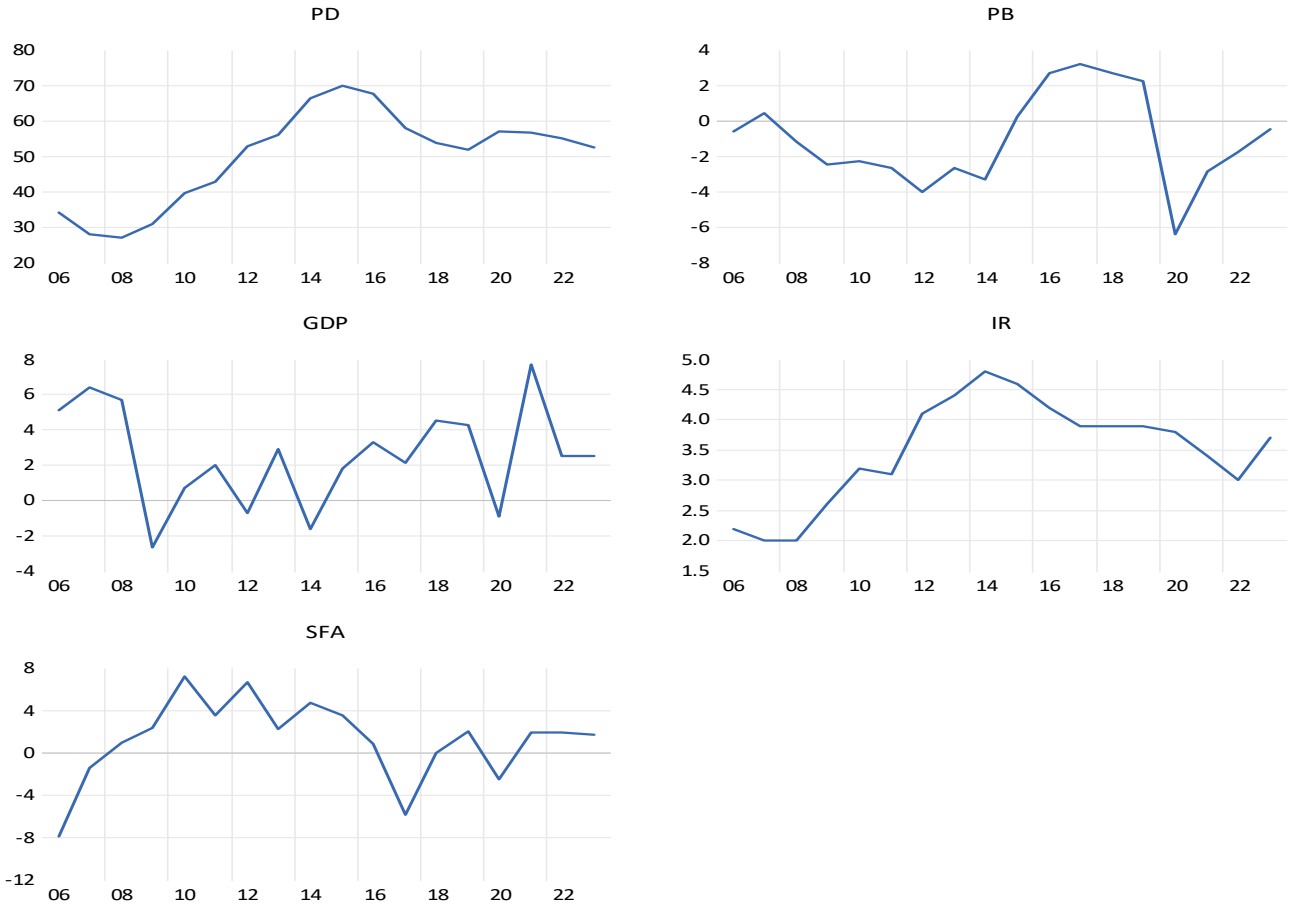
The interest rate (annual%) is calculated as the ratio between total interest payments at time t and the public debt stock at time t-1. Stock-flow adjustment (also known as debt-deficit adjustment) measures the difference between the overall fiscal balance and change in public debt, which in theory should be equal according to the underlying macroeconomic identity of debt accumulation. In reality, the sum of liabilities incurred never matches the overall fiscal balance. Stock-flow adjustment is generally a measurable variable, consisting of net flows of financial assets and other adjustments (transactions in financial derivatives, liabilities, impact of appreciation and depreciation of foreign currency on debt denominated in that currency, etc.), but the problem is that these data are not publicly available in Serbia. The calculation of the stock-flow adjustment is presented in Table 2.

Table 2: Stock-flow adjustment 2006-2023

In billions RSD	2006.	2007.	2008.	2009.	2010.	2011.	2012.	2013.	2014.
Public debt	738.81	703.25	778.04	944.41	1,282.54	1,547.51	2,014.75	2,309.04	2,753.20
Primary balance	-12.05	11.31	-34.26	-76.46	-74.13	-96.52	-150.73	-112.98	-139.00
Interest payments	19.28	14.81	13.88	20.02	30.13	40.34	63.15	89.26	110.36
Change in public debt	-140.36	-35.56	74.79	166.37	338.13	264.97	467.24	294.29	444.16
Stock-flow adjustment	-171.69	-39.06	26.65	69.89	233.87	128.11	253.36	92.05	194.80
Stock-flow adjustment (% of GDP)	-7.87	-1.55	0.92	2.29	7.19	3.55	6.65	2.23	4.68
In billions RSD	**2015.**	**2016.**	**2017.**	**2018.**	**2019.**	**2020.**	**2021.**	**2022.**	**2023.**
Public debt	3,018.59	3,064.61	2,751.12	2,720.20	2,815.64	3,135.79	3,543.24	3,909.89	4,236.15
Primary balance	10.61	120.12	152.01	137.72	119.58	-351.11	-179.18	-129.81	-41.25
Interest payments	125.76	128.07	118.16	106.50	106.83	108.07	106.90	105.36	146.59
Change in public debt	265.39	46.02	-313.49	-30.92	95.44	320.15	407.45	366.65	326.26
Stock-flow adjustment	150.24	38.07	-279.64	0.30	108.19	-139.03	121.37	131.48	138.42
Stock-flow adjustment (% of GDP)	3.48	0.84	-5.87	0.01	2.00	-2.53	1.94	1.85	1.71

Source: Authors' calculation based on the annual statistics by the Ministry of Finance of the Republic of Serbia

Picture 1 illustrates the movement of the selected variables in Serbia in the period 2006–2023. Until the global financial crisis, there was a gradual downward trend in public debt; however, there was an increase starting in 2009 and continuing until 2015, followed by a substantial decline. Again, in 2020, due to the crisis caused by the COVID-19 pandemic, there was an increase in public debt, followed by its stabilization and a more moderate decline over the period 2021–2023. The primary balance was in deficit from 2006 to 2014, with the exception of 2007, when a primary surplus was realized. The primary surplus was maintained from 2015 to 2019, followed by a period of primary deficit realization. In most of the observed period, GDP growth rates were positive, with the exception of 2009, 2012, 2014, and 2020, when GDP growth rates were negative due to the impact of the crisis and fiscal consolidation measures. The interest rate on public debt increased from 2.2% in 2006 to 4.8% in 2014, followed by a substantial decline and stabilization over the period 2015–2020. From 2021 to 2022, the interest rate declined from 3.8% to 3.0%, after which it began to rise, reaching 3.7% at the end of 2023. Stock-flow adjustment (calculated in Table 2) had negative values in 2006, 2007, 2017, and 2020, additionally influencing the reduction of public debt, while all other years of the observed period had positive values, additionally influencing the increase of public debt.



Picture 1: Movement of the selected variables in the period 2006-2023
Source: Authors, based on the annual statistics by the Ministry of Finance of the Republic of Serbia.

3.2. Hypothesis and tests

The results of the previous theoretical and practical research and studies in this area served us as a basis for the selection of the variables and the initial hypotheses from which we started our research, as well as for drawing conclusions regarding the effect of the selected variables on the public debt of Serbia. The research is based on the following hypotheses:

H01: The primary balance has a significant impact on the public debt of Serbia.
H02: GDP growth has a significant impact on the public debt of Serbia.
H03: The interest rate has a significant impact on the public debt of Serbia.
H04: Stock-flow adjustment has a significant impact on the public debt of Serbia.

For the purpose of the analysis, E-views and Stata software were used. Descriptive statistics were initially presented, followed by a series of diagnostic tests such as the unit root test and the derivation of the correlation matrix to reject hypotheses of non-stationarity and multicollinearity. Finally, the Ordinary Least Squares (OLS) method was applied to interpret the effects of independent variables on the dependent variable.
After defining research hypotheses as well as reviewing the diagnostic tests, the authors derive the following regression model that represents the subject of this study:

$$PD_t = \alpha + \beta_1 PB_t + \beta_2 GDP_t + \beta_3 IR_t + \beta_4 SFA_t + \epsilon_t \qquad (1)$$

Where:

- PDt, as a dependent variable, is the level of public debt as a percentage of GDP at time t.
- PB_t is the primary balance as a percentage of GDP at time t.
- GDP_t is the annual GDP growth rate in% at time t.
- IR_t is the annual interest rate in% at time t.
- SFA_t is stock-flow adjustment as a percentage of GDP at time t.
- ϵ_t is the white noise process.

4. RESULTS AND DISCUSSION

In the first stage of the analysis, the authors present descriptive statistics of the selected variables. The descriptive analysis presented in Table 3 shows that the highest amount of standard deviation (13.36%) is present in the public debt variable, which means that there is the largest spread between the minimum and maximum values of the indicator. The arithmetic mean of the public debt variable in the period from 2006 to 2023 in the Republic of Serbia is 49.93%, which could conditionally be taken as an indicator of the sustainability of the public debt in the analyzed period because it is below the limit determined by the Maastricht criteria. The average primary budget balance is in deficit and amounts to -1.08%, while the average GDP growth rate, interest rate, and stock-flow adjustment amount to 2.53%, 3.49%, and 1.19%, respectively.

Table 3: Descriptive statistics of the selected variables

Variables	Obs	Mean	Std. Dev.	Min	Max
PD	18	49.93333	13.35660	26.80000	70.00000
PB	18	-1.083333	2.616745	-6.400000	3.200000
GDP	18	2.533333	2.839428	-2.700000	7.700000
IR	18	3.488889	0.863569	2.000000	4.800000
SFA	18	1.188889	3.819130	-7.900000	7.200000

Source: Authors, Stata 13.0

One of the main conditions for performing a correct regression model is the absence of multicollinearity among independent variables. In order to prove the absence of multicollinearity, the authors use the correlation matrix as well as the variance inflation factor (VIF) test. Table 4 shows the correlation matrix in which the relationship between the dependent and independent variables is observed. It is noticeable that the level of correlation between the independent variables does not exceed the threshold of 0.80.

Table 4: Correlation matrix

	PD	PB	GDP	IR	SFA
PD	1.0000				
PB	0.0911	1.0000			
GDP	-0.2111	0.4539	1.0000		
IR	0.9147	0.0308	-0.3810	1.0000	
SFA	0.1788	-0.3459	-0.3682	0.3412	1.0000

Source: Authors, Stata 13.0

The VIF test, which shows us whether there is a high correlation between the independent variables, is also one of the necessary tests to check the validity of the data. If the variance inflation factor exceeds the threshold value of 10, the data is multicollinear and must be omitted from the regression model. According to Lin, Foster, and Ungar (2011), the VIF test was utilized for the analysis, and the computed regression is as follows:

$$VIF = 1 / (1 - R_j^2) \quad (2)$$

Where:

- VIF is the variance inflation factor.
- R_j^2 is the R square of the regression model.

The results of the VIF test presented in Table 5 show that there is no problem with multicollinearity of the used variables since the calculated value of VIF does not exceed the threshold value of 10.

Table 5: Variance inflation factor

Variables	VIF	1/VIF
PB	1.47	0.682558
GDP	1.58	0.630941
IR	1.37	0.728655
SFA	1.34	0.748316
Mean VIF	1.44	

Source: Authors, Stata 13.0

One of the requirements underlying the econometric analysis of time series is stationary data, which is the most crucial requirement for an econometric approach (Mushtaq, 2011). It speaks about time series` mean and variance as constant values. The data is not steady and has a unit root if the p-value is more than 0.05. Since using non-stationary data can lead to an unfavorable regression model (spurious regression), the unit root test is used to eliminate it. The Augmented

Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are applied to identify the order of integration of the variables. Table 6 summarizes the test results. According to the unit root test results, all the variables except the public debt and interest rate are stationary at level because the probability does not exceed the 5% significance level, while the public debt and interest rate data become stationary after performing the first difference.

Table 6: Unit root test

Variables	Level		1st difference	
	ADF	PP	ADF	PP
PD	0.133327 (0.7108)	0.199833 (0.7319)	-2.341890 **(0.0228)***	-2.461569 **(0.0176)***
PB	-2.090079 **(0.0385)***	-2.135113 **(0.0351)***	-4.376313 (0.0002)	-4.376313 (0.0002)
GDP	-4.093887 **(0.0066)***	-4.101391 **(0.0065)***	-4.943150 (0.0017)	-9.526304 (0.0000)
IR	0.440508 (0.7981)	0.357502 (0.7765)	-2.759599 **(0.0091)***	-2.752467 **(0.0092)***
SFA	-2.982877 **(0.0053)***	-3.009849 **(0.0050)***	-5.580088 (0.0000)	-5.869345 (0.0000)

Source: Authors, EViews 12

After diagnostic tests of multicollinearity and unit root, the authors use the OLS method to derive an adequate regression model. The results of OLS regression are presented in Table 7.

Table 7: Regression model

Variables	OLS
PB	**-0.812093** **(0.0011)***
GDP	**-0.702646** **(0.0040)***
DIR	-1.235957 (0.4098)
SFA	**1.044284** **(0.0001)***
C	0.162649 (0.8326)
R - squared	**0.928404**
Prob.	**0.000001**

Source: Authors, EViews 12

Based on the obtained results, we note that the influence of all independent variables, except the interest rate, proved to be statistically significant. Therefore, we cannot reject H01, H02, and H04, while H03 is rejected. It is noticeable that the increase in primary balance and GDP growth by 1% causes a decrease in public debt by 0.812093% and 0.702646%, respectively. The negative impact of primary balance and GDP growth is supported by studies such as Pirtea et al. (2013), Dumitrescu (2014), and Swamy (2020). The increase in stock-flow adjustment by 1% causes an increase in public debt by 1.044284%. The R-squared indicator of the regression model indicates that the given variables describe more than 92% of the changes in the public debt variable. The probability of the regression model is statistically significant ($p < 0.05$), which indicates that the model explains a significant amount of variance in the dependent variable.

5. CONCLUSION

The main goal of this study was to examine the impact of selected variables on Serbian public debt in the period from 2006 to 2023 by employing the OLS regression model. Our results of the coefficients assessment using the OLS approach indicate that the positive primary balance and GDP growth can affect the decrease in public debt. Therefore, we cannot reject H01 and H02. The results, which outline the importance of the impact of primary balance and GDP growth on the decrease of public debt, are in line with economic theory. Further, our results indicate that the interest rate has a negative coefficient and is not statistically significant, while stock-flow adjustment has a positive coefficient and a statistically significant influence on the public debt. Therefore, we reject H03, while H04 cannot be rejected. Considering that stock-flow adjustment is a synthetic indicator, the analysis of its composition deserves special attention in the future. The regression is significant, and the signs of the main explanatory variables are those that are

expected. This study provides an empirical basis for a better understanding of the dynamics of public debt and its main drivers and can be significant for policymakers in defining activities aimed at maintaining the stability of public debt. The research conducted has certain limitations since the analysis was carried out in one country and covered a rather short period of time. The author's suggestion for future research is the use of a larger number of countries that will be included in panel regression analysis, on the basis of which it could be concluded about the influence of the most important factors on the level of public debt in crisis conditions.

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