www.sjm06.com

Serbian Journal of Management 19 (2) (2024) 485 - 499

Serbian Journal of Management

PUBLIC DEBT MANAGEMENT IN SERBIA DURING TRANSITION, GREAT RECESSION AND COVID-19 PANDEMIC

Vladimir Andrić*

Institute of Economic Sciences, Zmaj Jovina 12, 11000 Belgrade, Serbia

(Received 15 August 2024; accepted 15 October 2024)

Abstract

This paper examines the nonlinear asymmetric behaviour of the public debt/GDP ratio in Serbia in the first two decades of economic transition following the political and market reforms started at the beginning of the twenty-first century. Using quarterly data for the government debt-to-GDP ratio, a two-regime self-exciting threshold autoregressive (SETAR) model of order one finds a public debt/GDP ratio threshold of 66.2% above which fiscal policymakers in Serbia take corrective action in the form of increased fiscal prudence. The estimated government debt/GDP ratio threshold corresponds to a 60% threshold from the Maastricht fiscal criteria and shows how fiscal authorities in Serbia systematically ignore the 45% public debt/GDP limit set in the national fiscal rules. Such fiscal policy behaviour could jeopardize the credibility of fiscal institutions in Serbia and have a negative impact on fiscal discipline and the likelihood of sovereign default.

Keywords: public debt management, Great Recession, COVID-19, SETAR model, Serbia

1. INTRODUCTION

At the end of the second quarter of the 2023 fiscal year, when the World Health Organization (WHO) officially announced the global end of the COVID-19 pandemic, the government debt of Serbia corresponded to approximately 55% of GDP (Andric, 2024). Although the government debt-to-GDP ratio of 55% meets the fiscal criteria from Maastricht Treaty, it is still ten percentage points above the national fiscal threshold of 45% sovereign debt/GDP ratio (Andric, 2024). In the context of the global COVID-19 pandemic, Davoodi et al. (2022) show that it has been exceedingly difficult to reverse deviations from the public debt limits. The inability of fiscal policy makers to steer the dynamics of sovereign debt towards the national fiscal rule thresholds might be potentially worrisome given the new findings of Badia et al. (2022) who argue that the likelihood of default in developing economies goes up when the

* *Corresponding author: vladimir.andric@ien.bg.ac.rs*

DOI: 10.5937/sjm19-52982

sovereign debt/GDP ratio is above 40%. The findings of Badia et al. (2022) go hand in hand with earlier OECD results (Fall et al., 2015), which find a negative relationship between public debt and GDP growth when the government debt-to-GDP ratio is higher than 50%.

Given the potentially negative impact that the level of government debt[1] could have on the probability of sovereign default and economic growth, this paper asks whether there is a non-linear threshold adjustment in the trajectory of sovereign debt-to-GDP ratio after 2001Q1. The results of the paper suggest that fiscal policymakers in Serbia take corrective action once public debt reaches about 66% of GDP. The estimated non-linear two-regime self-exciting threshold autoregressive (SETAR) model of order one captures a higher degree of fiscal prudence once the sovereign debt-to-GDP ratio breaches the 66% government debt/GDP threshold. While this result shows credible fiscal policy in the period under study, it also shows that fiscal policymakers adhere to the Maastricht fiscal criteria and do not follow national fiscal rules, which could jeopardize the integrity of fiscal institutions from the perspective of sovereign bond traders and international financial organizations.

The article has the following structure. Section 2 introduces the reader to the main stylized facts about the behaviour of sovereign debt-to-GDP ratio in the Republic of Serbia between 2001Q1 and 2023Q2. Section 3 outlines the econometric methodology, reports the empirical model estimates, presents the findings of robustness checks, and discusses the results. Section 4 provides policy recommendations and suggests avenues for further research.

2. STYLIZED FACTS

This section comprises two subsections. Subsection 2.1. outlines the most important trends in the behaviour of government debt-to-GDP ratio over the last two decades. Subsection 2.2. discusses the persistence of shocks to the public debt/GDP ratio and their importance for the specification of the SETAR model estimates from Section 3. The section builds on Andric (2024) who estimates the SETAR model with respect to the exogenous 45% sovereign debt-to-GDP limit in the case of Serbia after 2001Q1.

2.1. Trends

Figure 1 shows the trajectory of sovereign debt as % of GDP for the period 2001Q1-2023Q2. The first data point (2001Q1) in the sample corresponds to the initiation of market reforms that policy makers launched after the political changes at the end of 2001 (Andric & Minovic, 2018, 2022). The end of the sample (2023Q2) denotes the WHO's announcement of the end of the global COVID-19 pandemic, as in Andric (2024). The government debt data refer to the debt obligations of the central government, which are approximately equal to the debt obligations of the general government because of the relatively low level of indebtedness of the local government[2]. The time series data for GDP, which were compiled in accordance with the SNA 2008/ESA 2010 methodology, come from the Statistical Office of the Republic of Serbia[3]. As in Andric (2024), Figure 1 depicts movements in the trajectory of the government debt/GDP ratio in the Republic of Serbia. First, the reader can see a sharp decline in public debt from around 160% of GDP (2001Q1) to around 25% of GDP

[1]Throughout the article, I shall use the terms „public ", „government" and „sovereign" debt as synonyms.
[2]For details, see various monthly, publicly available (https://www.mfin.gov.rs/en/activities/bulletin-public-finance-2), issues of the Public Finance Bulletin printed by the Ministry of Finance of the Republic of Serbia
[3]Visit https://data.stat.gov.rs/Home/Result/09020202?languageCode=en-US for further details.

(2008Q2). The downward trend of sovereign debt as % of GDP in Serbia after 2001Q1 is primarily due to debt relief programs by international creditors, massive privatization proceeds, and absorption-driven growth financed by massive capital inflows from abroad (Koczan, 2017). However, from 2008Q2, when the Global Financial Crisis (GFC) hit the Serbian economy, the ratio of public debt-to-GDP skyrocketed to around 75% at the end of 2014 (Koczan, 2015). As a result, between 2008Q2 and 2014Q4, Serbian public finances recorded the sharpest increase in public debt among all post-communist economies from Eastern Europe (Andric, 2024). In 2012Q1, the sovereign debt as % of GDP breached the national fiscal rule upper bound of 45% and then, in 2014Q3, exceeded yet another threshold of 60% defined in Maastricht fiscal rules (Andric, 2024). To prevent further deterioration in Serbia's public finances and to stop the explosion in the ratio of public debt-to-GDP, fiscal policy makers in Serbia launched a three-year consolidation package. The most important result of the austerity measures implemented between 2015Q1 and 2018Q1 was a drastic reversal in the trend function of public debt in Serbia, so that the ratio of public debt-to-GDP was around 60% at the beginning of 2018, in line with the Maastricht fiscal criteria. During the COVID-19 pandemic, the evolution of public debt remained almost unchanged from the perspective of fiscal prudence and profligacy - although the public debt ratio increased from 51.7% (2020Q1) to 59.6% (2021Q1) in the year 2020, it never again exceeded the 60% threshold of the Maastricht debt rule, but it also never again went below the national fiscal rule limit of 45% (Andric, 2024). At the end of our sample, the ratio of public debt-to-GDP was 55% (Andric, 2024).

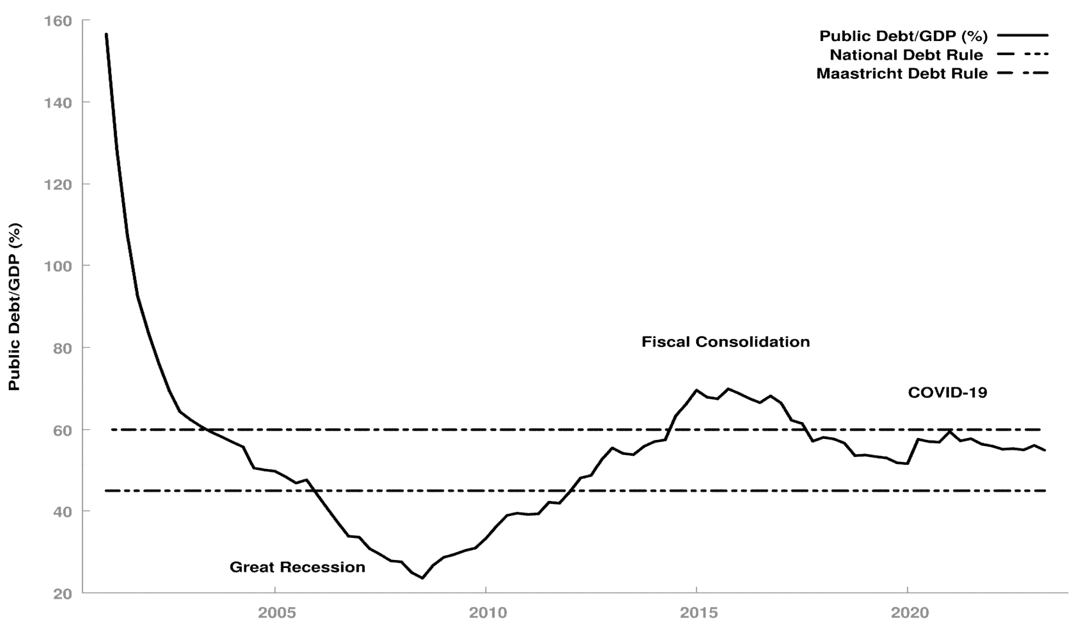

Figure 1. Public Debt/GDP Ratio In Serbia, 2001Q1-2023Q2 (Source: Author's Calculations)

2.2. Persistence

In addition to examining breaks and trends in the behaviour of sovereign debt/GDP ratio, it is equally important to characterize the persistence profile of innovations to the underlying trajectory of public debt/GDP ratio. Similarly to Andric (2024), Table 1 reports the autocorrelation coefficients, both ordinary and partial, for the government debt/GDP ratio in levels and in first differences where first differences approximate the overall budget deficit corrected for the stock-flow adjustments. The first two rows of Table 1 correspond to autocorrelation coefficients, both ordinary and partial, for the sovereign debt-to-GDP ratio measured in levels, while the last two rows of Table 1 document the autocorrelation coefficients, again both ordinary and partial, for the sovereign debt-GDP ratio measured in first differences. The number of columns corresponds to the number of lagged quarters and comes from Schwert's (1989) criterion. Similarly to Andric (2024), the level of public debt-to-GDP ratio exhibits high degree of persisitence with a first-order partial autocorrelation coefficient (PAC) equal to 0.82 and the corresponding 95% confidence (1.96/√T) interval between 0.61 and 1.03. The same is true for the sovereign debt-to-GDP ratio in first differences in the sense that stationary AR(1) process is the best characterization of its dynamics. Because the 95% interval of confidence for the first-order PAC contains a unit root, Table 2, similarly to Andric (2024)[4], presents the findings of the stochastic trend tests from Elliott et al. (1996), as well as the findings of stationarity test by Kwiatkowski et al. (1992). The findings in Table 2 consistently show that the behaviour of sovereign debt/GDP ratio in Serbia after 2001Q1 is not consistent with the unit root type behaviour.[5]

3. EMPIRICAL EVIDENCE

This section consists of four subsections.

Table 1. Autocorrelations & partial autocorrelations for public debt/GDP ratio: levels & first differences

Lags	1	2	3	4	5	6	7	8	9	10	11
B_t	**0.8**	**0.7**	**0.6**	**0.5**	**0.5**	**0.4**	**0.4**	**0.3**	**0.3**	**0.2**	**0.2**
	0.8	0.04	0.04	0.03	0.01	0.0	0.01	0.01	-0.01	-0.02	-0.02
ΔB_t	**0.6**	**0.5**	**0.4**	**0.3**	0.2	0.15	0.1	0.1	0.1	0.07	0.08
	0.6	0.08	0.04	0.03	0.02	-0.04	0.02	0.02	0.03	-0.03	0.06

Notes: author's calculations and Andric (2024). First row: autocorrelation coefficient for public debt/GDP ratio; second row: partial autocorrelation coefficient for public debt/GDP ratio; third row: autocorrelation coefficient for the first differenced public debt/GDP ratio; fourth row: partial autocorrelation coefficient for the first differenced public debt/GDP ratio. Bold cell entries show significance at least at 10% significance level.

Table 2. Stationarity and unit root tests for public debt/GDP ratio in levels and first differences

Series/Test	KPSS	ERS	DF-GLS	Verdict
B_t	0.285***	213.44***	-1.463	**I (0)**
ΔB_t	0.675***	64.21***	-0.13	**I (0)**

Notes: author's calculations and Andric (2024). *** One percent significance level, ** 5% significance level, * 10% significance level. Unit root test regressions include a constant and linear trend for levels, and only a constant for the first difference. Max number of lags in test regressions is four, due to quarterly data. General-to-specific method of optimal lag selection at 10% significance level.

[4] Andric (2024) uses the Schwert (1989) criterion to determine the maximum number of lags and modified Akaike criterion (MAIC) (Ng and Perron, 2001) to determine the optimal number of lags in test regressions. The approach in Andric (2024), however, might be inadequate in the case of relatively small sample sizes such is the case in the analysis of this article.

[5] The unit root tests from Elliott et al. (1996) have higher power in comparison to traditional Dickey-Fuller and Phillips-Perron unit root tests in the case of highly persistent AR (1) processes. I use the KPSS stationarity test of Kwiatkowski et al. (1992) as a complementary test to the unit root tests from Elliott et al. (1996). The greatest emphasis is put on the results of the ERS point optimal test since this test has the greatest power with respect to the close-to-one AR (1) point alternative (Elliott et al., 1996).

Subsection 3.1 outlines econometric methodology. Subsection 3.2 presents the main empirical findings. Subsection 3.3 discusses the baseline results. Finally, Subsection 3.4 presents the results of sensitivity analyses.

3.1. Econometric Methodology

Following Hansen (1996, 1997, & 2017) almost verbatim, a SETAR model with two regimes and an autoregressive order p has the representation

$$y_t = (\alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p})1(y_{t-1} \leq \gamma) + (\beta_0 + \beta_1 y_{t-1} + \cdots + \beta_p y_{t-p})1(y_{t-1} > \gamma) + e_t \quad (1)$$

in which 1(·) represents the indicator dummy variable function, y_{t-1} is the threshold variable for which the delay parameter d equals one (d=1), and γ is the threshold value that one seeks to estimate endogenously. The parameters $\alpha_0, \alpha_1, \ldots, \alpha_p$ are coefficient parameters for the autoregressive regime below the threshold ($y_{t-1} \leq \gamma$) while the parameters $\beta_0, \beta_1, \ldots, \beta_p$ are coefficient parameters for the autoregressive regime above the threshold ($y_{t-1} > \gamma$). The error e_t, not necessarily homoscedastic, represents a martingale difference sequence. The least square (LS) estimate of γ

$$\hat{\gamma} = \text{argmin}_{\gamma \in \Gamma}\, \hat{\sigma}_n^2(\gamma) \quad (2)$$

is the value that minimizes the residual variance $\hat{\sigma}_n^2(\gamma)$, $\hat{\sigma}_n^2(\gamma) = \frac{1}{n}\sum_{t=1}^{n} \hat{e}_t(\gamma)^2$ in which $\hat{e}_t(\gamma) = y_t - \hat{y}_t$ where $\hat{y}_t$ stands for the sequential conditional LS estimate of equation (1), and where $\Gamma = [\underline{\gamma}\ \ \overline{\gamma}]$ denotes the lower $(\underline{\gamma})$ and the upper $(\overline{\gamma})$ probability percentiles for the threshold variable ordered in the ascending fashion, as in Hansen (1997).

To find the 95% confidence interval for γ, Hansen (1997) defines the set

$$\hat{\Gamma} = \{\gamma : LR_n(\gamma) \leq c_\xi(\beta)\} \quad (3)$$

by visually comparing the values of the likelihood ratio $LR_n(\gamma) = n(\frac{\hat{\sigma}_n^2(\gamma) - \hat{\sigma}_n^2(\hat{\gamma})}{\hat{\sigma}_n^2(\hat{\gamma})})$ test statistic and the 95% critical value $c_\xi(\beta)$ equal to 7.35.

Hansen (1997) also computes the intervals of confidence for the coefficient estimates of the corresponding SETAR model. If z_α is the α-level critical value of the normal probability distribution and if $\hat{s}_\gamma$ is the standard error of coefficient estimates, then the confidence interval for the vector of coefficient estimates θ, conditional on γ being constant, is

$$\widehat{\Theta}(\gamma) = \hat{\theta}(\gamma) \pm z_\alpha \hat{s}(\gamma) \quad (4)$$

Hansen (1997) also proposes an algorithm designed to reduce the errors due to sampling. One must first define a φ-level, φ<1, confidence interval for γ. Consequently, for each γ in this φ-level interval of confidence, one must then calculate a confidence interval for the coefficient estimates, and finally construct the union of all these sets. More formally, if $\hat{\Gamma}(\varphi)$ represents an interval of confidence for γ for a given asymptotic coverage φ, φ<1, and if, for each $\gamma \in \hat{\Gamma}(\varphi)$, one computes the confidence intervals $\widehat{\Theta}(\gamma)$ as in equation

(4) and sets the union of these sets to

$$\widehat{\Theta}_{\varphi} = \cup_{\gamma \in \hat{\Gamma}(\varphi)} \widehat{\Theta}(\gamma) \quad (5)$$

then it is possible to minimize the errors due to sampling in the case of autoregressive coefficient estimates, as Hansen's (1997) Monte Carlo simulations show-see also Andric et al. (2024) for the application of equations (1) to (5) in the case of the United States after the Bretton Woods collapse.

3.2. Econometric Estimates

Setting p=1 in equation (1) yields the following SETAR (2,1,1) model specification

$$y_t = (\alpha_0 + \alpha_1 y_{t-1})1(y_{t-1} \leq \gamma) + (\beta_0 + \beta_1 y_{t-1})1(y_{t-1} > \gamma) + e_t \quad (6)$$

Table 3 shows the estimates of equation (1) for $y_t = B_t$ where B_t is the ratio of government debt-to-GDP. The threshold variable is the government debt/GDP ratio lagged by one quarter, $y_{t-1} = B_{t-1}$. The estimated value for the endogenous public debt threshold ($\hat{\gamma}$), which results from the estimation of equation (2), is 66.2 percent of GDP and corresponds to the last quarter of 2014 (2014Q4), a quarter in which the government launched its 3-year fiscal

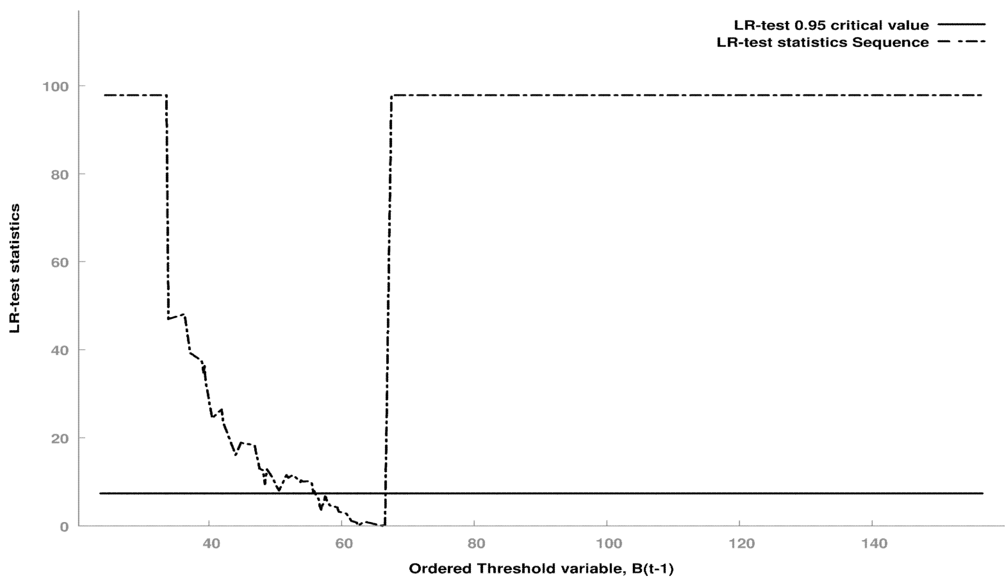

Figure 2. 95% Confidence Interval for the Treshold Variable, B(t-1)(Source: Author's Calculations)

Table 3. SETAR (2, 1, 1) model for public debt/GDP ratio in Serbia (2001Q1-2023Q2)

Regressors	Coefficients	Standard errors	95% interval
	$\boldsymbol{B_{t-1} \leq 66.2}$		
$\boldsymbol{c}$	0.74	1.11	$[-1.74, 3.49]$
$\boldsymbol{B_{t-1}}$	0.98***	0.02	$[0.92, 1.04]$
	$\boldsymbol{66.2 < B_{t-1}}$		
$\boldsymbol{c}$	19.79***	1.85	$[15.26, 24.16]$
$\boldsymbol{B_{t-1}}$	0.69***	0.02	$[0.64, 0.74]$

Notes: *** 1% significance level, ** 5% significance level, * 10% significance level. B_t: dependent variable (public debt/GDP ratio). B_{t-1}:threshold variable (15% trimming percentage for threshold search with ordinary standard errors and one thousand bootstrap repetitions).

consolidation package. The estimated threshold divides the sample into two regimes: the lower $B_{t-1} \leq 66.2\%$ regime which consists of 73 quarterly observations ($N_1=73$), and the upper $B_{t-1}>66.2\%$ regime which consists of only 16 observations ($N_2=16$). Figure 2 shows the 95% confidence interval for the threshold estimate $\hat{\gamma}$ in the range of [56.01, 66.55] percent of GDP, calculated using equation (3) with the 15% trimming percentage for grid search, as in Hansen (1997, 2017).

The coefficient estimates, standard errors, and the respective 95% confidence intervals for the lower regime ($B_{t-1} \leq 66.2\%$) are given in the upper panel of Table 3, while the coefficient estimates, standard errors, and the respective 95% confidence intervals for the upper regime ($B_{t-1}>66.2\%$) are given in the lower panel of Table 3. In particular, the first column of Table 3 gives the $\hat{\alpha}_0$, $\hat{\alpha}_1$, $\hat{\beta}_0$, and $\hat{\beta}_1$ conditional LS estimates from equation (6), the second column of Table 3 reports the associated ordinary standard errors, while the third column reports the 95% confidence intervals calculated according to equations (4) and (5).

From Table 3, the reader can see that the estimates of the intercept and the AR(1) slope for the lower regime are $\hat{\alpha}_0 = 0.74$ and $\hat{\alpha}_1 = 0.98$, respectively. While the intercept estimate is not statistically different from zero at the 95% confidence level, the AR(1) slope estimate is statistically significant at the 1% significance level with a 95% confidence interval of [0.92, 1.04]. Similarly, the intercept and the AR(1) slope estimates for the upper regime are $\hat{\beta}_0 = 19.79$ and $\hat{\beta}_1 = 0.69$, respectively. In contrast to the lower regime, both the intercept term ($\hat{\beta}_0$) and the AR(1) slope coefficient ($\hat{\beta}_1$) are statistically significant at the 1% significance level with the corresponding 95% confidence intervals of [15.26, 24.16] and [0.64, 0.74], respectively. The outlined coefficient estimates convey two important messages. First, the coefficient estimates for the parameters $\alpha_0, \alpha_1, \beta_0$ and β_1 fulfil the conditions for ergodicity and global stationarity from Petruccelli and Woolford (1984) and Chan et al. (1985).[6] Second, the 95% confidence interval for $\hat{\alpha}_1$, [0.92, 1.04], contains a unit root that potentially implies a two-regime self-exciting threshold unit root (SETUR) model of order one, first analysed by González and Gonzalo (1997).[7] A SETAR (2, 1, 1) model with a partial unit root could have important economic policy implications which the next subsection addresses.

3.3. Discussion of Results

The Wald coefficient restriction test cannot reject the null hypothesis that $\hat{\alpha}_1 = 1$ even at 10% significance level ($\chi^2(1)=1.05$, $p=0.3$). The unit-root type behaviour of public debt/GDP ratio below the estimated threshold of 66.2% of GDP is consistent with the seminal tax smoothing hypothesis of Barro (1979). However, one must exercise caution in interpreting these statistical results, as the original Barro (1979) model assumes a government whose goal is to minimize the overall tax burden. The first to question such altruistic behaviour of governments were Roubini and Sachs (1989) who found little evidence of such fiscal behaviour in OECD economies after 1973 due to political frictions and large coalition governments. More recently, in the case of a panel of Central and Eastern European economies, Arsic et al. (2017) found that electoral cycles affect the dynamics of the overall budget deficit, again suggesting that governments do not behave as Barro (1979)

[6]See Theorem 2.1. (Equation 2.2. on page 272) from Petrucelli and Woolford (1984), as well as Theorem 2.1. (Equation 2.3. on page 270) from Chan et al. (1985).

[7]Despite the presence of a unit root in one of the regimes, González and Gonzalo (1997) show that the coefficients of a SETUR model, provided that the SETUR model in question is ergodic and globally stationary in the sense of Petrucelli and Woolford (1984) and Chan et al. (1985), can be consistently estimated via LS with an asymptotic normal probability distribution even in the case of an unknown threshold, so that one can easily check, for example, with the Wald coefficient restriction test whether one of the estimated coefficient is equal to one. For details, see Theorems 1 and 2, Propositions 1 and 2, and Section 4.2. from González and Gonzalo (1997).

envisioned. In addition, Jiang et al. (2024) argue that a unit-root type behaviour of sovereign debt/GDP ratio would be difficult to reconcile with the documented fiscal history in both advanced and developing economies. More precisely, a random walk behaviour of government debt would mean that the innovations to sovereign debt-to-GDP ratio would not have a transitory effect. In other words, the ratio of public debt-to-GDP would never show a nonlinear correction towards its mean. Jiang et al. (2024) provide evidence to reject such behaviour of government debt and point out that fiscal policy makers usually reversed the escalating government debt trajectory using fiscal consolidation measures, high inflation, or even resorting to financial repression. It is, therefore, more likely that the dynamics of government debt-to-GDP below the 66.2% threshold follows a persistent AR (1) process with a coefficient of 0.98, which is in line with the theoretical predictions of Aiyagari et al. (2002) and Bhandari et al. (2017), and the results from Andric (2024) in the case of 45% exogenous threshold. Aiyagari et al. (2002) and Bhandari et al. (2017) argue that the close to unit-root behaviour of sovereign debt-to-GDP ratio is due to incomplete financial markets in which governments cannot issue state-contingent debt. As Andric (2024) reports in a companion paper, the absence of state-contingent debt issuance leads to a highly persistent trajectory of government debt-to-GDP ratio. The high level of persistence in sovereign debt behaviour stems from permanent government spending innovations, higher variability of government spending and public debt limits imposed on governments (Andric 2024). These characteristics are important in measuring fiscal space in Serbia since government spending tends to be more volatile in developing economies (see Koczan, 2015, 2017) and because international organizations and institutions, such as the European Commission, impose sovereign debt upper limits to ensure compliance with the Maastricht fiscal criteria, which is consistent with the endogenously estimated threshold of 66.2% from Table 3.

Regarding the AR(1) slope estimate in the upper regime, $\hat{\beta}_1$, the Wald coefficient restriction test rejects the null hypothesis that $\hat{\alpha}_1 = \hat{\beta}_1$ at the significance level higher than 1% ($\chi^2(1)$=91.46, p=0.00). In other words, the estimated AR(1) slope coefficient in the lower regime ($\hat{\alpha}_1 = 0.98$) differs statistically from the estimated AR(1) slope coefficient in the upper regime ($\hat{\beta} = 0.69$). Thus, the fiscal authorities in Serbia are more fiscally responsible when the sovereign debt-to-GDP ratio exceeds endogenously estimated 66.2% public debt-to-GDP threshold. The behaviour of fiscal policymakers in Serbia is, therefore, not in line with the fiscal fatigue hypothesis of Ghosh et al. (2013), as their model implies an explosion of government debt once a certain, endogenously determined, sovereign debt/GDP ratio is exceeded.[8] The results are, however, in accordance with theoretical models put forward by Blanchard (1990) and Sutherland (1997), which assume that governments stabilize the public debt/GDP ratio once it reaches a certain threshold.

3.4. Sensitivity Analyses

This subsection consists of i) Subsection 3.4.1 which evaluates the robustness of baseline results in the case of Serbia with respect to alternative autoregressive lag structures; and ii) subsection 3.4.2 which

[8]Andric et al. (2016) provide evidence in favour of fiscal fatigue hypothesis of Ghosh et al. (2013) but for the sample period 2004Q3-2014Q3, i.e., for the period before a 3-year fiscal consolidation package between 2015 and 2018.

provides cross-country comparison with Romania and Hungary, two economies from Central and Eastern Europe that have similar credit rating as Serbia according to the credit rating agency S&P Global Ratings.

3.4.1. Alternative Autoregressive Lag Structures

In the case of estimates from Table 3, fiscal policy makers in Serbia are targeting the long-run sovereign debt of 19.79/(1-0.69)=63.84% of GDP, which corresponds to the Maastricht limit, not the national fiscal rules limit. An estimated long-run target level of sovereign debt-to-GDP ratio of 63.84% is remarkably close to the one Andric (2024) reports in the case of an exogenous 45% government debt-to-GDP ratio. The estimates from Andric (2024) imply a long-run target sovereign debt/GDP threshold of 56.7% of GDP. Note, however, that both the methodology (multiple structural change methodology of Bai and Perron, 2003) and the type of threshold from Andric (2024) are fundamentally different from the methodology and the type of threshold of this article. The 45% public debt/GDP threshold from Andric (2024) is exogenous, i.e., Andric (2024) does not estimate a non-linear threshold to obtain the most appropriate econometric fit that minimizes the residual sum of squares but rather imposes an exogenous threshold level that equals the national fiscal rule limit. In other words, Andric (2024) finds that policy makers in Serbia do not comply with the 45% public debt/GDP threshold but does not estimate an endogenous discrete-type threshold after which the non-linear fiscal adjustment occurs. The analysis in this paper, however, quantifies the endogenous public debt threshold at 66.2% of GDP.

To further investigate the robustness of the results presented in this paper, Table 4 reports the results of an LM-test of null hypothesis of no threshold against the alternative hypothesis of a single discrete threshold under maintained assumption of homoscedastic errors.[9] The first row presents the results from the SETAR (2, 2, 1) model in which the sovereign debt-to-GDP ratio behaves as a piecewise AR(2) stochastic process for which the regime switch occurs in the sovereign debt-to-GDP ratio lagged one quarter, B_{t-1}. The second row presents the results from the SETAR (2, 2, 2) econometric specification in which the government debt-to-GDP ratio behaves as a piecewise AR(2) stochastic process for which the regime switch occurs in the sovereign debt-to-GDP ratio lagged for two quarters, B_{t-2}. In both cases, the identified thresholds of 48.43% and 47.60%, respectively, are not statistically significant even at 10% significance level, confirming the assertions from Andric (2024) that fiscal policy makers in Serbia disregard 45% public debt/GDP limit in fiscal sustainability assessments.

The estimates from Table 4, although potentially useful from the perspective of fiscal sustainability analysis in Serbia, do not provide comparative analysis with respect to other transition economies from Western Balkan region. In other words, to generalize the findings in the case of Serbia, it would be of interest to compare the reported results for Serbia with the results for Albania, Montenegro, Bosnia and Herzegovina and the Republic of North Macedonia. Unfortunately, to the best of my knowledge, there are no comparable data sets for these Western Balkan economies, at least for the period 2001Q1-2023Q2. Consequently, the following analysis provides comparison with

[9] The White's heteroscedasticity test does not report the existence of heteroscedasticity in the residuals of the linear AR (2) autoregression.

Romania and Hungary, since these economies have the same credit rating as Serbia, according to the credit rating agency S&P Global Ratings.[10]

3.4.2. Cross-Country Comparisons

Table 5 outlines the SETAR (2, 2, 2) estimates with White's heteroscedasticity corrected errors in the case of consolidated government debt-to-GDP ratio in Romania after 2001Q1. The data are from the European Central Bank (ECB) (2024a) data portal.

The SETAR (2, 2, 2) econometric specification provided better statistical fit in terms of Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) in comparison to SETAR (2, 1, 1) and SETAR (2, 2, 1) model specifications. The SETAR (2, 2, 2) estimates from Table 5 convey the following messages. First, the estimated threshold of 24.35%, with the associated 95% confidence interval [23.14, 24.82], is statistically significant at 5% significance level. Contrary to the case of Serbia, note that the estimated threshold value is much below the Maastricht government debt ceiling of 60% government debt-to-GDP ratio. In addition, the delay lag for the threshold variable equals two quarters, not one, as was the case in Serbia for the period 2001Q1-2023Q2. In the case of Romania, however, the sum of autoregressive coefficients (both coefficients statistically significant at 1% level) in the lower regime (B_{t-2}≤24.35%) is below 1 (1.47-0.60=0.87), which is not the case in the upper regime (B_{t-2}>24.35%). More precisely, in the upper regime only AR(1) coefficient with 1.08 estimate is statistically significant at 1% significance level which is not the case with the AR(2) coefficient of -0.12. The 95% confidence interval in the case of explosive AR(1) coefficient is [0.81, 1.35]. The reader should interpret this finding cautiously since

Table 4. SETAR (2, 2, 1) and SETAR (2, 2, 2) Model Estimates: Serbia (2001Q1-2023Q2)

Model/Statistics	Threshold Estimate	LM-Test for No Threshold	Bootstrap p-value
$\boldsymbol{SETAR}\ (\mathbf{2},\mathbf{2},\mathbf{1})$	48.43	11.73	0.15
$\boldsymbol{SETAR}\ (\mathbf{2},\mathbf{2},\mathbf{2})$	47.60	11.98	0.14

Notes: Author's calculations. *** 1% significance level, ** 5% significance level, * 10% significance level. B_t: dependent variable (public debt/GDP ratio). B_{t-1}: threshold variable in the case of SETAR (2, 2, 1) model; B_{t-2}: threshold variable in the case of SETAR (2, 2, 2) model. In both SETAR models trimming percentage for threshold search with ordinary standard errors equals 15%. *p*-values: 1000 bootstrapped repetitions.

Table 5. SETAR (2, 2, 2) model estimates for the public debt/GDP ratio in Romania (2001Q1-2023q2)

Regressors	Coefficients	Standard errors	95% interval
	$\boldsymbol{B_{t-2} \leq 24.35\%}$		
Intercept	1.99***	0.71	$[0.60, 3.38]$
$\boldsymbol{B_{t-1}}$	1.47***	0.16	$[1.16, 1.79]$
$\boldsymbol{B_{t-2}}$	-0.60***	0.17	$[-0.92, -0.27]$
	$\boldsymbol{24.35\% < B_{t-2}}$		
Intercept	1.95**	0.78	$[0.41, 3.48]$
$\boldsymbol{B_{t-1}}$	1.08***	0.14	$[0.81, 1.35]$
$\boldsymbol{B_{t-2}}$	-0.12	0.14	$[-0.40, 0.16]$

Notes: *** 1% significance level, ** 5% significance level, * 10% significance level. B_t : dependent variable (public debt/GDP ratio). B_{t-2} : threshold variable (15% trimming percentage for threshold search with White's standard errors and one thousand bootstrap repetitions).

[10]Among European economies, Greece also has a BBB- S&P credit rating, as is the case with Romania, Hungary, and Serbia. The analysis does not include Greece for two reasons: a) S&P Global Ratings assign positive outlook to Greece, while in the case of Hungary, Romania, and Serbia the assigned rating is stable; and b) Greece is not an ex-communist economy from Central and Eastern Europe like Romania and Hungary.

in the case of explosive AR (1) root, although the coefficient estimate is consistent, it does not have a normal limiting distribution (Liu et al., 2011).[11] However, the finding might still be useful from policy perspective since the explosive sovereign debt-to-GDP ratio implies a need for credible fiscal consolidation program. Note also that the explosive dynamics of the government debt-to-GDP ratio in the case of Romania is not impossible: between 2008Q2, when the GFC hit the Romanian economy, up until 2015Q1, when Serbia launched its 3-year fiscal consolidation package, the public debt/GDP ratio in Romania increased from 11% to 39%. Note that for the same period (2008Q2-2015Q1), the public debt/GDP ratio in Serbia increased from 25% to 70%. However, from 2015Q1 to 2023Q2, the government debt-to-GDP ratio in Serbia decreased from 70% to 55%, while in Romania it exhibited a sharp increase between 2019Q1 and 2023Q2 from 34% to 49% of GDP.

Table 6 outlines the SETAR (2, 2, 1) estimates with White's heteroscedasticity corrected errors in the case of consolidated government debt-to-GDP ratio in Hungary for the period 2001Q1- 2023Q2. The data, as in the case of Romania, are from the European Central Bank (ECB) (2024b) data portal. The SETAR (2, 2, 1) econometric estimates provided a better statistical fit in terms of Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) in comparison to SETAR (2, 1, 1) and SETAR (2, 2, 2) econometric estimates. The SETAR (2, 2, 1) results presented in Table 6 convey the following messages. First, the estimated threshold of 75.75%, with the associated 95% confidence interval [52.25, 83.61], is statistically significant at 10% significance level. Contrary to the case of Serbia, and especially the case of Romania, the estimated threshold value is fifteen percentage points above the Maastricht government debt upper limit of 60% public debt/GDP ratio. Like the case of Serbia, the sum of autoregressive coefficients (both coefficients statistically significant at 5% level) in the lower regime (B_{t-2}≤75.75%) is very close to 1 (1.57-0.59=0.98), which is not the case in the upper regime (B_{t-2}>75.75%). More precisely, in the upper regime only AR(1) coefficient estimate of 0.26 is statistically significant, but only at 10 % significance level. The size of the estimated coefficient implies much lower public debt/GDP ratio persistence in the upper regime, but the fact that it is only marginally statistically significant might question how strong the influence of discretionary fiscal austerity measures in Hungary is when sovereign debt-to-GDP

Table 6. SETAR (2, 2, 1) model estimates for the public debt/GDP ratio in Hungary (2001Q1-2023q2)

Regressors	Coefficients	Standard errors	95% interval
	$B_{t-1} \leq 75.75\%$		
Intercept	2.24	1.97	[-6.00,10.10]
B_{t-1}	1.57***	0.28	[0.58,2.14]
B_{t-2}	-0.59**	0.26	[-1.11,0.32]
	$75.75\% < B_{t-1}$		
Intercept	48.35***	13.26	[-48.61,113.01]
B_{t-1}	0.27*	0.14	[-0.48,1.31]
B_{t-2}	0.12	0.14	[-0.47,0.53]

Notes: *** 1% significance level, ** 5% significance level, * 10% significance level. B_t : dependent variable (public debt/GDP ratio). B_{t-2} : threshold variable (15% trimming percentage for threshold search with White's standard errors and one thousand bootstrap repetitions).

[11] See Theorem 2.2. on pages 971-972 in Liu et al. (2011).

ratio is above 75% of GDP. Note, however, because the estimated threshold value in the case of Hungary (75.75%) is higher than in the case of Serbia (66.2%) and in the case of Romania (24.35%), policy makers in Hungary would have to implement more severe fiscal austerity measures to revert the public debt/GDP ratio trajectory towards the 60% Maastricht threshold. The need for more stringent austerity measures in the case of Hungary comes also from the estimated level shifts across regimes: the model quantifies a statistically significant 45 percentage points shift in the level of public debt/GDP ratio in the upper regime.

4. CONCLUSION

This paper evaluates public debt management practices in Serbia using quarterly data from 2001Q1 to 2023Q2. The results suggest that fiscal policymakers in Serbia take fiscal corrective measures when public debt exceeds 60% of GDP. In other words, the 60% public debt-to-GDP threshold, which corresponds to a debt limit defined in the Maastricht fiscal criteria, has served as a target for public debt-to-GDP ratio over the past two decades. Moreover, this result shows that the fiscal authorities in Serbia are more interested in the Maastricht fiscal criteria than in the national fiscal rules, which limit public debt to 45% of GDP. Although policymakers have managed to successfully navigate the COVID-19 pandemic shock from a fiscal discipline perspective, the fact that they do not adhere to the national debt rule may jeopardize the credibility of fiscal policy in Serbia and lead to a higher probability of sovereign default. A default of the Serbian government could have severe domestic repercussions on the standard of living in Serbia if the government must put into practice a draconian package of fiscal austerity measures. Furthermore, given the relative size of Serbian economy in the Western Balkan region, the default could also have adverse consequences in terms of greater political instability and consequent trade disruptions. These assertions point to a greater need in overcoming the limitations of this study of which the most important ones are: first, the study focuses only on univariate behaviour of the public debt/GDP ratio in Serbia so the results are prone to an omitted variable bias because the univariate non-linear SETAR framework is less capable in capturing, apart from the GFC and the COVID-19 shocks, other potentially important exogenous shocks due to business cycle spillovers and exchange rate movements; second, the depreciation of exchange rate, which the SETAR model does not consider explicitly, could have severe negative effects in the case of Serbia since the majority of sovereign debt is issued in major global foreign currencies; third, it would be of practical interest for public debt management to complement the current SETAR estimates with the estimates of other nonlinear models, in particular the estimates of corresponding Markov-switching models that can identify probabilities that public debt/GDP is in a particular regime; and fourth, one could construct real-time data series for public debt and GDP to track and monitor government debt in a more timely and accurate manner. All outlined limitations are legitimate fruitful areas for further research from a public debt management perspective.

Acknowledgement

The grant under which the Ministry of Science funded the research presented in this article has the contract number 451-03-47/2023-01/200005.

References

Aiyagari, R., Marcet, A., Sargent, T., & Seppälä, J. (2002). Optimal Taxation without State-Contingent Debt. Journal of Political Economy, 110 (6), 1220-1254.

Andric, V. (2024). National Fiscal Rules, Maastricht Fiscal Criterion and Non-Linear Public Debt Dynamics in Serbia. Economic Analysis, online first, 38-51.

Andric, V., Arsic, M., & Nojkovic, A. (2016). Public Debt Sustainability in Serbia Before and During the Global Financial Crisis. Economic Annals, 61 (210), 47-78.

Andric, V., Bodroza, D., & Djukic, M. (2024). A Commentary on US Sovereign Debt Persistence and Nonlinear Fiscal Adjustment. Mathematics, 12 (20), 3250.

Andric, V., & Minovic, J. (2018). Public Debt Growth, Great Recession and Fiscal Consolidation-The Serbian Episode. Serbian Journal of Management, 13 (2), 251-262.

Andric, V., & Minovic, J. (2022). The Sources of Serbian Budgetary Imbalances in a Time of Transition, Crisis, and Global Pandemics. In Redzepagic, S., Duarte, A.P., Siničáková, M., & Bodroza D. (Eds.), Economic and Financial Implications of COVID-19 Crises. Nice: Université Côte d'Azur. 107-125.

Arsic, M., Nojkovic, A., & Randjelovic, S. (2017). Determinants of discretionary fiscal policy in Central and Eastern Europe. Economic Systems, 41 (3), 367-378.

Badia, M.M., Medas, P., Gupta, P., & Xiang, Y. (2022). Debt is not free. Journal of International Money and Finance, 127, 102654.

Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. Journal of Applied Econometrics, 18 (1), 1-22.

Barro, R. (1979). On the Determination of the Public Debt. Journal of Political Economy, 87 (5), 940-971.

Bhandari, A., Evans, D., Golosov, M., & Sargent, T. (2017). Fiscal Policy and Debt Management with Incomplete Markets. The Quarterly Journal of Economics, 132 (2), 617-663.

Blanchard, O.J. (1990). Can Severe Fiscal Contractions Be Expansionary? Tales of Two Small European Countries: Comment. NBER Macroeconomics Annual, 5, 111–116.

Chan, K.S., Petruccelli, J.D., Tong, H., & Woolford, S.W. (1985). A Multiple-Threshold AR (1) Model. Journal of Applied Probability, 22 (2), 267-279.

Davoodi, H.R., Elger, P., Fotiou, A., Garcia-Macia, D., Han, X., Lagerborg, A., Lam, R. W., & Medas, P. (2022). Fiscal Rules and Fiscal Councils: Recent Trends and Performance during the Covid-19 Pandemic. International Monetary Fund. IMF Working Paper 22/11.

European Central Bank (2024a). Government Finance Statistics. Retreived from: https://data.ecb.europa.eu/data/datasets/GFS/GFS.Q.N.RO.W0.S13.S1.C.L.LE.GD.T._Z.XDC_R_B1GQ_CY._T.F.V.N._T

European Central Bank (2024b). Government Finance Statistics. Retreived from: https://data.ecb.europa.eu/data/datasets/GFS/GFS.Q.N.HU.W0.S13.S1.C.L.LE.GD.T._Z.XDC_R_B1GQ_CY._T.F.V.N._T

Elliott, G., Rothenberg, T.J., & Stock,

УПРАВЉАЊЕ ЈАВНИМ ДУГОМ У СРБИЈИ У ТРАНЗИЦИЈИ, ВЕЛИКОЈ РЕЦЕСИЈИ И ПАНДЕМИЈИ КОВИД-19

Владимир Андрић

Извод

Овај рад испитује нелинеарно асиметрично понашање односа јавног дуга/БДП у Србији у прве две деценије економске транзиције након политичких и тржишних реформи започетих почетком двадесет првог века. Користећи кварталне податке за однос државног дуга према БДП-у, модел СЕТАР (енг. s*elf-exciting threshold autoregressive*) са два режима проналази праг односа јавног дуга/БДП од 66,2% изнад којег креатори фискалне политике у Србији предузимају корективне мере у облику повећане фискалне опрезности. Процењени праг односа државног дуга/БДП одговара прагу од 60% из фискалних критеријума из Мастрихта и показује како фискалне власти у Србији систематски игноришу ограничење од 45% јавног дуга/БДП постављено у националним фискалним правилима. Овакво понашање фискалне политике могло би да угрози кредибилитет фискалних институција у Србији и негативно утиче на фискалну дисциплину и вероватноћу државног банкрота.

Кључне речи: управљање јавним дугом, велика рецесија, КОВИД-19, СЕТАР модел, Србија

J.H. (1996). Efficient Tests for an Autoregressive Unit Root. Econometrica, 64 (4), 813-836.

Fall, F., Blochi, D., Fournieri, J.-M., & Hoelleri, P. (2015). Prudent debt targets and fiscal frameworks. OECD Economic Policy Papers, No. 15, OECD Publishing, Paris.

Ghosh, A.R., Kim, J.I., Mendoza, E.G., Ostry, J.D., & Qureshi, M.S. (2013). Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies. Economic Journal, 123 (566), F4-F30.

González, M., & Gonzalo, J. (1997). Threshold Unit Root Models. Universidad Carlos III de Madrid. DES Working Paper 97-50.

Hansen, B. (1996). Inference When a Nuisance Parameter is not Identified Under the Null Hypothesis. Econometrica, 64 (2), 413-430.

Hansen, B. (1997). Inference in TAR Models. Studies in Nonlinear Dynamics and Econometrics, 2 (1), 1-14.

Hansen, B. (2017). Regression Kink with an Unknown Threshold. Journal of Business & Economic Statistics, 35 (2), 228-240.

Jiang, Z., Lustig, H., Van Nieuwerburgh, S., & Xiaolan, M.Z. (2024). What Drives Variation in the U.S. Debt-to-Output Ratio? The Dogs that Did not Bark. Journal of Finance, 79 (4), 2603-2665.

Koczan, Z. (2015). Fiscal Deficit and Public Debt in the Western Balkans: 15 Years of Economic Transition. International Monetary Fund. IMF Working Paper 15/172.

Koczan, Z. (2017). Late to the game? Capital flows to the Western Balkans. International Monetary Fund. IMF Working Paper 17/92.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., & Shin, Y. (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. Journal of Econometrics, 54 (1-3), 159-178.

Liu, W., Ling, S., & Shao, Q.M. (2011).

On non-stationary threshold autoregressive models. Bernoulli, 17 (3), 969-986.

Ministry of Finance of the Republic of Serbia. (2024). Public Finance Bulletin. Retrieved from: https://www.mfin.gov.rs/en/activities/bulletin-public-finance-2.

Ng, S., & Perron, P. (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. Econometrica, 69 (6), 1519-1554.

Petruccelli, J.D., & Woolford, S.W. (1984). A Threshold AR (1) Model. Journal of Applied Probability, 21 (2), 270-286.

Roubini, N., & Sachs, J.D. (1989). Political and economic determinants of budget deficits in industrial economies. European Journal of Political Economy, 33 (5), 903-933.

Schwert, G.W. (1989). Tests for Unit Roots: A Monte Carlo Investigation. Journal of Business & Economic Statistics, 7 (2), 147-159.

Statistical Office of the Republic of Serbia. (2024). Quarterly Gross Domestic Product by Expenditure Approach (SNA 2008/ESA 2010). Retrieved from: Dissemination database search (stat.gov.rs).

Sutherland, A. (1997). Fiscal crises and aggregate demand: can high public debt reverse the effects of fiscal policy? Journal of Public Economics, 65 (2), 147-162.

World Bank. (2021). Subdued Recovery. Western Balkans Regular Economic Report, No. 19. Subdued Recovery. World Bank, Washington, DC.