Vladimir Lj. Andrić

FISCAL REACTION FUNCTIONS IN SERBIA IN THE EARLY XXI CENTURY

Belgrade, 2024

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Author:
Vladimir Lj. Andrić, PhD

Publisher:
Belgrade Banking Academy
Zmaj Jovina 12, Belgrade, Serbia
www.bba.edu.rs
office@bba.edu.rs

For publisher:
Prof. Emeritus Hasan Hanic, PhD

Reviewers:
Prof. Zoran Grubišić, PhD
Darko Marjanović, PhD
Prof. Miloš Pjanić, PhD

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PREFACE

In this monograph I present comprehensive and detailed estimates of fiscal reaction functions (FRFs) in the case of Serbia between 2001Q1 and 2023Q2. The monograph builds on the earlier work I did in my PhD thesis and the papers I have published since 2016 with the following, potentially useful, contributions. First, I wrote the monograph in English, so it is accessible to a wider audience. Second, in two appendices at the end of the monograph, I make all the data calculations and the associated computer code publicly available so that interested readers can replicate and improve the results presented. Third, the monograph extends the sample period under investigation to encompass the fiscal implications of the COVID-19 pandemic.

The monograph also corrects for oversights that I made in my earlier work. The first problem relates to a typographical error for the transversality condition (TC) formulae in which I omit the conditional expectation operator, $E_t(\cdot)$; see, in particular, equations (1.1) and (1.2) in Andric (2019), equations (1) and (2) in Andric et al. (2024), as well as equations (12.1) and (12.2) in Andric and Bodroza (2024). The second problem relates to the construction of a transitory government spending variable. In Andric et al. (2016a) and Andric et al. (2016b), transitory government spending stems from applying the Hodrick-Prescott filter to the time series of overall expenditures of a general government, instead to the time series of government spending presented in the quarterly national accounts. The third problem relates to the potential endogeneity of output gap and absorption gap measures used in Andric et al. (2016a) and Andric et al. (2016b). From equation (V.1) and Tables 4, 6 and 8 from Andric et al. (2016b), but also from equations (9), (10), (11) and (12) and Tables 1, 2 and 4 from Andric et al. (2016a), the reader can see that the variations in the primary fiscal balance are a function of the variations in the contemporaneous, not lagged, output and absorption gap, potentially invalidating econometric estimates due to reverse causality issues. Finally, the dummy variables for the Global Financial Crisis (GFC), the arrangements with the IMF and the electoral cycle from Andric et al. (2016a), Andric et al. (2016b), Andric (2019) and Andric and Minovic (2022) are potentially mis-specified. More precisely, the construction of dummies in cited contributions does not enable one to independently assess the isolated impact of a particular IMF arrangement and/or elections on the primary fiscal balance, but only their combined associated effect. Moreover, the level-shift dummy variable for the GFC in Andric et al. (2016a), Andric et al. (2016b) and Andric (2019) that takes value 1 for the entire post-2008Q3 period might not be the most suitable econometric specification to encompass the influence of GFC on primary fiscal balance variations.

Last, but certainly not the least, I would like to thank without implication to all the people who helped me in finishing the work on this monograph. First, I would like to thank Professor Hansan Hanic, the President of the Belgrade Banking Academy (BBA), for agreeing to be a publisher of this monograph. Without Professor's Hanic consent, the publishing of this monograph would not be possible. The hope is that the manuscript presented in this monograph could be potentially useful for both BBA students and professors.

Special thanks go to the reviewers, Professor Zoran Grubisic, Professor Darko Marjanovic and Professor Milos Pjanic for the support, help, excellent communication, and outstanding collaboration during my work on this monograph.

I would also like to thank Zorica Bozic, Nada Sironja, Jelena Banovic, and Jelena Durlevic for the superb technical aid. I am also thankful to my colleagues from the Institute of Economic Sciences, most notably Jelena Minovic, Dusko Bodroza, Mihajlo Djukic, Milica Kocovic De Santo, Dejana Pavlovic, Elena Jovicic, Marko Miljkovic, Emilija Cvetkovic, and Aleksandar Matkovic for their camaraderie during all these years at the Institute.

I am grateful to my PhD thesis supervisor, Professor Milojko Arsic, and members of my PhD thesis committee, Professor Aleksandra Nojkovic, Professor Zorica Mladenovic, and Professor Branko Urosevic. I learned the most about macroeconomics, finance, and time series econometrics under their guidance as the PhD student at the Faculty of Economics, University of Belgrade. I am also thankful to Professor Milos Bozovic for numerous insightful conversations during and after my PhD studies.

I would especially like to emphasize that the last version of this monograph was written during my international study visit to East-European Center for Research in Economics and Business (ECREB), Faculty of Economics and Business Administration, West University of Timisoara, Timisoara, Romania between the 9th of September and the 10th of October 2024. I am more than grateful for the use of services and facilities of ECREB, and for the help, the outreach and the hospitality provided to me by my friends and colleagues Stefana Maria Dima, Mihai Mutascu, Bogdan Dima, Bogdan Ianc, Claudiu Botoc, Gratiela Noja, Cosmin Enache and Gabriela Mircea.

At the very end, the most I owe to my family, my wife Sanja, my daughter Sophia, and my parents Ljubisa and Vesna, as well as my grand-mother Milena, who were a constant source of love and support through all these years.

I bear sole responsibility for any potential errors contained in this manuscript. I dedicate the monograph to future generations of economists in Serbia who, I am certain, will manage to tackle the problems of fiscal policy making in a more skilful way than I did.

The views expressed in this monograph are mine, and do not necessarily represent the views of the reviewers, the publisher, the ECREB research centre or the Ministry of Science, Technological Development and Innovation of the Republic of Serbia that funded this research under the contract number 451-03-47/2023-01/200005.

Belgrade, October 2024
Vladimir Andric

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INTRODUCTION

This monograph presents ordinary least squares (OLS) estimates of fiscal reaction functions (FRFs) first formulated by Henning Bohn in his influential 1998 Quarterly Journal of Economics article under the title "The Behaviour of US Public Debt and Deficits". More precisely, the monograph presents the OLS estimates of 25 FRFs for the period 2001Q1-2023Q2. The idea behind the estimated FRFs is to assess fiscal sustainability in Serbia in a time of transition, Global Financial Crisis (GFC), fiscal consolidation and COVID-19 pandemic. The most important findings of this monograph are as follows:

i) the response of primary fiscal balance to changes in debt in the case of Serbia for the period 2001Q1-2023Q2 is positive or statistically indistinguishable from zero. We interpret the positive estimate for the primary fiscal balance response as evidence that fiscal policy in Serbia in the period under scrutiny was sustainable. For estimated FRFs that yield a primary fiscal balance response equal to zero, our preferred explanation, following Mendoza and Ostry (2008), is to regard this finding as evidence that holders of Serbian public debt have finite lives, i.e., they do not behave in accordance with the overlapping generations model (OGM) with infinite lives. Instead, the bondholders have an investment outlook much shorter than the infinite forecast horizon implied by the intertemporal government budget constraint (IGBC).

ii) The response of primary fiscal balance to changes in debt shows the characteristics of fiscal fatigue. More precisely, the relationship between the primary fiscal balance/GDP ratio and public debt/GDP ratio can be described with the cubic polynomial function for which, at low levels of debt, there is a negative relationship between the two variables that eventually becomes positive at moderate debt levels and finally vanishes at extremely elevated levels of the public debt/GDP ratio.

iii) The response of the primary fiscal balance to lagged public debt does not change when the public debt/GDP is above its national fiscal rule upper limit of 45% of GDP. This finding, however, does not hold in the case of Maastricht fiscal rule limit of 60% public debt/GDP ratio. In other words, policy makers in Serbia do not consider national fiscal rule as binding, which is not the case with the fiscal rules imposed by the European Union (EU). This finding is probably because most holders of bonds issued by the Serbian government are foreign investors that evaluate the fiscal discipline of governments according to fiscal rules imposed by international regulators and organizations.

iv) The response of the primary fiscal balance to lagged public debt has increased after Serbian government launched a three-year fiscal consolidation programme in 2015Q1 implying relative successfulness of the fiscal sustainability measures implemented by policy makers in Serbia between 2015Q1 and 2018Q1.

v) With respect to output gap and absorption gap, the response of primary fiscal balance was either pro-cyclical or a-cyclical, but never counter-cyclical, as in the case of developed industrialized countries.

vi) The response of primary fiscal balance to transitory government spending was negative regardless of the estimated FRF in question. This result is the most robust finding in this monograph since it holds in every estimated FRF.

vii) The primary fiscal balance is a persistent autoregressive process such that current values of the primary fiscal balance depend on its lagged values up to a year. Putted differently, the primary fiscal balance/GDP ratio shows characteristics of a reduced AR (4) process with statistically significant first, third and fourth lag.

viii) The primary fiscal balance/GDP ratio dropped for about 3.5 percentage points of GDP in 2006Q4, a quarter before parliamentary elections of 2007Q1 took place. This result points to the existence of election cycle in Serbia characterized by more expansionary fiscal policy measures, especially on the side of primary government expenditures.

The similar result does not hold in the case of 2007 presidential and 2012 parliamentary elections with an important warning in mind that this finding might be due to significant revision of fiscal and macroeconomic data.

ix) Between 2009Q1 and 2011Q1, the share of overall primary fiscal balance in GDP dropped on average, by 1.6 percentage points. The finding is consistent with a prolonged negative influence of the GFC and the European sovereign debt crisis on fiscal policy stance in Serbia. Although the Republic of Serbia signed a stand-by agreement with the International Monetary Fund (IMF) on the 16ht of January of 2009, the program, which lasted for two years, and that stipulated tighter fiscal policy and more conservative fiscal deficit targets, had only a limited effect on fiscal sustainability in Serbia. In addition, in mid-2011, the Serbian government adopted a fiscal decentralization package which further pushed primary fiscal balance into a negative territory due to created vertical fiscal imbalances.

x) Finally, the temporary effect of the COVID-19 pandemic on primary fiscal balance/GDP ratio in Serbia in 2020Q2 was staggering and amounted to approximately twenty percentage points of GDP. Fiscal policy makers in Serbia, however, excelled in mitigating the effects of the COVID-19 fiscal shock by not allowing for its spillover to higher and ever-increasing public debt/GDP ratio.

The monograph consists of four main chapters. Section I, under the title Intertemporal Budget Constraint of Government, gives an overview of the most important studies on the topic of fiscal sustainability and FRFs. Section II, under the title Model-Based Fiscal Sustainability Analysis, acquaints the reader with the theoretical framework behind the construction and estimation of FRFs. Section III consists of two subsections: Subsection III.1. describes the most important stylized facts on fiscal policy variables between 2001Q1 and 2023Q2; Subsection III.2., on the other hand, shows the OLS estimates from 25 FRFs. Section 4 concludes by outlining the most important avenues for further research.

Finally, at the end, the monograph outlines two appendices: the first one describes the data used throughout the book in detail, while the second one outlines EViews 13 computer code for replicating the empirical results from subsection III.2.

I INTERTEMPORAL BUDGET CONSTRAINT OF THE GOVERNMENT

This section introduces the notion of the intertemporal budget constraint of the government. The idea is to acquaint the reader with the notion of unit root public debt sustainability testing.[1] The chapter also explores the pitfalls of the unit root testing approach in evaluating public debt sustainability and provides an overview of two alternative approaches in examining whether respective public debt trajectories are sustainable or not. The first strand of the literature deals with the application of non-linear and non-causal univariate econometric time series techniques, while the second strand of the literature provides arguments in favour of estimating fiscal reaction functions on economic grounds, following two very influential papers of Bohn (1998, 2007). Andric (2024) and Andric et al. (2024) have already reviewed the parts of this chapter, but here the reader can find a more comprehensive and more detailed overview of the issues in question.

Hamilton & Flavin (1986) were the first to apply unit-root testing methods to the following present value relation

$$B_t = \sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i}) + \lim_{n \to +\infty} \rho^n E_t(B_{t+n}). \quad (1)$$

The present value relation from equation (1) is also known as the intertemporal government budget constraint (IGBC) of the government. It says that the present value of public debt (B_t) is equal to the sum of

[1] Afonso (2005) provides a very comprehensive review of the unit root testing methods for evaluating public debt sustainability. See figure 1 on page 25 of Afonso (2005).

discounted future (expected)[2] primary fiscal balances, $\sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i})$, plus the present value of projected, i.e., forecasted, public debt n periods ahead, $\lim_{n\to+\infty} \rho^n E_t(B_{t+n})$.[3] Primary fiscal balance $(R_{t+i} - G_{t+i})$ represents the difference between public revenues (R_{t+i}) and primary public expenditures (G_{t+i}) where primary public expenditures are equal to the difference between overall public expenditures and interest payments on the stock of government debt. The term

$$A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n}) = 0 \qquad (2)$$

is commonly referred in the literature as the transversality condition (TC)[4] in which ρ represents a discount factor equal to $1/(1+r)$ where r can stand for *i)* nominal interest rate, if the time series for public debt, public revenues and primary public expenditures are expressed in nominal terms; *ii)* real interest rate, if the time series for public debt, public revenues and primary public expenditures are expressed in real, inflation-adjusted, terms; or *iii)* nominal (real) interest rate-nominal (real) growth rate differential, if the time series for public debt, public revenues and primary public expenditures are expressed in per cent of GDP.

Hamilton and Flavin (1986) argue that for public debt to be sustainable, it must be equal to the sum of discounted expected primary fiscal balances

$$B_t = \sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i}). \qquad (3)$$

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[2] The symbol $E_t(\cdot)$ denotes the expectation operator conditional upon all available information at period t.

[3] In earlier contributions by Andric (2019), Andric et al. (2024), and Andric & Bodroza (2024), there are typographical errors related to the TC equation in a sense that equation (2) omits the conditional expectation operator $E_t(\cdot)$.

[4] The notational symbol A_t comes from Wilcox (1989). See equation (9) on page 295.

In other words, Hamilton and Flavin (1986) posit that the TC must impose a no-Ponzi game condition on the behaviour of the government, i.e., in order for the public debt to be sustainable, the government must not finance current public debt obligations with the future issuance of government bonds

$$A_t = \lim_{n \to +\infty} \rho^n E_t(B_{t+n}) = 0. \tag{4}$$

Hamilton and Flavin (1986) go on to argue that one can formulate an alternative hypothesis to the one from equation (4) in the form of

$$A_t = \lim_{n \to +\infty} \rho^n E_t(B_{t+n}) > 0 \tag{5}$$

which shows that the current stock of public debt does not equal the sum of discounted expected primary fiscal balances in present value terms

$$B_t \neq \sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i}). \tag{6}$$

To assess whether the creditors could expect that the budget of the US government is in balance in present value terms, Hamilton and Flavin (1986)[5] formulate a following testing regression

$$B_t = A_0(1+r)^t + \sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i}) + e_t \tag{7}$$

in which e_t is the stationary regression disturbance term. The idea of Hamilton and Flavin (1986) is that if the stochastic process for the sum of discounted expected primary fiscal balances, $\sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i})$, is stationary, then the stochastic process for public debt B_t will be stationary if and only if $A_0 = 0$.[6] In other words, if stochastic processes

[5] See equation (10) on page 815 of Hamilton and Flavin (1986).

[6] In equation (17) on page 297, Wilcox (1989) uses the notation a_0 instead of A_0, but the essence of Wilcox's equation (17) is identical to the equation (10) of Hamilton and

for both $\sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i})$ and B_t are stationary, then it must be the case that $A_0 = 0$. On the other hand, if the stochastic process for $\sum_{i=1}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i})$ is stationary, then for $A_0 > 0$, it must be the case that the stochastic process for B_t is non-stationary.

Using annual observations, Hamilton and Flavin (1986) establish that both public debt and primary surplus in the case of the United States are stationary stochastic processes.[7] In particular, the value of the Dickey-Fuller test statistics of Dickey and Fuller (1981) is -2.92 in the case of public debt, and -2.82 in the case of primary fiscal surplus. The results, thus, favour the rejection of the unit-root null hypothesis, although only at the 10% significance level. Hamilton and Flavin (1986) conclude that the US public debt is sustainable, i.e., the intertemporal budget constraint of the US federal government holds in present value terms.

Kremers (1988) challenges the findings of Hamilton and Flavin (1986) in the case of US public debt on econometric grounds. Using Hamilton and Flavin's (1986) dataset for the real federal US public debt, Kremers (1988) finds the presence of statistically significant first order autocorrelation in the residual values of the Hamilton and Flavin (1986) unit root testing equation.[8] Using the Augmented Dickey-Fuller test (ADF) of Dickey and Fuller (1981), Kremers (1988) further shows that the ADF test statistic equals -0.37. Contrary to the conclusion of Hamilton and Flavin (1986), Kremers (1988) shows that one cannot reject the unit-

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Flavin (1986). Note that Hamilton and Flavin (1986) define $A_0 = E_t \lim_{N\to\infty} [B_N/((1+r)^N)]$. It is easy to see that the term A_t from equation (2), $A_t = \lim_{n\to\infty} 1/((1+r)^n) E_t(B_{t+n})$, is algebraically identical to A_0 from equation (7) for $N = t + n$, $N \to \infty$ when $n \to \infty$.

[7] The stationarity of the undiscounted surplus is the sufficient condition for the stationarity of the sum of discounted expected primary fiscal surpluses under the assumption of a positive real interest rate. See Wilcox (1989) for the further development of this argument.

[8] See the last equation on page 815 of Hamilton and Flavin (1986).

root null hypothesis in the case of real federal US government debt between 1960 and 1984.

In a companion paper, Kremers (1989) extends the sample in question back to 1920s to assess for the sustainability of the US public debt/GDP ratio. Kremers (1989) shows that both during the inter-war and post-World War II period, it is difficult to reject the unit-root null hypothesis since the realized value of the ADT test statistic is about -2.60, close to the 10% significance level.

Similarly to Kremers (1988, 1989), Wilcox (1989) is also critical of the findings presented by Hamilton and Flavin (1986). Wilcox (1989) finds two crucial shortcomings in the analysis of Hamilton and Flavin (1986). First, the assumption of a non-stochastic real interest rate in equation (7), which implies that the deviation of the current debt from the sum of discounted expected primary surpluses grows at a constant rate of interest, is unrealistic in a sense that is not consistent with the interest rate data on the US post-war government debt. Note, however, that the assumption of the constant real interest rate in the framework of Hamilton and Flavin (1986) is necessary to obtain the result that the sum of discounted expected primary surpluses is a linear function of current and lagged surpluses and debt. Second, Hamilton and Flavin (1986) deal with the undiscounted US public debt measured in real terms, although TC from equation (2), $A_t = \lim_{n \to +\infty} \rho^n E_t(B_{t+n}) = 0$, is formulated in discounted present value terms.

Given the shortcomings of Hamilton and Flavin (1986), Wilcox (1989) changes Hamilton and Flavin's (1986) analytical framework in two important ways. First, in the analysis of Wilcox (1989) interest rates are stochastic. Second, Wilcox (1989) tests for the sustainability of the real government debt discounted back to a fixed reference time point.

The assumptions of Wilcox (1989) lead to the following two questions. First, how one can use a time series for the discounted government debt to differentiate between a sustainable and an unsustainable fiscal policy? Second, if the fiscal policy is unsustainable, what would be the form of violation of the IGBC in present value terms?

The answer to the first question centres around the forecast trajectory of the discounted government debt. In particular, if the forecast trajectory of the real discounted government debt converges to zero, $A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n}) \to 0$, then fiscal policy is sustainable. In other words, an unsustainable fiscal policy implies that $A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n}) > 0$, i.e., an unsustainable fiscal policy does not imply that the discounted expected real value of government debt will converge to zero with the increase in the forecast horizon.

On the second question about the form of violation of the IGBC in present value terms, Wilcox (1989) outlines two possibilities. First, the limit value of the forecast trajectory of the discounted debt A_t may be stochastic, and in that case $A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n})$ is a martingale. Second, the limit value of the forecast trajectory of the discounted debt A_t may be non-stochastic, and in that case $A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n})$ is a constant (possibly zero).[9] The essence of the analysis in Wilcox (1989) is that the behaviour of A_t is determined by the behaviour of the real discounted value of the government debt.[10] In particular, Wilcox (1989) argues that if discounted debt is non-stationary, then A_t is stochastic. On the other hand, if discounted debt is stationary, then A_t is constant (possibly zero). The conclusion of Wilcox's (1989) analysis is that fiscal policy in the United States is unsustainable after 1974. In other words, the IGBC does not appear to hold in present value terms.

Although papers by Kremers (1988, 1989) and Wilcox (1989) differ from those of Hamilton and Flavin (1986), what is common for all these contributions is that they centre around a univariate time series unit root regressions. Bohn (2007), however, finds problems with the method of applying unit root tests in evaluating public debt sustainability.

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[9] A meticulous reader will note that only the second, non-stochastic, case for A_t is present in the analysis of Hamilton and Flavin (1986).

[10] See the equations (4), (5) and (6) on page 293 of Wilcox (1989) for the definition of real discounted government debt. Note also that Hamilton and Flavin (1986) use only undiscounted debt in their unit root testing regressions of the IGBC.

Bohn (2007) shows that conditions imposed by the IGBC on unit root testing strategies are incapable of deciding whether the trajectory of public debt is sustainable or not. In particular, Bohn (2007) claims that irrespective of the order of integration for the public debt stochastic process, the TC defined in equation (2), $A_t = \lim_{n \to +\infty} \rho^n E_t(B_{t+n}) = 0$, is always satisfied.[11] In particular, Bohn (2007) writes the following on page 1840

"The n-period ahead conditional expectation of an mth-order integrated variable is at most an mth-order polynomial of the time horizon n. The discounting in the transversality condition is exponential in n. Exponential growth is known to dominate polynomial growth of any order. Hence the discount factor ρ^n in (TC) will asymptotically dominate $E_t(B_{t+n})$ whenever debt is difference-stationary with arbitrary order of integration."

The statement from Bohn (2007) quoted above could be, however, misleading for a particularly relevant empirical case when fiscal variables (public debt, primary public expenditures and public revenues) are expressed as % of GDP and when $r < g$, i.e., when the average interest rate paid on government debt is lower than the average GDP growth rate of the economy. If $r < g$, then $1 + r - g < 1$, where $r - g$ stands for the interest rate-growth rate differential, i.e., it is a growth adjusted interest rate on government debt. If it is the case that $1 + r - g < 1$, then $\rho^n = 1/(1 + r - g)^n \to \infty$, which is consistent with the violation of TC, i.e., it implies that $A_t = \lim_{n \to +\infty} \rho^n E_t(B_{t+n}) \to \infty$. In other words, when $r < g$, public debt/GDP ratio grows without bounds and exhibits bubble-like behaviour due to the rollover of public debt by the government.[12]

[11] For a mathematical proof, see Proposition 1 in Bohn (2007) on page 1840.

[12] There are theoretical models which are consistent with the presence of bubbles in government bonds. For example, Brunnermeier et al. (2022) construct such a model in which the TC does not hold, and in which households use government bonds to hedge against idiosyncratic risk. The problem with this class of models is that they do not incorporate the aggregate output risk.

In a series of recent papers, however, Jiang et al. (2021, 2022, 2023a, 2023b, 2024a, 2024b) show that it is unlikely that the TC condition is not satisfied in the case of the US economy, both on empirical and theoretical grounds. Briefly, Jiang et al. (2021, 2022, 2023a, 2023b, 2024a, 2024b) argue that the US government debt is not a risk-free security, and its present value does not equal to the discounted value of expected future primary surpluses with the risk-free rate on US government bonds used as a discount factor. Jiang et al. (2021, 2022, 2024b) argue that a proper discount rate in the case of the US government debt is the sum of maturity-specific risk-free interest rate and the GDP risk premium, since the behaviour of fiscal variables crucially depends on the GDP behaviour.[13] Jiang et al. (2023a) estimate that a plausible value for the GDP risk premium is at least 2.5 percent per year. Adding this estimate for the GDP risk premium to the average, maturity-specific, risk-free interest rate leads to $r > g$ and the absence of violation of the TC condition.[14] In sum, Jiang et al. (2024a) argue that the standard practice of discounting future primary surpluses and forecasted public debt with the risk-free rate is inappropriate since it ignores the basic message of asset pricing literature that the discount rate must reflect the risks associated with underlying cash flow streams. Because future primary

[13] The projections of fiscal cash flows are dependent upon the GDP projections. In addition, the correlation of fiscal variables with respect to business cycle movements could either be pro-cyclical, a-cyclical or counter-cyclical. For example, Jiang et al. (2023a) argue that public revenues in the case of the US are pro-cyclical while the primary government expenditures are counter-cyclical. Similarly, Jiang et al. (2023b) show that even if the current debt/output ratio is constant, the value of the forecasted (projected) public debt is a stochastic (random) variable due to aggregate output risk and the associated GDP risk premium. Consequently, even if one can assume the absence of the default and liquidity risk in the case of the US Treasurys and treat the entire portfolio of the US government bonds as a riskless security, the risk-free rate not adjusted for the GDP risk premium is not the proper discount rate for surpluses in the presence of aggregate output risk.

[14] Jiang et al. (2023b) report that the asset pricing literature estimates that the GDP risk premium could even be around 5% per year. For this high GDP risk premium, the TC is easily satisfied even when $r < g$. For example, Jiang et al. (2023a) give an example that for a 3% GDP risk premium, the risk-free rate would need to be nearly 3 percentage points below the expected growth rate of the economy to engineer a TC violation.

surpluses are correlated with the future GDP movements, a risk-free interest rate adjusted for the GDP risk premium is the proper discount rate for the expected primary surpluses. If the GDP risk premium exceeds the gap between the growth rate and the risk-free rate, the TC will be satisfied.[15]

In sum, the findings of Bohn (2007) and Jiang et al. (2021, 2022, 2023a, 2023b, 2024a, 2024b) are as follows. First, the TC holds, irrespective of the order of integration of the public debt stochastic process. Second, the TC holds, even if it is the case that $r < g$, due to GDP risk premium. Since the TC violation is an untestable criterion for public debt sustainability analysis, at least from the standpoint of unit root testing and $r - g$ comparison, the literature on IGBC and public debt sustainability diverged in two directions.

The first strand of the literature acknowledges that the TC corresponds to the infinite forecasting horizon, so it could be of interest to employ univariate non-linear time series techniques to question regime-dependent fiscal sustainability in short-to-medium run. Following Bohn (1998), the second strand of the literature centres around the estimation of fiscal reaction functions (FRFs) which measure the response of the primary fiscal balance to lagged public debt after controlling for the variations in different macroeconomic variables, most notably output gap, and transitory government spending.

Non-linear Univariate Public Debt Modelling: Related Literature

Bohn (2007) writes the following on page 1841

"Most notions of sustainability—all except Hamilton–Flavin's case—also allow debt to be non-stationary in levels, which means that the debt series

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[15] The reader should note that in the case of Serbia, it is even more likely that the $r - g > 0$ condition holds since *i)* the GDP risk premium is higher in the case of emerging economies; and *ii)* the average, maturity specific, interest rate on Serbian government debt cannot be considered risk-free as in the case of the US due to default and liquidity risk.

would violate any upper bound that might be imposed by (additional) economic considerations. Regarding bounds, the paper's focus on the infinite-horizon IBC is not meant to dispute that more stringent bounds on the path of debt are sometimes of economic interest. Fiscal applications may, for example, involve a bounded tax rate, and international applications may feature a bounded capacity to export. Such bounds may in turn imply upper bounds on debt, either directly or after suitable scaling (e.g., for debt/GDP)."

The argumentation of Bohn (2007) essentially claims that testing for the stationarity of the public debt/GDP ratio could be insightful not from an econometric, but from an economic perspective.[16] Note, however, that even if one establishes the stationarity of public debt/GDP ratio, one cannot infer the TC violation from this result due to the Proposition 1 from Bohn (2007). Establishing the stationarity of the debt/GDP ratio could, however, lead to considering stronger conditions on policy such as, for example, *upper bounds* on public debt/GDP ratio.

One of the first papers in the literature that considers estimating an upper bound in the case of the US public debt is Sarno (2001). Sarno (2001) shows that the US public debt/GDP ratio between 1916 and 1995 follows a nonlinear mean-reverting exponential smooth transition autoregressive (ESTAR) process. Sarno (2001) estimates that the US public debt reverts to its mean once it reaches the threshold of 27% public debt/GDP ratio.

Considine and Gallagher (2008) apply the same method as Sarno (2001) to assess the mean-reversion of the UK public debt/GDP ratio between 1919 and 2001. The results of Considine and Gallagher (2008) reject the tax smoothing hypothesis of Barro (1979) in favour of the alternative hypothesis of active debt management.[17] In other words, Considine and

[16] The most well-known stationarity test in the literature is the KPSS test of Kwiatkowski et al. (1992).

[17] The tax smoothing hypothesis of Barro (1979) implies that taxes and government debt are random walk unit root stochastic processes.

Gallagher (2008) interpret the presence of ESTAR-type non-linearity in the UK public debt as evidence against the tax-smoothing policy between 1919 and 2001.

Chortareas et al. (2008) analyzed the sustainability of government debt in the case of Latin American and Caribbean economies. Chortareas et al. (2008) use non-linear unit-root tests to conclude that there is growing evidence in favour of public debt sustainability once one evaluates the unit-root null hypothesis against a non-linear stationarity alternative hypothesis.

Legrenzi and Milas (2011) are interested in the sustainability of the public debt/GDP ratio in the cases of Greece, Ireland, Italy, Portugal, and Spain (GIIPS) from 1850 to 2010. Contrary to Sarno (2001) and Considine and Gallagher (2008), Legrenzi and Milas (2011) hypothesize that a logistic smooth transition autoregressive (LSTAR) non-linear mean-reverting stochastic process is the best characterization of the public debt/GDP ratio dynamics. The results of Legrenzi and Milas (2011) show that in the cases of Greece and Italy public debt/GDP thresholds exceed 87% and even rise further during financial crises.

Contrary to Sarno (2001), Considine and Gallagher (2008) and Legrenzi and Milas (2011), Gnegne and Jawadi (2013) opt for the self-exciting threshold autoregressive (SETAR) process in modelling the dynamics of UK and US public debt/GDP. While the transition function in the case of ESTAR and LSTAR stochastic processes is continuous, the transition function between the two regimes in the case of SETAR process is discrete. In both the case of the UK and the US, Gnegne and Jawadi (2013) find statistical evidence to support the SETAR-type public debt/GDP ratio mean reversion after 1970.

As Bai and Perron (2003) show, threshold regressions are identical to *breakpoint* least squares regressions with data ordered in a non-decreasing fashion with respect to the threshold variable. Or, alternatively, breakpoint least squares regressions are equivalent to threshold regressions when time is the threshold variable.

Jawadi and Sousa (2013) find two structural breaks in the dynamics of the growth rates of the US and the UK public debt/GDP ratios after 1970. The results of Jawadi and Sousa (2013) strongly point to structural breaks around 2003 and around the GFC.

Similarly to Jawadi and Sousa (2014), Cuestas et al. (2014) also show that in the case of most European economies there is a structural break in the dynamics of public debt/GDP ratio situated around the outbreak of the GFC. The exceptions are Germany and France since in these countries the GFC had little influence on public debt/GDP ratio behaviour.

Cuestas and Regis (2018) examine public debt sustainability in the case of China. The results of Cuestas and Regis (2018) point towards unsustainable fiscal practices after 2014. Cuestas and Regis (2018) further argue that if post-2008 economic growth does not return to pre-crisis levels, China may face problems with servicing its sovereign debt.

Cuestas (2020) explores public debt sustainability in the case of Central and Eastern European economies. Cuestas (2020) describes the challenges in achieving fiscal sustainability in Croatia, Lithuania, Romania, and Slovenia after the outbreak of the GFC in 2008.

The literature reviewed so far that relates public debt sustainability with endogenous threshold estimation and structural break identification is primarily concerned with finding public debt thresholds, i.e., time points that are associated with *regime switches* in fiscal policy behavior. One notable contribution on the topic of Markov regime switching in public debt dynamics is Davig (2005).

Davig (2005) differentiates between global fiscal sustainability and local fiscal sustainability. For the fiscal policy to be *globally* sustainable, Definition 1 of Davig (2005) claims that the unconditional mean of the discounted public debt must be zero. Similarly, for the fiscal policy to be *locally* sustainable, Definition 2 of Davig (2005) stipulates that the mean of the discounted public debt, conditional upon the regime, is zero.

The reader should recognize that the Definition 1 of Davig (2005) regarding global fiscal sustainability is identical to the equation (2), $A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n}) = 0$, and the discussion of why equation (2) posits untestable econometric restrictions for examining public debt sustainability is already presented and originally treated in the contributions of Bohn (2007) and Jiang et al. (2021, 2022, 2023a, 2023b, 2024a, 2024b). What is of potential economic interest, however, is the definition of the notion of *local* fiscal sustainability. By estimating a two-regime Markov-switching autoregression for the discounted value of the real US public debt, Davig (2005) finds a regime of *expanding* discounted public debt in the US between 1981 and 1996. In other words, fiscal policy in the United States was locally unsustainable between 1981 and 1996.

A notion close to the concept of locally expanding public debt is the notion of mildly *explosive* public debt associated with the recursive unit-root testing framework of Phillips et al. (2011). The most important feature of the framework developed by Phillips et al. (2011) is its ability to date stamp the episodes of public debt explosiveness.

One of the first articles to apply the method of Phillips et al. (2011) in the context of public debt sustainability is Yoon (2012). Yoon (2012) claims that the US public debt/GDP ratio was explosive during the sample period 1791-2009. However, the interpretation of Yoon (2012) of the results presented in his paper in Table 1, page 2, and Figure 2, page 3, is imprecise, since it is not the case that the US public debt/GDP ratio was explosive during the whole sample period. More precisely, the Figure 2 from Yoon (2012) clearly shows that the period of public debt explosiveness occurred only during the World War II. Yoon (2012) is imprecise when he generalizes this finding to claim that the US public debt/GDP ratio was explosive during the whole 1791-2009 period. As Esteve and Prats (2023) correctly point out on page 7 below their equation (13)

"...it must be indicated that this type of mildly explosive and collapsing behaviour under the alternative hypothesis corresponds to, at least, one subperiod of the full sample, ***not to the whole sample*** *(emphasis added)."*

Bystrov and Mackiewicz (2020) correct for the interpretation of Yoon (2012) and analyse, apart from the US case, public debt explosiveness in UK and Sweden. Bystrov and Mackiewicz (2020) argue that the explosive public debt episodes are a consequence of structural changes in economic, political, and institutional factors.

Similarly to Bystrov and Mackiewicz (2020), Esteve and Prats (2022, 2023) analyse the dynamics of the Spanish public debt/GDP ratio over the period 1850-2021. Esteve and Prats (2022, 2023) identify four periods of explosiveness in the case of Spanish public debt: the first period spans from 1874 up to 1880 and is related to the first and second Cuban wars; the second period lasted from 1917 to 1920 and it is related to the sharp fiscal adjustment that followed aforementioned Cuban wars; the third period between 1951 and 1981 is associated to another period of fiscal adjustment during the period of Franco's regime until the democratic changes occurred in 1971; and the fourth episode is associated with public debt bubble-like build-up due to chronic budget deficits between 1982 and 2002.

Finally, Creel et al. (2023) study fiscal bubbles in relation to fiscal rules in eleven economies from Central and Eastern Europe. Creel et al. (2023) find that the tightening of fiscal rules constrains public debt from exploding between 2000 and 2021.

The overview of the alternative univariate time series approaches points that these non-linear modeling techniques are useful in detecting periods of local fiscal sustainability. However, the problem with these techniques is that they, like unit-root testing regressions, suffer from an omitted variable bias in a sense that they do not consider variations in other macroeconomic variables. To overcome the omitted variable bias, Bohn (1998, 2007, 2008) proposes the estimation of FRFs that relate changes in primary fiscal balance to changes in public debt and variations in output gap and transitory government spending. The next section explains the logic behind Bohn's (1998) results and reviews the most influential contributions from the literature.

Fiscal Reaction Functions: Related Literature

Barro' s (1979) tax smoothing model serves as a baseline theoretical framework for FRF formulation presented in Bohn (1998). Barro (1979) constructs a tax-smoothing model according to which taxes and government debt behave as random walk stochastic processes. One of the consequences of the Barro's (1979) tax-smoothing model is that there is no optimal threshold debt level that minimizes the costs of tax collection of the government or that maximizes a utility function of the representative household. The random movements in government debt follow from pro-cyclical transitory government spending shocks and counter-cyclical output shocks. Barro (1979) brings his model to the post-World War I US data to conclude that the empirical estimates are in large consistent with the theoretical predictions of the tax smoothing model.

Building on the tax-smoothing model of Barro (1979), Bohn (1998) estimates an ordinary least squares regression (OLS) in which the changes in the primary fiscal balance are a function of lagged public debt, output gap and transitory government spending. Using the US data between 1916 and 1995, Bohn (1998) quantifies a positive response of primary fiscal balance to changes in public debt/GDP ratio. Bohn (1998) further argues that the positive response of primary fiscal balance to lagged public debt is a *sufficient*[18] condition for the mean-reverting behaviour of the U.S public debt/GDP ratio.[19]

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[18] It is possible, for example, that an econometrician does not see a positive response of the primary fiscal balance to public debt accumulation in finite samples, but this sample specific result does not *necessarily* imply that the government will not take corrective fiscal actions in the future. Conversely, if the econometrician finds the positive FRF response of the primary fiscal balance in a defined period, this sample specific result does not *necessarily* guarantee that the government will be fiscally responsible over an infinite forecasting horizon.

[19] An important feature of Bohn's (1998) FRF approach is that it does not depend on the value of the $r - g$ differential. In other words, regardless of the value of the interest

Since the positive conditional response of the primary fiscal balance to changes in public debt is only a sufficient condition for public debt sustainability, Bohn (1998) also estimates non-linear FRF specifications.[20] The idea behind these non-linear FRF specifications is to evaluate how governments behave when debt accumulates to higher and higher levels. For the US data between 1916 and 1995, Bohn (1998) finds an increasing marginal response of primary fiscal balance to changes in public debt.

In sum, the most important message from Bohn's (1998) FRF article is that univariate time series approaches suffer from an omitted variable bias since they do not incorporate business cycle and transitory government spending shocks in the evaluation of public debt sustainability. In other words, the key problem with univariate time series techniques, both on econometric and economic grounds, is that they do not consider transitory government spending and cyclical output shocks leading, consequently, to a failure to reject a unit-root null hypothesis for the public debt/GDP ratio.

Uctum et al. (2006) extend the analysis of Bohn (1998) to examine public debt sustainability in G7 and selected Latin American and Asian countries after 1970. The results of Uctum et al. (2006) support the original findings of Bohn (1998) in a sense that *i)* traditional linear unit

rate-growth rate differential, a positive response of primary fiscal balance to changes in public debt is a *sufficient* condition for ensuring stationarity, i.e., mean-reversion in public debt/GDP ratio. Note, however, that the sufficient condition of Bohn (1998) does not exclude the possibility of ever-increasing public debt/GDP ratio, i.e., the reversion to an ever-increasing mean level of the public debt-to-GDP. Therefore, Ghosh et al. (2013) term the sufficient condition of Bohn (1998) as a *weak* sustainability criterion that does not necessarily imply a FRF primary fiscal balance response higher than the interest rate-growth rate differential.

[20] The condition is only *sufficient* since *i)* a positive non-linear response above a certain public debt/GDP threshold; or *ii)* an almost sure positive time-varying response in the long run; are also consistent with notion of public debt sustainability. For details, see Section 2 of Mendoza and Ostry (2008).

root tests are incapable of rejecting random walk like behavior for government debt, even when is clear that governments take corrective fiscal actions and *ii)* FRFs with structural breaks support the findings of baseline FRFs that find a statistically significant positive response of primary fiscal balance to changes in public debt for the period and sample of countries in question.

Adedeji and Williams (2007) evaluate public debt sustainability in Central African Economic and Monetary Community (CEMAC) and West African Economic and Monetary Union (WAEMU). The article of Adedeji and Williams (2007) emphasizes the importance of including external macroeconomic variables when estimating FRFs. Adedeji and Williams (2007) include trade openness and terms of trade in respective FRF specifications. The econometric evidence suggests that both terms of trade and trade openness are important determinants of primary fiscal balance in small open economies, especially those which are highly dependent upon the movements in commodity markets.

Bohn (2008) builds on the original article of Bohn (1998) by examining public debt sustainability in the US for a much longer period, 1791-2003. Although Bohn (2008) treats a much longer period with respect to Bohn (1998), who focuses only on the 1916-1995 period, the main results and policy messages are still the same. In other words, Bohn (2008) also reports a robust positive conditional response of primary fiscal balance to changes in public debt. The article by Bohn (2008), however, stresses that between 1791 and 2003 the U.S government relied on a negative interest rate-growth rate differential, $r - g < 0$, to keep public debt sustainable. In addition, another important result from Bohn (2008) is that public debt time series measured in nominal and real terms are prone to non-stationarity in their respective variances. Consequently, Bohn (2008) concludes that fiscal variables (revenues, primary expenditures, primary fiscal balance, and public debt) should be in percent of GDP, since their nominal and real counterparts show severe heteroscedasticity issues which could distort the results of unit root tests. Finally, Bohn (2008) concludes that one cannot reject the stationarity in the case of the U.S public debt/GDP ratio and that all deficit/GDP series unequivocally follow stationary stochastic trajectories.

Mendoza and Ostry (2008) recommend that policymakers be responsible and prudent in not allowing public debt to rise above 50-60 percent of GDP. Using the data for the 34 emerging market economies between 1990 and 2005 and data for 22 industrial countries between 1970 and 2005, Mendoza and Ostry (2008) reach the conclusion that for public debt values above 50-60% of GDP, the fiscal reaction functions of governments start to exhibit fiscal fatigue characteristics. In other words, it becomes harder and harder for governments to raise primary surpluses in other to keep pace with the accelerating public debt. In fact, Mendoza and Ostry (2008) split both group of countries to low-debt and high-debt countries and find that for the countries for which the public debt/GDP ratio is above their respective group means and medians, a fiscal sustainability criterion of Bohn (1998) fails. In other words, the fiscal solvency criterion is only satisfied in the case of low-debt emerging market and industrial economies.[21]

Staerh (2008) compares the fiscal policy conduct between twelve original eurozone countries and newly accepted member states from Central and Eastern Europe (CEE) between 1995 and 2005. On balance, Staerh (2008) finds significant differences in the conduct of fiscal policy in the analyzed period for the sample of economies in question. The results of Staerh (2008) are as follows: *i)* on average, the CEE economies record higher fiscal deficits than eurozone economies; *ii)* the overall fiscal balance is less persistent and more counter-cyclical in CEE economies than in eurozone countries; *iii)* in eurozone countries there is a positive conditional response of primary fiscal balance when the

[21] Note that the fiscal solvency criterion is satisfied even in high-debt emerging market economies if one includes non-linear debt terms in respective FRFs. The included non-linear debt terms are, however, consistent with the fiscal fatigue behaviour of primary fiscal balance response when public debt/GDP ratio is above 50%. The estimates show that in the case of high-debt industrial countries, the estimated coefficient for the primary fiscal balance response is either negative or statistically indistinguishable from zero when the public debt/GDP ratio is above the mean (median) debt level of 59% (57.8%) of GDP.

interest payments on government debt start to rise, which is not the case in the CEE economies, *iv)* in both the case of eurozone countries and the CEE economies, there is no statistically significant response of the *overall* fiscal balance to movements in public debt and interest payments; *v)* the eurozone countries had conducted pro-cyclical tax policies, while in the CEE economies tax policies were a-cyclical or counter-cyclical; *vi)* autonomous or non-systematic discretionary fiscal policies exacerbate business cycle fluctuations both in eurozone and CEE economies, but to a larger extent in the latter group of countries; *vii)* counter-cyclical fiscal policy does not influence private growth variability in eurozone countries, which is not the case for the CEE economies; and *viii)* the size of government is much more crucial factor in explaining output growth variability in the CEE economies.

Ghosh et al. (2013) define a concept of fiscal space. Fiscal space stands for a difference between the current public debt value and the limit value of the public debt. Ghosh et al. (2013) define the debt limit value as a maximum value for the public debt above which the default of the government on its maturing debt obligations becomes a certainty, i.e., it occurs with a probability one.[22] The debt limit, and the associated fiscal space, stem from a rational expectations equilibrium model in which the sovereign borrower follows a reduced-form FRF with the fiscal fatigue characteristics while risk-neutral creditors arbitrage between the expected return on government debt (which incorporates a default risk premium) and the risk-free interest rate. Putted differently, the most important feature of the model developed by Ghosh et al. (2013) from

[22] The theoretical assumptions of Ghosh et al. (2013) yield a *finite* debt limit. If public debt is ever to breach this finite debt limit, it would grow without bound. The explosion of public debt would lead to skyrocketing interest rates and a consequent default of the government. For the economy to converge to the finite public debt/GDP limit, the FRF response of the primary fiscal balance must be greater than the interest rate-growth rate differential, a condition that Ghosh et al. (2013) term as *stricter* sustainability criterion. Note also, that apart from the debt limit, which stands for dynamically unstable equilibrium of the model, the model also predicts the existence of a dynamically stable equilibrium public debt/GDP ratio to which the economy converges conditionally, i.e., if and only if public debt/GDP ratio stays below the debt limit.

the standpoint of FRF estimation is that the response of primary balance to changes in public debt shows the characteristics of fiscal fatigue. The fiscal fatigue characteristic of the primary fiscal balance implies that with an increase in public debt, the response of the primary fiscal balance to changes in public debt eventually starts to fade away becoming smaller and smaller in comparison to the interest rate-growth rate differential.[23]

Ghosh et al. (2013) evaluate their theoretical assertions on a sample of twenty-three advanced economies over the period 1970-2007. Ghosh et al. (2013) prefer a cubic function as the best approximation to their non-linear FRF specification with fiscal fatigue since the cubic function implies *i)* no response, or even a negative response, of primary fiscal balance at low levels of debt; *ii)* the increase in the primary fiscal balance response with an increase in public debt; and *iii)* the eventual decrease in the FRF primary fiscal balance response at very high debt levels. Ghosh et al. (2013) estimate that the marginal conditional response of the primary fiscal balance starts to decline around 90-100% of GDP and becomes negative around 150% of GDP.

Similarly to Ghosh et al. (2013), Piergallini and Postigliola (2013) are also interested in a non-linear primary fiscal balance response to changes in public debt, but with an emphasis on a longer period. Piergallini and Postigliola (2013) examine the sustainability of public debt in the case of Italy for the period 1862-2012 by estimating a logistic smooth transition regression of primary fiscal balance on lagged public debt, transitory government spending and cyclical output fluctuations. Piergallini and Postigliola (2013) estimate a public debt threshold of 110% of GDP above which the policy makers in Italy start to take

[23] If the increase in the primary fiscal balance is high enough to offset the increase in interest payments, i.e., if the primary fiscal balance FRF response is higher than the interest rate-growth rate differential, then the public debt/GDP ratio will converge to some finite debt level. The insight of Ghosh et al. (2013) is that while the primary fiscal balance-to-GDP ratio cannot exceed the value of the GDP, the interest payments-to-GDP ratio can, if the public debt/GDP ratio is sufficiently high. In other words, Ghosh et al. (2013) argue that the fiscal fatigue of the primary balance is not just a feature of their theoretical model, but also an empirically plausible and policy relevant stylized fact.

corrective fiscal actions in terms of increased primary fiscal balance response.

Baldi and Staerh (2013) are also interested in a non-linear change in the FRF primary fiscal balance response to public debt accumulation but from a structural break perspective. Baldi and Staerh (2013) are interested in FRF estimates in the case of European economies before and after the GFC. Before the GFC and with respect to business cycle movements, Baldi and Staerh (2013) find that in CEE countries the response of primary fiscal balance was a-cyclical, while in the case of Euro area countries it was counter-cyclical. On the other hand, the response of primary fiscal balance in Euro area countries to changes in public debt was positive, which was not the case in the CEE economies before the outbreak of the GFC. However, after the outbreak of the GFC, the response of the primary fiscal balance to lagged public debt is higher and more precisely estimated, especially in the case of countries that experienced fiscal problems before the crisis. This empirical finding applies to all the countries, irrespective of their geographical position and the level of economic development.

Lewis (2013) provides a notable contribution with respect to papers reviewed so far, since Lewis (2013) examines fiscal policy conduct in ten CEE economies between 1995 and 2008 based on real time data. Lewis (2013) finds that one percentage point increase in GDP growth rate results in a 0.3 percentage points improvement of the budged balance-to-GDP ratio. In addition, Lewis (2013) reports that the use of real time data does not influence the estimated cyclicality of fiscal policy, but rather influences the results on the persistence of budget balances. In particular, the coefficient on lagged budget balance is twice as high when one uses real time data in comparison to ex post revised data. In other words, the results seem to suggest that fiscal plans based on real time data are more persistent than fiscal outcomes measured with ex post fiscal data.

Lamé et al. (2014) estimate FRFs for Greece and France. The idea of Lamé et al. (2014) is to investigate econometric and statistical pitfalls in formulating and estimating FRFs. For example, the FRFs estimated by

Lamé et al. (2014) quantify a positive primary fiscal balance response to changes in public debt in the case of Greece before the GFC. The opposite is true in the case of France. In particular, for the period 1978-2007, the estimated FRF coefficient for the marginal primary fiscal balance response to changes in public debt is not statistically significant implying, potentially, that public debt/GDP ratio in the case of France is not sustainable, i.e., it does revert to its mean public debt/GDP ratio level eventually. However, the estimates of Lamé et al. (2014) in the case of France are difficult to reconcile with the behaviour of bond investors after the GFC who continued to buy bonds issued by the French government on a large-scale implying, consequently, that they deemed French public debt to be sustainable.

The article of Lamé et al. (2014) also adds two important methodological contributions to the current state of knowledge regarding FRF public debt sustainability tests. First, Lamé et al. (2014) provide a proof (see pages 627-628 in the Appendix of Lamé et al., 2014) that a positive conditional response of the primary fiscal balance to changes in public debt represents a sufficient sustainability condition if and only if it is accompanied with an additional condition that the FRF error term, as well as control variables, are bounded stochastic processes.[24] Second, Lamé et al. (2014) discuss econometric difficulties when primary surplus and public debt have different persistence and propose both parametric and non-parametric approaches to deal with this issue in practical empirical work.

Égert (2014) focuses on analysing the fiscal policy reaction to business cycle movements in OECD economies between 1970 and 2008. The findings of Égert (2014) are as follows *i)* cyclically unadjusted fiscal balances were pro-cyclical with respect to output gap and GDP growth; *ii)* cyclically adjusted fiscal balances were counter-cyclical in Australia, Canada, Denmark and the US, while they were pro-cyclical in Austria, Belgium, Hungary, the Netherlands, Poland, Portugal and the United

[24] Lamé et al. (2014) provide counterexamples when the error term and control variables are weakly, or strong, stationary stochastic processes for which the Bohn's (1998) sufficient condition does not hold.

Kingdom; *iii)* the fiscal policy reaction function reacts in a non-linear fashion to movements in cyclical output fluctuations only if business cycle movements are measured with output gap, but not in the case when they are measured with the GDP growth rate[25]; *iv)* the larger the size of the government, the more counter-cyclical fiscal policy will be, and vice versa; *v)* fiscal balances are positively correlated with trade openness; *vi)* fiscal balances, both cyclically adjusted and unadjusted, are positively correlated with the house price and stock market prices; and *vii)* cyclically unadjusted revenues are pro-cyclical, while government expenditures are a-cyclical.[26]

Mauro et al. (2015) construct time series data spanning from 30 to 150 years for fiscal revenues, primary expenditures, interest payments, primary and overall fiscal balance for fifty-five countries worldwide. On balance, Mauro et al. (2015) identify a regime of fiscal prudence in most advanced economies before the GFC, but also a regime of fiscal profligacy after the GFC.[27] In fact, Mauro et al. (2015) report that the GFC represents the most important peace time outlier with respect to its influence on worsening fiscal positions globally. Finally, Mauro et al. (2015) find that the primary fiscal balance response coefficient can vary

[25] The results of Égert (2014) seem to suggest that discretionary fiscal policy is pro-cyclical when the deficit is above 3% of GDP and counter-cyclical when the deficit is below 3% of GDP. In addition, fiscal policy tends to be pro-cyclical if public debt is above 90% of GDP, a-cyclical if the public debt is between 30%-90% of GDP, and counter-cyclical if public debt is below 30% of GDP.

[26] Among different categories of government revenues, corporate taxes show the highest degree of pro-cyclicality, while income and consumption taxes, as well as social security contributions tend to be less pro-cyclical. Among different categories of government spending, investment spending and government wage bill show the highest degree of pro-cyclicality, while subsidies to government owned enterprises tend to be counter-cyclical. Finally, social security transfers are shown to be a-cyclical.

[27] In general, for the period from 1950 to 2007, i.e., for the period before the Global Financial Crisis, Mauro et al. (2015) find a positive response of the primary fiscal balance to lagged public debt in the case of advanced economies, the exceptions being France and Japan where the estimated FRF coefficient was negative and statistically significant.

from 0.00-0.05 depending on whether one controls for the interest rates and growth surprises in estimated FRFs.

Afonso and Jalles (2017) differ from the earlier contributions since they focus on estimating time-varying FRFs for the 11 Eurozone countries between 1991Q1 and 2013Q4. The FRF time-varying coefficient estimates show that the GFC of 2008-2009 reduced the response of primary fiscal balance to changes in public in a statistically significant manner. Afonso and Jalles (2017) propose expenditure-based fiscal rules as the most potent fiscal policy tool in achieving prudent debt targets. One side result of the article by Afonso and Jalles (2017) is that they find circumstantial evidence against the Fiscal Theory of the Price Level (FTPL). Afonso and Jalles (2017) find evidence in favour of Ricardian (monetary dominant) regime in Belgium, France, Germany, and the Netherlands.

Arsic et al. (2017) focus on 11 CEE economies, including Serbia, between 2000 and 2013 to investigate the discretionary response of fiscal policy to changes in public debt before and after the outbreak of the GFC. The results of Arsic et al. (2017) are as follows *i)* there is a statistically significant positive response of the primary fiscal balance to public debt accumulation both before and after the GFC; *ii)* with respect to output gap, discretionary fiscal policy in CEE economies was procyclical both before and after the outbreak of the GFC, but, with respect to absorption gap, discretionary fiscal policy seems to behave in a-cyclical fashion; *iii)* political fragmentation does not influence the dynamics of the primary fiscal balance in the CEE economies between 2000 and 2013; *iv)* political election cycle does influence fiscal developments, but only before the GFC; *v)* some circumstantial evidence points in a direction that the arrangements with the IMF contribute to larger fiscal prudence in the economies under study; and finally *vi)* there is no statistically significant influence of the EU accession process on fiscal profligacy in the CEE economies between 2000 and 2013.

II MODEL-BASED FISCAL SUSTAINABILITY ANALYSIS

The section I acquainted the reader with the algebra of IGBC. It also reviewed the most important empirical studies on *i)* univariate non-linear public debt modelling, based on the recommendations of Bohn (2007), and *ii)* the estimation of FRFs, based on the results of Bohn (1998). This section outlines the theoretical foundations on which the FRF estimates are based. It follows from Section 2 of Mendoza and Ostry (2008) who, in turn, follow Bohn (2008) closely.

The most important feature of the reduced-form FRFs is that they are model-based, i.e., the FRFs stem from a general equilibrium model that explicitly relates the behaviour of government with the behaviour of the private sector. The model-based public debt sustainability analysis also shows that the risk-free interest rate on government debt is not a suitable discount factor in public debt sustainability analysis.

Mendoza and Ostry (2008) consider an economy in which the total output of the economy is y and government purchases are g. Consequently, the state of the economy at period t is $s_t = (y_t, g_t)$. Furthermore, the probability of transitioning from the $s_t = (y_t, g_t)$ to $s_{t+1} = (y_{t+1}, g_{t+1})$ is given by Markov density function $f = (s_{t+1}, s_t)$. Mendoza and Ostry (2008) assume that asset markets are complete, and that their equilibrium asset prices come from the j −periods ahead pricing kernel $Q_j(s_{t+j}|s_t)$

$$Q_j(s_{t+j}|s_t) = \frac{\beta^j u'\big(y(s_{t+j}) - g(s_{t+j})\big)}{u'(y(s_t) - g(s_t))} f^j(s_{t+j}, s_t) \quad (8)$$

in which $u'(\cdot)$ is the marginal utility of consumption, and the consumption bundle is $c(s_{t+j}) = y(s_{t+j}) - g(s_{t+j})$. The complete markets assumption, as Mendoza and Ostry (2008) explain, imply that the prices of all securities issued, traded, and held by the private households and the government have unique prices.

Mendoza and Ostry (2008) further express the risk-free interest rate on public debt that matures $\boldsymbol{j}$ −periods ahead of time $\boldsymbol{t}$ as

$$\left[R_{jt}\right]^{-1} = \beta^{j} E_t \left[\frac{u'(y_{t+j}-g_{t+j})}{u'(y_t-g_t)}\right]. \tag{9}$$

Consequently, Mendoza and Ostry (2008) express the budget constraint of the government as

$$g(s_t) = \tau(s_t) + \int Q_1(s_{t+1}|s_t)\, b_t(s_{t+1}|s^t) ds_{t+1} - b_{t-1}(s_t) \tag{10}$$

in which government revenues are denoted with $\tau(s_t)$ while $b_t(s_{t+1}|s^t)$ represent securities by which the government commits at date t to deliver an amount of goods at $t+1$ in state s_{t+1} after a history of states s^t (Mendoza and Ostry, 2008).

Note also, as Mendoza and Ostry point out (2008), that the government can also issue non-state contingent bonds[28] for which

$$\boldsymbol{b_t(s_{t+1}|s^t) = b_t(s_t), \forall s_{t+1}}. \tag{11}$$

From equations (8) and (10), Mendoza and Ostry (2008) express the intertemporal budget constraint of the government[29] as

$$b_{t-1}(s_t) = \tau_t - g_t + \sum_{j=1}^{\infty} E_t \left[\frac{\beta^j u'(y_{t+j}-g_{t+j})}{u'(y_t-g_t)}\left(\tau_{t+j} - g_{t+j}\right)\right]. \tag{12}$$

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[28] Even in the case of non-state contingent bonds, due to market completeness, it is possible to find the price of these securities.

[29] For the expression in equation (12) to hold, it must be the case that the transversality condition from equation (2) holds, i.e., $A_t = \lim_{n\to+\infty} \rho^n E_t(B_{t+n}) = 0$. See also footnote 3 on page 1083 of Mendoza and Ostry (2008).

Using the expression for the risk-free interest rate from equation (9), Mendoza and Ostry (2008) express the intertemporal budget constraint of the government from equation (12) as

$$b_{t-1}(s_t) = \tau_t - g_t + \sum_{j=1}^{\infty}\left\{R_{jt}^{-1}E_t\left[\tau_{t+j} - g_{t+j}\right] + cov_t\left[\frac{\beta^j u'(y_{t+j}-g_{t+j})}{u'(y_t-g_t)}, \tau_{t+j} - g_{t+j}\right]\right\}. \qquad (13)$$

If one now compares the expression for the intertemporal budget constraint of the government from equation (13) with the expression for the intertemporal budget constraint of the government from equation (3) for B_{t-1}

$$B_{t-1} = \sum_{i=0}^{+\infty} \rho^i E_t(R_{t+i} - G_{t+i}) \qquad (14)$$

one can conclude that, under the assumption that the transversality condition holds, the two expressions differ with respect to the covariance term

$$b_{t-1}(s_t) - B_{t-1} = cov_t\left[\frac{\beta^j u'(y_{t+j}-g_{t+j})}{u'(y_t-g_t)}, \tau_{t+j} - g_{t+j}\right]. \qquad (15)$$

In other words, the expression for the intertemporal budget constraint of the government from equations (3) and (13) will be identical if and only if

$$cov_t\left[\frac{\beta^j u'(y_{t+j}-g_{t+j})}{u'(y_t-g_t)}, \tau_{t+j} - g_{t+j}\right] = 0. \qquad (16)$$

Mendoza and Ostry (2008) outline three cases when the equality from equation (16) holds: *i)* no uncertainty; *ii)* private agents are risk neutral; or *iii)* future government surpluses are uncorrelated with future marginal utilities of consumption (Mendoza and Ostry, 2008). The first two assumptions, as Mendoza and Ostry (2008) note, are unrealistic, while the third assumption is not in the accordance with available empirical evidence on cyclicality of fiscal policy.[30]

The expression from equation (13) is a theoretical backbone of the model based fiscal sustainability analysis.[31] As Mendoza and Ostry (2008) state on page 1084

"If the primary balance-GDP ratio (pb) *is an increasing, linear function of the initial debt-GDP ratio* (b)*, after controlling for other determinants* (μ) *of the primary balance output ratio, and if these other determinants measured as GDP ratios are bounded and the present value of output is finite, then the solvency condition (4) holds."*[32]

As Bohn (2008) and Mendoza and Ostry (2008) explain, the model-based sustainability condition yields a following reduced-form FRF

$$pb_t = \rho b_{t-1} + \mu_t + \varepsilon_t. \tag{17}$$

in which ε_t is a zero-mean error. A positive and statistically significant ordinary least squares (OLS) estimate of ρ is a sufficient condition for public debt sustainability. The other determinants of the primary balance (μ_t) usually consist of output gap and transitory government spending

$$\mu_t = \alpha_0 + \alpha_1 ygap_t + \alpha_2 ggap_t \tag{18}$$

in which output gap $(ygap_t)$ and transitory government spending $(ggap_t)$ are usually in percent of GDP.

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30 See, for instance, the contributions reviewed in Section 2 of this monograph, most notably the articles by Staerh (2008), Baldi and Staerh (2013), Lewis (2013), Égert (2014), Mauro et al. (2015) and Arsic et al. (2017).

31 See Proposition 1 in Bohn (2005) for mathematical details.

32 The equation (4) of Mendoza and Ostry (2008) corresponds to the equation (12) of this section.

After combining equations (17) and (18), one arrives at the final expressions for the reduced form FRF

$$pb_t = \rho b_{t-1} + \alpha_0 + \alpha_1 ygap_t + \alpha_2 ggap_t + \varepsilon_t. \qquad (19)$$

Mendoza and Ostry (2008) explain the economic intuition behind equations (17) and (19). If the coefficient for the primary fiscal balance response to lagged debt, ρ, is positive and statistically significant, then the solvency condition from equation (12) is satisfied. If the solvency condition from equation (12) is satisfied, then the transversality condition holds, and the government cannot run a Ponzi scheme. To see more clearly the absence of a Ponzi scheme, note that one percentage point increase in b_{t-1} would imply that the government would cover ρ percentage points of b_t with primary fiscal balance pb_t, so that $(1-\ \rho)$ percentage points of b_{t-1} would have to be financed via Ponzi scheme, under the assumptions that central bank does not print money to cover for the deficit. In other words, the solvency condition implies that public debt grows from $t-1$ and t to a level that is $(1-\ \rho)$ of the level that implies a Ponzi scheme, so that j −periods ahead the value of the public debt becomes $(1-\ \rho)^j$ the size of a Ponzi scheme (Mendoza and Ostry, 2008). However, if $0 < \rho < 1$, then there is no Ponzi scheme since $(1-\ \rho)^j \to 0$ for $0 < \rho < 1$. On the other hand, if $\rho > 1$, then $(1-\ \rho)^j \to -\infty$, implying that the government does not issue debt, but instead accumulate assets, which is inconsistent with a Ponzi scheme deficit financing.

As Mendoza and Ostry (2008) imply, the model-based fiscal sustainability analysis also provides an expression for calculating the long-run expected value of the public debt/GDP ratio

$$E[B_t] = \frac{-\bar{\mu} + (1-\rho)cov(1+r_t, b_{t-1})}{\rho(1+\bar{r}) - \bar{r}} \qquad (20)$$

in which $\bar{\mu}$ is the mean value of μ_t from equation (18) and $\bar{r}$ is the mean value of the growth adjusted interest rate.

Finally, there are two important shortcomings of the model-based sustainability analysis, as Mendoza and Ostry (2008) discuss. First, the model-based sustainability analysis yields a fiscal solvency test in the case of the complete asset markets. If the asset markets are incomplete, which is usually the case in emerging and developing economies, then households and other private agents can infer the possible realizations of idiosyncratic shocks, but they do not have an ability to insure themselves against these shocks, since state-contingent security claims do not exist. The only way to interpret the estimated ρ coefficient in this case is to assume fiscal solvency for the incomplete markets setting with a warning that higher indebtedness would be possible if the markets were complete. Second, an econometrician and practitioner must take stance on how to interpret a negative, or statistically insignificant, estimate for the primary fiscal balance response coefficient ρ. Bohn (2008) and Mendoza and Ostry (2008) outline three potential interpretations: *i)* the estimated value for the coefficient ρ indeed points to unsustainable fiscal practices, *ii)* the estimated value for the coefficient ρ suggests future fiscal policy changes that the private agents currently predict; and *iii)* the estimated value for the coefficient ρ implies that private agents have finite forecasting horizons, so that an intertemporal budget constraint of infinitely lived agents is not the relevant one.

III EMPIRICAL RESULTS

This section of monograph consists of two subsections. The first subsection details the most important stylized facts about the behaviour of macroeconomic and fiscal aggregates between the 2001Q1 and 2023Q2. The second subsection presents the results of 25 OLS estimated FRFs for the same period.

3.1. STYLIZED FACTS

This subsection builds on fiscal policy measures and macroeconomic trends already documented in Andric et al. (2016a, 2016b), Andric and Minovic (2018, 2022) and Andric (2019, 2024). The reader can find a much-detailed account of measures and trends presented here in references from above. Here the focus is only to give an overview of macroeconomic and fiscal developments so that the reader can have a better understanding of the FRFs estimated in the next subsection.

Figure 1 shows the evolution of the public debt/GDP ratio in Serbia between 2001Q1 and 2023Q2. The figure conveys three important messages about the dynamics of public debt/GDP ratio in Serbia. First, between 2001Q1 and 2008Q2 one can see a steady decline in the public debt/GDP ratio from approximately 160% of GDP to approximately 25% of GDP. The decline in the public debt/GDP ratio was primarily due to strong absorption-led growth, the unprecedented surge in privatization receipts and debt write-offs from international creditors, most notably the Paris Club and London Club of creditors, as Andric et al. (2016a, 2016b), Andric and Minovic (2018) and Andric (2019) describe. Second, the GFC hit the Serbian economy in the second half of 2008.

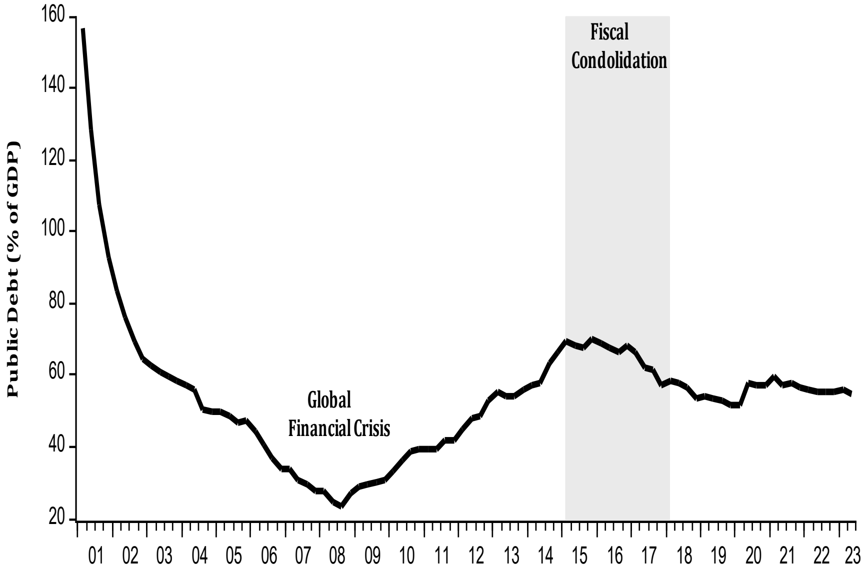

Figure 1: Public Debt-to-GDP ratio in Serbia, 2001Q1-2023Q2.
Source: Author's calculations.

The spillover of the GFC to Serbia had detrimental consequences for the trajectory of the public debt/GDP ratio. The growth of public indebtedness in Serbia between 2008Q2 and 2014Q4 was the fastest among all economies from Central, Eastern and South-Eastern Europe (Andric et al., 2016b). Public debt/GDP ratio skyrocketed for approximately forty-five percentage points of GDP between 2008Q2 and 2014Q4. In the first half of fiscal 2012, the share of public debt in GDP went above the 45% upper limit defined in national fiscal rules (Andric, 2024). Moreover, in the second half of 2014, the ratio breached yet another threshold, the one of 60% of GDP defined in the Maastricht fiscal criteria (Andric, 2024). Consequently, in 2015Q1, public indebtedness as % of GDP equalled 70% (Andric, 2024). Faced with rapidly deteriorating fiscal stance, in 2015Q1 policy makers launched a 3-year fiscal consolidation package that successfully reversed the escalating trajectory of public debt in Serbia. As a result of successful fiscal austerity

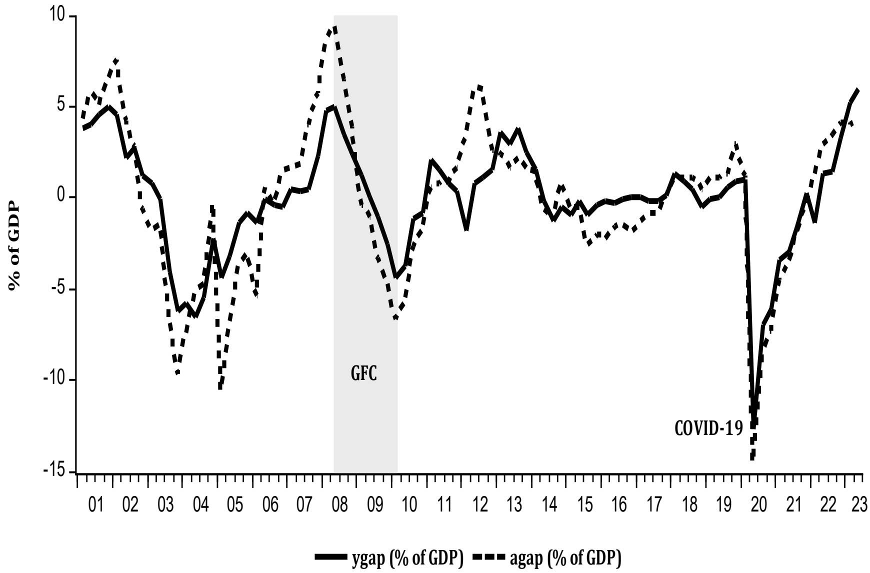

Figure 2: Output Gap (ygap) as % of GDP and Absorption Gap (agap) as % of GDP in Serbia, 2001Q1-2023Q2.

Source: Author's calculations.

measures, supported by the IMF stand-by arrangement, the public debt/GDP ratio between 2015Q1 and 2018Q1 dropped by more than ten percentage points of GDP, and at the beginning of the fiscal 2018 it was two percentage points below the Maastricht 60% public debt criterion. Finally, during the COVID-19 pandemic, fiscal policy makers in Serbia managed to stop the growth of public debt/GDP ratio above the Maastricht debt threshold.

Although the COVID-19 pandemic did not cause public debt to go above the 60% of GDP limit, Figure 2 shows that it had an adverse effect on business cycle developments in Serbia. Figure 2 shows the movements in the output gap and the absorption gap[33] in Serbia, measured as % of GDP, for the period under scrutiny. One can infer from Figure 2 that in 2020Q2, due to the COVID-19 pandemic, the output gap and the absorption gap in Serbia dropped for approximately fifteen percentage points of GDP. The decline in the output gap and the absorption gap due to the COVID-19 pandemic was even larger than the respective decline due to the GFC of 2008 and 2009 when the output gap and the absorption gap dropped for little more than 5 percentage points of GDP, as shaded area from Figure 2 above shows. Finally, note also that prior to the COVID-19 pandemic, the values for the absorption gap differ from those for the output gap, since the absorption gap only refers to the domestic absorption, i.e., to a sum of domestic private consumption, domestic private investments and government spending, while the output gap measures business cycle movements in the domestic absorption corrected for the cyclical fluctuations in the trade deficit which were sizeable for the period under analysis due to the opening of the Serbian economy since the beginning of the century (Andric and Minovic, 2022). The two gaps, however, coincided closely in the period of COVID-19 pandemic due to a global stop in foreign trade, foreign capital flows caused by the quarantine, and other precautionary medical and pandemic measures.

Although it did not have a significant impact on the size of public indebtedness, the COVID-19 pandemic has influenced the movements in public revenues and expenditures, and the developments in the overall and primary fiscal balance in Serbia between 2001Q1 and 2023Q2. Figure 3 below plots the dynamics of public revenues as % of GDP and

[33] More precisely, output gap is defined as the share of cyclical GDP in the overall GDP where cyclical output is the difference between the overall GDP and trend GDP. Similarly, absorption gap is defined as the share of cyclical absorption in the overall GDP where cyclical absorption is the difference between the overall absorption and the trend absorption. In both the case of the output gap and the absorption gap, the respective trend values were computed via Hodrick-Prescott (HP) filter with the smoothing parameter set to 1600 ($\lambda = 1600$), as usual when analysing business cycle movements at quarterly frequency. For details about pros and cons in using the HP filter with respect to other filters from the literature, see Schüler (2018) and Hodrick (2020).

discretionary, i.e., structural, public revenues as % of GDP in the sample period. Discretionary (structural) public revenues are equal to

$$dr_t = r_t - 0.17 \times (ygap_t + agap_t) \tag{21}$$

as in Andric (2019) and Andric and Minovic (2022).[34] Regarding the equation (21), in the corrective factor of $0.17 \times (ygap_t + agap_t)$ for overall public revenues as % of GDP (r_t), the 0.17 coefficient represents the average share of direct and indirect public revenues in GDP between 2001Q1 and 2023Q2 while the linear combination ($ygap_t + agap_t$) has the purpose to correct for the cyclical movements in direct revenues due to $ygap_t$ as well as the cyclical movements in the indirect revenues due to $agap_t$.[35]

[34] Equation (1.32) in Andric (2019) and equation (1) in Andric and Minovic (2022) are imprecise, and do not use the right time subscripts which could be important in calculating discretionary revenues since the lagged, and not the contemporaneous, values of the output gap and the absorption gap might also influence structural measures on the revenue side of the budget.

[35] As Andric (2019) notes, the calculated values for the discretionary public revenues are not calculated by estimating equation (21) econometrically due to a relatively high correlation between the output gap and the absorption gap. The relatively high correlation between the two gaps could lead to inflated standard errors and, so, to a false statistical conclusion that the absorption gap does not influence revenue fluctuations. However, if one does not include the absorption gap in the estimation of discretionary public revenues, one must deal with the consequences of an omitted variable bias.

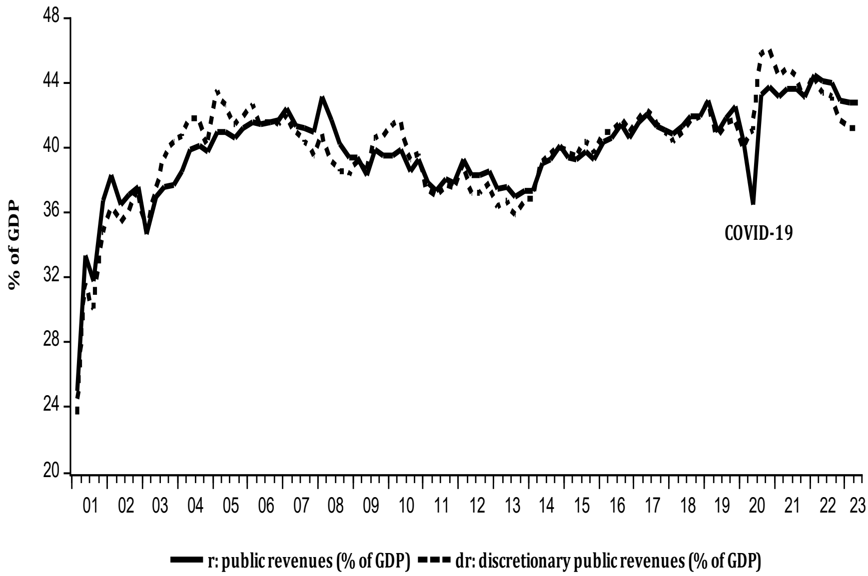

Figure 3: Public Revenues (r) and Discretionary Public Revenues (dr) as % of GDP in Serbia, 2001Q1-2023Q2.

Source: Author's calculations.

The idea behind the calculation of discretionary (structural) public revenues is to measure public revenue changes due solely to policy makers' discretion.[36] In other words, by excluding the impact of a business cycle on the fluctuations in overall public revenues, one can track and monitor movements in public revenues that are only a consequence of discretionary fiscal policy measures. Note, however, that the time series for overall public revenues (r) and discretionary public revenues (dr) from Figure 3 move in a synchronized manner, i.e., they track each other very closely. The high degree of correlation between (r) and (dr) further implies that the variations in overall public revenues are due to the discretionary fiscal policy measures and have little to do

[36] For a detailed account on computing structural fiscal balances in the presence of absorption gap, consult Rahman (2010), as well as Dobrescu and Salman (2011).

with business cycle fluctuations. Furthermore, see that the recovery of public revenues and discretionary public revenues from 2020Q2 COVID-19 shock to its pre-pandemic levels was much quicker than the recovery in output gap and absorption gap depicted in Figure 2. The faster recovery of revenues in comparison to business cycle is another confirmation of the fact that the greatest percentage of variations in overall public revenues is due to discretionary measures.

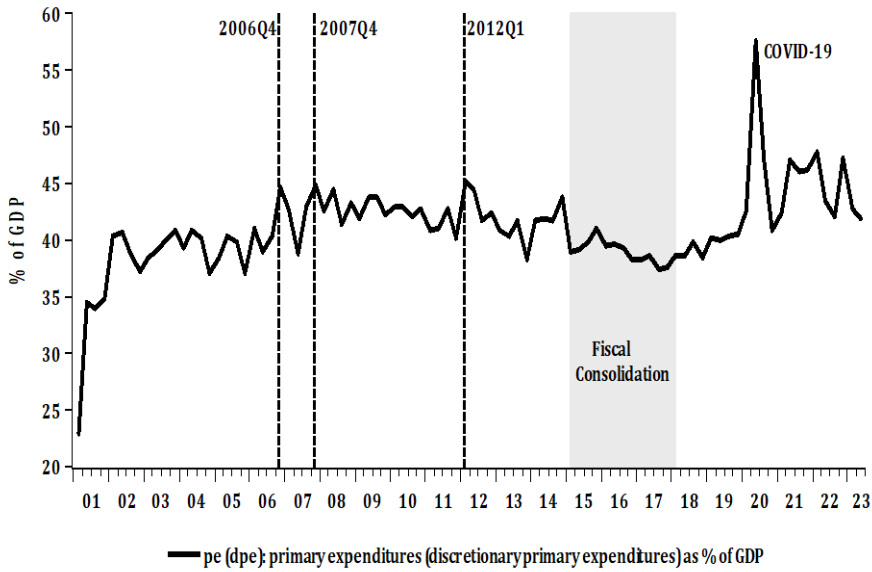

Figure 4: Primary Expenditures (*pe*) and Discretionary Primary Expenditures (*dpe*) as % of GDP in Serbia, 2001Q1-2023Q2.

Source: Author's calculations.

Policy makers can also exert its discretionary influence on the spending side of the government budget. Figure 4 above, hence, presents the dynamics of primary expenditures (*pe*) and discretionary (structural) primary expenditures (*dpe*) in the case of Serbia between 2001Q1 and 2023Q2. Four things about Figure 4 are worth emphasizing. First, Figure 4 shows the dynamics of primary expenditures, i.e., the dynamics of overall expenditures minus interest payments on the stock of public debt from the earlier period. Since interest payments are a consequence of earlier borrowing decisions, they are an exogenous variable beyond the influence of policy makers' decisions in the current period. Second, the plot of just one solid bold line in Figure 4 implies that primary expenditures equal discretionary primary expenditures. Equating the time series for (pe) and (dpe) is standard in the literature on computing structural fiscal balances[37] since, on the expenditure side of the budget, unemployment benefits represent the only component in terms of size that can been influenced by business cycle fluctuations. However, in the case of Serbia, unemployment benefits stand for only a small percentage of GDP so their influence on the dynamics of overall primary expenditures is negligible. Third, one can see that (discretionary) primary expenditures reach their sample maximum of approximately 60% of GDP in 2020Q2 because of COVID-19 pandemic shock. As in the case of revenues, however, the return to the pre-pandemic level is faster than in the case of output gap and absorption gap. Note, also, that there are three "local" maxima in the behaviour of primary expenditures, and they are all associated with the election cycle in the Republic of Serbia between 2001Q1 and 2023Q2. More precisely, the spikes in 2006Q4, 2007Q4 and 2012Q1, which push the share of primary expenditures to around 45% of GDP, all correspond to a quarter before major parliamentary and/or presidential elections.[38] Finally, due to a 3-year fiscal consolidation package, there is a downward trend in the dynamics of primary expenditures between 2015Q1 and 2018Q1, from slightly above the 40% of GDP in 2015Q1 to slightly below the 40% of GDP in 2018Q1.

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[37] See Bornhorst et al. (2011) for a detailed overview.

[38] The 2006Q4 spike corresponds to a quarter before parliamentary elections held in 2007Q1. The 2007Q4 spike corresponds to a quarter before presidential elections held in 2008Q1. Finally, the 2012Q1 spike corresponds to a quarter before parliamentary and presidential elections held in 2012Q2.

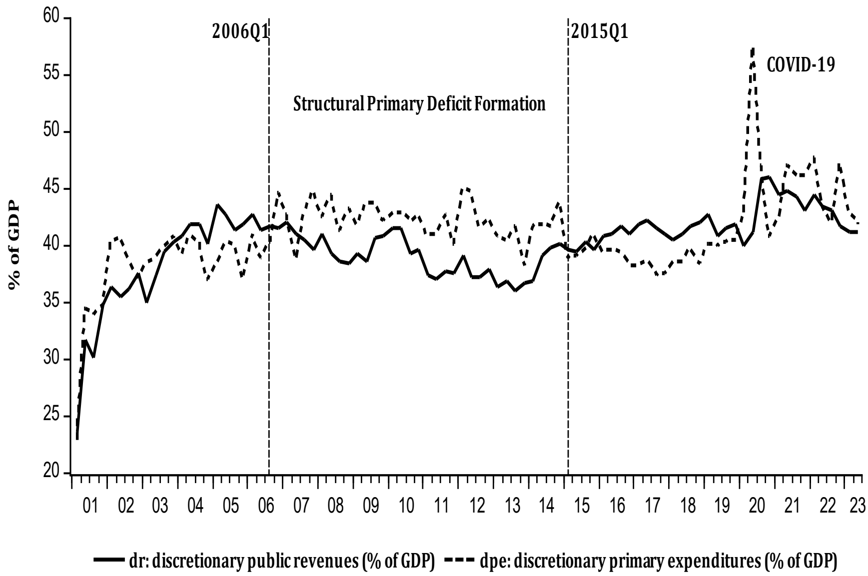

Figure 5: Discretionary public revenues (r) and discretionary primary expenditures (dpe) as % of GDP, 2001Q1-2023Q2.

Source: Author's calculations.

Note also that the fiscal consolidation package managed to curb the growth of primary expenditures in 2017Q1, a quarter before parliamentary elections held in 2017Q2.

Figure 5 plots together the time series for discretionary public revenues *dr* from Figure 3 and discretionary primary expenditures *dpe* from Figure 4. Apart from the expected influence of the COVID-19 pandemic, one can also see in Figure 5 two important stylized facts about structural fiscal developments in Serbia after 2001Q1. First, the formation of the structural primary fiscal deficit in the case of Serbia occurred between 2006Q1 and 2015Q1. This finding, already discussed in Andric and Minovic (2022), shows that the outbreak of the GFC in 2008 was not the only cause of deteriorating fiscal stance in Serbia. In fact, structural fiscal problems appeared a couple of years before the spillover of the GFC to

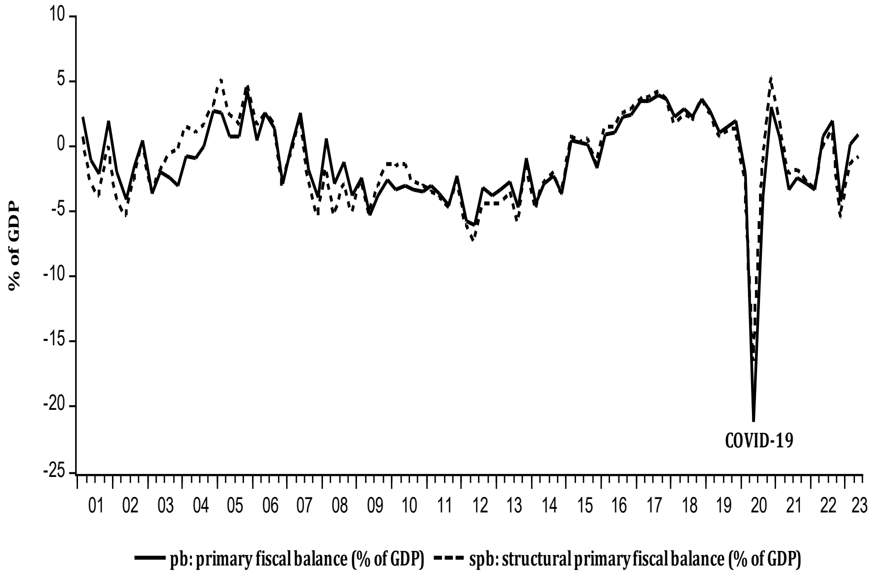

Figure 6: Structural Primary Fiscal Balance (*spb*) and Primary Fiscal Balance (*pb*) in Serbia as % of GDP, 2001Q1-2023Q2.
Source: Author's calculations.

Serbian economy. More precisely, due to a pro-cyclical fiscal deficit policy in 2006 and 2007 in the form of several discretionary tax cuts, reviewed in detail by Andric et al. (2016a) and Andric et al. (2016b), the share of government revenues in GDP between 2006Q1 and 2009Q1 dropped for approximately four percentage points of GDP. Second, the structural primary fiscal deficit turned into a surplus between 2015Q1 and 2018Q1 due to fiscal consolidation package that managed to simultaneously *i)* reduce the share of primary expenditures in GDP; and to *ii)* increase the share of public revenues as % of GDP.

Finally, Figure 6 above compares the evolution of structural primary fiscal balance (*spb*) from Figure 5 with the evolution of overall primary fiscal balance (*pb*). The two series show almost indistinguishable trajectories. The correlation coefficient between the two series is higher than 0.9. The high degree of concordance between (spb) and (pb) implies that both series can be the dependent variable in FRF estimates that the next subsection outlines.

3.2. ECONOMETRIC FRF ESTIMATES

Following equation (19) from Section II of this monograph, this subsection begins by outlining the estimates from the following baseline FRF first estimated by Bohn (1998)

$$pb_t = \rho b_{t-1} + \mu_t + \varepsilon_t = \rho b_{t-1} + \alpha_0 + \alpha_1 ygap_t + \alpha_2 ggap_t + \varepsilon_t \qquad (22)$$

in which the dependent variable pb_t, which represents the share of primary fiscal balance in GDP[39], is regressed on one quarter lagged public debt-to-GDP ratio b_{t-1}, on a constant term α_0, the output gap $ygap_t$ (measured in % of GDP), and transitory government spending $ggap$, also measured in percent of GDP. The *i.i.d.* error term with normal probability distribution is ε_t The parameters of the equation (22) represent OLS estimates. Table 1 on next page presents the results of the OLS estimation method.

Table 1 conveys four important messages. First, the percentage of variations in primary fiscal balance explained by the regressors from equation (22) is only 22%, as the adjusted R^2 from Table 1 shows. Second, the response of primary fiscal balance to output gap fluctuations is positive and statistically significant at 1% significance level. The estimated positive value for the $ygap_t$ coefficient implies that primary fiscal balance behaved pro-cyclically with respect to business cycle fluctuations after 2001Q1. Third, the response of primary fiscal balance

[39] Throughout the monograph the terms primary fiscal balance and primary balance are used synonymously.

Table 1: Baseline FRF from Bohn (1998)

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−1.42	0.96	−1.47	0.14
$ygap_t$	0.39***	0.11	3.45	0.00
$ggap_t$	−1.88***	0.42	−4.50	0.00
b_{t-1}	0.01	0.02	0.35	0.73
$Adj.R-squared$	0.22	$F-stat.(prob.)$		9.3 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

to transitory changes in government spending is negative and statistically significant at 1% significance level. Note, however, that the estimated coefficient is double in size with respect to estimates presented in Andric et al. (2016a, 2016b) due to wrong transitory government spending calculations in Andric et al. (2016a, 2016b).

Finally, the response of primary fiscal balance to lagged public debt[40] is both economically and statistically indistinguishable from zero which is consistent with three potential economic and econometric interpretations. First, as Bohn (2008) and Mendoza and Ostry (2008) argue, the absence of statistically significant response of primary fiscal balance to changes in public debt does not necessarily imply that fiscal policy in Serbia was unsustainable after 2001Q1. As already said in the

[40] The use of lagged instead of contemporaneous value of the public debt/GDP ratio aims to correct for potential reverse causality, i.e., endogeneity, that could go from primary fiscal balance to public debt. In other words, a one quarter lagged public debt/GDP ratio serves as an instrument to contemporaneous values of the public debt ratio.

introduction of this monograph, it could be the case that investors in bonds issued by the Serbian government do not behave according to the infinite investment horizon implied by the IGBC. Second, the failure of finding the positive, statistically significant, response of primary fiscal balance to lagged public debt stock could also be a consequence of an econometrically mis-specified FRF from equation (22). In particular, the FRF from equation (22) is identical to the FRF from equation (19) that the tax smoothing model of Barro (1979) and Bohn (1998) imply. As such, the FRF from equation (22) does not encompass potential autocorrelation and/or non-normal probability distribution in the residual values of the primary fiscal balance/GDP ratio.[41] Furthermore, it does not control for the potential endogeneity, i.e., reverse causality, that could go from primary fiscal balance variations to output gap fluctuations. Finally, it could be the case that fiscal policy in Serbia was indeed unsustainable between 2001Q1 and 2023Q2.

The estimated FRFs from Table 2 to Table 10 deal with potential econometric misspecifications associated with the FRF from Table 1. Table 2 outlines the estimates from the following FRF

$$pb_t = \rho b_{t-1} + \mu_t + \varepsilon_t = \rho b_{t-1} + \alpha_0 + \alpha_1 ygap_{t-1} + \alpha_2 ggap_t + \varepsilon_t \qquad (23)$$

that uses lagged output gap, $ygap_{t-1}$, as a potential instrument for the contemporaneous output gap variations to control for potential reverse causality from primary fiscal balance to $ygap_t$. The estimated coefficient for the lagged output gap, however, is not statistically significant implying that fiscal policy in Serbia might be a-cyclical with respect to business cycle.[42] Note, however, that the FRF from equation (23) and Table 2 explains only 11% of variations in primary fiscal balance, a 50%

[41] One potential source of a non-normal probability distribution for the residual values of primary fiscal balance could be a COVID-19 outlier shock.

[42] As emphasized in the introduction, according to the results of FRFs presented in this monograph, primary fiscal balance behaves pro-cyclically or a-cyclically, but never counter-cyclically, with respect to changes in output and absorption gap.

less than the corresponding FRF from equation (22) and Table 1 further implying that FRF from equation (22) dominates the FRF from equation (23) in statistical and econometric terms.

Table 2: Baseline FRF with lagged output gap

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−2.13**	1.04	−2.04	0.04
$\boldsymbol{ygap_{t-1}}$	0.02	0.13	0.16	0.87
$\boldsymbol{ggap_t}$	−1.45***	0.47	−3.07	0.00
$\boldsymbol{b_{t-1}}$	0.02	0.02	1.01	0.31
$\boldsymbol{Adj.R-squared}$	0.11	$\boldsymbol{F-stat.(prob.)}$		4.6 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 3 outlines the estimates from FRF in which the variations in the output gap are replaced with the variations of the absorption gap, $agap_t$, since Figure 2 from the previous subsection identifies the divergence between the two gaps, especially during the GFC.

Table 3: Baseline FRF with absorption gap

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−1.61*	0.97	−1.65	0.10
$\boldsymbol{agap_t}$	0.26***	0.08	3.06	0.00
$\boldsymbol{ggap_t}$	−2.03***	0.45	−4.52	0.00
$\boldsymbol{b_{t-1}}$	0.01	0.02	0.56	0.58
$\boldsymbol{Adj.R-squared}$	0.20	$\boldsymbol{F-stat.(prob.)}$		8.2 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

More precisely, Table 3 from above outlines the estimates from the following FRF

$$pb_t = \rho b_{t-1} + \mu_t + \varepsilon_t = \rho b_{t-1} + \alpha_0 + \alpha_1 agap_t + \alpha_2 ggap_t + \varepsilon_t. \quad (24)$$

The OLS estimates of equation (24) are, however, identical to the estimates from Table 1 where $ygap_t$, instead of $agap_t$, measures the movements in business cycle fluctuations.

Like equation (23) and Table 2, equation (25) and Table 4 present the OLS estimates from the FRF with lagged absorption gap

$$pb_t = \rho b_{t-1} + \mu_t + \varepsilon_t = \rho b_{t-1} + \alpha_0 + \alpha_1 agap_{t-1} + \alpha_2 ggap_t + \varepsilon_t. \quad (25)$$

Identically to the lagged output gap estimates from Table 2, the estimates from Table 4 show that lagged absorption gap does not influence primary fiscal balance in a statistically significant manner. In sum, the results from Tables 1-4 convey two messages.

Table 4: Baseline FRF with lagged absorption gap

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−2.12**	1.03	−2.07	0.04
$\boldsymbol{agap_{t-1}}$	0.02	0.09	0.25	0.81
$\boldsymbol{ggap_t}$	−1.48***	0.50	−2.99	0.00
$\boldsymbol{b_{t-1}}$	0.02	0.02	1.02	0.31
$\boldsymbol{Adj.R-squared}$	0.11	$\boldsymbol{F-stat.(prob.)}$		4.6 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

First, the contemporaneous, not lagged, values of output and absorption gap influence the changes in primary fiscal balance. Second, note also that the vast majority of literature on fiscal multipliers, reviewed in Andric (2019), does not find a statistically significant response of GDP to shocks in fiscal policy in the case of small-open-euroized economies with quasi-flexible exchange rates and moderate-to-high levels of public indebtedness. In other words, it is most probably the case that there is no causality stemming from primary fiscal balance to output gap, i.e., there is no reverse causality from primary balance to output gap. Finally, since the $\boldsymbol{ygap_t}$ is a more consistent measure with the theoretical frameworks from Barro (1979) and Bohn (1998), in the rest of the monograph $\boldsymbol{ygap_t}$ will be used as a preferred measure of business cycle fluctuations.

Another potential issue about the estimates of the baseline FRF from Table 1 pertains to the scaling of variables from equation (22). Note that the variables from equation (22) are in percentages of the overall GDP, not trend GDP, as Mendoza and Ostry (2008) advise. Mendoza and Ostry (2008) argue that scaling with GDP might not adequately remove business cycle fluctuations from the denominator of FRF variables and hence, produce an artificial correlation of these variables with movements in $ygap_t$ and $agap_t$. Tables 5-8, hence, show the estimates of FRFs in which all the variables are in % of HP detrended GDP. Respectively, in Tables 5-8, the OLS estimates of the following FRF specifications are presented

$$pb1_t = \rho b_{t-1} + \alpha_0 + \alpha_1 ygap1_t + \alpha_2 ggap1_t + \varepsilon_t \tag{26}$$

$$pb1_t = \rho b_{t-1} + \alpha_0 + \alpha_1 ygap1_{t-1} + \alpha_2 ggap1_t + \varepsilon_t \tag{27}$$

$$pb1_t = \rho b_{t-1} + \alpha_0 + \alpha_1 agap1_t + \alpha_2 ggap1_t + \varepsilon_t \tag{28}$$

$$pb1_t = \rho b_{t-1} + \alpha_0 + \alpha_1 agap1_{t-1} + \alpha_2 ggap1_t + \varepsilon_t. \tag{29}$$

The equations (26) and (27) use the contemporaneous and lagged values of the output gap, while equations (28) and (29) use contemporaneous and lagged values of the absorption gap. The findings from Tables 5-8 are, however, identical to those presented in Tables 1-4. In sum, the contemporaneous output gap is still the preferable business cycle measure with respect to lagged output gap due to its, both statistically and economically, more significant effect on the variations in primary fiscal balance. In addition, the contemporaneous fluctuations in output gap, as already said, are preferable to fluctuations in the absorption gap since they are more in line with tax smoothing models of Barro (1979) and Bohn (1998).

Another consistent message from Tables 1-8 is that the estimated response of primary fiscal balance to lagged changes is not statistically significant which could signal fiscal sustainability issues in the period in question. To exclude the possibility that this finding is due to a COVID-19 outlier shock and the autocorrelation in the residual values of the primary fiscal balance, equation (30), presented in Table 9, explicitly accounts for these potential econometric misspecifications. In particular, the FRF from equation (30) has the following form

Table 5: Baseline FRF $ygap1$ and $ggap1$ as % of trend GDP

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	-1.45	0.94	-1.55	0.12
$\boldsymbol{ygap1_t}$	0.33***	0.11	2.92	0.00
$\boldsymbol{ggap1_t}$	-1.82***	0.41	-4.44	0.00
$\boldsymbol{b_{t-1}}$	0.01	0.02	0.40	0.69
$\boldsymbol{Adj.R-squared}$	0.20	$\boldsymbol{F-stat.(prob.)}$		8.4 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of trend GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 6: Baseline FRF with lagged $ygap1$ and $ggap1$ as % of trend GDP

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−2.07**	0.99	−2.08	0.04
$ygap1_{t-1}$	0.01***	0.13	0.07	0.00
$ggap1_t$	−1.43***	0.45	−3.15	0.00
b_{t-1}	0.02	0.02	1.02	0.31
$Adj.R-squared$	0.12	$F-stat.(prob.)$		5.0 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of trend GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 7: Baseline FRF with $agap1$ and $ggap1$ as % of trend GDP

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	**−1.61***	**0.94**	**−1.72**	**0.09**
$agap1_t$	**0.21*****	**0.08**	**2.57**	**0.01**
$ggap1_t$	**−1.93*****	**0.44**	**−4.41**	**0.00**
b_{t-1}	**0.01**	**0.02**	**0.59**	**0.56**
$Adj.R-squared$	**0.18**	$F-stat.(prob.)$		**7.6 (0.0)**

Notes: Author's calculations. Dependent variable: pb (% of trend GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 8: Baseline FRF with lagged $agap1$ and $ggap1$ as % of trend GDP

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	-2.06**	0.98	-2.10	0.04
$\boldsymbol{agap1_{t-1}}$	0.01	0.09	0.15	0.88
$\boldsymbol{ggap1_t}$	-1.45***	0.48	-3.05	0.00
$\boldsymbol{b_{t-1}}$	0.02	0.02	1.03	0.31
$\boldsymbol{Adj.R-squared}$	0.12	$\boldsymbol{F-stat.(prob.)}$		5.0 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of trend GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

$$pb_t = \rho b_{t-1} + \mu_t + \beta COVID19 + \gamma_1 pb_{t-1} + \gamma_2 pb_{t-2} + \gamma_3 pb_{t-3} + \gamma_4 pb_{t-4} + \varepsilon_t \quad (30)$$

in which $\mu_t = \alpha_0 + \alpha_1 ygap_t + \alpha_2 ggap_t$, as in equation (18), $COVID19$ is a dummy variable that takes value 1 in 2020Q2, while $pb_{t-p}, p = 1,2,3,4$, represents distributed lag coefficients for the dependent variable pb_t. The idea of distributed lag approach is to encompass potential autocorrelation in the residuals of pb_t in a parametric fashion, since the use of Newey-West heteroscedasticity and autocorrelation corrected standard errors entails the estimates of a long-run residual variance which could be biased in a relatively small sample such as the one used in this monograph. The distributed lag approach is based on the general-to-specific modelling approach, i.e., it starts from the most general specification that includes a total of four lags of the dependent variable, since the empirical analysis is based on quarterly data. The final specification will, however, keep only those lags of the dependent variable that are statistically significant at least at 10% significance level.

The estimates from Table 9 differ sharply with respect to earlier findings presented in Tables 1-8. First, the response of primary fiscal balance to lagged public debt/GDP ratio jumps to 0.04 and it is statistically significant at the 1% significance level which shows that fiscal policy in Serbia was indeed sustainable between 2001Q1 and 2023Q2. Second, the response of primary fiscal balance to changes in output gap is not statistically significant reinforcing the earlier findings about a-cyclical fiscal policy. Third, the COVID-19 dummy variable is significant at 1% significance level and shows an unprecedented drop in primary fiscal balance-to-GDP ratio of almost twenty percentage points. Fourth, among the distributed lag coefficients, the only statistically insignificant coefficient is the one associated with the second lag of the dependent variable, pb_{t-2}. Finally, the FRF from equation (30) and Table 9 has the value for an adjusted R^2 of 0.75 which means that the regressors from equation (30) explain around 75% of variations in the primary fiscal balance. In comparison to previously estimated FRFs outlined in Tables 1-8, the value of the adjusted R^2 jumps between 50 and 65 percentage points.

Table 9: FRF with COVID-19 & general-to-specific parametric autocorrelation correction

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−2.49***	0.77	−3.21	0.00
$COVID-19$	−20.33***	2.07	−9.82	0.00
$ygap_t$	0.01	0.08	0.21	0.84
$ggap_t$	−1.34***	0.29	−4.68	0.00
b_{t-1}	0.04***	0.01	3.11	0.00
pb_{t-1}	0.25***	0.07	3.81	0.00
pb_{t-2}	−0.05	0.07	−0.80	0.43
pb_{t-3}	0.17**	0.07	2.47	0.02
pb_{t-4}	0.20***	0.06	3.23	0.00
$Adj.R-squared$	0.75	$F-stat.(prob.)$		32.9 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

To refine the estimates presented in Table 9, the equation (31) and Table 10 exclude the insignificant pb_{t-2} regressor from equation (30). In particular, the FRF that keeps only statistically significant lags of the dependent variable is of the following form

Table 10: FRF with COVID-19 & optimal number of lags for the dependent variable

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−2.43***	0.77	−3.16	0.00
$\boldsymbol{COVID-19}$	−20.58 ***	2.04	−10.08	0.00
$\boldsymbol{ygap_t}$	0.01	0.08	0.11	0.91
$\boldsymbol{ggap_t}$	−1.31***	0.28	−4.63	0.00
$\boldsymbol{b_{t-1}}$	0.04***	0.01	3.08	0.00
$\boldsymbol{pb_{t-1}}$	0.23***	0.06	3.78	0.00
$\boldsymbol{pb_{t-3}}$	0.14**	0.06	2.34	0.02
$\boldsymbol{pb_{t-4}}$	0.21***	0.06	3.35	0.00
$\boldsymbol{Adj.R-squared}$	0.75	$\boldsymbol{F-stat.(prob.)}$		37.7 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

$$pb_t = \rho b_{t-1} + \mu_t + \beta_1 COVID19 + \gamma_1 pb_{t-1} + \gamma_2 pb_{t-3} + \gamma_3 pb_{t-4} + \varepsilon_t. \quad (31)$$

Table 10 bears two important messages. First, the only statistically insignificant regressor is the $ygap_t$ which remains the regressor in equation (31) primarily for two reasons: *i)* the inclusion of the output gap is consistent with tax smoothing model of Barro (1979) and theoretical framework of Bohn (1998); and *ii)* the estimation and interpretation of the effect of the business cycle on fiscal stance is important from a policy perspective. Second, the impact of the distributed lag coefficients $y_{1,}$ y_2 and y_3 which correspond to pb_{t-1}, pb_{t-3} and pb_{t-4}, respectively, is positive and statistically significant implying that past changes in the primary balance up to a year could exert economically and statistically significant changes in the current primary balance.

Up to now, the FRF from equation (30) presented in Table 10, is, both statistically and economically, the most proper FRF specification. The next three FRFs, shown in equations (32), (33) and (34), and for which the results are presented in Tables 11, 12 and 13, respectively, extend the FRF from equation (30) and Table 10 with dummy variables that capture spikes in primary expenditures due to pre-election government spending.[43] In particular, the FRFs with election dummies are as follows

$$pb_t = \rho b_{t-1} + \mu_t + \beta_1 COVID19 + \beta_2 Elections2006Q4 + \gamma_1 pb_{t-1} + \gamma_2 pb_{t-3} + \gamma_3 pb_{t-4} + \varepsilon_t. \quad (32)$$

[43] There is a large literature on the effects of pre-election government spending on budget deficits and debts. The classic references are Roubini and Sachs (1989) and Alesina and Tabellini (1990). The reviews of the literature are given in Eslava (2010) and de Haan (2013). The more recent studies include Brender and Drazen (2005), Ebeke and Ölçer (2013), Blinder and Watson (2016), Eyraud et al. (2017), Alesina et al. (2021), David and Sever (2022) and de Haan et al. (2023). The interplay of election cycle and COVID-19 pandemic is investigated in Lokshin et al. (2022). In the case of Serbia, earlier notable studies include Pavlovic and Besic (2019) and Ivanovic et al. (2023)

Table 11: FRF with COVID-19 & 2006Q4 elections

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−2.17***	0.77	−2.81	0.00
$COVID-19$	−20.80***	2.01	−10.32	0.00
$Elections2006Q4$	−3.20*	1.76	−1.82	0.07
$ygap_t$	0.00	0.08	0.00	0.97
$ggap_t$	−1.26***	0.28	−4.51	0.00
b_{t-1}	0.04***	0.01	2.82	0.01
pb_{t-1}	0.24***	0.06	3.97	0.00
pb_{t-3}	0.15**	0.06	2.38	0.02
pb_{t-4}	0.23**	0.06	3.61	0.02
$Adj.R-squared$	0.76	$F-stat.(prob.)$		34.4 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 12: FRF with COVID-19 & 2007Q4 elections

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−2.43***	0.79	−3.05	0.00
$COVID-19$	−20.59***	2.05	−10.02	0.00
$Elections2007Q4$	−0.04	1.82	−0.02	0.98
$ygap_t$	0.01	0.08	0.11	0.91
$ggap_t$	−1.31***	0.29	−4.51	0.00
b_{t-1}	0.04***	0.01	2.99	0.00
pb_{t-1}	0.23***	0.06	3.74	0.00
pb_{t-3}	0.15**	0.06	2.32	0.02
pb_{t-4}	0.21**	0.06	3.31	0.00
$Adj.R-squared$	0.75	$F-stat.(prob.)$		32.6 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 13: FRF with COVID-19 & 2012Q1 elections

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−2.30***	0.77	−2.99	0.00
$COVID-19$	−20.80***	2.03	−10.23	0.00
$Elections2012Q1$	−2.53	1.76	−1.44	0.15
$ygap_t$	−0.01	0.08	−0.08	0.94
$ggap_t$	−1.25***	0.28	−4.39	0.00
b_{t-1}	0.04***	0.01	2.94	0.00
pb_{t-1}	0.24***	0.06	3.87	0.00
pb_{t-3}	0.15**	0.06	2.35	0.02
pb_{t-4}	0.21***	0.06	3.30	0.00
$Adj.R-squared$	0.75	$F-stat.(prob.)$		33.7 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

$$pb_t = \rho b_{t-1} + \mu_t + \beta_1 COVID19 + \beta_2 Elections2007Q4 + \gamma_1 pb_{t-1} + \gamma_2 pb_{t-3} + \gamma_3 pb_{t-4} + \varepsilon_t. \quad (33)$$

$$pb_t = \rho b_{t-1} + \mu_t + \beta_1 COVID19 + \beta_2 Elections2012Q1 + \gamma_1 pb_{t-1} + \gamma_2 pb_{t-3} + \gamma_3 pb_{t-4} + \varepsilon_t. \quad (34)$$

in which dummy variables $Elections2006Q4$, $Elections2007Q4$ and $Elections2012Q1$ take the value 1 in 2006Q4, 2007Q4 and 2012Q1, respectively, the periods that correspond to quarters before parliamentary and/or presidential elections held in 2007Q1, 2008Q1 and 2012Q2. The reader can see from Tables 11, 12 and 13 that the statistically significant negative impact on the dynamics of primary balance pertains only to 2006Q4 when pre-election government spending increased the primary fiscal deficit by 3.2 percentage points of GDP. In other words, the elections held in 2007Q4 and 2012Q1 have not influenced the dynamics of primary fiscal balance in Serbia. This finding is in contrast with the estimates from Andric (2019) who reports the negative influence of all three election cycles on the fiscal policy stance in Serbia. The discrepancy in results comes from an erroneous definition of an election dummy in Andric (2019) which takes a combined value of 1 for 2006Q4, 2007Q4 and 2012Q1 quarters so it impossible to investigate the separate isolated effect of each election cycle in the case of Serbia between 2001Q1 and 2023Q2.

The FRFs from equations (32), (33) and (34) model the impact of election cycle on the behaviour of primary fiscal balance but do not consider, however, the potential influence of the GFC on the dynamics of primary fiscal balance. The exclusion of the GFC influence on fiscal stance might lead to an omitted variable bias which can produce biased estimates of the FRF coefficients. The omitted variable bias could be particularly important in the case of Serbia, since the GFC, as Figure 2 from the earlier subsection shows, caused a large drop of five percentage points in the values of the output and absorption gap. Hence, the equation (35), along with the Table 14 below, presents the FRF that explicitly considers the impact of the GFC on primary balance-to-GDP ratio and in which $IMFGFC$

$$\begin{aligned} pb_t = \rho b_{t-1} &+ \mu_t + \beta_1 COVID19 + \beta_2 Elections2006Q4 + \\ &+ \beta_3 IMFGFC + \gamma_1 pb_{t-1} + \gamma_2 pb_{t-3} + \gamma_3 pb_{t-4} + \varepsilon_t \end{aligned} \tag{35}$$

is a dummy variable that takes value 1 between 2009Q1 and 2011Q1, and zero otherwise. The construction of the dummy variable $IMFGFC$ is motivated, hence, not only by the GFC influence on fiscal developments, but also by the two-year stand-by arrangement that the Serbian government signed with the IMF on the 16th of January 2009 due to larger than projected external imbalances caused by the GFC spillover to Serbian economy.[44] The estimates from Table 14 show that, on average, the GFC caused a drop in the share of primary fiscal balance in GDP by

[44] As in the case of election cycle, there is a large literature on the effect of IMF stand-by arrangements on fiscal stance and macroeconomic performance in general. See, for example, Bulíř and Moon (2003), Barro and Lee (2005), Nooruddin and Simmons (2006), Imam (2007), Clements et al. (2011), Crivelli and Gupta (2016) and Reinsberg et al. (2020), among others.

approximately 1.6 percentage points. Two things are worth emphasizing about the estimated $IMFGFC$ coefficient from Table 14. First, it is hard, even impossible, to disentangle the isolated effect of the IMF stand-by arrangement and the GFC on fiscal policy stance between 2009Q1 and 2011Q1. Only a counterfactual time series analysis could potentially show whether the primary fiscal deterioration would be greater in the absence of the arrangement with the IMF. Second, it could be the case that the estimated drop in the primary fiscal balance is due to a 2011 fiscal decentralization package that caused a vertical fiscal imbalance in public finance system of Serbia of approximately 1.7 percentage points of GDP, as Andric et al. (2016a, 2016b) and Andric (2019) report. In sum, one can only argue that the combined effect of the GFC, the IMF stand-by arrangement and the 2011 fiscal decentralization package caused an increase of fiscal deficit-to-GDP ratio of 1.6 to 1.7 percentage points.

Table 14: FRF with COVID-19 & GFC plus 2009Q1-2011Q1 IMF stand-by arrangement

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−1.52*	0.85	−1.78	0.08
$\boldsymbol{COVID-19}$	−20.76***	1.99	−10.43	0.00
$\boldsymbol{IMF\ GFC}$	−1.62**	0.72	−2.26	0.03
$\boldsymbol{ygap_t}$	0.00	0.08	0.06	0.95
$\boldsymbol{ggap_t}$	−1.44***	0.28	−5.11	0.00
$\boldsymbol{b_{t-1}}$	0.03*	0.01	1.82	0.07
$\boldsymbol{pb_{t-1}}$	0.21***	0.06	3.43	0.00
$\boldsymbol{pb_{t-3}}$	0.13**	0.06	2.02	0.05
$\boldsymbol{pb_{t-4}}$	0.21***	0.06	3.37	0.00
$\boldsymbol{Adj.R-squared}$	0.76	$\boldsymbol{F-stat.(prob.)}$		35.4 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

From FRFs presented so far in this monograph one can reach the conclusion that the most important exogenous shocks that influenced the fiscal stance in Serbia are: *i)* a staggering drop in primary balance/GDP ratio of approximately twenty percentage points in 2020Q2 due to COVID-19 pandemic; *ii)* a 3.5 percentage points drop in primary balance-to-GDP ratio in 2006Q4 due to higher pre-election government spending; and *iii)* approximately 1.7 percentage points drop in the share of primary balance in GDP due to a combined effect of the GFC, IMF stand-arrangement and the 2011 fiscal decentralization package.

Table 15 below reports the combined dummy variable effect of described exogenous shocks. Note also that the estimates from Table 15 with respect to transitory government spending ($ggap_t$) and output gap ($ygap_t$) remain unchanged with respect to other estimated FRFs. The same conclusion holds for the distributed lag coefficients of the primary fiscal balance pb_t. Finally, the positive primary balance response to lagged stock of public debt in Table 15 is almost significant at 10% significance level. Note, however, as already argued on other places throughout this monograph, that the absence of statistical significance does not necessarily imply fiscal unsustainability. In fact, the statistically insignificant response is consistent with the finite investment horizon of investors who hold Serbian government bonds because all estimated FRFs rest on the theoretical notion that IGBC is consistent with infinitely lived investors (households) that behave as overlapping generations. More intuitively, the fact that there is no primary balance response for a given period does not necessarily mean that the response would be also absent in the case of longer forecasting horizon.[45]

Table 16 reports the estimates from FRF that includes two lags of the public debt/GDP ratio. Putted differently, Table 16 reports the findings from the FRF that on the right-hand side of equation (35) has both b_{t-1} and b_{t-2}. The idea for including the b_{t-2} regressor comes from Lamé et al. (2014) who put arguments in favour of such approach when the

[45] The lack of statistical significance in Table 15 could also be due to overfitting and the associated multicollinearity issues.

primary fiscal balance and public debt differ in their respective degrees of persistence, as usually the case in the FRF literature.[46]

Table 15: FRF with combined dummy variable effect

$variable$	$coefficient$	$std. error$	$t-stat.$	$prob.$
α_0	−1.18	0.85	−1.38	0.17
$COVID-19$	−21.00***	1.95	−10.74	0.00
$Elections2006Q4$	−3.49**	1.71	−2.04	0.04
$IMF\ GFC$	−1.72**	0.70	−2.44	0.02
$ygap_t$	−0.01	0.08	−0.10	0.92
$ggap_t$	−1.39***	0.28	−5.04	0.00
b_{t-1}	0.02	0.01	1.50	0.14
pb_{t-1}	0.22***	0.06	3.64	0.00
pb_{t-3}	0.12**	0.06	2.04	0.04
pb_{t-4}	0.22***	0.06	3.69	0.00
$Adj. R-squared$	0.77	$F-stat. (prob.)$		33.2 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

[46] Using the unit root and stationarity tests from Zivot and Andrews (1992), Kwiatkowski et al. (1992), Elliott et al. (1996) and Ng and Perron (2001), Andric et al. (2016a, 2016b) and Andric (2019) show that the primary fiscal balance in the case of Serbia after 2001Q1 is a stationary stochastic process while the public debt/GDP ratio is near-unit root stochastic process.

Table 16: FRF with combined dummy variable effect and parametric persistence correction

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−1.10	0.86	−1.27	0.21
$COVID-19$	−20.94***	1.96	−10.66	0.00
$Elections2006Q4$	−3.57**	1.72	−2.07	0.04
$IMF\ GFC$	−1.74**	0.71	−2.46	0.02
$ygap_t$	−0.01	0.08	−0.08	0.94
$ggap_t$	−1.47***	0.30	−4.90	0.00
b_{t-1}	−0.03	0.08	−0.36	0.72
b_{t-2}	0.05	0.07	0.66	0.51
pb_{t-1}	0.20***	0.06	3.12	0.00
pb_{t-3}	0.12*	0.06	1.91	0.06
pb_{t-4}	0.22***	0.06	3.55	0.00
$Adj.R-squared$	0.77	$F-stat.(prob.)$		29.7 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

More precisely, the primary fiscal balance/GDP ratio is less persistent stochastic process than the (near) unit root stochastic process for public debt. The inclusion of b_{t-2} on the right-hand side of FRF function from equation (35) stands for a parametric correction for the different degrees of persistence between the primary balance/GDP and public debt/GDP ratio. Note, however, that the estimates from Table 16 do not differ at all from those already presented in Table 15. In addition, the estimated coefficient for b_{t-2} is not statistically significant.

The FRFs presented in Tables 1-16 consider only the linear changes in public debt/GDP ratio. In other words, the FRFs from Table 1 to Table 16 do not consider potential non-linear changes in the public debt/GDP ratio. The exclusion of non-linear public debt/GDP terms on the right-hind side of respective FRFs might lead to an omitted variable bias. More importantly, the linear changes in public debt-to-GDP cannot measure potential fiscal fatigue effects first analyzed by Ghosh et al. (2013). Hence, Tables 17-21 present the estimates from FRFs that include different non-linear terms as regressors on the right-hand side of equation (35). Table 17 includes a non-linear term of the form $b_t = \max(0, b_t - 45)$ to encompass a primary balance response above the 45% public debt/GDP threshold from national fiscal rules. Similarly, Table 18 includes a non-linear term of the form $b_t = \max(0, b_t - 60)$ to quantify a primary balance response above the 60% public debt/GDP threshold from Maastricht fiscal criteria. Table 19 includes a quadratic public debt spline on the right-hide side of equation (35). Table 20 deals with the cubic public debt spline of the form $b_{t-1}^2 + b_{t-1}^3$ while Table 21 uses only the reduced cubic public debt term b_{t-1}^3.

The results from FRFs presented in Tables 17-21 are as follows[47]: *i)* the results from Table 17 imply that fiscal policy makers do not take more corrective fiscal actions when public debt/GDP ratio is above the 45% threshold, consistent with the findings reported in Andric (2024); *ii)* the results from Table 18 imply that fiscal policy makers take, to a certain extent[48], corrective fiscal actions when public debt/GDP ratio is above the 60% threshold, consistent with the findings from Andric (2024); *iii)* the quadratic and reduced cubic public debt splines fail to adequately capture the potential non-linearities in the response of primary fiscal balance to public debt/GDP ratio movements; and *iv)* the FRF with cubic public debt spline produces the best statistical fit among all estimated

[47] As Bohn (1998) cautions, the results from FRFs with non-linear public debt terms should not interpreted at face value due to potential multicollinearity issues.

[48] The estimated response coefficient for b_{t-1} is statistically significant which is not the case for the estimated coefficient associated with the non-linear term $b_t = \max(0, b_t - 60)$.

non-linear specifications since its adjusted-R^2 reports a value of 0.78 which further implies that this specification is capable of explaining 78% of variations in primary fiscal balance-to-GDP ratio. In addition, all non-linear public debt regressors from Table 20 are statistically significant. The response of primary fiscal balance to public debt has an s-shaped form consistent with the fiscal fatigue hypothesis of Ghosh et al. (2013). In other words, the response of primary balance to public debt at low debt levels is negative (or zero), then it increases with the accelerating public debt dynamics, and finally it becomes zero at extremely elevated levels of debt.

Table 17: FRF with non-linear 45% public debt/GDP threshold

$variable$	$coefficient$	$std. error$	$t-stat.$	$prob.$
α_0	0.03	1.65	0.02	0.98
$COVID-19$	−21.36***	2.00	−10.67	0.00
$Elections2006Q4$	−3.49**	1.71	−2.04	0.04
$IMF\ GFC$	−1.87**	0.73	−2.57	0.01
$ygap_t$	−0.02	0.08	−0.26	0.79
$ggap_t$	−1.44***	0.28	−5.10	0.00
b_{t-1}	−0.01	0.04	−0.24	0.81
$b45$	0.05	0.06	0.86	0.39
pb_{t-1}	0.22***	0.06	3.66	0.00
pb_{t-3}	0.13**	0.06	2.11	0.04
pb_{t-4}	0.22***	0.06	3.68	0.00
$Adj. R-squared$	0.77	$F-stat. (prob.)$		29.8 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 18: FRF with non-linear 60% public debt/GDP threshold

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−2.11*	1.12	−1.88	0.06
$COVID-19$	−20.71***	1.96	−10.56	0.00
$Elections2006Q4$	−3.30*	1.71	−1.93	0.06
$IMF\ GFC$	−1.41*	0.74	−1.90	0.06
$ygap_t$	0.02	0.08	0.28	0.78
$ggap_t$	−1.39***	0.27	−5.04	0.00
b_{t-1}	0.04**	0.02	1.97	0.05
$b60$	−0.08	0.07	−1.28	0.20
pb_{t-1}	0.21***	0.06	3.63	0.00
pb_{t-3}	0.12**	0.06	1.99	0.05
pb_{t-4}	0.23***	0.06	3.75	0.00
$Adj.R-squared$	0.77	$F-stat.(prob.)$		30.3 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 19: FRF with quadratic public debt spline

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	-2.02	2.27	-0.89	0.38
$COVID-19$	-20.97***	1.97	-10.66	0.00
$Elections2006Q4$	-3.48**	1.72	-2.02	0.05
$IMF\ GFC$	-1.60**	0.77	-2.08	0.04
$ygap_t$	-0.01	0.08	-0.01	0.99
$ggap_t$	-1.36***	0.29	-4.68	0.00
b_{t-1}	0.06	0.08	0.66	0.51
b_{t-1}^2	-0.00	0.001	-0.40	0.69
pb_{t-1}	0.22***	0.06	3.63	0.00
pb_{t-3}	0.13**	0.06	2.04	0.05
pb_{t-4}	0.23***	0.06	3.69	0.00
$Adj.R-squared$	0.77	$F-stat.(prob.)$		29.6 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 20: FRF with cubic public debt spline

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	7.85	5.48	1.43	0.16
$COVID-19$	−20.62***	1.94	−10.64	0.00
$Elections2006Q4$	−3.09*	1.70	−1.82	0.07
$IMF\ GFC$	−1.51**	0.75	−2.01	0.05
$ygap_t$	0.01	0.08	0.12	0.91
$ggap_t$	−1.39***	0.29	−4.87	0.00
b_{t-1}	−0.57*	0.32	−1.74	0.09
b_{t-1}^2	0.01*	0.01	1.91	0.06
b_{t-1}^3	-7.1×10^{-5}**	3.6×10^{-5}	−1.97	0.05
pb_{t-1}	0.21***	0.06	3.67	0.00
pb_{t-3}	0.12*	0.06	1.94	0.06
pb_{t-4}	0.24***	0.06	3.90	0.00
$Adj.R-squared$	0.78	$F-stat.(prob.)$		28.3 (0.0)

Notes: Author's calculations. Dependent variable: *pb* (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

Table 21: FRF with reduced cubic public debt spline

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	-2.10	1.67	-1.26	0.21
$COVID-19$	-20.93***	1.97	-10.66	0.00
$Elections2006Q4$	-3.45**	1.72	-2.01	0.05
$IMF\ GFC$	-1.52**	0.78	-1.99	0.05
$ygap_t$	0.00	0.08	0.04	0.97
$ggap_t$	-1.34***	0.29	-4.63	0.00
b_{t-1}	0.05	0.04	1.11	0.27
b_{t-1}^3	-3×10^{-6}	4.67×10^{-6}	-0.65	0.52
pb_{t-1}	0.22***	0.06	3.66	0.00
pb_{t-3}	0.13**	0.06	2.05	0.04
pb_{t-4}	0.23***	0.06	3.71	0.00
$Adj.R-squared$	0.77	$F-stat.(prob.)$		29.7 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS. Sample: 2001Q1-2023Q2. *:10% significance level; ** 5% significance level; ***1 significance level.

Finally, Tables 22-25 show the last set of empirical estimates from this monograph. Tables 22-25 report the time-varying response of primary fiscal balance to changes in public debt. Based on the sequential endogenous structural break estimation method of Bai and Perron (2003), the FRFs in Tables 22 and 23 find two structural breaks in the primary balance/GDP-public debt/GDP relationship.[49] The first break

[49] The estimates in Tables 22-23 are based on the sequential method of endogenous structural break dating. The estimates in Tables 24-25 take the breaks from Tables 22 and 23 as exogenous. In addition, since the pb_{t-3} regressor is not significant in FRFs

Table 22: FRF with two endogenous structural breaks and homogeneous error distribution across breaks

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−1.26	0.82	−1.53	0.13
$\boldsymbol{COVID-19}$	−20.89***	1.93	−10.81	0.00
$\boldsymbol{Elections2006Q4}$	−3.14*	1.65	−1.90	0.06
$\boldsymbol{IMF\ GFC}$	−1.48**	0.68	−2.16	0.03
$\boldsymbol{ygap_t}$	0.04	0.08	0.45	0.65
$\boldsymbol{ggap_t}$	−1.48***	0.28	−5.25	0.00
$\boldsymbol{b_{t-1(2002Q1-2008Q3)}}$	0.02	0.02	1.42	0.16
$\boldsymbol{b_{t-1(2008Q4-2016Q2)}}$	0.001	0.02	0.46	0.65
$\boldsymbol{b_{t-1(2016Q3-2023Q2)}}$	0.03**	0.01	2.22	0.03
$\boldsymbol{pb_{t-1}}$	0.17***	0.06	2.88	0.00
$\boldsymbol{pb_{t-3}}$	0.08	0.06	1.37	0.18
$\boldsymbol{pb_{t-4}}$	0.19***	0.06	3.21	0.00
$\boldsymbol{Adj.R-squared}$	0.79	$\boldsymbol{F-stat.(prob.)}$		30.1 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS with fixed number of sequentially determined breaks and 25% trimming percentage from Bai and Perron (2003). Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

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from Tables 22-23, the FRFs from Tables 24-25 only include the pb_{t-2} and pb_{t-4} lags of the dependent variable. The results are, however, consistent across different FRFs given in Tables 21-25, even if one allows for heterogeneous error distributions across structural breaks.

Table 23: FRF with two endogenous structural breaks and heterogeneous error distribution across breaks

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−1.26	0.82	−1.53	0.13
$COVID-19$	−20.89***	2.16	−9.67	0.00
$Elections2006Q4$	−3.14*	1.74	−1.81	0.07
$IMF\ GFC$	−1.48***	0.59	−2.49	0.01
$ygap_t$	0.04	0.08	0.44	0.66
$ggap_t$	−1.48***	0.29	−5.06	0.00
$b_{t-1(2002Q1-2008Q3)}$	0.02	0.02	1.42	0.16
$b_{t-1(2008Q4-2016Q2)}$	0.007	0.01	0.48	0.63
$b_{t-1(2016Q3-2023Q2)}$	0.03**	0.01	2.18	0.03
pb_{t-1}	0.17***	0.07	2.61	0.01
pb_{t-3}	0.08	0.07	1.25	0.22
pb_{t-4}	0.19***	0.07	2.91	0.00
$Adj.R-squared$	0.79	$F-stat.(prob.)$		30.1 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS with fixed number of sequentially determined breaks and 25% trimming percentage from Bai and Perron (2003). Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; ***1 significance level.

occurs in 2008Q3 due to the GFC. The second break occurs in 2016Q2, and it is due to the delayed fiscal consolidation effects started in 2015Q1. The empirical estimates from Tables 22-25 show that the response of

Table 24: FRF with two fixed structural breaks, homogeneous errors, and optimal number of lags for the dependent variable

$\boldsymbol{variable}$	$\boldsymbol{coefficient}$	$\boldsymbol{std.error}$	$\boldsymbol{t-stat.}$	$\boldsymbol{prob.}$
$\boldsymbol{\alpha_0}$	−1.33*	0.83	−1.61	0.11
$\boldsymbol{COVID-19}$	−20.41***	1.91	−10.68	0.00
$\boldsymbol{Elections2006Q4}$	−3.14*	1.66	−1.89	0.06
$\boldsymbol{IMF\ GFC}$	−1.58**	0.68	−2.31	0.02
$\boldsymbol{ygap_t}$	0.07	0.08	0.85	0.40
$\boldsymbol{ggap_t}$	−1.59***	0.27	−5.89	0.00
$\boldsymbol{b_{t-1(2002Q1-2008Q3)}}$	0.02	0.01	1.50	0.14
$\boldsymbol{b_{t-1(2008Q4-2016Q2)}}$	0.005	0.02	0.33	0.74
$\boldsymbol{b_{t-1(2016Q3-2023Q2)}}$	0.03**	0.01	2.30	0.02
$\boldsymbol{pb_{t-1}}$	0.16***	0.06	2.71	0.01
$\boldsymbol{pb_{t-4}}$	0.22***	0.06	3.89	0.00
$\boldsymbol{Adj.R-squared}$	0.79	$\boldsymbol{F-stat.(prob.)}$		32.6 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS with exogenously fixed breaks and 25% trimming percentage from Bai and Perron (2003). Sample: 2001Q1-2023Q2. * 10% significance level; ** 5% significance level; *** 1 significance level.

primary balance to public debt increases, both in terms of size and in terms of statistical significance after 2016Q2. In other words, the three-year fiscal consolidation programme from 2015Q1-2018Q1 acted in a direction of more prudent fiscal policy conduct which enabled policy makers in Serbia to meet the COVID-19 pandemic with greater fiscal space.

Table 25: FRF with two fixed structural breaks, heterogeneous errors, and optimal number of lags for the dependent variable

$variable$	$coefficient$	$std.error$	$t-stat.$	$prob.$
α_0	−1.33*	0.84	−1.59	0.11
$COVID-19$	−20.41***	2.13	−9.60	0.00
$Elections2006Q4$	−3.14*	1.78	−1.76	0.08
$IMF\ GFC$	−1.58***	0.59	−2.67	0.01
$ygap_t$	0.07	0.08	0.81	0.42
$ggap_t$	−1.59***	0.28	−5.63	0.00
$b_{t-1(2002Q1-2008Q3)}$	0.02	0.02	1.48	0.14
$b_{t-1(2008Q4-2016Q2)}$	0.005	0.02	0.34	0.73
$b_{t-1(2016Q3-2023Q2)}$	0.03**	0.01	2.23	0.03
pb_{t-1}	0.16**	0.06	2.45	0.02
pb_{t-4}	0.22***	0.06	3.55	0.00
$Adj.R-squared$	0.79	$F-stat.(prob.)$		32.6 (0.0)

Notes: Author's calculations. Dependent variable: pb (% of GDP). Method: OLS with exogenously fixed breaks and 25% trimming percentage from Bai and Perron (2003). Sample: 2001Q1-2023Q2. *: 10% significance level; ** 5% significance level; ***1 significance level.

IV CONCLUSION

The concluding section of this monograph outlines directions for further research which can significantly improve on the work presented in this monograph. Potentially fruitful avenues for further research are: *i)* the estimation of FRFs on real-time instead on revised, ex post, fiscal and macroeconomic data; *ii)* the construction of an alternative dependent variable in the reduced-form FRF; *iii)* the use of Stambaugh (1999) small sample bias correction in the case of highly persistent regressors such as public debt/GDP ratio; *iv)* the estimation of a primary fiscal balance response to lagged debt in a multivariate vector autoregressive (VAR) setting; and *v)* the incorporation of surplus-debt regressions in a more general dynamic stochastic general equilibrium (DSGE) framework.

i) Cimadomo (2014) provides a comprehensive review of the literature that deals with the use of real-time data in fiscal policy analysis. In particular, Cimadomo (2014) documents that fiscal revisions are large and that initial releases of fiscal data are biased estimates of their respective finally revised values.[50] The use of real-time data, as Cimadomo (2014) shows, is potentially useful and practical at least from two perspectives: *i)* it turns out that the estimated response of fiscal policy variables to a business cycle tends to be more counter-cyclical when real-time data are used; and *ii)* the use of real-time data provides more accurate identification of exogenous fiscal shocks. As Cimadomo explains (2014), the problem is that existing real-time fiscal policy data sets pertain to advanced economies and are non-existent in the case of emerging and developing economies.

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[50] Cimadomo (2014) argues that strong fiscal rules and institutions offer a very potent way to reduce the discrepancy between real-time fiscal plans and finally published ex-post fiscal data.

ii) Following the standard practice in the literature, the estimated FRFs in this monograph focus on quantifying the response of primary fiscal balance to lagged public debt.[51] Two relevant issues for future research are worth emphasizing. First, instead of using a primary fiscal balance, one strand of literature quantifies the response of the structural (cyclically adjusted) primary fiscal balance to lagged public debt and business cycle stance. The idea behind the use of structural fiscal balance is that it more accurately measures the discretionary behaviour of fiscal policy makers. Second, primary fiscal balance does not measure the size of stock-flow adjustments which, according to the recent literature, have a systematic part which policy makers use as a strategic fiscal policy tool. Consider the following simple debt dynamics equation

$$\Delta B_t = B_t - B_{t-1} = -(R_t - G_t) + r_t B_{t-1} + SFA_t. \quad (36)$$

The equation (36) is equivalent to

$$\Delta B_t = B_t - B_{t-1} = G_t - R_t + r_t B_{t-1} + SFA_t. \quad (37)$$

Subtracting the interest payments for current period t, $r_t B_{t-1}$, from both sides of equation (37) yields the following expression

$$\Delta B_t - r_t B_{t-1} = G_t - R_t + SFA_t \quad (38)$$

which is equivalent to the expression

$$\Delta B_t - r_t B_{t-1} = -pb_t + SFA_t. \quad (39)$$

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[51] In the case of Serbia, the correlation coefficient between the structural primary fiscal balance and primary fiscal balance is around 0.8 for the period 2004Q3-2014Q3. See Andric et al. (2016a) for details on the period 2004Q3-2014Q3, as well as Section III of this monograph for the updated sample span.

in which $-pb_t$ stands for the size of primary fiscal deficit. In other words, the primary fiscal balance equals to

$$pb_t = r_t B_{t-1} - \Delta B_t + SFA_t. \qquad (40)$$

The overall primary fiscal balance is, hence, the sum of two components: *i)* the one that is due to changes in interest payments and first differenced public debt, $r_t B_{t-1} - \Delta B_t$, and the other one that is due to changes in SFA_t. Since equation (40) holds as an accounting identity, i.e., holds for each and every value of the variables from equation (40), it would be of potential interest to estimate two separate FRFs, the one that would measure the response of $r_t B_{t-1} - \Delta B_t$ component to lagged debt, transitory government spending and business cycle fluctuations, and the other one that would measure the response of the SFA_t component to lagged debt, transitory government spending and output gap.

The conventional wisdom until recently was that the SFA_t from accounting identity presented in equation (40) are just a statistical residual. Novel econometric evidence, however, points in a different direction. Campos et al. (2006) are among the first to show that budget deficits are less important in explaining the changes in public debt with respect to stock-flow adjustments, especially in the case of countries from Latin America and Sub-Saharan Africa. In the context of EU countries, von Hagen and Wolff (2006) document persistent stock-flow adjustments used in a strategic manner by governments to circumvent national and supra-national fiscal rules imposed by the EU. Weber (2012) provides a comprehensive econometric study for 163 economies worldwide, not only to document the existence of stock-flow adjustments, but also to relate their size to fiscal transparency of fiscal actions. More recently, Jaramillo et al. (2017) show that large public debt spikes, defined as changes in the public debt-to-GDP ratio greater than ten percentage points of GDP, occur because of stock-flow adjustments, not primary deficits, both in advanced and emerging economies. [52] In a

[52] Jaramillo et al. (2017) further argue that stock-flow adjustments have been largely ignored in public debt projections which could have detrimental implications for public debt sustainability analysis due to overly optimistic public debt forecasts.

companion paper, Jaramillo et al. (2017) further show that stock-flow adjustments have an indirect negative influence on financial stress indicators via their direct influence on the size of public debt spikes, again both in advance and emerging economies.

iii) Although this monograph used a two-period lagged public debt, b_{t-2}, to mitigate the potential bias in the OLS estimated primary fiscal balance response to lagged public debt along the lines of Lamé et al. (2014), this type of parametric correction, strictly speaking, is not entirely consistent with the Bohn's (1998) theoretical framework inspired by the tax-smoothing model of Barro (1979). To encompass different degrees of persistence between the public debt/GDP ratio and the primary fiscal balance/GDP ratio, one of the alternatives might be to use the small sample bias correction of Stambaugh (1999), as Jiang et al. (2024b) do in the case of the US public debt/GDP ratio. Jiang et al. (2004b) show the importance of the Stambaugh (1999) correction in the context of seminal results of Bohn (1998). Although Bohn (1998) finds affirmative evidence that changes in the lagged public debt/GDP ratio predict future surpluses implying, consequently, the absence of unit root in the public debt/GDP ratio, Jiang et al. (2024b) show that this finding is not a robust when they apply the Stambaugh (1998) small sample bias correction. In other words, Jiang et al. (2024b) show that the positive response of primary balance to changes in public debt disappears when one implements the small sample bias correction of Stambaugh et al. (1999).

iv) A fourth potentially fruitful avenue for further research is to estimate the response of primary fiscal balance to lagged debt in a multivariate VAR setting like Cochrane (2020, 2022) and Jiang et al. (2024b). In particular, Cochrane (2020, 2022) and Jiang et al. (2024b) apply the well-known Campbell-Shiller (1988) decomposition to decompose the variations in the public debt/GDP ratio into three main components: *i)* expected future government surpluses; *ii)* expected future real growth-adjusted bond returns (discount rates); and *iii)* the expected future value of the public debt/GDP ratio. The use of the VAR variance decomposition can help to better explain the variations in primary fiscal balance and public debt in a more dynamic setting less prone to an omitted variable bias.

v) Finally, D'Erasmo et al. (2015) and Leeper and Li (2016) call for the incorporation of surplus-debt FRFs into a more general DSGE framework. D'Erasmo et al. (2015) show the limitations of the FRF approach using the 1791-2014 sample in the case of the US economy. On page 2 of their article, D'Erasmo et al. (2015) explicitly write

"*Using the estimated FRFs, we illustrate that there are* ***multiple parameterizations of a FRF*** *(emphasis added) that support the same expected present discounted value of primary balances, and thus all of them make the same initial public debt position sustainable. However, these multiple reaction functions yield* ***different short- and long run dynamics of debt and primary balances*** *(emphasis added), and therefore* ***differ in terms of social welfare and their macro effects*** *(emphasis added). At this point, this non-structural approach reaches its limits, because comparing across these different patterns of fiscal adjustment requires a* ***structural framework*** *(emphasis added) that models explicitly the mechanisms and distortions by which tax and expenditure policies affect the economy, and the structure of financial markets the government can access*."

In other words, D'Erasmo et al. (2015) argue that the reduced-form FRF approach cannot say much about the general equilibrium effects of fiscal policy of a government that follows the estimated FRF. Leeper and Li (2016) reiterate the message of D'Erasmo et al. (2016) by arguing that FRFs are prone to a *simultaneity bias* that stems from the failure of FRFs to encompass general equilibrium effects. Leeper and Li (2016) show that the simultaneity bias is regime dependent. Putted differently, the bias does not exist, or it is negligible in the so-called Ricardian regime in which the general price level does not depend on the behaviour of primary fiscal surpluses, i.e., the general price level depends upon the monetary policy actions and measures. On the other hand, in a non-Ricardian regime, in which the general price level depends on the behaviour of primary fiscal surpluses, i.e., the general price level depends upon the fiscal policy actions and measures, the bias is not negligible, and its sign is related to the calibrated parameter values of a particular model economy. Similarly to D'Erasmo et al. (2015), Leeper and Li (2016) conclude that fully specified and parameterized DSGE models are currently the most relevant alternative in examining the general equilibrium effects of fiscal policies. The construction and calibration or, alternatively, VAR estimation of a DSGE model in the case of Serbian economy is even more important because, due to its high degree of euroization, fiscal policy can produce more significant macroeconomic effects. The construction, calibration, or estimation of such a DSGE model is beyond the scope of this monograph and is the most important direction forward in examining the effects of fiscal policy in the case of Serbia.

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APPENDIX A DATA

The fiscal and macroeconomic data used in this monograph cover the period between 2001Q1 and 2023Q2. The data availability sets the beginning of the sample in 2001Q1, while the end of the sample corresponds to the World's Health Organization (WHO) announcement about the end of the COVID-19 pandemic globally.

The time series data used in this study are publicly available at the author's personal webpage under the section Research via the link: http://www.vladimirandric.com/research.html. By clicking on the link with the title *Fiscal Reaction Functions in Serbia in the Early XXI Century*, the interested reader can download the text of this monograph along with supplementary data files. Two Excel files are of potential interest to the readers: *i) Seasonally Unadjusted Data 2001Q1-2023Q2.xlsx;* and *ii) Seasonally Adjusted Data 2001Q1-2023Q2.xlsx.*

The Excel file *Seasonally Unadjusted Data 2001Q1-2023Q2.xlsx* contains the following time series: public debt/GDP ratio[53] (denoted as b in the Excel file), public revenues (denoted as $revenues$ in the Excel file), public expenditures (denoted as $expenditures$ in the Excel file), interest payments (denoted as $interest$ in the Excel file), gross domestic product (denoted as y in the Excel file), private consumption of households

[53] Due to data availability, the time series for public debt refers to the central government level, while the time series for revenues and expenditures refer to the general level of government. Note, however, that the central government debt is approximately 95% of the general government debt. Note also that the time series, except the one for public debt/GDP ratio, are in nominal, millions of Serbian dinars (RSD), terms.

(denoted as *c*01 in the Excel file)[54], government spending (denoted as *g* in the Excel file) and private investment (denoted as *i* in the Excel file). The data for public debt, revenues, expenditures and interest payments come from various issues of the monthly Public Finance Bulletin published by the Ministry of Finance of the Republic of Serbia and they are available for download free of charge on the following link https://www.mfin.gov.rs/en/activities/bulletin-public-finance-2. The data for gross domestic product, private consumption of households, government spending and private investment come from the official website of the Statistical Office of the Republic of Serbia and they are available for download free of charge on the following link https://data.stat.gov.rs/Home/Result/09020202?languageCode=en-US. The download of data from respective online sources dates the 13th of September 2024. Table A1 on the next page provides an overview of seasonally unadjusted time series data for the period 2001Q1-2023Q2.

The Excel file *Seasonally Adjusted Data 2001Q1-2023Q2.xlsx* has seasonally adjusted values for the time series presented in Table A1.[55] The seasonal adjustment of original data follows the TRAMO/SEATS seasonal adjustment procedure of Gómez and Maravall (1996) within the EViews 13 econometric package. The TRAMO/SEATS seasonal adjustment procedure follows the guidelines and recommendations of Eurostat (Eurostat, 2015). Since the econometric analysis deals with

quarterly data, the seasonal adjustment procedure has the following properties *i)* it does not consider calendar effects; and *ii)* it considers all potential types of outliers-additive outlier, temporary change, and level

[54] The time series for private consumption of households is denoted as *c*01 since the symbol *c* in the EViews programming language is reserved for the values of the coefficient vector.

[55] The time series for public debt/GDP ratio *b* does not show significant seasonal variations, so in both Excel files the values of the public debt/GDP ratio are identical. All other seasonally adjusted time series have a suffix "_sa" after their corresponding titles. For example, seasonally unadjusted *revenues* from the Excel file *Seasonally Unadjusted Data 2001Q1-2023Q2.xlsx* are denoted as *revenues_sa* in the Excel file *Seasonally Adjusted Data 2001Q1-2023Q2.xlsx.*

shift. The EViews 13 code for the TRAMO/SEATS seasonal adjustment and the construction of final seasonally adjusted series is below Table A1.

Table A1: Seasonally unadjusted data, 2001Q1-2023Q2

SERIES	NOTATION	UNITS	SOURCE	NOTES
Public Debt/GDP ratio	b	% of y	MF	central government level
Public Revenues	$revenues$	RSD (millions)	MF	includes income from donations for the period 2001-2007
Public Expenditures	$expenditures$	RSD (millions)	MF	includes interest payments on public debt
Interest Payments	$interest$	RSD (millions)	MF	/
Gross Domestic Product	y	RSD (millions)	RZS	expenditure approach (SNA 2008/ESA 2010)
Private Consumption	$c01$	RSD (millions)	RZS	expenditure approach (SNA 2008/ESA 2010)
Government Spending	g	RSD (millions)	RZS	expenditure approach (SNA 2008/ESA 2010)
Private Investment	i	RSD (millions)	RZS	expenditure approach (SNA 2008/ESA 2010)

Notes: MF-Ministry of Finance of the Republic of Serbia; RZS-Statistical Office of the Republic of Serbia. Sample: 2001Q1-2023Q2.

EViews 13 TRAMO SEATS Seasonal Adjustment Code

```
#import data from Excel
import "C:\Users\vladimir.andric\Desktop\Seasonally Unadjusted Data 2001Q1-2023Q2.xlsx"

#expenditures_sa
expenditures.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") expenditures

#revenues_sa
revenues.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") revenues

#interest_sa
interest.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") interest

#y_sa
y.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") y

#c01_sa
c01.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") c01

#g_sa
g.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") g

#i_sa
i.tramoseats(opt="seats=2 mq=4 lam=-1 inic=3 idif=3 ieast=0 itrad=0 iatip=1 aio=0", save="sa") i
```

EViews 13 Code for Final Seasonally Adjusted Data

```
#Generate series for (primary) expenditures, revenues, and primary balance
series primaryexpenditures_sa=expenditures_sa-interest_sa
series r=(revenues_sa/y_sa)*100
series e=(expenditures_sa/y_sa)*100
series pe=(primaryexpenditures_sa/y_sa)*100
series pb=r-pe

#Generate series for trend GDP, cyclical GDP, and output gap
y_sa.hpf y_satrend @ y_sacycle
series ygap=(y_sacycle/y_sa)*100

#Generate the absorption series: total, trend, cycle, and gap
series a_sa=c01_sa+g_sa+i_sa
a_sa.hpf a_satrend @ a_sacycle
series agap=(a_sacycle/y_sa)*100

#Generate series for transitory government spending: trend, cycle, and gap
g_sa.hpf g_satrend @ g_sacycle
series ggap=(g_sacycle/y_sa)*100

#Generate discretionary (structural) fiscal series
series dr=r-0.17×(ygap+agap)
series dpe=pe
series spb=dr-dpe

#Generate alternative series as % of seasonally adjusted trend GDP
series ygap1=(y_sacycle/y_satrend)*100
series agap1=(a_sacycle/y_satrend)*100
series ggap1=(g_sacycle/y_satrend)*100
series pb1=((revenues_sa-primaryexpenditures_sa)/y_satrend)*100
```

Table A2 below shows an overview of final seasonally adjusted time series data used in an econometric analysis in Section III.

Table A2: Final seasonally adjusted data, 2001Q1-2023Q2

SERIES	NOTATION	NOTES
Public Debt	b	central government level
Public Revenues	r	includes income from donations for 2001-2007
Public Expenditures	e	includes interest costs on public debt
Primary Public Expenditures	pe	$pe = (primaryexpenditures\_sa/y\_sa) * 100$
Primary Fiscal Balance	pb	$pb = r - pe$
Output Gap	$ygap$	$YGAP = \left(\frac{y_{\_sacycle}}{y_{\_sa}}\right) \times 100$
Absorption Gap	$agap$	$AGAP = \left(\frac{a_{\_sacycle}}{y_{\_sa}}\right) \times 100$
Transitory Government Spending	$ggap$	$GGAP = \left(\frac{g_{\_sacycle}}{y_{\_sa}}\right) \times 100$
Discretionary Public Revenues	dr	$dr = r - 0.17 \times (ygap + agap)$
Discretionary Primary Public Expenditures	dpe	$dpe = pe$
Structural Primary Fiscal Balance	spb	$spb = dr - dpe$

Notes: $ygap$, $agap$ and $ggap$: HP filter with $\lambda = 1600$.

Table A2: continued

SERIES	NOTATION	NOTES
Public Debt above 45% of GDP	$b45$	$b45 = \max(0, b - 45)$
Public Debt above 60% of GDP	$b60$	$b60 = \max(0, b - 60)$
Output Gap as % of Trend GDP	$ygap1$	$YGAP1 = \left(\frac{y_{\_sacycle}}{y_{\_satrend}}\right) \times 100$
Absorption Gap as % of Trend GDP	$agap1$	$AGAP1 = \left(\frac{a_{\_sacycle}}{y_{\_satrend}}\right) \times 100$
Transitory Government Spending as % of Trend GDP	$ggap1$	$GGAP1 = \left(\frac{g_{\_sacycle}}{y_{\_satrend}}\right) \times 100$
Primary Fiscal Balance as % of Trend GDP	$pb1$	$pb1 = \left(\frac{revenues\_sa - primaryexpenditures\_sa}{y_{\_satrend}}\right) \times 100$
COVID 19	$covid19$	dummy variable that takes value 1 in 2020Q2
Elections 2006Q4	$elections2006Q4$	dummy variable that takes value 1 in 2006Q4
Elections 2007Q4	$elections2007Q4$	dummy variable that takes value 1 in 2007Q4
Elections 2012Q1	$elections2012Q1$	dummy variable that takes value 1 in 2012Q1
IMF GFC	$imfgfc$	dummy variable that takes value 1 for 2009Q1-2011Q1

Notes: $ygap$, $agap$ and $ggap$: HP filter with $\lambda = 1600$.

APPENDIX B FRF CODE

EViews 13 Code for FRFs presented in Tables 1-25

```
#Table 1: Baseline FRF
ls pb c ygap ggap b(-1)

#Table 2: Baseline FRF with lagged output gap
ls pb c ygap(-1) ggap b(-1)

#Table 3: Baseline FRF with absorption gap
ls pb c agap ggap b(-1)

#Table 4: Baseline FRF with lagged absorption gap
ls pb c agap(-1) ggap b(-1)

#Table 5: Baseline FRF with ygap and ggap as % of trend GDP
ls pb1 c ygap1 ggap1 b(-1)

#Table 6: Baseline FRF with lagged ygap and ggap as % of trend GDP
ls pb1 c ygap1(-1) ggap1 b(-1)

#Table 7: Baseline FRF with agap and ggap as % of trend GDP
ls pb1 c agap1 ggap1 b(-1)

#Table 8: Baseline FRF with lagged agap and ggap % of trend GDP
ls pb1 c agap1(-1) ggap1 b(-1)

#Table 9: FRF with Covid-19 & general-to-specific parametric
autocorrelation correction
ls pb c covid19 ygap ggap b(-1) pb(-1) pb(-2) pb(-3) pb(-4)

#Table 10: FRF with Covid-19 & optimal number of lags for the
dependent variable
ls pb c covid19 ygap ggap b(-1) pb(-1) pb(-3) pb(-4)
```

#Table 11: FRF with Covid-19 & 2006Q4 elections
ls pb c covid19 elections2006q4 ygap ggap b(-1) pb(-1) pb(-3) pb(-4)

#Table 12: FRF with Covid-19 & 2007Q4 elections
ls pb c covid19 elections2007q4 ygap ggap b(-1) pb(-1) pb(-3) pb(-4)

#Table 13: FRF with Covid-19 & 2012Q1 elections
ls pb c covid19 elections2012q1 ygap ggap b(-1) pb(-1) pb(-3) pb(-4)

#Table 14: FRF with Covid-19 & GFC plus 2009Q1-2011Q1 IMF stand-by arrangement
ls pb c covid19 imfgfc ygap ggap b(-1) pb(-1) pb(-3) pb(-4)

#Table 15: FRF with combined dummy variable effect
ls pb c covid19 elections2006Q4 imfgfc ygap ggap b(-1) pb(-1) pb(-3) pb(-4)

#Table 16: FRF with combined dummy variable effect & parametric persistence correction
ls pb c covid19 elections2006q4 imfgfc ygap ggap b(-1) b(-2) pb(-1) pb(-3) pb(-4)

#Table 17: FRF with non-linear 45% public debt/GDP threshold
ls pb c covid19 elections2006Q4 imfgfc ygap ggap b(-1) b45 pb(-1) pb(-3) pb(-4)

#Table 18: FRF with non-linear 60% public debt/GDP threshold
ls pb c covid19 elections2006Q4 imfgfc ygap ggap b(-1) b60 pb(-1) pb(-3) pb(-4)

#Table 19: FRF with quadratic debt spline
ls pb c covid19 elections2006Q4 imfgfc ygap ggap b(-1) b(-1)^2 pb(-1) pb(-3) pb(-4)

#Table 20: FRF with cubic debt spline
ls pb c covid19 elections2006Q4 imfgfc ygap ggap b(-1) b(-1)^2 b(-1)^3 pb(-1) pb(-3) pb(-4)

#Table 21: FRF with reduced cubic debt spline

```
ls pb c covid19 elections2006Q4 imfgfc ygap ggap b(-1) b(-1)^3 pb(-1) pb(-3) pb(-4)
```

#Table 22: FRF with two endogenous structural breaks and homogenous errors

```
breakls(method=fixedseq, trim=25, nbreaks=2) pb b(-1) @nv c covid19 elections2006q4 imfgfc ygap ggap pb(-1) pb(-3) pb(-4)
```

#Table 23: FRF with two endogenous structural breaks and heterogeneous errors

```
breakls(method=fixedseq, trim=25, nbreaks=2, heterr) pb b(-1) @nv c covid19 elections2006q4 imfgfc ygap ggap pb(-1) pb(-3) pb(-4)
```

#Table 24: FRF with two fixed structural breaks and homogeneous errors

```
breakls(method=user, breaks="2008Q4 2016Q3") pb b(-1) @nv c covid19 elections2006q4 imfgfc ygap ggap pb(-1) pb(-4)
```

#Table 25: FRF with two fixed structural breaks and heterogeneous errors

```
breakls(method=user, breaks="2008Q4 2016Q3", heterr) pb b(-1) @nv c covid19 elections2006q4 imfgfc ygap ggap pb(-1) pb(-4)
```

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