CHAPTER 24.

PUBLIC DEBT SUSTAINABILITY IN WESTERN BALKAN COUNTRIES[1]

Aleksandar ZDRAVKOVIĆ[2]
Aleksandra BRADIĆ-MARTINOVIĆ[3]

Abstract:

In this work we analyse framework for debt sustainability assessment (DSA), which is used by IMF country teams for the projections of mid-term debt-to-GDP ratio. Comparative analysis of DSA application to WB countries shows that under the baseline scenario, fiscal solvency of countries seems to be stable in period of five years ahead. Stress testing under the deterministic scheme of shocks shows that under the certain circumstances public debt of Montenegro, Albania and Croatia could turn to reach such high levels of debt-to-GDP that arguably could not be sustained in the long-run. Furthermore, we provide some methodological criticism and empirical evidence that DSA projections tend to underestimate or overestimate actual values even for short forecasting period ahead. We propose methodological improvements based on Garcia and Rigobon (2004) work and apply it on Serbian monthly data, comparing the results with IMF mid-term projections. Our projections of debt-to-GDP ratio in three years ahead give the significantly higher values than those given by IMF and strongly suggest that Serbia could face considerably high levels of debt-to-GDP ratio in mid-run, even without adverse macroeconomic shocks.

Key words: *debt sustainability assessment, debt-to-GDP forecast, Vector Autoregression Model, impulse response analysis, Western Balkan*

---

[1] This chapter is a part of research projects: 47009 (*European integrations and social and economic changes in Serbian economy on the way to the EU*) and 179015 (*Challenges and prospects of structural changes in Serbia: Strategic directions for economic development and harmonization with EU requirements*), financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

[2] Aleksandar Zdravković, MA, Research associate, Institute of Economic Sciences

[3] Aleksandra Bradić-Martinović, PhD, Research associate, Institute of Economic Sciences

INTRODUCTION

The concept of fiscal sustainability draws on the idea that public debt cannot keep on growing relative to national income because this would require governments to constantly increase taxes and reduce spending on goods and services (Akyüz 2007). There is the waste of academic and policy making literature discussing the most appropriate methodology for the public debt sustainability assessment in medium and long run. According to Tran-Nguyen and Tola, (2009) existing literature could be categorized to following main approaches:

- Present value analysis;
- Financing gaps analysis;
- The indicators of debt crisis;
- A development policy based framework.

Probably the most used approach for debt sustainability assessment in practice is financial gap analysis approach, based on three national account identities related to the balance of payments, domestic investment and savings, and government budget. This is due to the considerable application IMF Debt Sustainability Assessment framework (DSA), which belongs to the financing gap approach to public debt sustainability assessment (Tran-Nguyen and Tola, 2009). Basically, DSA methodology imposes assessment of debt sustainability as the medium-term simulations of the debt-to-GDP ratio given specific macroeconomic forecasts and fiscal policy assumptions. Within this analytical framework, sustainability is interpreted as whether underlying policies can be sustained under plausible macroeconomic conditions without endangering solvency (Debrun, Celasun and Ostry, 2006). Specifically, a declining trend in the debt ratio signals that government policies are unlikely to jeopardize sustainability, whereas a positive trend or even stabilization at a high level may motivate concerns about sustainability. IMF country teams impose routinely this framework and publish the results as the part of report on "Article IV Consultations"[4].

Considering the analysis of public debt sustainability in Western Balkan countries, several papers that explored this issue have been presented in recent years, e.g. Samizafy (2008), Sopek (2011), Zdravkovic et al. (2012). However, apart from the occasional academic research concerning issues of public debt sustainability in WB countries, IMF conducts and publishes debt sustainability analysis within DSA framework, almost on regular basis.

[4] The IMF consults annually with each member government. Through these contacts, known as "**Article IV Consultation**s," the IMF attempts to assess each country's economic health and to forestall future financial problems.

In this work we analyse sustainability of Western Balkan countries (WB) public debt in regard to the DSA methodology. First section is dealing with standard DSA methodology and points out its weaknesses. Second section provides some empirical evidence on WB countries debt sustainability based on DSA standard approach. Third section introduces version of stochastic DSA framework and its application on Serbian public debt sustainability analysis.

DEBT SUSTAINABILITY ASSESSMENT FRAMEWORK AND ITS CRITICISM

IMF Sustainability Assessment (DSA) framework for Market Access Countries[5] (MAC) was introduced in 2002 and refined in 2003 and 2005. The latter framework for low income countries[6] (LIC) was developed jointly with the World Bank in 2005. According to the DSA, change in public debt could be decomposed into the regular part, comprised of identified debt-creating flows and irregular, comprised of unidentified residuals and change of asset. Identified part is further decomposed to automatic debt dynamics, i.e. contribution of interest rate, real GDP growth and change of exchange rate, then primary balance contribution and other identified flows, manly privatization receipts and recognition of contingent liabilities. Basically, it starts with the equation of debt accumulation:

$$D_t = \left[\left(1+\varepsilon_t\right)\left(1+r_t^f\right)D_{t-1}^f\right] + \left(1+r_t^d\right)D_{t-1}^d + PB_t, \tag{2.1}$$

with following notation:

D_t - total stock of debt

PB_t - primary balance

D_{t-1}^f - foreign-currency debt in previous period

D_{t-1}^d - domestic-currency debt in previous period

r_t^f - foreign interest rate

r_t^d - domestic interest rate

ε_t - depreciation of exchange rate

[5] See Assessing Sustainability, Information Note on Modifications to the Fund's Debt Sustainability Assessment Framework for Market-Access Countries (2002), Sustainability Assessments – Review of Application (2003) and Methodological Refinements (2005)

[6] See Operational Framework for Debt Sustainability Assessments in Low-Income Countries - Further Considerations (2005)

Under some assumptions and after rearrangements[7], equation 2.1 could be rewritten in relative terms:

$$d_t - d_{t-1} = \frac{\left[r_t - \pi_t (1+g_t) - g_t + \varepsilon_t \alpha_{t-1} (1+r_t) \right]}{(1+g_t)(1+\pi_t)} d_{t-1} + pb_t \tag{2.2}$$

where g_t and π_t are real GDP growth and inflation measured by change of GDP deflator, while d_t and pb_t denote the values of debt and primary balance relative to GDP, respectively.

First part of the right side of equation represents the automatic debt creating flows, more specifically:

$\frac{r_t - \pi_t (1+g_t)}{(1+g_t)(1+\pi_t)} d_{t-1}$ - real interest rate contribution to change in public debt,

$\frac{-g_t}{(1+g_t)(1+\pi_t)} d_{t-1}$ - real GDP growth contribution to change in public debt,

$\frac{\left[\varepsilon_t \alpha_{t-1} (1+r_t) \right]}{(1+g_t)(1+\pi_t)} d_{t-1}$ - exchange rate depreciation contribution to change in public debt.

Decomposition of public debt, according to this methodology allows sensitivity analysis of public debt under different scenarios of economic policies and macroeconomic development and stress testing of debt dynamic assuming some arbitrary market or fiscal shocks. Next table briefly summarizes usual scenario analysis and bound tests for MAC.

[7] For details, see IMF (2008) or Zdravkovic et al. (2012)

Table 1: DSA methodology - Stress testing of Public Debt

Alternative scenarios (A1-A2) *Permanent shock over the entire projection period*	**A1. Historical** *Key variables are at their historical averages*	**Bound tests (B1-B6)** *Temporary shocks*	**B1. Real interest rate** *Real interest rate is at baseline plus certain fraction of standard deviation* **B2. Real GDP growth** *Real GDP growth is at baseline minus certain fraction of standard deviation* **B3. Primary Balance** *Primary balance is at baseline minus certain fraction of standard deviation* **B4. Combination of B1-B3** *Each reduced only by certain fraction of standard deviations.* **B5. Depreciation** *One-time nominal depreciation of certain percent* **B6. Other Flows** *One-time increase of public debt by certain percent of GDP*
	A2. Primary balance *No policy change (constant primary balance)*		

Source: summary of DSA assessment from various MAC country reports

DSA has been widely criticized, from the conceptual level (Wyplosz, 2011) to methodological level (Debrun, Celasun and Ostry, 2006; Gray at al, 2008). Despite its shortcomings, the IMF's framework for fiscal sustainability analysis is found to be quite useful to the practicing economist (Burnside 2004). The main methodological critic of DSA is addressed to neglecting of stochastic nature of macroeconomic variables and shocks, as well as their correlation. Brief overview of difference between stochastic and deterministic approach to DSA is given in next table.

Table 2: Deterministic vs. probabilistic approach to DSA

	Deterministic	**Probabilistic**
Diagnostic based on...	a few stylized, isolated shocks;	... shock constellations drawn from an estimated joint distribution;
Calibration of shocks	Fraction or multiple of historical standard deviations of underlying variables.	Directly based on the estimated joint distribution of disturbances (country specific)
Main advantages	Amenable to standardized bound tests across countries; low data requirement	Better reflection of country specificity; explicitly probabilistic output

Source: adapted from Debrun, Celasun and Ostry (2006)

Consequently, further improvements of DSA methodology move toward the larger application of risk management tools and stochastic modelling. Introduction of stochastic modelling to DSA framework by Ferruci and Penalver (2003) and Garcia and Rigobon (2004) was followed by Debrun, Celasun and Ostry (2006), Penalver and Thwaites (2005), Tanner and Samake (2006), Di Bella (2008), Gray et al. (2008), Giovanni and Gardner (2008) and Kawakami and Romeu (2011). In addition to DSA related frameworks, several different approaches that include uncertainty in the debt sustainability assessment are proposed, most notably Hostland and Karam (2006), Gray, Merton and Bodie (2007) and Gapen et al. (2008).

DSA DETERMINISTIC FRAMEWORK – EMPIRICAL EVIDENCE IN WESTERN BALKAN COUNTRIES

Considering the analysis of public debt sustainability in Western Balkan countries, several paper that explored these issue have been presented in recent years, e.g. Samizafy (2008), Sopek (2011), Zdravkovic et al. (2012). Semazefy (2008) points that public debt dynamic in Serbia, Albania and Bosnia is not sustainable, using the net present value analysis approach; thus public indebtedness does not help in generating a sufficient return to face debt principal repayments and interest payments for 2007-2016 in those countries. Sopek (2011) tested the hypothesis that Croatian public debt will not exceed the 60% threshold till 2015, but failed to find unambiguous evidence to accept or reject it. Zdravkovic et al. (2012) decompose Serbian public debt increments according to the DSA methodology for the quarterly data and pointed that in medium-run public debt dynamic is sustainable in the absence of some external serious shocks.

However, apart from the occasional academic research concerning issues of public debt sustainability in WB countries, IMF conducts and publishes debt sustainability analysis within DSA framework, almost on regular basis. Table 3 shows mid-term projections of public debt dynamics for WB countries, based on the most recent DSA analyses for baseline scenarios, for period 2012-2015. Baseline scenarios reflect, according to the opinion of IMF and consultations with countries' authorities, the most probable macroeconomic development and countries' economic policy. Roughly generalized, DSA projections suggest that under the baseline scenarios, WB countries should not face some escalating debt dynamic in medium run which could seriously deteriorate public debt sustainability. Additionally, projections of public debt to GDP ratio levels in years to follow should remain below the 60% threshold of Maastricht admission criterion, which is important for WB countries in regard to their intentions to join EU.

Table 3: Projections of gross public debt for WB based on DSA under baseline scenarios

Country	Reporting year	2012	2013	2014	2015	2016
Albania	2011	59.2	59.6	60.6	62	63.6
Bosnia & Herzegovina	2010	39.7	34.5	30.8	27.1	N/A
Croatia	2011	50	51.8	53.1	53.9	54.1
Macedonia	2012	32.3	30.2	30.8	30.9	30.6
Montenegro	2012	50.2	52.1	53.2	54.8	56.7
Serbia	2011	44.5	43.1	40.8	38.2	35.6

Source: IMF countries reports

In addition, bound test could give the hint on the most critical variables whose sudden adverse change could seriously hurt fiscal solvency and lead to unsustainable debt paths. Table 4 illustrates the most critical issues according to existing DSA bound test analyses for WB countries. Regarding the particular countries, bound tests suggest that even in the worst case shocks scenarios, Bosnian and Macedonian debt dynamic seems sustainable, while Montenegro, Albania, Croatia, and to less extent Serbia could face significant increase in public debt.

Table 4: The highest debt-to-GDP realizations under the DSA bound tests

Country	Type of shock	Reporting year	End-of-projection year	Debt-to-GDP ratio in %
Albania	Combination of real depreciation and contingent liabilities shock	2011	2016	76
Bosnia & Herzegovina	Primary balance shock	2010	2015	42
Croatia	Growth shock	2012	2016	69
Macedonia	Combination of real depreciation and contingent liabilities shock	2012	2017	42
Montenegro	Growth shock	2012	2017	79
Serbia	Primary balance shock	2011	2016	51

Source: IMF countries reports

Table 4 shows that threats for the public debt expansion mostly come from the fiscal issues (increase in primary deficit and activation of contingent liabilities), drop in general economic activities and deteriorations of terms of trade. It is also worth emphasizing that interest rate shock does not significantly influence debt dynamic, as a consequence of interest rate structure of debt portfolio in WB countries, where fixed interest rate instruments prevail.

DSA bound test could be very helpful as a risk management tool for mid-offices within Public Debt Administration. However, it is obvious that deterministic character of this stress testing implies significant limitations to reliability of their results; individual shocks are imposed in analysis according to deterministic schemes and treated isolated as the existing framework doesn't consider that possible shock in one variable could significantly influence other variables. Even when the shocks are combined, this is implemented also in deterministic manner apart from the calibration of real correlations among variables.

Reliability issues of bound tests seems even worse, regarding that they are mostly grounded on baseline projections of budget items, stated economic policies and macroeconomic forecasts, which prove in many cases to be wrong, thus level of projected debt/GDP ratios under the baseline significantly mishit the actual realization. Next table illustrate it on the case of projections for Croatia.

Table 5: Comparison of DSA baseline projections and actual values of debt-to GDP for Croatia

Reporting year	**2007**	**2008**	**2009**	**2010**	**2011**	**Projections of debt-to-GDP in %**
2006	41.90	41.80	41.40	40.60	39.60	
2007	37.90	37.00	35.90	34.00	32.00	
2008		36.70	38.50	38.50	37.20	
2010				38.20	39.60	
2011					47.40	
Actual Values	**32.88**	**29.17**	**35.12**	**41.25**	**45.57**	
Forecast errors						**Average**
2006	-9.02	-12.64	-6.28	0.65	5.97	6.91
2007	-5.02	-7.84	-0.78	7.25	13.57	6.89
2008		-7.54	-3.38	2.75	8.37	5.51
2010				3.05	5.97	4.51
2011					1.83	1.83
Average	7.02	9.34	3.48	3.42	7.14	6.08

Source: IMF country reports for Croatia and IMF World Outlook database

Therefore, beside the methodological criticism that has been discussed in previous section, empirical evidence also shows that forecasting performance of DSA deterministic framework could be very poor. In its recent report (IMF 2011), IMF staff recognized needs to modernize current framework for debt sustainability analysis and proposes moving towards a risk-based approach to DSA with use of stochastic simulation methods and away from standardization of most DSA elements.

DSA STOCHASTIC FRAMEWORK – SERBIAN CASE

Ferruci and Penalver (2003) and Garcia and Rigobon (2004)[8] works became the basis for the most persistent line in further research as they introduced stochastic

[8] It is worthy to emphasize that their approach is not directly addressed as the DSA criticism, but it is very similar to work of DSA critics, e.g. Debrun, Celasun and Ostry (2006).

modelling to the IMF (2002, 2003) Debt Sustainability Assessment framework. In this work we used approach based on Garcia and Rigobon (2004).

Methodology

Starting point of the methodology is debt accumulation equation which operates with real variables, under additional assumption that real interest rate on domestic and foreign debt is the same. Thus, debt accumulation equation in relative terms could be simply rewritten as:

$$d_t = (1 + r_t - g_t)d_{t-1} + pb_t, \tag{4.1}$$

where d_t is ratio of "real" [9] public debt to real GDP and pb_t is "real" primary deficit to real GDP, while r_t and g_t now represent real interest rate and real growth of GDP. In addition, as the left and right side of this equation in practice would never be equal do to the irregular changes of government balance sheet (e.g. activation of contingent liabilities), as well as due to the consequences of aggregation of debt instruments with different interest rates and currencies, equation 4.1 could be further extended with new term which represents public debt skeletons, or simply said debt shocks, denoted as s_t.

$$d_t = (1 + r_t - g_t)d_{t-1} + pb_t + s_t. \tag{4.2}$$

It has to be emphasized that within the stochastic framework all variables in equation 4.2 apart from public debt are considered to be stochastic by nature and therefore they represent the possible sources of riskiness of public debt unexpected changes. If we include inflation rate π_t and real exchange rate depreciation e_t as the additional risk factors out of equation 4.2 and take into the consideration that all of these risk variables are most probably correlated to certain degree, we could assume that they follow multinomial normal distribution with conditional mean $\boldsymbol{\mu}_t$ and conditional variance-covariance matrix $\boldsymbol{\Sigma}_t$

$$\{r_t, g_t, e_t, \pi_t, pb_t, s_t\} \sim N(\boldsymbol{\mu}_t, \boldsymbol{\Sigma}_t).$$

[9] Garcia and Rigobon originally used term "valorized" to denote inflation-free value of debt and primary balance.

Under the assumption of joint distribution, dynamic of these variables could be modelled by the standard reduced-form VAR models. In this case, VAR model in vector terms is given as:

$$\mathbf{x_t} = \mathbf{c} + \sum_{i=1}^{p} \mathbf{A_i x_{t-i}} + \mathbf{v_t}, \quad \mathbf{x_t} = \{r_t, g_t, e_t, \pi_t, pb_t, s_t\}$$
$$\mathbf{v_t} \sim N(\mathbf{0}, \mathbf{\Sigma_v}), \tag{4.3}$$

where $\{\mathbf{A_i}\}$ are matrices of lag coefficients up to p lags and $\mathbf{\Sigma_v}$ is variance-covariance matrix of reduced-form residuals. However, as the reduced-form residuals are linear combination of structural shocks, they are not suitable to perform impulse response analysis of innovations in risk variables dynamic which requires structural VAR models. Of course, the main problem with structural VAR models is identification of the model. As we do not impose some specific theory about the contemporaneous relations structure, we use recursive ordering approach by arbitrary proposed exogeneity of variables and set simple AB specification of structural VAR model:

$$\mathbf{Av_t} = \mathbf{Bu_t}, \tag{4.4}$$

where $\mathbf{A}$ is the matrix defining contemporaneous relations, $\mathbf{u_t}$ represent structural shocks and $\mathbf{B}$ is the matrix of structural form parameters. In order to perform impulse response analysis, under the assumption that $\mathbf{x_t}$ is stable process (no co-integration), it could be rewritten using Wald moving average representation as:

$$\mathbf{x_t} = \sum_{i=0}^{\infty} \mathbf{\Phi_i v_{t-i}}, \quad \mathbf{\Phi_i} = \sum_{j=1}^{i} \mathbf{\Phi_{i-j} A_j}, \tag{4.5}$$

with $\mathbf{\Phi_0 = I}$ and $\mathbf{A_j = 0}$, $j > p$.

Structural model is identified with orthogonalization of reduced-form residuals to obtain matrix $\mathbf{B}$ by Cholesky decomposition (Sims, 1981), $\mathbf{\Sigma_v = BB'}$, while matrix $\mathbf{A}$ is assumed to be identity matrix. As matrix $\mathbf{B}$ is lower triangular matrix, the first variable will be the most exogenous and thus its innovation will have contemporaneous effects on all variables, while innovation in last variable will affect only itself.

Finally, impulse response function for structural exogenous innovations is given as:

$$\mathbf{x_t} = \sum_{i=0}^{\infty} \mathbf{\Psi_i u_{t-i}}, \quad \mathbf{u_t = B^{-1} v_t}, \quad \mathbf{\Psi_j = \Phi_j B} \tag{4.6}$$

Data

In regard to the political and economic changes that Serbia has passed during the recent decades, consistent series of annual data do not exist for longer periods; therefore implementation of proposed methodology requires use of data with higher frequency for the empirical estimation of the model. We use the annualized monthly data to provide sufficient data set regarding the possible large number of parameters to be estimated by VAR model. This limits scope of data to period 2008-2011, for which exists consistent monthly data series of public debt and primary balance in nominal values. It is also important to emphasize that public debt in this analysis comprise only the debt of central government.

Additional problem to analysis is lack of monthly data on GDP, which is measured only on quarterly basis. In order to end up with approximated monthly data on GDP, we use methodology of Zaman and Markovic (2011) based on quarterly real GDP values weighted by weights obtained from index of industrial production, which is usually highly correlated with GDP dynamic. We used data on chain-linked values of GDP (in 2005 relative prices) as real GDP measure, as it is usual in statistical offices. Further, in order to obtain "real" values of public debt and primary balances, we used CPI base index as denominator which creates another issue, as the methodology of CPI calculation has changed in 2009, so there is no consistent dataset of CPI values. This issue is overcome by extrapolation of old CPI index, using the estimated coefficients of linear regression model with new CPI index as explanatory variable, for the overlapping period wherein both indices were calculated. Data for public debt, primary balance and GDP are annualized as the rolling sum of monthly data for previous twelve months.

As the Serbian public debt portfolio is composed from loans and securities which very differ in maturities and currencies, we have to use some approximations of interest rates and exchange rate depreciation to meet the parsimonious data requirements of the model. Hence, we use the data on weighted average interest rate on government debt instruments which are provided by National Bank of Serbia as an approximation of aggregate interest rate. Real interest rate is obtained as a difference between nominal interest rates and inflation rates. Such simplification brings at least two issues; use of the single real interest rates for both domestic and foreign loans is problematic because they could significantly differ if it is expected large depreciation of exchange rate. Even more important issue comes from the interest rate structure of debt portfolio, where large proportion of debt (over 70% in observed period) is indexed in fixed rates, so use of the market rates might not reflect well change of the interest increments dynamic relative to use of implicit interest rate. However, in regard of the short

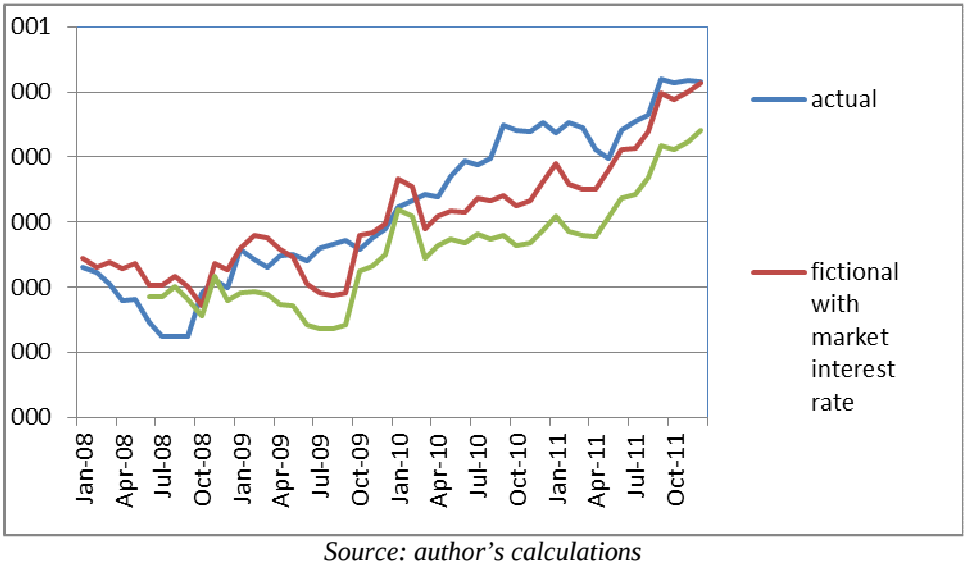
period of debt sustainability assessment, we think that these two shortcomings will not significantly influence the analysis.

Aggregate exchange rate is approximated with EUR/RSD exchange rate, in regard to currency structure of debt portfolio were euro-indexed debt dominates, as well as strong correlation between EUR/RSD correlation with exchange rates of other instruments indexed in foreign currency (mostly USD and CHF). Real depreciation is calculated as a difference between nominal depreciation and inflation rate. Debt shocks are calculated based on equation 4.2, as a difference between right and left side of the equation.

Results

At first step, we decomposed debt-to-GDP ratio according to equation 4.2, in order to get time series of debt shocks. Then we create fictional path of the debt without debt shocks. We repeat this exercise also with implicit interest rates, in order to check whether the public debt-to-GDP ratio is better calibrated by using these rates, having in mind that debt instruments with fixed interest rates have considerably larger participation in debt portfolio structure. As we didn't find empirical evidences to confirm it, we continued further analysis with market interest rates. In next figure shows actual and fictional values of debt-to-GDP ratio.

Figure 1: Debt-to-GDP ratio



Source: author's calculations

Table 6 shows correlation matrix of considered variables. General pattern of correlation coefficients seems reasonable from the standpoint of economic theory, as the market variables are mutually highly correlated, and that primary balance as the only non-market variable and debt shocks are generally less correlated.

Table 6: Correlation matrix of risk variables

	Real interest rate	**Real GDP growth**	**Real exchange rate depreciation**	**Inflation rate**	**Primary deficit to GDP**	**Debt shocks**
Real interest rate	1	-0.8248	0.6750	-0.7719	0.4583	-0.7341
Real GDP growth	-0.8248	1	-0.6841	0.8049	-0.3528	0.6169
Real exchange rate depreciation	0.6750	-0.6841	1	-0.6730	0.1052	-0.2950
Inflation rate	-0.7719	0.8049	-0.6730	1	-0.1866	0.3415
Primary deficit to GDP	0.4583	-0.3528	0.1052	-0.1866	1	-0.6370
Debt shocks	-0.7341	0.6169	-0.2950	0.3415	-0.6370	1

Source: author's calculation

According to the Swartz estimation criterion which suggests choice of two lags, we estimated reduced-form VAR model given in equation 4.3 with two lags. Estimated coefficients of VAR model are given in Table 7 together with t-values in brackets. Although t-values suggest that some variables could have statistically insignificant influence and that VAR model should be estimated with restriction on coefficients, we proceed further analysis with unrestricted VAR estimated model.

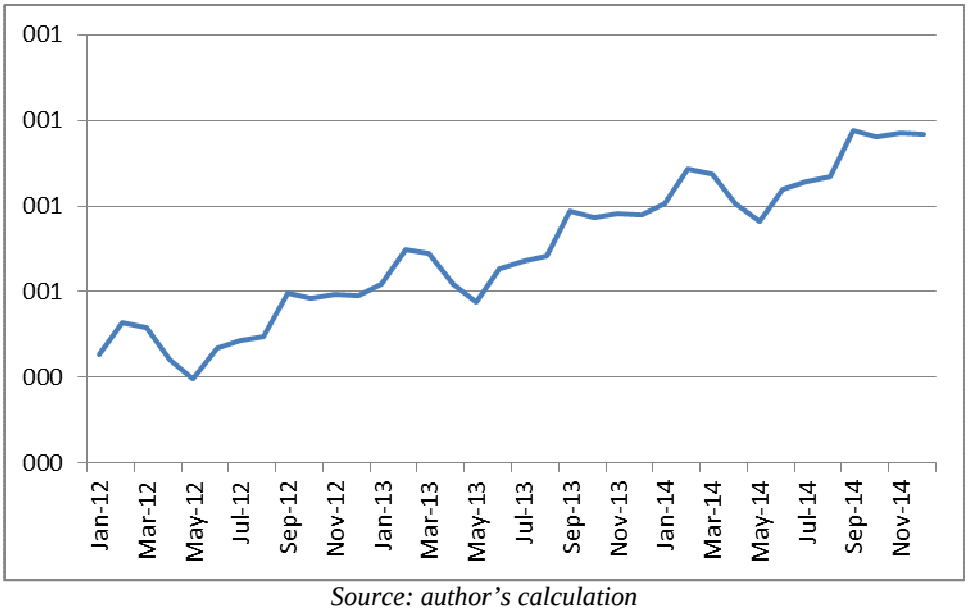
Table 7: Estimated VAR coefficients

Variable	Lag	Real interest rate	Real GDP growth	Real exchange rate depreciation	Inflation rate	Primary deficit to GDP	Debt shocks
Real interest rate	t-1	1.397779 [5.5446]	-0.11439 [-0.8804]	-0.12464 [-0.8895]	0.104688 [0.3011]	0.129422 [1.8489]	-0.35979 [-2.1088]
	t-2	-0.55195 [-1.2410]	0.010192 [-0.2085]	0.568069 [1.8267]	-0.07531 [-0.9731]	-0.1117 [-1.3241]	0.548806 [0.3202]
Real GDP growth	t-1	-0.02327 [0.9026]	0.647422 [5.4294]	1.261528 [0.19418]	0.520464 [1.2347]	-0.09036 [-0.0987]	1.114852 [0.1457]
	t-2	0.010239 [-1.7657]	0.243641 [0.3443]	-0.27568 [0.3494]	-0.27954 [0.0300]	-0.00371 [-0.6858]	-0.6699 [0.6560]
Real exchange rate depreciation	t-1	-0.12645 [-1.7657]	0.000938 [0.3443]	0.589812 [0.3494]	0.016064 [0.0300]	-0.03349 [-0.6858]	0.062709 [0.6560]
	t-2	0.145265 [0.4429]	-0.0398 [-0.8718]	0.311989 [0.0550]	0.007052 [0.7984]	0.01621 [0.1815]	-0.03114 [-1.6324]
Inflation rate	t-1	-0.34834 [0.9403]	0.073777 [1.0754]	-2.0082 [-2.24346]	1.307257 [4.2203]	0.157847 [2.2623]	-0.61644 [-3.0777]
	t-2	0.325787 [0.6213]	-0.22187 [-2.5156]	1.524348 [2.2522]	-0.4586 [-2.3124]	-0.10734 [-1.7057]	0.470693 [1.8845]
Primary deficit to GDP	t-1	1.098396 [1.3671]	-0.06743 [-0.3303]	0.710555 [-0.34871]	-0.43887 [-0.7324]	0.623109 [3.6535]	-0.06357 [-2.1438]
	t-2	-0.91218 [0.3516]	0.390298 [1.5630]	-1.83849 [0.2896]	0.444584 [-0.0145]	-0.28245 [-1.2439]	0.631742 [-0.0946]
Debt shocks	t-1	0.49989 [2.2247]	-0.02482 [-1.3372]	0.420346 [0.0826]	-0.06759 [-0.7842]	0.103463 [1.7393]	0.576727 [-1.4648]
	t-2	-0.38344 [2.6904]	0.134716 [0.1189]	-0.93452 [1.8473]	0.089493 [-2.2542]	-0.0806 [-0.5152]	0.061113 [-0.4715]
Constant		-0.01669 [-1.2281]	0.001052 [-1.2281]	0.00867 [1.1116]	0.049581 [1.7606]	0.011233 [1.6750]	0.005824 [0.8587]
R squared adjusted		0.935685	0.935685	0.973188	0.870646	0.907137	0.324066

Using the estimated VAR regression model, we produce forecast of risk variables 36 months ahead and construct path of public debt according to the debt accumulation equation, which represents the baseline scenario (no policy change or setting the initial conditions to historical averages). There are at least two reasons why we use three years as the forecasting period instead of five years, which is usual mid-term forecasting horizon. First, as our time series of data are very short, it would be too ambitious to use estimated coefficients of VAR model to look for such long forecasts. Second, it is not realistic to assume that change of public debt will not influence the fiscal policy of the country and decisions about level of primary deficit. Thus, it is reasonable to assume that forecast for longer

periods would probably non-reliable. Forecasted debt-to-GDP ratio for the period 2012-2014 is given in next figure.

Figure 2: forecast of debt-to-GDP ratio



Source: author's calculation

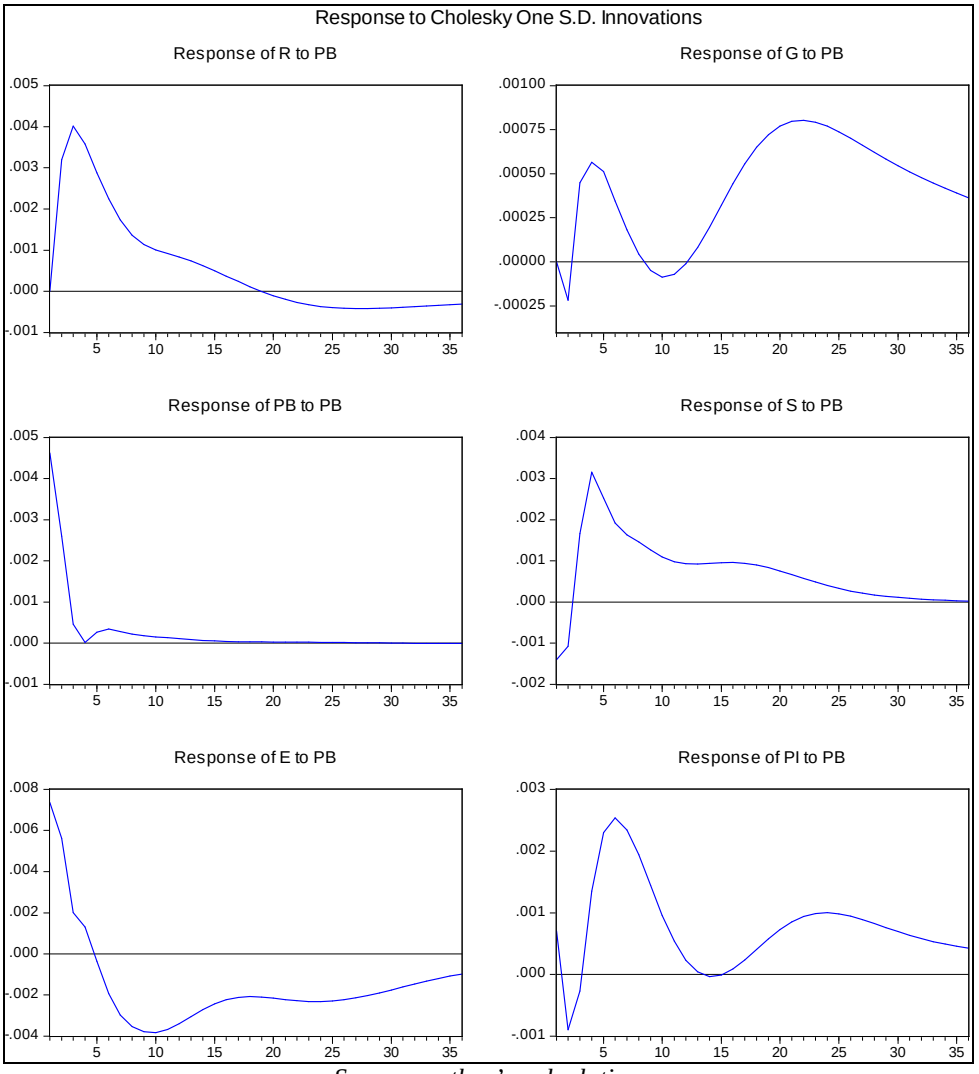
Forecasted values of public debt under the baseline scenario clearly shows increasing trend, approaching to around 60% of GDP at the end of 2014. This is much higher values that those given by IMF projections[10]. We think that our projections are more realistic, as in 2012 Serbian government haven't make significant efforts to stabilize fragile public finance.

We further conducted stress testing using the above-mentioned procedure of impulse response analysis. We didn't take into consideration all of possible shocks, but look for only primary deficit innovation, which is found by IMF bound tests to be the one with the most negative influence on debt-to-GDP increase. Variables are ordered in a same way as proposed by Garcia and Rigobon (2004) – real interest rate, real GDP growth, primary deficit, debt shocks, real exchange rate depreciation and inflation; such ordering means that inflation contemporaneously influence all variables in the model, while interest rate acts

[10]IMF projections are related to general government gross debt, while our projections of public debt take into account only debt of central government.

only with lag. Figure 3 shows the effect of one standard deviation innovation in all variables entering the VAR model.

Figure 3: Impulse response analysis of innovation in primary deficit

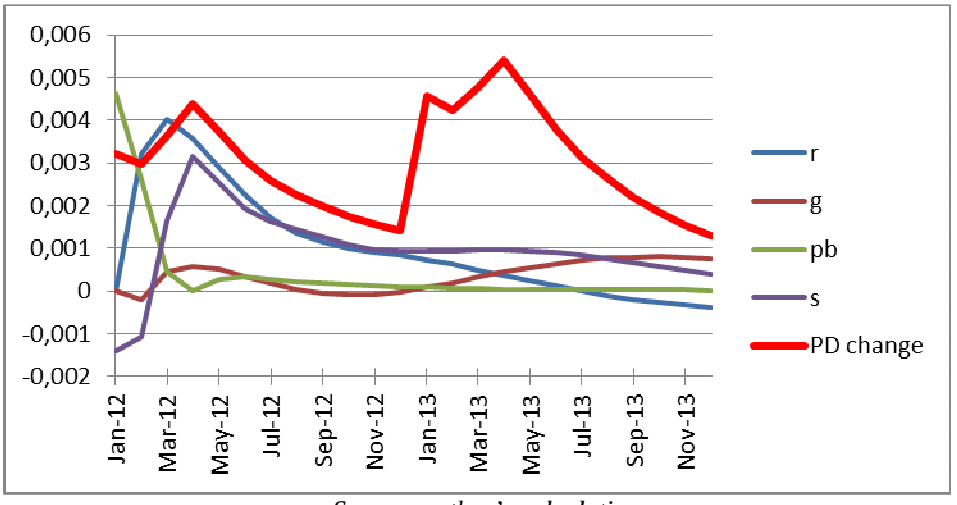


Source: author's calculation

The results of the impulse response analysis shows the economically reasonable results – one time primary balance innovation in first period increase real interest rate, real deprecation, inflation and GDP growth, but effect of shock is temporary and variables tends to reach their steady states. An increase in interest rate and

primary balance will deteriorate debt-to-GDP ratio, while increase in GDP growth works in the opposite direction. The overall effect that prevails in this case is negative, and the debt-to-GDP ratio increase, as it is shown in next figure.

Figure 4: Impulse response analysis to an increase in primary deficit



Source: author's calculation

However, this effect is not as large as it would be case in deterministic application of DSA framework, which treats primary deficit shock as an isolated shock, hence it doesn't take into account that primary deficit increase will probably result in increase of GDP growth, as it is suggested by the Keynesian economic theory.

CONCLUSIONS

In this work we analyse framework for debt sustainability assessment (DSA), which is used by IMF country teams for the projections of mid-term debt-to-GDP ratio. Comparative analysis of DSA application to WB countries shows that under the baseline scenario, fiscal solvency of countries seems to be stable in period of five years ahead. Stress testing under the deterministic scheme of shocks shows that under the certain circumstances public debt of Montenegro, Albania and Croatia could turn to reach such high levels of debt-to-GDP that arguably could not be sustained in the long-run. Furthermore, we point out the most important and obvious issues of methodological criticism and provide empirical evidence that DSA projections tend to underestimate or overestimate actual values even for short forecasting period ahead.

There were several advances in recent years toward the improvements of the key shortcomings of existing DSA framework, mainly lack of stochastic tools in application and lack of country specific calibration of shocks. Garcia and Rigobon (2004) propose VAR models to capture the correlation patterns among the macro variables and Cholesky decomposition of reduced-form residuals variance-covariance matrix in order to calibrate shocks. We apply their approach on Serbian monthly data and compare the results with IMF mid-term projections. Our projections of debt-to-GDP ratio in three years ahead give the significantly higher values than those given by IMF and strongly suggest that Serbia could face considerably high levels of debt-to-GDP ratio in mid-run, even without adverse macroeconomic shocks. Stress testing on primary deficit innovation tends to increase debt-to-GDP ratio, but not so substantially as the one given by deterministic approach, as the stochastic approach implies positive effect of primary deficit increase on GDP growth.

Use of such parsimonious model for DSA analysis like the one proposed in this research has its obvious advantages: lower data requirements (in sense of number of variables entering the model), ease of application, endogenous forecasting and capturing of country specific factors. Furthermore, in regard to our exercise with Serbian data, there is no evidence that IMF standard DSA approach over performs our results. Nonetheless, it should be bear in mind that this approach still suffer from several shortcomings and one of the most important is neglecting fiscal reaction function, i.e. the fact that the government will adjust their budget and primary deficits taking into account public debt dynamics. Panel estimation of fiscal reaction function for WB countries could be one of the future steps toward improvement of probabilistic DSA methodology and obtaining of more reliable debt dynamic assessments and stress testing of public debt sustainability for WB countries.

References

[1] Debrun, X., Celasun O. and Ostry, J. (2006). Primary surplus behavior and risks to fiscal sustainability in emerging market countries: a "fan-chart" approach, *IMF Working Papers 06/67*

[2] Di Bella, G. (2008). A stochastic framework for public debt sustainability analysis. *IMF Working Paper Series*

[3] Ferrucci, G. and Penalver, A. (2003). Assessing sovereign debt under uncertainty. *Financial Stability Review. 15,* 151-59, Bank of England.

[4] Gapen at al. (2008). Measuring and analyzing sovereign risk with contingent claims. *IMF Staff Papers 55*

[5] Garcia, M. and Rigobon R. (2004). A risk management approach to emerging market's sovereign debt sustainability with an application to Brazilian data, *NBER Working Papers Series*
[6] Giovanni, J. & Gardner, E. (2008). A simple stochastic approach to debt sustainability applied to Lebanon. *IMF Working Paper Series*
[7] Gray at al. (2008). A risk-based debt sustainability framework: incorporating balance sheets and uncertainty. *IMF Working Paper Series*
[8] Gray, D.F., Merton, R.C. & Bodie, Z. (2007). Contingent claims approach to measuring and managing sovereign credit risk. *IMF Working Paper Series*
[9] Hostland, D. & Karam, P. (2006). Assessing debt sustainability in emerging market economies using stochastic simulation methods. *IMF Working Papers Series*
[10] International Monetary Fund. (2003). Debt sustainability in low-income countries - towards a forward-looking strategy, *IMF Working Paper Series*
[11] International Monetary Fund. (2004). Debt-related vulnerabilities and financial crises - an application of the balance sheet approach to emerging market countries, *IMF Working Paper Series*
[12] International Monetary Fund. (2008). Staff Guidance Note on Debt Sustainability Analysis for Market Access Countries. IMF Paper
[13] International Monetary Fund. (2011). Modernizing the Framework for Fiscal Policy and Public Debt Sustainability Analysis
[14] International Monetary Fund. Country reports for Albania, Bosnia & Herzegovina, Croatia, Macedonia, Montenegro, Serbia
[15] Kawakami, K. & and Romeu, R. (2011). Identifying fiscal policy transmission in stochastic debt forecasts, *IMF Working Paper Series*
[16] Penalver A. and Thwaites, G. (2005). *Fiscal rules for debt sustainability in emerging markets: the impact of volatility and default risk.* Bank of England Working Paper no. 307
[17] Samizafy, M. (2008). Public debt and the financial integration of the Balkan countries in the financial European system. *Challenges of Economic Sciences in 21st Century*, Institute of Economic Sciences, Belgrade
[18] Sims, C. (1980). Macroeconomics and reality, *Econometrica* 48,1–48.
[19] Sopek, P. (2011). Testing debt sustainability by dynamic models. *Croatian Public Debt: Management and Challenges of the Market Development*, Institute for Public Finance, Zagreb
[20] Tanner E. and Samake, I. (2006). Probabilistic sustainability of public debt: a vector autoregression approach for Brazil, Mexico, and Turkey. *IMF Working Paper* WP/06/295
[21] Tran-Nguyen, A. and Tola, A. (2009). The mechanics of debt sustainability analysis. *Compendium on Debt Sustainability and Development, UNCTAD*

[22] Wyplosz, C. (2011). Debt sustainability assessment: mission impossible. *Review of Economics and Institutions*, Università di Perugia, Dipartimento Economia, Finanza e Statistica, vol. 2(3).

[23] Zdravkovic A., Bradic-Martinovic A. and Stefanovic S. (2012). Sustainability of Serbian public debt in regard to economic crisis, *Ekonomski signali*, 7/1,1-16