

Macroeconomic Effects of the Adoption of the Euro in Serbia

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ABSTRACT: In 2009, Serbia applied officially for EU membership, and on 21 January 2014, membership negotiations started. If Serbia joins the EU, it will have to adopt the euro as legal tender as soon as it fulfils the relevant Maastricht criteria. By means of simulations with a macroeconomic model of the Serbian economy, this paper examines what macroeconomic effects can be expected from Serbia's EU membership and from its membership of the Euro Area. The macroeconomic model for Serbia comprises the key macroeconomic markets, i.e. the labor, goods, monetary and foreign exchange markets. It contains equations for GDP and its expenditure components (consumption of private households, government consumption, fixed capital formation, exports, and imports), the price level, wages, employment, unemployment, interest rates, and exchange rates. In addition, the government sector is modeled in some detail. It is shown that EU accession and the introduction of the euro bring about higher real GDP, more employment, and slightly higher inflation due to additional aggregate demand. Public finances are affected positively. The benefits of joining the Euro Area are mainly due to supply side effects, viz. increases in productivity.

KEYWORDS: *Serbia; EU; Euro Area; Open economy Macroeconomics.*

1 Introduction

On 22 December 2009, Serbia formally applied for EU membership. In March 2012, Serbia was granted EU candidate status. In September 2013, a Stabilisation and Association Agreement (SAA) entered into force between Serbia and the EU. Formal accession negotiations started in January 2014.¹

The primary motivation of countries in Central and Eastern Europe as well as in the Western Balkans to strive for EU integration is the prospect of economic gains. It can be taken for granted that closer economic integration brings about economic benefits in terms of higher GDP growth and more employment. However, the extent of these benefits is controversial, and their magnitude is often overestimated *ex post*. As a prominent example, the influential Cecchini Report (1988) forecast that the completion of the European Single Market would raise EU-wide GDP by 4.5 to 6.5%. Most reports that were issued *ex ante*, however, came up with much lower estimates. Empirical analyses show that the Single Market has realistically increased GDP in the EU by 2 to 3%. The reason for the differences between the *ex post* and *ex ante* estimations may be the lack of sound empirical estimations in the *ex post* study. Based on the empirical evidence, it can be concluded that positive growth effects mainly arose from higher exports and foreign direct investment while the removal of trade barriers reduced trade costs and intensified competition in the Single Market made companies more competitive globally. The reduction in barriers for intra-EU trade also made the countries in the EU more attractive for investment by foreign companies (Vetter, 2013).

Twenty years after the envisaged completion of the Single European Market, integration has still not been completed in many fields. This applies particularly to the free movement of services, the creation of a Single Digital Market, as well as liberal professions. In 2013, the European Parliament's Committee on Internal Market and Consumer Policy requested a new Cost of Non-Europe report in the field of the Single Market. This report aimed at quantifying the costs arising from the lack of full achievement of the Single Market. The report considers the economic cost of market fragmentation as well as of the gaps and shortcomings in five areas: the free movement of goods, the free movement of services, public procurement, the digital economy, and the body of consumer law known as the consumer *acquis*. The report estimates that completing the Single Market in these fields would bring potential economic gains ranging between 5 and 8.6% of EU GDP (Pataki, 2014).

In this paper, we use a macroeconometric model of the Serbian economy to quantify possible macroeconomic effects of Serbia's integration in the EU and, subsequently, to the Euro Area. In the next section, the model is described. Then, the simulation design will be sketched out, followed by a discussion of the results. The final section summarizes the main findings and draws conclusions.

¹ Details on the state and progress of the accession negotiations between the EU and Serbia can be found on the Website of the European Commission: http://ec.europa.eu/enlargement/countries/detailed-country-information/serbia/index_en.htm.

2 The Model

This section outlines the macroeconomic model of the Serbian economy that was used for the simulations. A comprehensive description of an earlier version of the model is found in Weyerstrass and Grozea-Helmenstein (2013). All equations are listed in detail in the appendix of this paper.

The macroeconomic model for Serbia contains equations for the GDP expenditure components, prices, wages, employment, unemployment, interest rates, and exchange rates. In addition, the government sector bloc contains equations for the most important revenue and expenditure items of the consolidated general government.

Unit root tests identify most variables as integrated of order one, i.e. the variables are non-stationary in levels, but the first differences are stationary.² Hence, for almost all behavioral equations, error correction models (ECM) were chosen as the most appropriate modeling technique. An ECM combines the long run, cointegrating relationship between the levels of the variables included and the short-run relationship between the growth rates of the variables. An error correction model has the following form:

$$\Delta^4 y_t = \alpha \Delta^4 y_{t-1} + \sum_{i=0}^p (\beta_1 \Delta^4 x_{1,t-i} + \dots + \beta_i \Delta^4 x_{i,t-i}) + \gamma (y_{t-4} - c - \delta_1 x_{1,t-4} - \dots - \delta_i x_{i,t-4}) + \varepsilon_t$$

In this specification, y is the endogenous variable, x stands for the explanatory variables, and ε denotes the error term in period t . The second term in brackets comprises the cointegrating relationship. In order to eliminate seasonal effects as far as possible, the endogenous variables are growth rates over the same quarter of the previous year in the equation denoted by Δ^4 . As the specification shows, the short-run dynamic of the endogenous variable is driven by short-run movements of the exogenous variables and by past deviations from the long-run equilibrium.

Market for goods and services – GDP expenditure components

The behavioral equation for the *consumption of private households* combines the Keynesian consumption theory and the permanent income / life cycle hypothesis. According to the Keynesian view, the consumption of private households depends on current disposable income. The permanent income / life cycle hypothesis stipulates that it is the present value of expected future income rather than current disposable income that is relevant for consumption decisions. Taking both strands of consumption theory together, private household consumption depends on both current disposable income and wealth, the latter being captured by the real long-term

² The results of the unit root tests are not shown here for the sake of brevity, but may be found, for an earlier model version, in Weyerstrass and Grozea-Helmenstein (2013). In some cases, the results of the unit root tests are inconclusive. These problems are caused by the shortness of the time series and by the fact that some quarterly time series had to be constructed on the basis of related quarterly and annual series.

interest rate. The interest rate as a determinant of consumption accounts both for the fact that some households finance part of their consumption via bank loans, and for the intertemporal decision on the allocation of income to consumption in the present period and in the future. The higher the interest rate, the higher the opportunity costs of spending income on current consumption.

Gross fixed capital formation serves two objectives, namely the renewal of capital stock, and its adjustment to expected changes in final demand. According to the accelerator theory, changes in demand determine fixed capital formation. Since it takes time to purchase and install new capital goods, it is expected rather than actual demand that has to be considered. However, in the case of adaptive expectations, as assumed here, expectations are based on past observations. Therefore, in the investment equation, actual demand is included as an approximation for expected future demand. According to theories based on the profitability of investment projects, the value of the capital stock equals the discounted expected future income that can be generated by using the capital stock. Therefore, the user cost of capital is crucial for the profitability of an investment project. According to the theory, the user cost of capital comprises the real long-term interest rate, the depreciation rate of the capital stock, profit taxes, investment credits, and the change in the prices of investment goods. The neoclassical theory of investment combines the accelerator hypothesis and profitability considerations. In this case, the investment function is derived from the profit maximization of companies, based on a neoclassical production function with the input factor capital and a positive but diminishing marginal product. The optimal capital stock equalizes the marginal revenue product of capital and the user cost of capital. Due to the availability of data, in the model for Serbia the user cost of capital is approximated by the real long-term interest rate plus the depreciation rate of the capital stock. In addition to the user cost of capital, investment is influenced by real GDP as the most comprehensive measure of total demand.

Exports of Serbian goods and services depend on foreign demand, approximated by the volume of world trade, and on the relative price of Serbian exports on the world market. The real effective exchange rate accounts for these price effects. *Imports of goods and services* depend on total demand in Serbia and on the relative price between Serbian and imported products. Total demand is approximated by real GDP. As in the case of exports, relative prices are approximated by the real effective exchange rate of the Serbian dinar.

Labor market

Labor demand by companies (i.e. actual employment) is influenced by production and labor costs. In the model, production is approximated by real GDP, and labor costs consist of the average real gross wage per employee. *Labor supply* by private households is modeled via the participation rate, i.e. that part of the population of working age (15 to 64) that is engaged on the labor market. The participation rate depends on real GDP and on the real wage rate. The real wage positively influences labor supply, implying that the substitution effect dominates the income effect. The influence of real GDP on labor market participation represents the “encouraged” or “discouraged” worker effect. This means that an improvement in the general economic situation encourages more people to actively seek employment, while in a period of economic deterioration people withdraw from the labor market.

Prices and wages

The *consumer price index* (CPI) is determined by internal and external factors. External influences are approximated by the oil price in dinar. Internal cost-push factors are the gross wage and capacity utilization. The inclusion of the latter ensures that in the medium to long run the gap between potential and actual GDP is closed. The more actual GDP deviates from potential GDP, the lower inflationary pressure becomes. This increases real income and stimulates consumption, eventually leading to closure in the output gap. The *GDP deflator* is simply linked to the development of the consumer price index. In the model, nominal GDP is calculated by inflating real GDP via the GDP deflator. Hence, the individual deflators of the demand components are not needed. However, what is needed is the deflators of private and public consumption. The former is used to calculate nominal private consumption, which then influences the determination of value added tax revenues. The deflator of public consumption is needed to deflate public consumption, since nominal public consumption is treated as a policy instrument, while real public consumption enters the determination of real GDP. The *private consumption deflator* depends solely on the CPI. The *deflator of public consumption* is influenced by government consumption according to fiscal statistics. This specification is based on the fact that public consumption consists of the wages of public employees and the purchasing of goods and services. Hence, the wage outlays for public employees are the most important determinant of the price level of public consumption. In an *extended Phillips curve equation*, the *wage rate* is negatively influenced by the unemployment rate. In addition, wages are positively influenced by the consumer price index and labor productivity.

Financial market

In the financial market block of the model, interest rates and exchange rates are determined. Since the National Bank of Serbia (NBS) runs an independent monetary policy, the *NBS interest rate for open market operations* has been included in the model as the relevant monetary policy instrument. In model simulations and forecasts, this short-term interest rate determined by the National Bank of Serbia might be either exogenous or endogenous. For the case of a model-based monetary policy path, the model contains a Taylor rule for determining the short-term interest rate, i.e. the NBS interest rate. In this equation, the NBS interest rate for open market operations depends positively on the inflation rate and on the output gap in Serbia. This approach implies that the National Bank of Serbia follows both inflation and an output target. Monetary policy becomes more restrictive, i.e. the interest rate is raised, if inflation rises and/or actual output exceeds potential output.

In a term structure equation, the *long-term interest rate* depends on the short-term interest rate. In addition, the ratio between public debt and GDP positively influences the long-term interest rate. As the financial crisis of 2008/2009 has shown, with rising public debt, the possibility of a sovereign default increases, and financial markets claim higher risk premiums on long-term interest rates to compensate for this higher risk. The *implicit interest rate on outstanding public debt* depends on the long-term market interest rate. The *real effective exchange rate* of the Serbian dinar is determined by the nominal exchange rate vis-à-vis the euro, accounting for the

fact that the aggregated Euro Area is Serbia's most important trading partner. When including both the euro and the US dollar, the latter has the wrong sign. Hence, only the euro is considered as a determinant of the nominal effective exchange rate of the dinar in the Serbian model. In addition to nominal exchange rate, the real effective exchange rate is influenced by the inflation differential between Serbia and the average of its trading partners. However, it would have been difficult to construct an international inflation rate consistent with the regional pattern of Serbia's external trade as reflected in the effective exchange rate. Therefore, in the real effective exchange rate equation, only inflation in Serbia has been included in addition to the nominal exchange rate vis-à-vis the euro.

Public sector

In the *public sector* part, the model contains behavioral equations for the most important revenue and expenditure items of the consolidated general government. In a fiscal rule, *public expenditures on goods and services* are inversely related to the past change in the debt level. This rule prevents public debt from increasing forever since a rise in the debt level is counteracted in the next period by a spending restraint. In the version of the model used for the simulations for this paper, this equation was not used. Rather, public consumption according to national accounts was set exogenously. In order to account for differences between national accounts and public finance data, the model includes a behavioral equation relating government consumption according to national accounts to government *consumption according to public finance statistics*. *Interest payments* on outstanding public debt are determined in a definition equation by multiplying the debt level at the end of the previous quarter by the implicit interest rate on public debt. *Social security benefits* are determined by the average gross wage, multiplied by the sum of unemployed persons and the population not of working age. The *remaining government expenditures* are explained by the remaining government revenues, i.e. those revenues for which the model does not include a behavioral equation. This specification prevents government expenditures from exploding. On the revenue side of the general government budget, *personal income tax revenues* are linked to the number of employees, multiplied by the average income tax rate and the gross wage rate. In a similar vein, revenues from *corporate income taxes* are explained by GDP as a proxy for company profits, multiplied by the average corporate income tax rate. *Value added tax (VAT) revenues* are determined by nominal private consumption expenditures, multiplied by the value added tax rate. *Social security contributions* by employees and employers are linked to the number of employees, multiplied by the average gross wage and the average social security contribution rate. The *remaining government revenues* are positively related to the economic situation, which is measured by nominal GDP.

Supply side

In the *supply block*, potential GDP is determined. The calculation of potential output is based on a Cobb-Douglas production function with constant returns to scale and using the production factors labor, capital, and autonomous technical progress. Since potential GDP is a measure of the long-run production possibilities of an economy, the long-run trends of the production

factors enter the production function. Capital stock is the one exception, as it is assumed that it is normally fully utilized. Autonomous technical progress is defined as total factor productivity (TFP). Under these assumptions, trend employment, capital stock and the trend of total factor productivity determine potential output. The production function has the following form:

$$\log(\text{YPOT}) = 0.65 \log(\text{TRENDEMP}) + 0.35 \log(\text{CAPR}) + \text{TRENDTFP}.$$

In this equation, YPOT is potential GDP, TRENDEMP is the labor force adjusted for structural unemployment, CAPR is the real capital stock, and TRENDTFP is the long-run trend of total factor productivity. In accordance with economic theory, the production elasticities of employment (0.65) and capital (0.35) should equal the share of the production factors in total income.

Before calculating potential GDP according to the above equation, trend employment and the trend of total factor productivity have to be determined. Trend employment is calculated by subtracting natural or structural unemployment (NAIRU, the non-accelerating inflation rate of unemployment) from the labor force. Since structural unemployment is non-observable, this variable has to be approximated. In the model for Serbia, the NAIRU is estimated by applying the Hodrick-Prescott (HP) filter to the actual unemployment rate. In order to endogenize the NAIRU, it is modeled as an autoregressive (AR) process.

In a growth accounting exercise, total factor productivity is calculated as that part of the change in real GDP that is not due to increased labor and capital input, where both production factors are weighted with their production elasticities of 0.65 and 0.35, respectively. For the production possibilities, the long-run trend rather than the current level of total factor productivity is relevant. Therefore, the actual TFP series is smoothed by applying the Hodrick-Prescott filter so as to remove short-run fluctuations that are caused by the business cycle or by any short-run shocks.

3 Simulation design

We estimated the gains from Serbia's EU and possible Euro Area accession by running three simulations with the macroeconometric model. All simulations were performed over the period 2016 to 2030. The baseline simulation assumes that Serbia does not join the EU at all. In a second simulation, we assume that Serbia joins the EU in 2020, but does not introduce the euro until 2030. Finally, for the third simulation we assume Euro Area accession in 2023.

As discussed in the introduction, gains arise from economic integration, first, from the promotion of exports, and second, from higher foreign direct investment (FDI), bringing about technology transfer with positive effects on total factor productivity. We assume that the prospect of EU accession itself as well as the continuous lifting of the remaining trade barriers induces positive effects even before actual EU accession. Therefore, we introduce positive add factors to exports and TFP in several steps, starting in 2018, i.e. two years prior to the assumed EU accession. Specifically, we increase (with respect to the baseline) TFP by 0.5% in 2018, 1% in 2019, 1.5% in 2020, and 2.5% from 2021 onwards. Likewise, exports are raised by 1.5% in 2018, 1.75% in 2019, 2% in 2020, 2.25% in 2021, and 2.75% from 2022 onwards with respect to the baseline. Since exports are determined endogenously in the model, the final deviation of exports from the baseline is higher than that induced by these add factors.

In principle, all EU member states are obliged to join the Euro Area as soon as they fulfil the relevant criteria as defined in the Maastricht treaty. Exceptions have only been negotiated by Sweden and Denmark. Neither was the UK obliged to join the Euro Area, but this exception will become obsolete with the imminent exit of the UK from the EU. For most small EU member states, also those from Central and Eastern Europe, Euro Area accession has not only been an obligation, but also one of their own policy goals. This can be seen by the repeated accession to the Euro Area by several Central and Eastern European EU member states over the last couple of years. Hence, it is safe to assume that Serbia will also become a member of the Euro Area eventually after EU accession. We presume that Serbia's Euro Area accession will take place in 2023, i.e. three years after its assumed EU accession. For the entire Euro Area, the European Central Bank (ECB) is responsible for monetary policy. Hence, after Euro Area accession, Serbia will no longer have control over its monetary policy. We model this by assuming the short-term interest rate to be exogenous, as opposed to endogenous determination based on a Taylor rule involving inflation and the output gap in Serbia as used in the other simulations. In the Euro Area accession scenario, we let the short-term interest rate in Serbia gradually converge towards the Euribor, which we set at 3%. In the scenarios with an independent monetary policy in Serbia, the short-term interest rate is much higher; hence, Euro Area accession brings about an additional demand-pull impact due to the reduction in interest rates, similar to the experiences of the Southern Euro Area member states Greece, Spain and Italy after agreement on the composition of the Euro Area.

There is evidence that some retailers took advantage of the cash changeover to the euro to increase prices. This can be explained by the observation that consumers take some time to adapt to a new currency. This is particularly true for low-priced goods. In line with these considerations, based on a theoretical model, Mastrobuoni (2004) found evidence for higher inflation for certain goods after the euro cash changeover. According to Mastrobuoni (2004), this inflationary effect was largest and most significant in France, Spain, and Italy. For our simulations, we took this additional inflationary effect of the euro changeover into account with a one-off increase in the price level. Specifically, we increased the CPI level in 2023 by 1% of the simulation results without Euro Area accession. Hence, we have an additional inflation effect in 2023, i.e. the assumed year of Serbia's Euro Area accession. Afterwards, the price level remains higher, but the deviations in inflation after 2023 are solely due to internal dynamics in the model.

In addition to these monetary policy and price effects, we assumed that Euro Area integration would bring about additional boosts to TFP and exports. Specifically, from 2023 onwards, total factor productivity was raised by one additional percentage point with respect to the EU accession scenario. Hence, the final TFP impact of EU and Euro Area accession was 3% from 2023 onwards. Exports were increase by an additional 0.5 percentage points, i.e. from 2023 the add factor amounted to 3.25% as opposed to 2.75% in the EU accession scenario.

All assumptions regarding the dates and macroeconomic effects of Serbia's EU and Euro Area accession are, of course, more or less arbitrary. However, the assumptions were based on empirical evidence regarding previous EU and Euro Area enlargement rounds.

4 Results

Figures 1 to 10 visualize the simulation results regarding the impact of Serbia's accession to the EU and to the Euro Area on important macroeconomic indicators. In the figures, the suffix *_base* denotes the baseline with no EU and Euro Area accession, the suffix *_EU* denotes the scenario with EU accession taking place in 2023, but not followed by Euro Area accession, and the suffix *_Euro* stands for the combined EU and Euro Area accession effects. The size of the effects clearly depends on the assumed magnitude of the initial increases in TFP and exports.

Figure 1: Real GDP

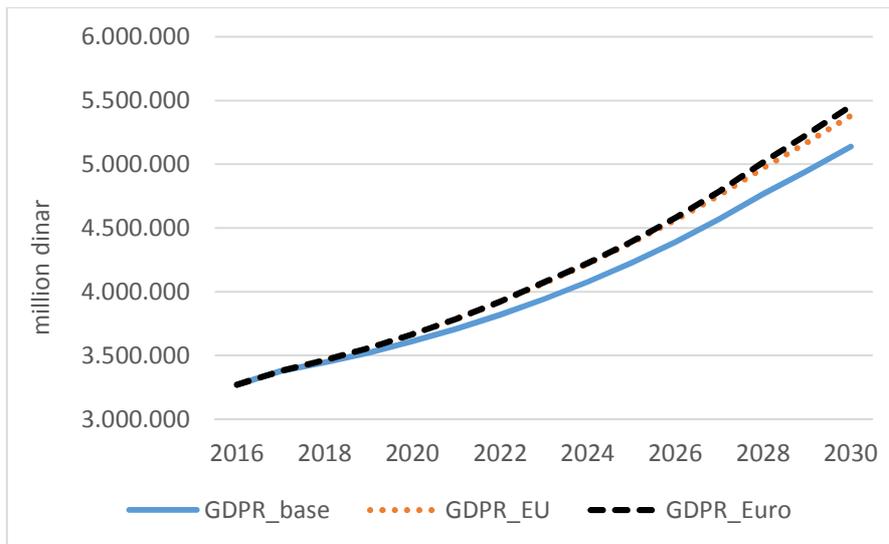


Figure 2: Real GDP growth rate

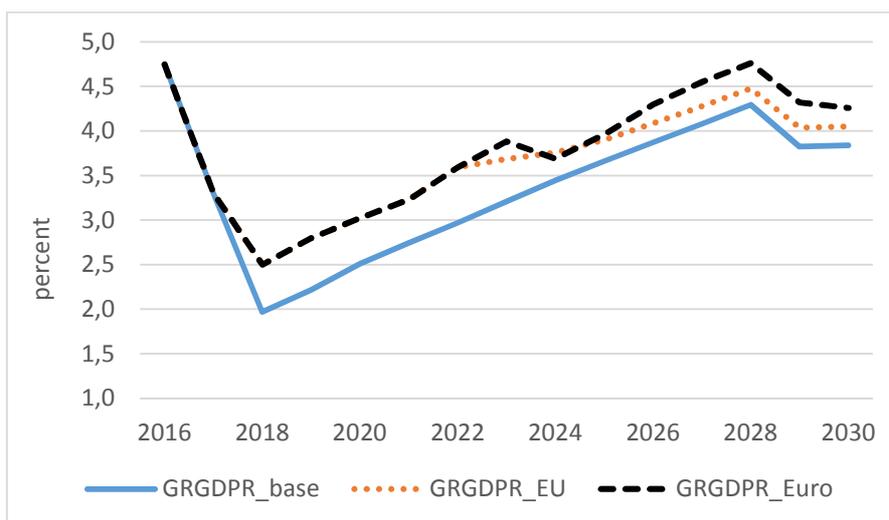


Figure 3: Employment

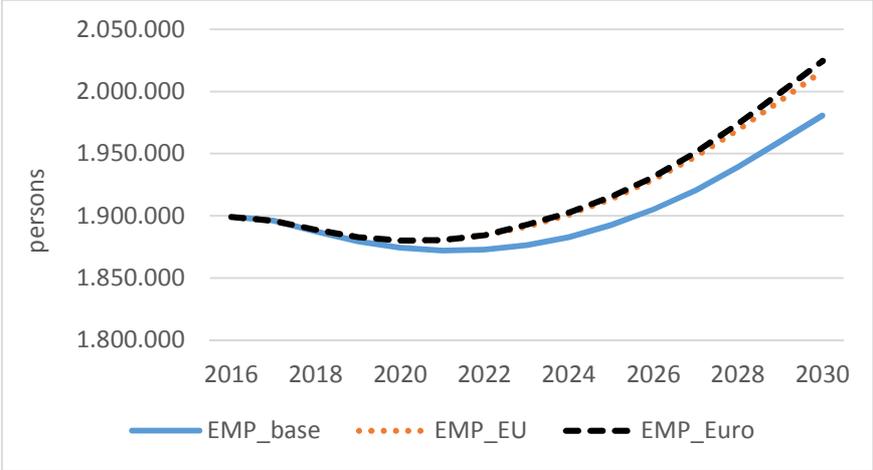


Figure 4: Unemployment rate

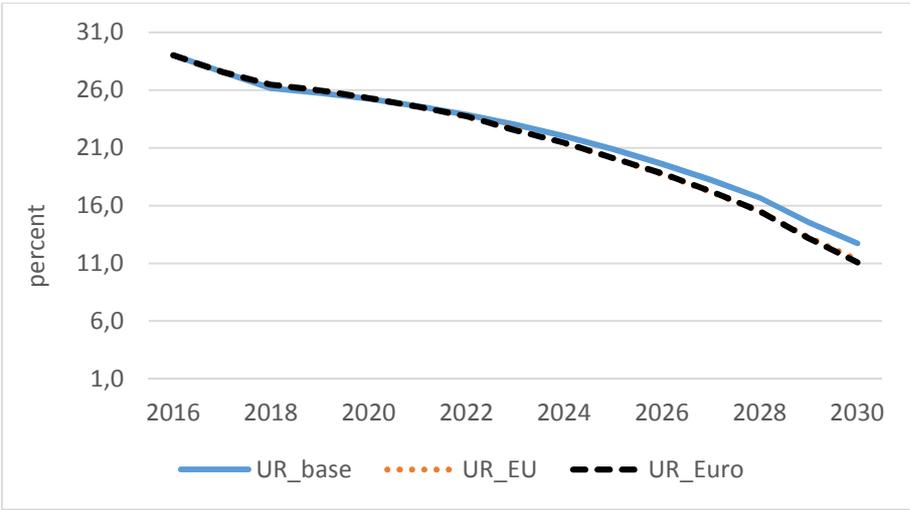


Figure 5: Inflation rate

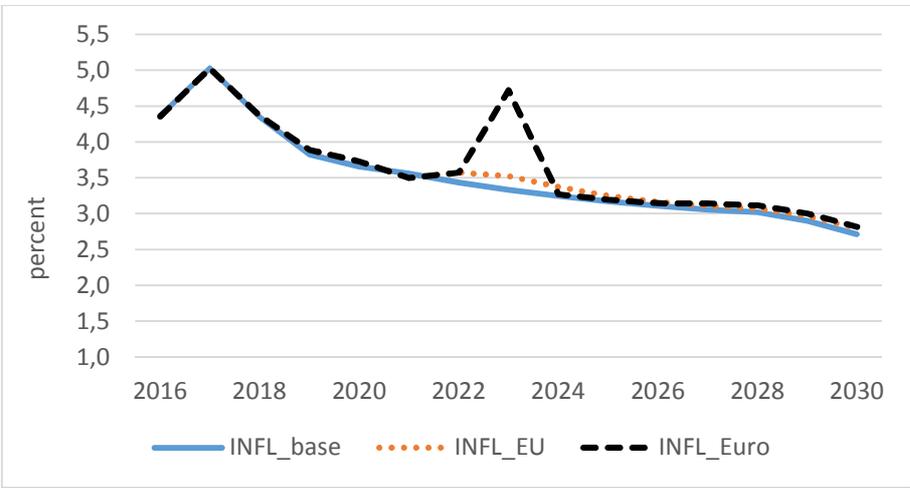


Figure 6: Budget balance in relation to GDP

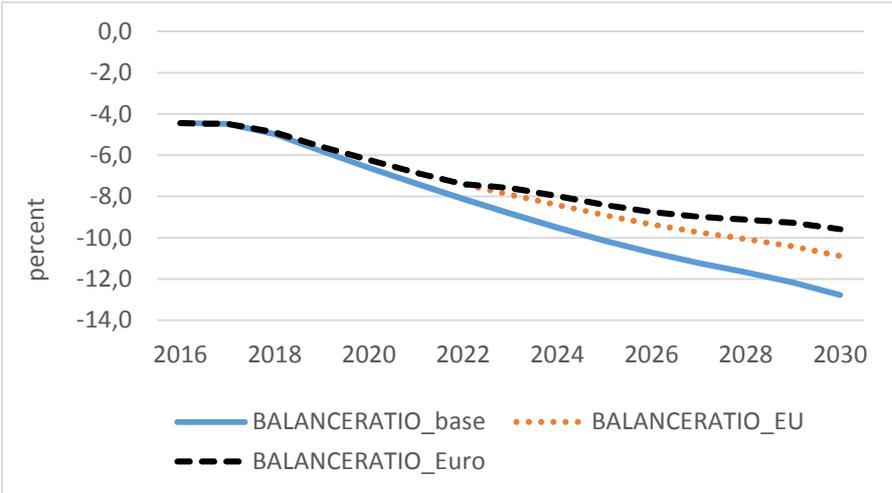


Figure 7: Primary budget balance in relation to GDP

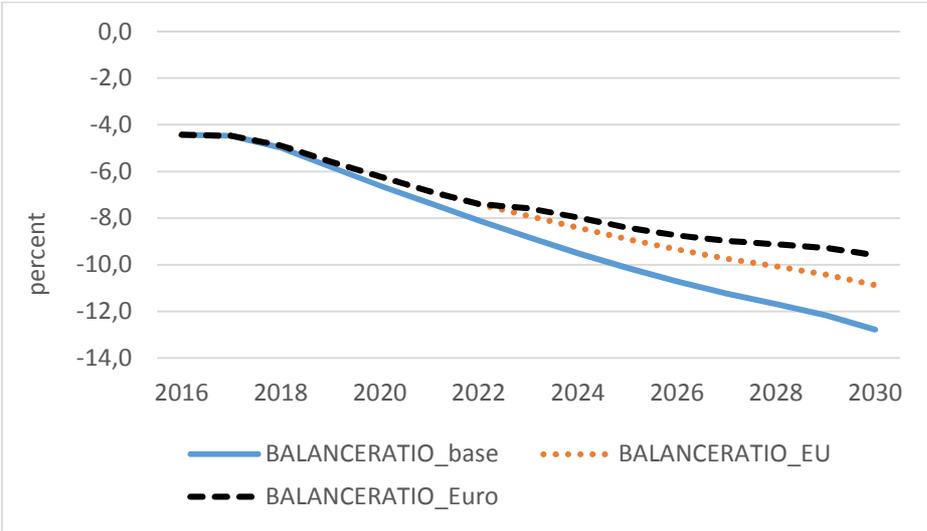


Figure 8: Public debt in relation to GDP

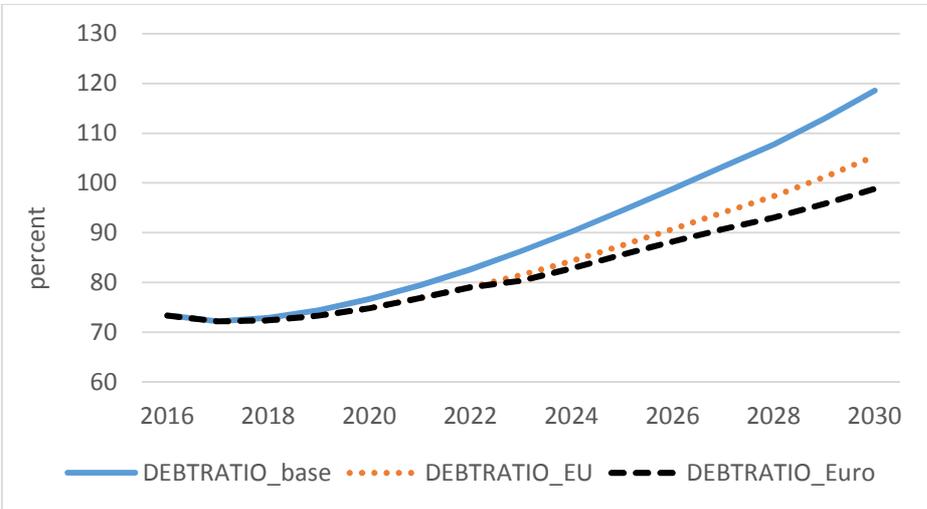


Figure 9: Net exports in relation to GDP

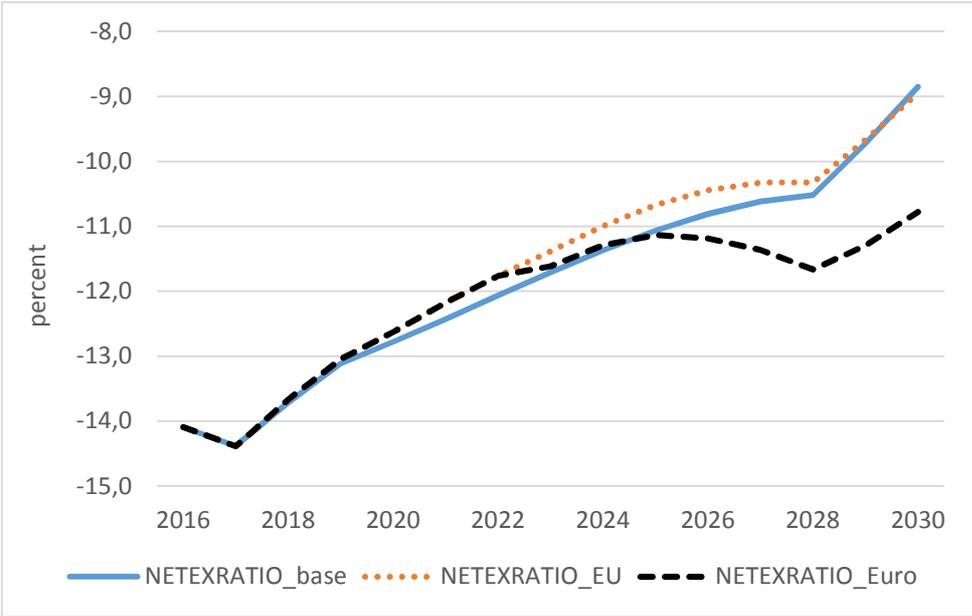
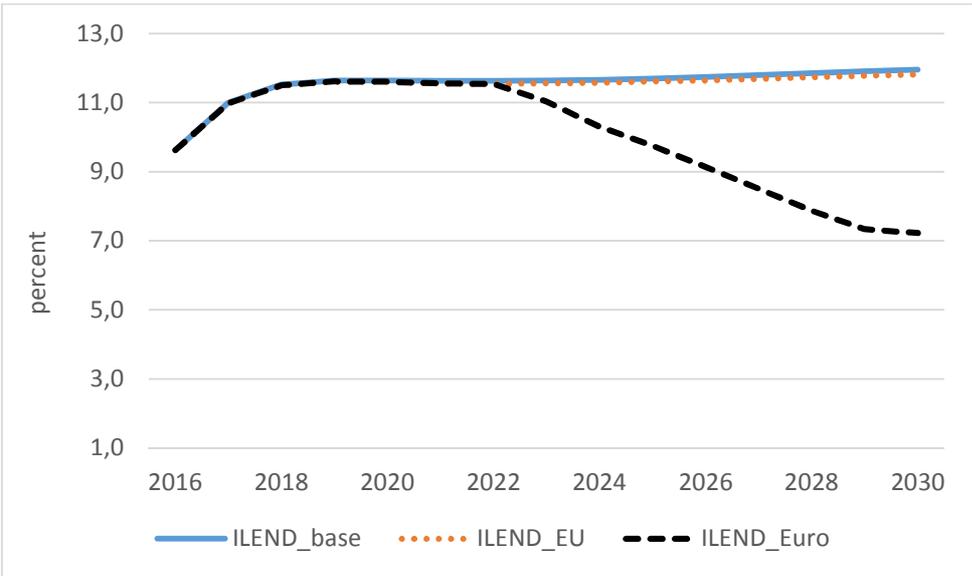


Figure 10: Long-term interest rate



According to our simulation results, compared to the baseline, by 2030 real GDP is 4.8% higher in the scenario with EU accession, and 6.2% higher when Serbia also joins the Euro Area in 2023, as we assumed. The average real GDP growth rate amounts to 3.3% in the baseline scenario, 3.6% in the EU accession scenario, and 3.8% in the Euro Area accession scenario. The assumed higher TFP directly translates into an increase in potential GDP. Without any additional demand-side effects, this higher potential GDP leads to a reduction in capacity utilization, which reduces inflationary pressure. However, a lower capacity utilization also means less need for capacity-widening investment. However, we also assumed additional demand via exports, due to the reduction of trade barriers once Serbia has full access to the European Internal Market. This additional export demand has a positive multiplier effect on

consumption and employment, and hence via the accelerator effect capital formation is also higher.

Net exports are affected positively in the EU accession scenario, which arises mainly from the assumed positive impacts on exports. In the Euro Area accession scenario, on the other hand, net exports deteriorate slightly. This is caused by higher imports due to higher domestic demand. Furthermore, the increase in inflation induces a real appreciation for the Serbian currency.

As mentioned, the labor market is influenced positively by the positive demand-side and supply-side impacts. By 2030, the number of employed persons is 1.8% and 2.2% higher in the EU and the Euro Area accession scenarios, respectively, as compared to the baseline. The unemployment rate drops to 11.3% and 11.1%, respectively, compared to 12.7% in the baseline.

Due to higher demand and the assumed additional price increase in the Euro Area accession scenario, inflation is slightly higher in the two alternative scenarios, despite the boost to potential GDP. However, this higher potential GDP restricts the additional inflation to an average of 0.1 and 0.2 percentage points, respectively, over the period 2018 (the assumed first year in which the macroeconomic effects of imminent EU accession materialize) to 2030.

The EU and Euro Area accessions also have positive effects on Serbia's public finances. Without EU accession, in our simulations the debt-to-GDP ratio rises from 73.4% in 2016 to 118.5%. EU accession restricts the increase to 105.4%, and Euro Area accession even reduces the end-of-simulation-period debt ratio to 99%. The increase in GDP causes higher tax revenues, while the improvement on the labor market leads to higher social security contributions by employees and employers and, correspondingly, lower expenditure on unemployment benefits. The higher revenues and reduced expenditures lead to a considerable improvement in the primary budget balance. The overall budget balance is additionally relieved by the reduced public debt, leading to lower interest outlays.

The interest rates remain on a high level in the baseline and the EU accession scenarios. The independent monetary policy pursued by the Serbian National Bank thus remains relatively restrictive as a response to what is still a high rate of inflation. In the Euro Area scenario, monetary policy for Serbia is conducted by the ECB. Hence, the interest rate in Serbia is substantially lower than in the case of an independent monetary policy. This effect could be observed in Euro Area countries on the Southern periphery once the composition of the Euro Area had been defined. This drop in interest rates created additional private or public demand in Greece, Spain, and Portugal, and similar effects cannot be excluded in the case of Serbia.

5 Summary and conclusions

On 22 December 2009, Serbia formally applied for EU membership. The formal accession negotiations started in January 2014. If Serbia joins the EU, it will have to adopt the euro as

legal tender as soon as it fulfils the relevant Maastricht criteria. By means of simulations with a macroeconomic model of the Serbian economy, this paper examines what macroeconomic effects can be expected from Serbia's EU membership and from its membership of the Euro Area. Based on experiences with previous EU enlargement rounds, we assumed that Serbia will join the EU in 2020 and the Euro Area in 2023, and that EU accession will be beneficial for total factor productivity and exports in particular. In addition, Euro Area accession will change its monetary policy regime since the European Central Bank will also conduct monetary policy for Serbia. The simulations with the macroeconomic model show that EU accession and the introduction of the euro bring about higher real GDP and more employment, but also slightly higher inflation due to additional aggregate demand. Public finances are affected positively. The benefits of joining the Euro Area are mainly due to supply side effects, viz. productivity increases.

It should be mentioned that our assumptions regarding the initial impacts of EU and Euro Area accession are more or less arbitrary, but they are based on past experience in other countries. Furthermore, our model stresses the demand side, while the supply side comes into play mainly via potential GDP. Expectations are not forward looking in our model. Despite these limitations, the simulations could show that positive macroeconomic effects can be expected for Serbia once it joins the EU and the Euro Area.

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Appendix

In this appendix, the equations of the Serbian model are documented. The coefficients of the estimated equations are shown together with standard errors. In addition, the adjusted R² and the values of the Breusch-Godfrey Lagrange multiplier test for serial correlation are displayed. The null hypothesis is that there is no serial correlation up to lag p. In the following, the value of the LM(p) test statistic is reported, and “*”, “**” and “***”, respectively, indicate that the null hypothesis of no serial correlation has to be rejected at the 10, 5 and 1 percent level of significance. All equations except for the participation rate were estimated by OLS. The labor supply equation (with the participation rate as the left-hand side variable) was estimated as a Tobit model, where the endogenous variable was restricted to lie between 0 and 0.9.

Employment (labor demand)

$$\begin{aligned} \log(\text{EMP}/\text{EMP}_{-4}) &= 0.243 + 0.576 \log(\text{EMP}_{-1}/\text{EMP}_{-5}) + 0.101 \log(\text{GDPR}/\text{GDPR}_{-4}) \\ &\quad (0.165) \quad (0.086) \quad (0.057) \\ &- 0.051 \log(\text{GWAGER}/\text{GWAGER}_{-4}) - 0.022 [\log(\text{EMP}_{-4}) - \log(\text{GDPR}_{-4}) + \log(\text{GWAGER}_{-4})] \\ &\quad (0.024) \quad (0.015) \end{aligned}$$

R²: 0.476 LM(2): 3.394

Participation rate (labor supply)

Estimated as Tobit model

$$\begin{aligned} \text{PARTRATE} &= 0.542 + 0.276 \log(\text{GWAGER}/\text{GAWAGER}_{-4}) + 0.406 \log(\text{GDPR}/\text{GDPR}_{-4}) \\ &\quad (0.003) \quad (0.059) \quad (0.108) \\ &+ 0.052 \text{D2009} \\ &\quad (0.011) \end{aligned}$$

R² and LM: not applicable

Private consumption

$$\begin{aligned} \log(\text{CONSR}/\text{CONSR}_{-4}) &= 1.625 + 0.207 \log(\text{CONSR}_{-1}/\text{CONSR}_{-5}) + 0.471 \log(\text{YDR}/\text{YDR}_{-4}) \\ &\quad (0.476) \quad (0.078) \quad (0.096) \\ &- 0.002 (\text{ILEND}-\text{INFL}) - 0.221 \log(\text{CONSR}_{-4}) + 0.100 \log(\text{YDR}_{-4}) + 0.111 \text{D2004q4} \\ &\quad (0.0009) \quad (0.065) \quad (0.056) \quad (0.024) \\ &- 0.076 \text{D2005q4} \\ &\quad (0.022) \end{aligned}$$

R²: 0.843 LM(2): 1.416

Gross fixed capital formation

$$\begin{aligned} \log(\text{GFCFR}/\text{GFCFR}_{-5}) = & -8.630 + 0.351 \log(\text{GFCFR}_{-1}/\text{GFCFR}_{-5}) \\ & (1.633) \quad (0.064) \\ & + 1.932 \log(\text{GDPR}/\text{GDPR}_{-4}) - 0.004 (\text{UCC}-\text{UCC}_{-1}) - 0.509 \log(\text{GFCFR}_{-4}) \\ & (0.204) \quad (0.001) \quad (0.083) \\ & + 1.086 \log(\text{GDPR}_{-4}) - 0.401 \text{D2005q1} \\ & (0.188) \quad (0.096) \\ R^2: & 0.758 \quad \text{LM}(2): 12.225^{***} \end{aligned}$$

Exports of goods and services

$$\begin{aligned} \log(\text{EXR}/\text{EXR}_{-4}) = & 1.956 + 0.538 \log(\text{WTRADE}/\text{WTRADE}_{-4}) - 0.043 \log(\text{REER}_{-1}/\text{REER}_{-5}) \\ & (0.446) \quad (0.185) \quad (0.031) \\ & - 0.225 [\log(\text{EXR}_{-4}) - \log(\text{WTRADE}_{-4})] - 0.037 \log(\text{REER}_{-4}) \\ & (0.072) \quad (0.029) \\ R^2: & 0.466 \quad \text{LM}(2): 5.984^{**} \end{aligned}$$

Imports of goods and services

$$\begin{aligned} \log(\text{IMR}/\text{IMR}_{-4}) = & -6.508 + 2.217 \log(\text{GDPR}/\text{GDPR}_{-4}) + 0.162 \log(\text{REER}/\text{REER}_{-4}) \\ & (2.605) \quad (0.291) \quad (0.047) \\ & - 0.498 \log(\text{IMR}_{-4}) + 0.884 \log(\text{GDPR}_{-4}) + 0.198 \log(\text{REER}_{-4}) + 0.630 \text{D2000q4} + 0.525 \text{D2001} \\ & (0.113) \quad (0.270) \quad (0.052) \quad (0.137) \quad (0.089) \\ R^2: & 0.736 \quad \text{LM}(2): 2.930 \end{aligned}$$

Gross wage per employee

$$\begin{aligned} \log(\text{GWAGE}/\text{GWAGE}_{-4}) = & 1.962 + 0.670 \log(\text{CPI}_{-1}/\text{CPI}_{-5}) + 0.711 \log(\text{PROD}/\text{PROD}_{-4}) \\ & (0.374) \quad (0.066) \quad (0.169) \\ & - 0.002 \text{UR} - 0.317 \log(\text{GWAGE}_{-4}) + 0.312 \log(\text{CPI}_{-4}) \\ & (0.001) \quad (0.062) \quad (0.075) \\ R^2: & 0.952 \quad \text{LM}(2): 10.498^{***} \end{aligned}$$

Consumer price index (CPI)

$$\begin{aligned} \log(\text{CPI}/\text{CPI}_4) = & -0.205 + 0.021 \log(\text{OILDIN}/\text{OILDIN}_4) + 0.288 \log(\text{GWAGE}/\text{GWAGE}_4) \\ & (0.204) \quad (0.015) \qquad \qquad \qquad (0.082) \\ & + 0.230 \log(\text{UTIL}_{-1}/\text{UTIL}_{-5}) - 0.143 \log(\text{CPI}_4) + 0.088 \log(\text{GWAGE}_4) \\ & (0.166) \qquad \qquad (0.056) \qquad \qquad (0.039) \end{aligned}$$

R²: 0.669 LM(2): 28.797***

GDP deflator

$$\begin{aligned} \log(\text{PGDP}/\text{PGDP}_4) = & 0.003 + 0.184 \log(\text{PGDP}_{-1}/\text{PGDP}_{-5}) + 0.732 \log(\text{CPI}/\text{CPI}_4) \\ & (0.004) \quad (0.067) \qquad \qquad \qquad (0.068) \\ & + 0.101 \text{D2000} \\ & (0.017) \end{aligned}$$

R²: 0.978 LM(2): 1.416

Private consumption deflator

$$\begin{aligned} \log(\text{PCONS}/\text{PCONS}_4) = & -0.003 + 0.954 \log(\text{CPI}/\text{CPI}_4) \\ & (0.003) \quad (0.011) \end{aligned}$$

R²: 0.991 LM(2): 22.287***

Public consumption deflator

$$\begin{aligned} \log(\text{PG}/\text{PG}_4) = & 0.005 + 0.814 \log(\text{PG}_{-1}/\text{PG}_{-5}) + 0.048 \log(\text{GOVCONS}/\text{GOVCONS}_4) \\ & (0.005) \quad (0.081) \qquad \qquad \qquad (0.039) \end{aligned}$$

R²: 0.800 LM(2): 0.356

Taylor rule for the short-term interest rate

$$\begin{aligned} \text{NBSRATE} = & 0.658 \text{NBSRATE}_{-1} + 0.038 \text{UTIL} + 0.050 \text{INFL} \\ & (0.071) \qquad \qquad (0.009) \qquad \qquad (0.028) \end{aligned}$$

R²: 0.864 LM(2): 18.637***

Long-term interest rate

$$\begin{aligned} \text{ILEND} = & 0.207 \text{ILEND}_4 + 0.407 \text{NBSRATE} + 0.878 \log(\text{DEBTRATIO}) \\ & (0.026) \qquad \qquad (0.043) \qquad \qquad (0.171) \end{aligned}$$

R²: 0.813 LM(2): 35.295***

Implicit interest rate on outstanding public debt

$$I_DEBT-I_DEBT_{-4} = 0.343 (I_DEBT_{-1}-I_DEBT_{-5}) + 0.014 (ILEND-ILEND_{-4})$$

(0.136) (0.012)

R²: 0.060 LM(2): 0.000

Real effective exchange rate

$$\log(\text{REER}/\text{REER}_{-4}) = -0.037 + 0.742 \log(\text{REER}_{-1}/\text{REER}_{-5})$$

(0.026) (0.044)

$$- 0.560 \log(\text{DINEUR}/\text{DINEUR}_{-4}) + 0.921 \log(\text{CPI}/\text{CPI}_{-4})$$

(0.063) (0.119)

R²: 0.891 LM(2): 2.451

Value added tax revenues

$$\log(\text{VAT}/\text{VAT}_{-4}) = 0.449 + 0.414 \log(\text{VAT}_{-1}/\text{VAT}_{-5}) - 0.250 \text{D2006q1}$$

(0.679) (0.099) (0.073)

$$+ 0.567 \log[(\text{CONS}*\text{VATR}/100)/(\text{CONS}_{-4}*\text{VATR}_{-4}/100)]$$

(0.248)

$$- 0.600 \log(\text{VAT}_{-4}) + 0.547 \log(\text{CONS}_{-4}*\text{VATR}_{-4}/100)$$

(0.108) (0.120)

R²: 0.769 LM(2): 3.810

Personal income tax revenues

$$\log(\text{TAXINC}/\text{TAXINC}_{-4}) = -2.7360 + 0.572 \log(\text{TAXINC}_{-1}/\text{TAXINC}_{-5}) - 0.231 \text{D2007q1}$$

(1.018) (0.085) (0.054)

$$+ 0.442 \log((\text{EMP}*\text{GWAGE}*\text{PINCTR}/100)/(\text{EMP}_{-4}*\text{GWAGE}_{-4}*\text{PINCTR}_{-4}/100))$$

(0.143)

$$- 0.423 \log(\text{TAXINC}_{-4}) + 0.309 \log(\text{EMP}_{-4}*\text{GWAGE}_{-4}*\text{PINCTR}_{-4}/100)$$

(0.092) (0.075)

R²: 0.766 LM(2): 0.205

Corporate income tax revenues

$$\log(\text{TAXICORPTAXICORP}_4) = -0.088 + 0.336 \log(\text{TAXCORP}_{-1}/\text{TAXCORP}_{-5})$$

(0.054) (0.113)

$$+ 2.000 \log[(\text{GDP}*\text{CORPTRATE})/(\text{GDP}_{-4}*\text{CORPTRATE}_{-4})] + 1.130 \text{D2014q2}$$

(0.520)

(0.207)

R²: 0.553 LM(2): 0.723

Social security contributions

$$\log(\text{SOCCONTR}/\text{SOCCONTR}_{-4}) = -1.688 + 0.654 \log(\text{SOCCONTR}_{-1}/\text{SOCCONTR}_{-5})$$

(1.046) (0.079)

$$+ 0.245 \log[(\text{EMP}*\text{GWAGE}*\text{SOCCONTRATE}/100)/(\text{EMP}_{-4}*\text{GWAGE}_{-4}*\text{SOCCONTRATE}_{-4}/100)]$$

(0.094)

$$- 0.184 \log(\text{SOCCONTR}_{-4}) + 0.161 \log(\text{EMP}_{-4}*\text{GWAGE}_{-4}*\text{SOCCONTRATE}_{-1}/100)$$

(0.077)

(0.078)

$$- 0.230 \text{D2005q1}$$

(0.039)

R²: 0.845 LM(2): 0.587

Other government revenues

$$\log(\text{REVREST}/\text{REVREST}_{-4}) = 0.021 + 0.307 \log(\text{REVREST}_{-1}/\text{REVREST}_{-5})$$

(0.019) (0.103)

$$+ 0.578 \log(\text{GDP}/\text{GDP}_{-4}) - 0.176 \text{D2009q1} + 0.205 \text{D2015q1}$$

(0.197)

(0.069)

(0.071)

R²: 0.546 LM(2): 4.494

Public consumption (fiscal statistics)

$$\log(\text{GOVCONS}/\text{GOVCONS}_{-4}) = 0.0007 + 0.091 \log(\text{GOVCONS}_{-1}/\text{GOVCONS}_{-5})$$

(0.006) (0.047)

$$+ 1.005 \log(\text{G}/\text{G}_{-4}) + 0.345 \text{D2005}$$

(0.081)

(0.020)

R²: 0.959 LM(2): 0.606

Social benefits

$$\log(\text{SOCBENEFIT}/\text{SOCBENEFIT}_{-4}) = 0.011 + 0.801 \log(\text{SOCBENEFIT}_{-1}/\text{SOCBENEFIT}_{-5})$$

(0.012) (0.084)

$$+ 0.122 \log((\text{UN}+\text{POP}-\text{POP1564})*\text{GWAGE})-\log((\text{UN}_{-4}+\text{POP}_{-4}-\text{POP1564}_{-4}*\text{GWAGE}_{-4}))$$

(0.075)

R²: 0.699 LM(2): 1.054

Other government expenditures

$$\log(\text{EXPREST}/\text{EXPREST}_{-4}) = -0.014 + 1.189 \log(\text{REVREST}/\text{REVREST}_{-4})$$

(0.045) (0.260)

R²: 0.292 LM(2): 2.743

Extrapolation of NAIRU

$$D(\text{NAIRU}) = -0.275 - 0.052 \text{AR}(1) + 0.007 \text{AR}(2) + 0.014 \text{AR}(3) - 0.021 \text{AR}(4)$$

(0.294) (0.122) (0.122) (0.122) (0.122)

R²: 0.003 LM(2): 0.060

Identities

$$\text{OILDIN} = \text{OILUSD} \cdot \text{DINUSD}$$

$$\text{GWAGER} = \text{GWAGE} / \text{CPI} \cdot 100$$

$$\text{INFL} = (\text{CPI}/\text{CPI}_{-4} - 1) \cdot 100$$

$$\text{UCC} = \text{ILEND} - (\text{PGDP}/\text{PGDP}_{-4} - 1) \cdot 100 + \text{DEPRATE}$$

$$\text{PROD} = \text{GDPR} / \text{EMP}$$

$$\text{ULC} = \text{GWAGE} / \text{PROD}$$

$$\text{LFORCE} = \text{PARTRATE} \cdot \text{POP1564}$$

$$\text{UN} = \text{LFORCE} - \text{EMP}$$

$$\text{UR} = \text{UN} / \text{LFORCE} \cdot 100$$

$$\text{GDPR} = \text{CONSR} + \text{GR} + \text{GFCFR} + \text{INVENTR} + \text{EXR} - \text{IMR}$$

$$\text{GRGDPR} = (\text{GDPR}/\text{GDPR}_{-4} - 1) \cdot 100$$

$$\text{GDP} = \text{GDPR} \cdot \text{PGDP} / 100$$

$$\text{YD} = \text{GDP} - \text{TAXINC} - \text{VAT} - \text{SOCCONTR} + \text{SOCBENEFIT}$$

$$\text{YDR} = \text{YD} / \text{CPI} \cdot 100$$

$$\text{GR} = \text{G} / \text{PG} \cdot 100$$

$$\text{DEMANDR} = \text{CONSR} + \text{GR} + \text{GFCFR} + \text{INVENTR} + \text{EXR}$$

$$\text{CONS} = \text{CONSR} \cdot \text{PCONS} / 100$$

$$\text{INTEREST} = \text{I_DEBT} \cdot \text{DEBT}_{-1} / 100$$

$$\text{GOVREV} = \text{REVREST} + \text{TAXINC} + \text{TAXCORP} + \text{VAT} + \text{SOCCONTR}$$

$$\text{GOVEXP} = \text{SOCBENEFIT} + \text{GOVCONS} + \text{INTEREST} + \text{EXPREST}$$

$$\text{BALANCE} = \text{GOVREV} - \text{GOVEXP}$$

$$\text{BALANCERATIO} = (\text{BALANCE} + \text{BALANCE}_{-1} + \text{BALANCE}_{-2} + \text{BALANCE}_{-3}) / (\text{GDP} + \text{GDP}_{-1} + \text{GDP}_{-2} + \text{GDP}_{-3}) \cdot 100$$

$$\text{PRIMBALANCE} = \text{BALANCE} + \text{INTEREST}$$

$$\text{PRIMBALANCERATIO} = (\text{PRIMBALANCE} + \text{PRIMBALANCE}_{-1} + \text{PRIMBALANCE}_{-2} + \text{PRIMBALANCE}_{-3}) / (\text{GDP} + \text{GDP}_{-1} + \text{GDP}_{-2} + \text{GDP}_{-3}) \cdot 100$$

$$\text{DEBT} = \text{DEBT}_{-1} - \text{BALANCE} + \text{DELTADEBT}$$

$$\text{DEBTRATIO} = \text{DEBT} / (\text{GDP} + \text{GDP}_{-1} + \text{GDP}_{-2} + \text{GDP}_{-3}) \cdot 100$$

$$\text{TRENDTFP} = \text{TRENDTFP}_{-4} \cdot 1.015$$

$$\text{CAPR} = \text{CAPR}_{-1} \cdot (1 - \text{DEPRATE} / 100) + \text{GFCFR}$$

$$\text{TRENDEMP} = \text{LFORCE} \cdot (1 - \text{NAIRU} / 100)$$

$$\log(\text{YPOT}) = 0.65 \cdot \log(\text{TRENDEMP}) + 0.35 \cdot \log(\text{CAPR}) + \log(\text{TRENDTFP})$$

$$\text{UTIL} = \text{GDPR} / \text{YPOT} \cdot 100$$

Variables

<i>Endogenous variables</i>	
BALANCE	Budget balance
BALANCERATIO	Budget balance in relation to nominal GDP
CAPR	Real capital Stock [mill. RSD]
CONS	Consumption of households and NPISHs, nom.
CONSR	Consumption of households and NPISHs, real
CPI	Consumer price index
DEBT	Public debt [mill. Din.] (end of period)
DEBTRATIO	Public debt in relation to nominal GDP
DEMANDR	Real final demand
EMP	Persons in employment
EXPREST	Remaining government expenditures
EXR	Exports of goods and services, real
GDP	GDP, nominal [mill. RSD]
GDPR	GDP, const. 2002 prices [mill. RSD]
GFCFR	Gross fixed capital formation, real
GOVCONS	Government consumption (fiscal statistics)
GOVEXP	Total government expenditures
GOVREV	Total government revenues
GR	Public consumption, real
GRGDPR	Growth rate of real GDP
GWAGE	Average gross wage [dinar]
GWAGER	Average gross wage, real
I_DEBT	Implicit interest rate on public debt
IEND	Total lending interest rate
IMR	Imports of goods and services, real
INFL	CPI inflation rate
INTEREST	Interest payment
LFORCE	Labor force
NAIRU	Non-accelerating inflation rate of unemployment

NBSRATE	NBS interest rate - Open market operations
OILDIN	Oil price [dinar] per barrel Brent
PARTRATE	Labor force participation rate
PCONS	Deflator of private consumption
PG	Deflator of public consumption
PGDP	GDP deflator
PRIMBALANCE	Primary budget balance
PRIMBALANCERATIO	Primary budget balance in relation to GDP
PROD	Labor productivity
REER	Real effective exchange rate
REVREST	Remaining government revenues
SOCBENEFIT	Social insurance benefits
SOCCONTR	Social contributions
TAXCORP	Corporate income tax
TAXINC	Personal income tax
TRENDEMP	Trend employment (labor force minus NAIRU)
TRENDTFP	Trend TFP
UCC	User cost of capital (ILEND - INFL + depreciation rate)
ULC	Unit labor cost (GWAGE / PROD)
UN	Unemployed persons; before 2004-2 persons seeking employment
UR	Unemployment rate
UTIL	Capacity utilization rate
VAT	Value added tax revenues
YD	Disposable income
YDR	Disposable income, real
YPOT	Potential GDP
<i>Exogenous variables</i>	
CORPTRATE	Corporate income tax rate
D2000	Dummy, 1 in 2000
D2001	Dummy, 1 in 2001
D2004	Dummy, 1 in 2004

D2005	Dummy, 1 in 2005
D2006	Dummy, 1 in 2006
D2007	Dummy, 1 in 2007
D2009	Dummy, 1 in 2009
D2014	Dummy, 1 in 2014
D2015	Dummy, 1 in 2015
DELTADEBT	Change in debt level aside from budget balance
DEPRATE	Capital stock depreciation rate
DINEUR	Exchange rate, dinar per euro
DINUSD	Exchange rate, dinar per US dollar
G	Public consumption, nom.
INVENTR	Change in inventories, real
OILUSD	Oil price, USD per barrel Brent
PINCTRATE	Personal income tax rate
POP	Population, total
POP1564	Population, 15 to 64
SOCCONTRATE	Social security contribution rate
VATRATE	Value added tax rate
WTRADE	World trade volume, goods and service; source: CPB