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BUSINESS CYCLES IN SERBIA AND ITS EU NEIGHBOURS

Privredni ciklusi u Srbiji i njenim EU susedima

Abstract

In this paper, we have analysed business cycles in Serbia and its five neighbouring EU Member States (Bulgaria, Romania, Hungary, Croatia and Slovenia) for the Q1Y2000-Q3Y2017 period. This period was long enough to capture two depressions and two prosperity stages. The analysis was based on a RBC stochastic DSGE model because it ignores differences among countries due to particular monetary policies, and works with a small number of mutually compatible time series. Business cycles in Serbia are similar to those of the neighbouring countries; particularly, all economies considered were hit by the Great Recession. They are now out of the depression stage and the period of prosperity is highly likely to continue for the next four years. Some countries, such as Hungary, entered the depression early and the shape of its business cycles had the form of the letter U. The other countries, such as Serbia, had the letter V profile of depression, with different duration and slopes of the letter wings.

Serbia was not hit the hardest by the depression; that was Romania, but it recovered faster than Serbia and is now performing the best in the region. The problem concerning Serbia was that it stayed in the depression for the longest period of time, that its period of prosperity will probably end over the four-year horizon, and the cycle of capital accumulation is still in the stage of depression. Policymakers in Serbia need to do something to improve investment activity. We conducted simulations with conditional forecasts encompassing promotion of FDIs, and concluded that such a policy might bring positive impacts on growth. However, our other simulations clearly indicated that the optimal strategy for promoting growth should focus on improving total factor productivity instead of meddling with investment. That would imply institutional reforms and educational adjustment to match requirements of the new Industrial Revolution 4.0. We are sceptical that the Serbian policymakers will pay due attention to higher education reform and institutional changes as they did for subsidising FDIs.

Keywords: *cross-country business cycles, RBC model, Bayesian estimation, conditional forecast*

Sažetak

Mi smo analizirali privredne cikluse u Srbiji i pet susednih zemalja članica EU (Bugarska, Rumunija, Mađarska, Hrvatska i Slovenija) između Q1Y2000 i Q3Y2017. Ovaj period je bio dovoljno dug da bi obuhvatio dve faze prosperiteta i dve faze recesije. Analiza je bila zasnovana na DSGE modelu realnog poslovnog ciklusa koji ignoriše specifičnosti razlika u monetarnim politikama i zasniva se na malom broju uporedivih makroekonomskih serija. Ciklusi u Srbiji su slični onima u susednim zemljama, jer su sve privrede bile pogođene Velikom recesijom. One su sada izašle iz recesije i biće, verovatno, u fazi prosperiteta naredne 4 godine. Neke zemlje, kao što je Mađarska, rano su ušle u recesiju, dugo su stajale na donjoj obrtnoj tački, a onda su se oporavile brzo i nenadano, što sve liči na profil recesije slično slovu „U". Druge zemlje, poput Srbije, imale su profil recesije sličan slovu „V" sa različitim trajanjem i nagibom ulaska i izlaska iz recesije.

Srbija nije bila najteže pogođena recesijom. To je bila Rumunija, koja se oporavila pre Srbije i sada beleži najbolje poslovne rezultate u regionu. Problem sa Srbijom je bio u tome što je recesija trajala najduže, period oporavka teško da može da traje duže od naredne četiri godine i što se ciklus akumulacije kapitala još uvek nalazi u fazi recesije. To je razlog zbog kog se očekuju poboljšanja u investicionoj politici. Mi smo simulirali efekte fiskalnog podsticanja stranih direktnih investija i ne sporimo njihovo pozitivno dejstvo. Međutim, naše simulacije pokazuju da bi se bolji efekti na rast postigli podizanjem opšte produktivnosti faktora proizvodnje. To bi podrazumevalo reformu visokog obrazovanja i poslovnih institucija da bi se odgovorilo na zahteve nove industrijske revolucije 4.0. Mi smo, međutim, skeptični da će se dati prioritet reformama u obrazovanju i institucijama u odnosu na fiskalne stimulanse.

Ključne reči: *unakrsno poređenje privrednih ciklusa u različitim zemljama, RBC model, Bajesovo zaključivanje, uslovna prognoza*

JEL classification: C11, E32, O47

Introduction

Fiscal consolidation was implemented in Serbia mostly by increasing the tax burden and redistribution of income. Even if those factors were not recognised as drivers of growth in the modern literature on economic growth [2], Serbia recorded positive growth in the past two years. That was due to the synergy effect of the business cycle in Europe, which entered the expansion phase at that time[1]. In order to capture the main characteristics of this cycle, we need to study technology shocks and the capital accumulation process. They are the key components in any Dynamic Stochastic General Equilibrium (DSGE) model, being of the Real Business Circle (RBC) type or New Keynesian origin.

In this paper, we will conduct an empirical research that will not focus on Serbia exclusively. Serbia is not a member of the EU, but is highly integrated into its single market. The reasonable expectation is that cyclical fluctuations in the EU should have a strong impact on the Serbian economy. In order to study such an impact, we will estimate a stochastic RBC model in all EU economies neighbouring to Serbia: Croatia, Hungary, Romania and Bulgaria. We add the economy of Slovenia to this sample due to the history of economic relations, as well as the present connection with the Serbian economy. This constitutes a sample of six economies for each of which we will estimate the same DSGE model, and examine the technological progress and the process of capital accumulation. The time period for investigation is between Q1 of 2000 and Q3 of 2017. This period includes two sub-periods: one of strong growth and one of stagnation, due to the impact of the Great Recession.

The Real Business Cycle theory is one of the most controversial in the modern literature on macroeconomic fluctuations. Its conceptual simplicity and relative success in matching movements between employment, output and investment fluctuations for a given sequence of aggregate productivity shocks attracted large support. On the other hand, the absence of monetary factors and demand shocks has generated strong opposition and much debate on the merits of this theory. Nevertheless, it has become one of the most important applications of the neoclassical growth model under uncertainty and labour supply choices.

We will demonstrate that an RBC framework is useful for the analysis of macroeconomic fluctuations in Serbia and its neighbouring economies. It captures the key feature of such fluctuations, i.e. the movements of Total Factor Productivity (TFP). The estimates of TFP indicate its procyclical nature – that is, it fluctuates considerably and is higher in periods during which output is above trend and investments are high. Under standard assumptions, real wage rate and labour supply should be high, as well. The Cobb-Douglas aggregate production function associates higher employment with higher output, which should create higher savings and investment. Hence, output, investment and employment exhibit persistent fluctuations. This is the empirical evidence for all economies considered, as Table 1 suggests, with a slight aberration for Serbia in the sub-period between 2000 and 2007 due to a negative impact of transition on employment.

The paper is organised in the following way. We present a solution and estimation of a canonical RBC

1 A cycle is in the expansion stage if output or other macroeconomic variables are above the long-run equilibrium, and in the depression stage when they are below the long-run equilibrium. The long-run equilibrium in a DSGE framework is alternatively called the steady state. Large positive deviations from the steady state are called peaks, while the relatively large negative deviations are known as troughs.

Table 1: Coefficients of correlation

Economies	Period	Correlation	Economies	Period	Correlation
	Correlation between output and employment				
Serbia	2000:1-2007:4	-0.81	Serbia	2008:1-2017:3	0.80
Slovenia	2000:1-2017:3	0.85	Croatia	2000:1-2017:3	0.79
Bulgaria	2000:1-2017:3	0.77	Romania	2000:1-2017:3	0.80
Hungary	2000:1-2008:1	0.63	Hungary	2008:2-2017:3	0.71
	Correlation between output and investment				
Serbia	2000:1-2017:3	0.72	Slovenia	2000:1-2017:3	0.95
Croatia	2000:1-2017:3	0.93	Bulgaria	2000:1-2017:3	0.91
Romania	2000:1-2017:3	0.94	Hungary	2000:1-2017:3	0.75

model in the first part. The output cycles of the analysed economies are discussed in the second part. The third part is dedicated to TFP and capital accumulation cycles. The fourth part is reserved for Serbia and its conditional forecasts based on TFP improvements and investment promotion. Finally, we offer a brief conclusion.

Model representation and estimation

The Real Business Cycle literature began with Kydland and Prescott [5], but gained widespread attention only after Hansen presented his model with indivisible labour [4]. In a simple one-sector stochastic growth model with shocks affecting technology, it is assumed that individuals can either work for a given positive number of hours or not work at all. Fluctuations in the number of employed people reveal fluctuations in the number of hours worked. Those fluctuations are caused by real (in contrast to monetary) shocks in a market environment with flexible prices. It is assumed that households are similar to each other, so there is only one representative household in the model. The budget constraint of the representative household for each period balances the real income, i.e. the sum of capital income, labour income and real profits, with the sum of real consumption and investment. The problem faced by the representative household consists of selecting the paths of consumption, employment rate and capital stock for each period so as to maximise an expected inter-temporal utility function subject to the budget constraints. The law of motion of the physical capital stock for each period is equal to the capital stock of the previous period that has not depreciated, plus the investment in physical capital in that period. Firms are also assumed to be similar to each other and are represented by a single representative firm. A representative firm maximises the real profits function subject to the Cobb-Douglas production function. It chooses the amount of capital and labour that maximises the expected profit. TFP follows a (strictly) stationary autoregressive stochastic process driven by technology shocks.

In addition to the technology shock, we introduced one more shock to our model. This additional shock indicates higher maintenance costs associated with a more intensive use of capital, and it captures all uncertainties related to investment decisions. We also eliminated the impact of growth rates on cyclical fluctuations by detrending all variables. Despite that, the model remains simple and standard. It is explained in detail in many textbooks such as Dejong and Dave [3], McCandless [8], Wickens [10] and Torres [9]. We used the Bayesian technique to estimate the model's parameters and provide results that proved the elegance and usefulness of the model.

The model specification is summarised in Table 2 with equations (1)-(6). The non-linear system of equations describes the dynamic evolution of the model's variables: output y_t, consumption c_t, capital accumulation k_t, investment i_t, employment h_t and TFP a_t. The steady-state equations (7)-(12) are derived from the non-linear

Table 2: Model specification

	Stochastic non - linear equations		Steady - state equations
(1)	$k_t = \frac{1}{1-\delta}(k_{t+1} - i_t(1+\varepsilon_t^i))$	(7)	$k = \alpha^{\frac{1}{1-\theta}}\left(\frac{\beta\theta}{1-\beta(1-\delta)}\right)^{\frac{1}{1-\theta}}\frac{(1-\theta)(1-\beta(1-\delta))}{\rho(1-\beta(1-\delta)-\theta\beta\delta)}$
(2)	$y_t = a_t k_t^{\theta} h_t^{1-\theta}$	(8)	$y = \alpha^{\frac{1}{1-\theta}}\left(\frac{\beta\theta}{1-\beta(1-\delta)}\right)^{\frac{\theta}{1-\theta}}\frac{(1-\theta)(1-\beta(1-\delta))}{\rho(1-\beta(1-\delta)-\theta\beta\delta)}$
(3)	$lna_t = \rho \cdot lna_{t-1} + \varepsilon_t^a$	(9)	$a = 1$
(4)	$i_t = \frac{y_t - c_t}{1+\varepsilon_t^i}$	(10)	$i = \alpha^{\frac{1}{1-\theta}}\frac{(1-\theta)\theta\beta\delta}{\rho(1-\beta(1-\delta)-\theta\beta\delta)}\left(\frac{\beta\theta}{1-\beta(1-\delta)}\right)^{\frac{\theta}{1-\theta}}$
(5)	$h_t = \frac{1}{\gamma}\frac{(1-\theta)y_t}{c_t}$	(11)	$h = \frac{(1-\theta)(1-\beta(1-\delta)}{\rho(1-\beta(1-\delta)-\theta\beta\delta)}$
(6)	$c_t = \frac{1}{\beta E_t\left\{\frac{1}{c_{t+1}}\left(1-\delta+\theta\frac{y_{t+1}}{k_{t+1}}\right)\right\}}$	(12)	$c = \alpha^{\frac{1}{1-\theta}}\frac{1-\theta}{\rho}\left(\frac{\beta\theta}{1-\beta(1-\delta)}\right)^{\frac{\theta}{1-\theta}}$

equations under the assumption that shocks disappear in the long-run equilibrium. They provide solutions for the steady-state levels of the model variables *k, y, i, h, c* and *a* in terms of the model parameters α, β, γ, δ, θ, and ρ. The model parameters will be estimated by using the Bayesian estimation procedure.

DSGE models usually do not have closed-form analytical solutions, and the underlying non-linear system of difference equations needs to be solved numerically. Following Adjemian et al. [1], a DSGE model of rational expectations can be expressed in a general form by a set of first order and equilibrium conditions:

$$\begin{aligned} &\mathrm{E}_t \{f(y_{t+1}, y_t, y_{t-1}, \varepsilon_t)\} = 0 \\ &\mathrm{E}(\varepsilon_t) = 0 \\ &\mathrm{E}(\varepsilon_t \cdot \varepsilon_t') = \Sigma_\varepsilon \end{aligned} \tag{13}$$

where E_t is the expectation operator, f are structural equations, y_t is a vector of endogenous variables, and ε_t is a vector of stochastic shocks. The system of equations (13) comprises linear and non-linear first-order difference equations, with leads and lags, which have no explicit algebraic solution. The solution needs to be computed numerically in the form of policy functions that relate all endogenous variables in the current period to the endogenous variables of the previous period, and current shocks. To be more precise, endogenous variables in the current period are to be expressed as a function of state variables alone in the previous period and current shocks:

$$y_t = g(y_{t-1}, \varepsilon_t) \tag{14}$$

The policy functions g are computed by linearising the system (13) around the steady state (y_{ss}) using the first-order Taylor expansion and the certainty equivalence principle:

$$y_t = y_{ss} + g_y \cdot (y_{t-1} - y_{ss}) + g_u \cdot \varepsilon_t \tag{15}$$

Labus and Labus [6] demonstrated that endogenous variables in equations (15) can be split into state s_t and control variables q_t, $y_t = s_t + q_t$, and transformed into deviations from the steady states $\hat{s}_t = s_t - s_{ss}$, $\hat{q}_t = q_t - q_{ss}$, and $\hat{y}_t = \hat{s}_t + \hat{q}_t$. Then, evolution of the system (15) can be rearranged as follows:

$$\begin{bmatrix} \hat{s}_t \\ \hat{q}_t \\ \hat{\varepsilon}_t \end{bmatrix} = \begin{bmatrix} g_s^s & 0 & g_s^\varepsilon \\ g_q^s & 0 & g_q^\varepsilon \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} \hat{s}_{t-1} \\ \hat{q}_{t-1} \\ \hat{\varepsilon}_t \end{bmatrix} \tag{16}$$

The submatrix g_s^s denotes responses of $\hat{s}_t$ to movements in $\hat{s}_{t-1}$, while the submatrix g_s^ε denotes responses of $\hat{s}_t$ to movements in the exogenous shock terms $\hat{\varepsilon}_t$. Submatrices g_q^s and g_q^ε capture responses of the control variables to the movement of state variables and exogenous shocks, respectively. From equations (16) it is obvious that only the state variables and the exogenous shocks drive the dynamics of the model.

We shall now proceed with the estimation for the parameters of the model. To do this, we first need to select data. Quarterly data from Q1 year 2000 to Q3 year 2017 are obtained from the national statistical offices[2]. Following Hansen [4], these data must be suitable to be transformed before they are used as observables for the estimation. The only difference with respect to the Hansen model is that the present model neither has a government, nor does it assume an open economy. Therefore, we needed to correct the GDP series (Y) for the effects of government expenditure (G) and net exports (X - M). The obtained series was the GDP used domestically, and it is expressed by y = Y - G - X + M. It can be called GDP in a Closed Economy (GDPCE). The coefficient of correlation between GDP and GDPCE is 0.9638 in Serbia. Also, their cyclical components are highly correlated. As an example, graphs of both the GDP series for Serbia and their cyclical variations are provided in Figure A1 in the Annex. A similar situation is observed in all other analysed economies. All variables are further transformed into logarithms. Then, series are seasonally adjusted by using the X13 procedure. The model's variables should also be stationary, and for that reason a detrending process was deployed. We used the Hodrick-Prescott filter with a high value for the smoothing parameter (10,000) in order to detrend the observable variables.

2 Statistical Office of the Republic of Serbia, http://webrzs.stat.gov.rs/WebSite/public/PublicationView.aspx? pKey=41&pLevel=1&pubType=2&pubKey=4464, Webrzs.stat.gov.rs/WebSite/userFiles/file/Zaposlenost i zarade/ZP20/Registrovana zaposlenost 2000-2014, revidirani podaci.xlsx, http://www.nbs.rs/internet/english/80/index.html , Croatian Bureau of Statistics, Republic of Croatia, https://www.dzs.hr/Hrv_Eng/publication/2014/12-01-01_02_2014.htm, Romania's National Institute of Statistics, http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=en&context=35, Republic of Slovenia, Statistical Office, http://pxweb.stat.si/pxweb/Dialog/viewplus.asp?ma=H244E&ti=&path=../Database/Hitre_Repozitorij/ &lang=1, Republic of Bulgaria, National Statistical Institute, http://www.nsi.bg/en/content/5509/gdp-final-expenditure-%E2%80%93-total-economy, Hungarian Central Statistical Office, https://www.ksh.hu/docs/ eng/xstadat/xstadat_infra/e_qpf003a.html.

Next, let μ denote the vector containing the model's parameters

$$\mu = [\beta,\delta,\theta,\gamma,\rho,\Sigma_a,\Sigma_i]'$$

where 0 < β < 1 denotes the discount rate, 0 < δ < 1 denotes the depreciation rate of physical capital, 0 < θ < 1 denotes the exponent of the Cobb-Douglas production function, γ > 0 denotes a positive utility parameter of the household's utility function, 0 < ρ < 1 denotes the auto-correlation coefficient of the strictly stationary AR(1) process that the total factor productivity is assumed to follow, $\Sigma_a > 0$ denotes the standard deviation of the independent and identically distributed stochastic error of the strictly stationary AR(1) process of the total factor productivity, while $\Sigma_i > 0$ denotes the similar value for investment shocks.

Finally, we specify priors in the following way:

$$\mu = [0.990,0.010,0.340,0.780,0.950,0.040,0.05]'$$

We have chosen the beta distribution density for parameters β, δ, θ and ρ, whereas the gamma distribution density was selected for parameter γ, and the inverted gamma distribution densities were selected for parameters Σ_a and Σ_i. We relied on the empirical literature for specifying the means and standard errors, being aware that the concerned economies might differ from the examples or each other. In order to capture their diversities, we allowed a rather large margin of standard errors.

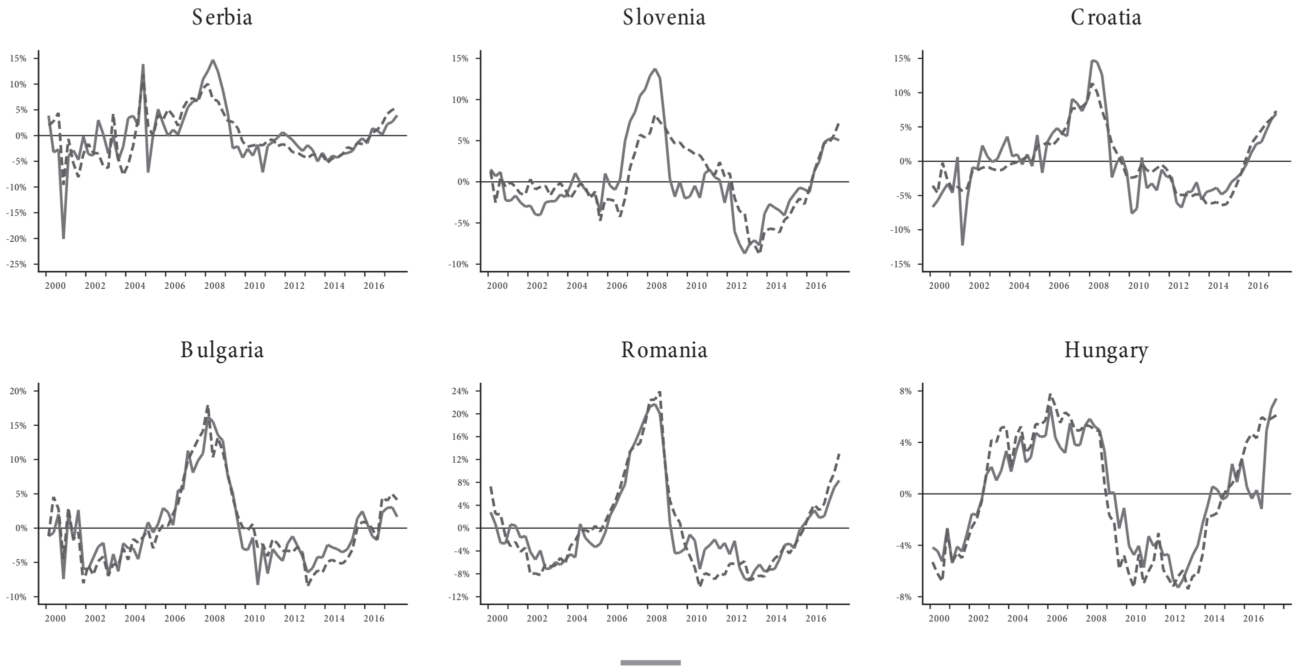
The model's parameters were estimated by using the Bayesian technique and the Random Walk Metropolis-Hastings sampling algorithm with 10,000 random draws. All econometric analyses are performed in Dynare, which is a collection of procedures written in MATLAB for solving rational expectation models.

The posterior values of the parameters for the Serbian economy and all other economies are reported in Table 1A of the Annex. The solution of the model reveals that out of six endogenous variables, there are only two state variables: TFP a_t and capital k_t. Other variables are control, as well as empirical variables: domestic output y_t, consumption c_t, investment i_t and employment h_t. There are two additional shocks: technology shock ε^a_t which drives TFP, and investment shock ε^i_t which drives capital accumulation. In the case of Serbia, the solution to equation (16) has the following numerical representation:

$$\text{(17)}\quad \begin{bmatrix} \hat{a}_t \\ \hat{k}_t \\ \hat{c}_t \\ \hat{h}_t \\ \hat{y}_t \\ \hat{i}_t \\ \varepsilon^a_t \\ \varepsilon^i_t \end{bmatrix} = \begin{bmatrix} 0.9991 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0.1325 & 0.9148 & 0 & 0 & 0 & 0 & 0.1326 & -0.0378 \\ 0.7891 & 0.4815 & 0 & 0 & 0 & 0 & 0.7898 & -0.0199 \\ 0.6043 & -0.3857 & 0 & 0 & 0 & 0 & 0.6048 & 0.0573 \\ 1.3934 & 0.0957 & 0 & 0 & 0 & 0 & 1.3947 & 0.0374 \\ 2.8789 & -0.8525 & 0 & 0 & 0 & 0 & 2.8815 & 0.1782 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} \hat{a}_{t-1} \\ \hat{k}_{t-1} \\ \hat{c}_{t-1} \\ \hat{h}_{t-1} \\ \hat{y}_{t-1} \\ \hat{i}_{t-1} \\ \varepsilon^a_t \\ \varepsilon^i_t \end{bmatrix}$$

TFP and capital are two state variables, which do not have corresponding empirical values. They are computed by the model, but nevertheless they provide a solution for

Figure 1: Original output (blue solid line) and the replicated output (red dotted line)



all empirical variables in the model. This is one of the striking characteristics of our model. Numerical solutions for economies other than Serbia are reported in Table 2A of the Annex.

Original and the model's replicated output are presented in Figure 1. The solid (blue) line shows the original data of the business cycle, while the dotted (red) line shows data replicated by the model. The scale in each graph is different because the local minimum and maximum points do not coincide across the time series. The goodness of fit of the model, i.e. the differences between values predicted by the model and the values actually observed, is measured by RMSE (Root Mean Square Error). The countries' figures are reported in Table 3. RMSE is the smallest for the Hungarian economy, while the Serbian and Slovenian economies have the highest RMSE. RMSE is a scale-dependent measure, but the output cycle means in the all economies are close to zero, and the scale bias is negligible[3].

Output cycles

Figure 2 depicts real business cycles for all the analysed economies, as reported by the model, marks the time of depression with a shadow, and forecasts the output paths for the next four years. The Great Recession hit all of the regional economies, but with different durations and severity, as shown in Table 4. Serbia was not as badly hit by the depression as some other economies. The maximum decline from the steady state at the point of trough was only -5.3%. The problem originated, however, on the other side. Serbia stayed in the depression for too long, at 26 quarters. No other economy was stuck in the depression for so long. Additionally, the period of prosperity before depression was short, following another episode of serious depression. This previous depression was a consequence of international sanctions, isolation and inappropriate macroeconomic policy during the time of the authoritarian regime. Other economies in the region were in a similar depression stage at that time, but the severity in Serbia's depression cannot be compared to their experience. Finally, recovery in Serbia was modest. The level of activity in the post-depression period was only 3.1% over the steady state. The maximum absolute difference between the peak and the trough points in the cycle was 15%.

Hungary entered the Great Recession in the first quarter of 2009, before others, and stayed in it for the next 24 quarters. The maximum absolute difference between the peak and the trough points in its cycle was also 15%. This means that cycle amplitudes were similar for two countries, but the shape of cyclical adjustment was different. Serbia was slowly moving towards the lowest point of activity and, afterwards, slowly recovering. Hungary, on the other side, quickly fell into depression, fluctuated around the bottom of the cycle for some time, and then suddenly and rapidly recovered.

On the other hand, Romania fell into depression rapidly and recovered slowly. Bulgaria recorded a similar pattern of depression as Serbia. Activity in Croatia was slowly declining, but quickly recovered. The Slovenian economy declined rapidly, but also came out of the depression rapidly. The depression period was the shortest for this economy, i.e. 16 quarters only.

Let us now consider the period of business fluctuations since the depression ended. All economies experienced more vibrant activity than Serbia. The last column in Table 4 shows the average level of activity compared to the steady state. So far, Romania has performed the best among the group of countries. It is interesting to notice that this economy suffered the most from the depression: its trough point was at 10.3% below the steady state and the absolute distance between the maximum and the minimum

3 There are complaints in the Serbian economic literature that the time series on employment is not correctly compiled after a recent revision of the methodology. If we apply the Bayesian estimation of parameters without the employment series, log data density is 254.540. However, if we do the same estimation including the employment series, log data density is 288.760, which is clearly higher than in the previous case. Since the Bayesian estimation maximises log data density, the better performed model has a higher value of log data density. Therefore, we stick to the officially released series on employment.

Table 3: RMSE between actual outputs and the model's replicates

Variables	Countries					
	Serbia	Slovenia	Croatia	Bulgaria	Romania	Hungary
Output	0.0353	0.0314	0.0236	0.0206	0.0282	0.0195

points in the cycle was very large (34%). Nevertheless, its economy has recovered and it is currently performing the best in the region.

We can visually inspect from Figure 2 the two stages of prosperity and two stages of depression in the business cycle since the beginning of 2000. Our model was quite successful in reproducing this cyclical behaviour. As the literature predicts and Table 5 shows, variability of the activity was higher during the prosperity stage than during the depression stage. The only exception refers to the Hungarian economy. Its depression profile had a U shape, while depression in other cases had a V shape.

The model also generated a forecast for GDP over the next four years. Serbia's stage of prosperity will continue for a while and return to the steady state at the end of the four-year horizon. Bulgaria will have a similar shape, but will stay above the steady state all of the time. It seems that Slovenia will soon reach the peak of its business cycle and slow down steeply in the midterm. Croatia, Hungary and Romania will stay above the steady state with a non-linear downturn trend. Broadly speaking, the considered economies will not return to a depression in the midterm, but their activities will slowly lose momentum.

Total factor productivity and capital accumulation

In equations (2) and (3), a_t represents the state of neutral technology that is called the Total Factor Productivity (TFP). It is unobservable, but can be estimated in the

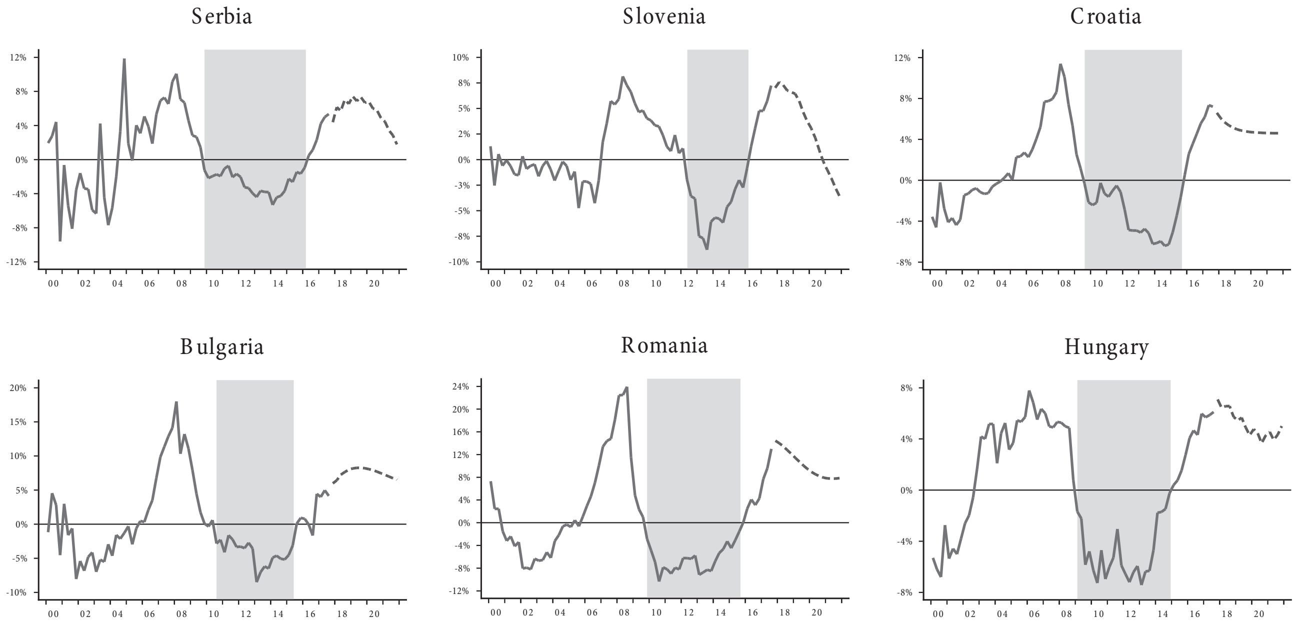
Table 4: Timing and severity of the business cycles

Countries	Depression period	Quarters	Trough	Decline	Absolute difference	Recovery above steady state
Serbia	2009:4 – 2016:1	26	2014:1	-5.3%	15%	3.1%
Slovenia	2012:2 – 2016:1	16	2013:3	-8.8%	17%	4.5%
Croatia	2009:3 – 2015:3	25	2014:3	-6.1%	18%	4.3%
Bulgaria	2010:1 – 2015:2	22	2013:1	-8.5%	26%	4.4%
Romania	2009:4 – 2015:3	24	2010:3	-10.3%	34%	5.5%
Hungary	2009:1 – 2014:4	24	2013:1	-7.4%	15%	3.8%

Table 5: Coefficients of variation of GDP across cycles

Country	Prosperity	Depression	Country	Prosperity	Depression
Serbia	148%	-120%	Bulgaria	188%	-111%
Slovenia	150%	-140%	Romania	184%	-104%
Croatia	170%	-122%	Hungary	114%	-121%

Figure 2: Model's updated output (blue solid line) and its forecasts (red dotted line)



model as a variable of the production function. It can be interpreted as a broad concept of technology reflecting aggregate productivity of the economy in the use of labour and physical capital. It is modelled in the equation (3) as an autoregressive stochastic process. In reality, it would be determined by technological knowledge, organisational structure, human capital, and institutional factors. It is subject to an exogenous autoregressive technology shock ε_t^a. Dynamics of the total factor productivity is reported in Figure 3 on the left-hand side for all the economies in the group. Data for Serbia are displayed as bars, while for other economies they are displayed as different types of lines.

According to the literature, estimates of TFP should reveal a procyclical nature. TFP is expected to fluctuate more in periods during which output is above trend and employment is high, than in the opposite periods of depression. Those expectations are broadly supported by figures stimulated by the model, for which the statistics are reported in Table 6.

Fluctuations of TFP were almost equal in the periods of prosperity and depression in Slovenia. The situation in Hungary was surprising, where fluctuations were clearly higher during depression than in the prosperity stage (-126% vs. 114%). However, in all of the remaining four economies, TFP was more volatile in the prosperity than in the depression stage, which was broadly expected by the literature.

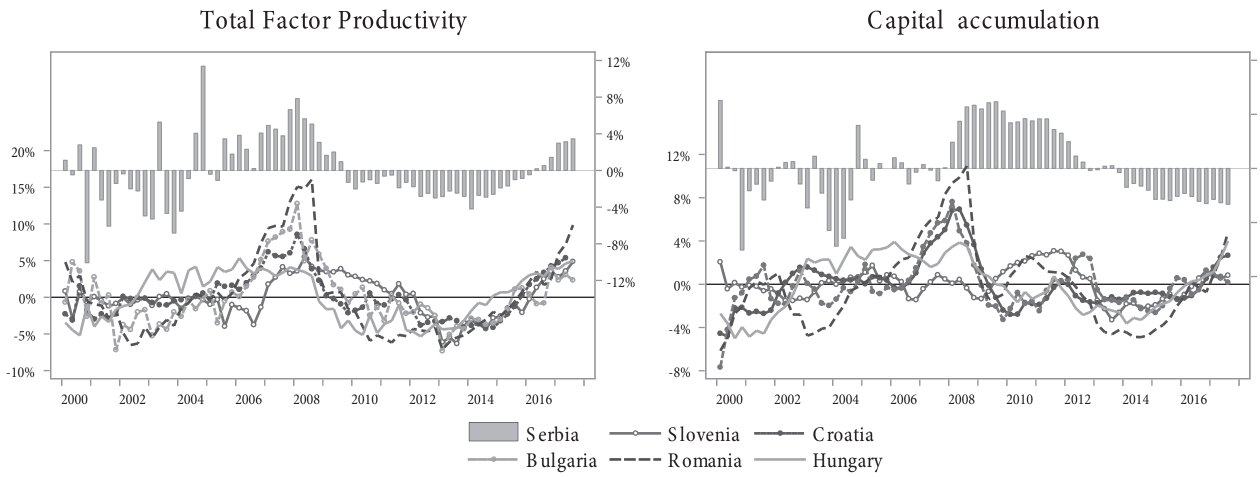
Fluctuations are measured by coefficients of variation. The other moment is the average of TFP over the period under consideration. Overall, the average TFP was negative in Serbia and (almost negative in) Slovenia. This should be a concern for the Serbian policymakers. The good thing is that it was above the steady state in the last six quarters. On the other hand, the average TFP had a clear positive value in other neighbouring economies, and an upward trend above the steady state in the past eight quarters.

TFP was a fairly uniform process across the region. Coefficients of correlation between TFP in Serbia and in

Table 6: Fluctuations around the steady state

	Serbia	Slovenia	Croatia	Bulgaria	Romania	Hungary
	Total Factor Productivity					
Mean overall	-0.06%	-0.01%	0.06%	0.07%	0.10%	0.06%
Peak	1.41%	1.07%	1.19%	1.55%	2.19%	1.56%
Coefficient of variation	162%	147%	174%	179%	186%	114%
Trough	-1.47%	-1.08%	-1.13%	-1.49%	-2.09%	-1.49%
Coefficient of variation	-133%	-144%	-125%	-124%	-112%	-126%
	Capital accumulation					
Mean overall	0.08%	0.01%	-0.05%	-0.09%	-0.13%	-0.08%
Peak	1.08%	0.59%	0.83%	0.82%	1.35%	1.07%
Coefficient of variation	155%	149%	194%	198%	188%	127%
Trough	-1.00	-0.58%	-0.88%	-0.91%	-1.47%	-1.15%
Coefficient of variation	-145%	-140%	-126%	-139%	-128%	-129%

Figure 3: TFP and capital accumulation cycles



other economies were: 0.4505 (Slovenia), 0.6721 (Croatia), 0.6579 (Bulgaria), 0.6833 (Romania) and 0.3972 (Hungary). All coefficients were positive and fall into the range of significant, albeit not very strong, comovements.

Capital accumulation k_t in the equation (1) depends on investment activity i_t, rate of depreciation δ, and investment shocks ε_t^i. In reality, capital stock is composed of different types of assets with different depreciations rates associated with them. The value of δ depends on the proportion of each type of physical capital asset in the aggregate capital stock. In equilibrium, total savings, selected by households, should match total investment performed by the firms. This process does not go without costs and uncertainties. We assume that all external shocks originated in the open economy were absorbed by investment inside the domestic market. Therefore, there is a particular stochastic shock ε_t^i, which captures all of these uncertainties and costs.

Capital accumulation is an unobservable variable which is generated by the model. It is displayed in Figure 3 on the right-hand side for all the economies in the group. Figures for Serbia are displayed as bars, while for other economies they are displayed as different types of lines. The striking contrast between Serbia and all the other economies is that capital accumulation in Serbia is still below the steady state, while in other economies it has already recovered from the previous episode of depression.

One curiosity is that Serbia recorded a period of quite a high capital accumulation, and its overall average, compared to the steady state, is a positive number. The same is true for Slovenia, while other economies in the group experienced negative average rates of relative capital accumulation.

It is evident that all the economies but Hungary display a procyclical nature of the capital accumulation process. Coefficients of variation are much higher during the prosperity period than they were in the depression stage.

Capital accumulation processes in the region were completely heterogenic, with no significant correlation across countries. Coefficients of correlation between capital accumulation in Serbia and in the other economies were: 0.3605 (Slovenia), 0.0652 (Croatia), -0.0209 (Bulgaria), 0.3278 (Romania) and 0.0688 (Hungary).

Conditional forecasts in Serbia

Serbia's TFP cycle is similar to those of its neighbouring countries. However, Serbia's capital accumulation cycle is lagging four quarters behind the comparable cycles in the region. Its positive value with respect to the steady state is predicted to emerge with a delay of four quarters. This finding corresponds to the empirical evidence of how investments have contributed to the GDP growth in Serbia. In Figure 2A of the Annex, we report on the contributions of investments to the GDP growth rates. It is evident that investments had a much lower impact on growth during the last five years than in any period before. That makes the official policy of promoting FDIs through fiscal subsidies highly controversial. Therefore, the interesting question is how to proceed with the policy measures in order to improve the business climate and promote more efficient investments.

This can be achieved in various ways. In a technical way, potential effects of the policy measures can be simulated by using a technique of generating conditional forecast in a DSGE model. Before proceeding with this simulation, we will now briefly explain the process of computing conditional forecast [6]. Generating a conditional forecast implies that variables are split into two subsets – predetermined policy variables and adjustable flexible variables, and that the entire process of forecasting is conducted in two steps. For policy variables, the future paths are given by the policymaker in accordance with the policy scenario which the policymaker aims to implement. These variables are fully under control of the policymaker for all the forecast periods and have the status of exogenous variables in a DSGE model. Adjustable variables are endogenous, for which equilibrium values are the solution of the underlying non-linear DSGE model.

Each policy variable must have an associated stochastic shock in order to perform a conditional forecast. In a DSGE framework, shocks are stochastic variables with a known probability density distribution, variance and stochastic path modelled by first-order autoregressive equations. Solutions of the conditional forecast suppress these autoregressive equations and compute the corresponding shocks that are needed to match the restricted paths from the reduced form of first order state-space representation of the DSGE model (15). However, the state-space representation (15), before moving to a transformation (16), should be rearranged in order to accommodate for both policy and flexible variables. Vectors of all variables and shocks (y_t, ε_t) are therefore split up into policy variables ($\overline{y}_t$, $\overline{\varepsilon}_t$) and adjustable variables ($\tilde{y}_t$, $\tilde{\varepsilon}_t$) in order to get to the solution for the policy variables:

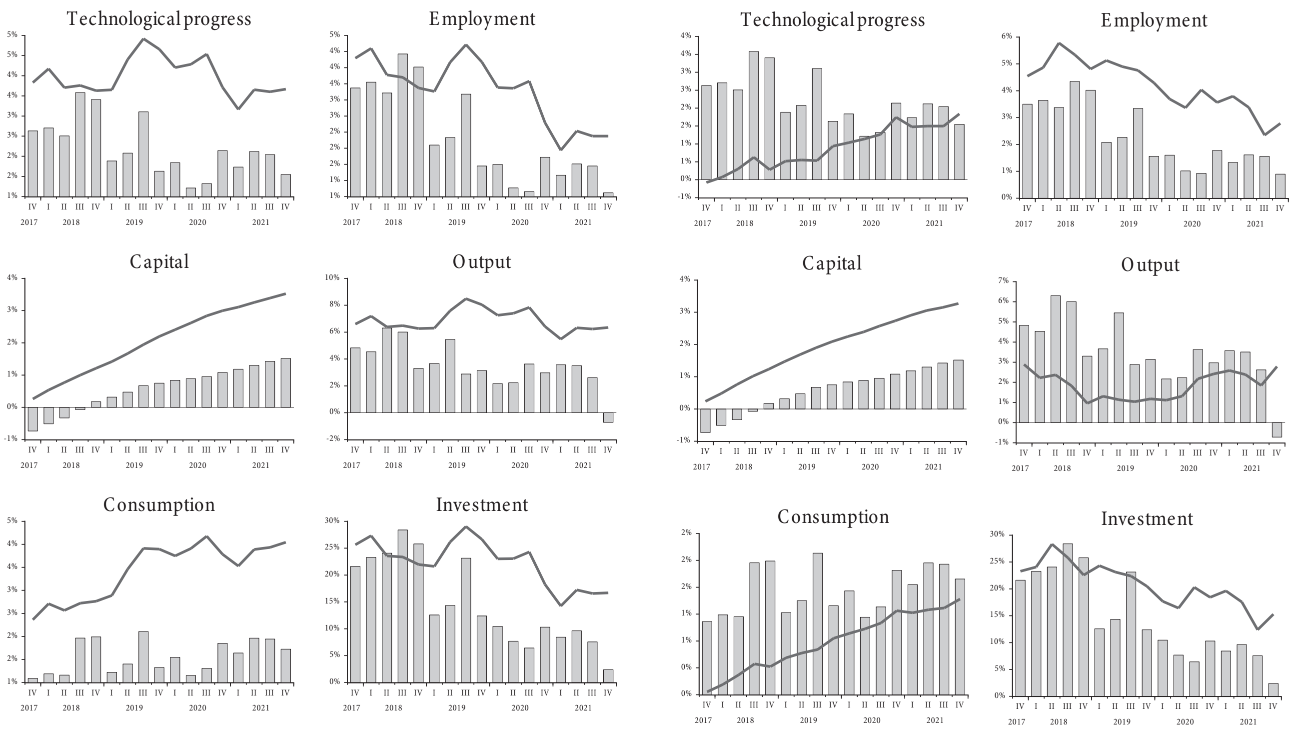
(18) $$\overline{y}_t = g_y \cdot \overline{y}_{t-1} + g_\varepsilon^{\overline{y},\hat{\varepsilon}} \cdot \hat{\varepsilon}_t + g_\varepsilon^{\overline{y},\overline{\varepsilon}} \cdot \varepsilon_t$$

Putting $y_{ss} = y_0$, where y_0 is the vector of the last observations in the model, the system of equations (18) can be solved algebraically for controlled shocks ($\overline{\varepsilon}_t$). That is the first step of computation. In the second step, the solutions from (18) are plugged into the system of equations (15) in order to calculate the remaining adjustable variables $\tilde{y}_t$ and $\tilde{\varepsilon}_t$ in a recursive way.

Although policy variables are taken as instruments perfectly under the control of the policymaker, they are nevertheless random and considered as unforeseen shocks from the perspective of the households and firms. Households and firms are in each period surprised by the occurrence of the shocks that keep the policy variables at their respective level. They revise their optimal positions in each period according to the new occurrence of shocks and available information. With a conditional forecast, therefore, a DSGE model does not lose its stochastic substance.

What can the Serbian policymakers do with respect to the investment cycle? One option is to prepare the ground for the incoming Industrial Revolution 4.0 to improve human capital and the absorption capacity of the Serbian economy. Improvements in higher education, upgrading curriculum, promoting natural and physical science, as well as information technology at university levels will have a positive effect on TFP. Improving TFP will further generate positive effects across the economy. We have simulated this policy scenario in a) Panel in Figure 4. In the first graph, unconditional forecast of TFP is displayed as bars, while the effect of improved TFP is shown as a solid red line. We assume a rather high and persistent level of improvement in TFP. The resulting outcomes for all other variables are displayed as solid red lines in the remaining graphs. They can be compared with the outcomes without push-up of TFP that are represented as bars. The capital accumulation cycle would immediately benefit from this policy choice. Consumption would also give a remarkable impetus to growth. All the remaining macroeconomic variables would also benefit from a higher TFP.

Figure 4: Unconditional forecasts (blue bars) and conditional forecasts (red solid lines)



a) Panel: Improvements in TFP

b) Panel: Investment promotion

An alternative policy choice is to continue with fiscal incentives for attracting FDIs at a more forceful pace. Strictly speaking, our model is not prepared to handle such a policy option. To do this, we would need at least four additional variables and empirical time series: fiscal expenditure and fiscal revenue, a price level variable and interest rate, including Taylor's monetary policy function. However, we can instead perform an equally interesting exercise. We can plug in the model the same increase in investment as that generated by the improvement of TFP and let all other variables adjust themselves to this initial shock. Then, we will see what the resulting outcomes would be: is it irrelevant where the initial positive shock hits the economy or not, and how the economy reacts to alternative policy shocks?

This scenario is reported in b) Panel in Figure 4. The resulting outcomes are presented as solid red lines. It is obvious that all macroeconomic variables will react positively to this policy stimulus. However, the size of the reaction will be lower than that achieved by the initial improvement in TFP. This information carries a very important message. It really does matter where new policy measures are initiated. Improvements in TFP are a more efficient way to promote GDP growth than state interventions in private decisions on investment.

People usually consider this causality chain to work in the opposite direction, i.e. that investments materialise new technology. In general, this is not an incorrect position, but it is not always true. For instance, Serbia has spent a lot of taxpayers' money on promoting foreign investments based on the technology from the second industrial revolution. What is generally missed is that better education and more efficient institutions, as soft drivers of growth, can facilitate much more investments and, in turn, higher growth than financial or fiscal measures.

Conclusions

In this paper, we have analysed the business cycles in Serbia and its five neighbouring countries from the EU (Bulgaria, Romania, Hungary, Croatia and Slovenia) for the period from the beginning of 2000 up to the third quarter of 2017. This period was long enough to capture two depressions and two business prosperity stages. The analysis was based on an RBC stochastic DSGE model for two reasons. Firstly, this is a simple model which is able to capture the impacts of total factor productivity and accumulation process on growth, ignoring potentially disturbing factors on the monetary side. Secondly, it requires only a small number of time series for macroeconomic variables that can be collected from statistical offices and compared to each other. Those series facilitate a proper comparison of the underlying business cycles in the region.

Business cycles in Serbia are similar to those of the neighbouring countries. All the analysed economies were hit by the Great Recession. They are now out of the depression stage, and the period of prosperity is highly likely to continue for the next four years, except in Slovenia for the fourth year. Some countries, such as Hungary, entered the depression early and the shape of its business cycle had the form of the letter U. Its fall into depression was rapid, and the economy fluctuated for a number of quarters around the bottom of the cycle, and then suddenly and rapidly recovered. The other countries, such as Serbia, had the letter V profile of depression, with different duration and slopes of the letter wings. Serbia was not hit by the depression the hardest; that was Romania, but it has recovered and it is now performing the best in the region.

The problem concerning Serbia was that it stayed in the depression stage for the longest period of time. It is highly likely that the period of prosperity will expire at the end of the four-year horizon, while it will continue beyond that in most other countries. Additionally, the cycle of capital accumulation is at present still in the stage of depression. Therefore, policymakers in Serbia need to do something to improve investment activity.

Usually, the policymakers in Serbia opted for promoting FDIs through fiscal stimulations. We conducted a simulation with conditional forecasts encompassing such a policy and testified that it might bring positive impacts on growth. However, our other simulations clearly indicated that the optimal strategy for promoting growth would stay on the other side. Improving TFP will bring higher growth than direct investment promotions. Improving TFP implies institutional reforms and educational adjustment to the requirements of the new Industrial Revolution 4.0. However, we are sceptical that the Serbian policymakers will pay due attention to higher education reform and institutional changes as they did for subsidising FDIs.

Annex

Figure A1: Real quarterly GDP in Serbia

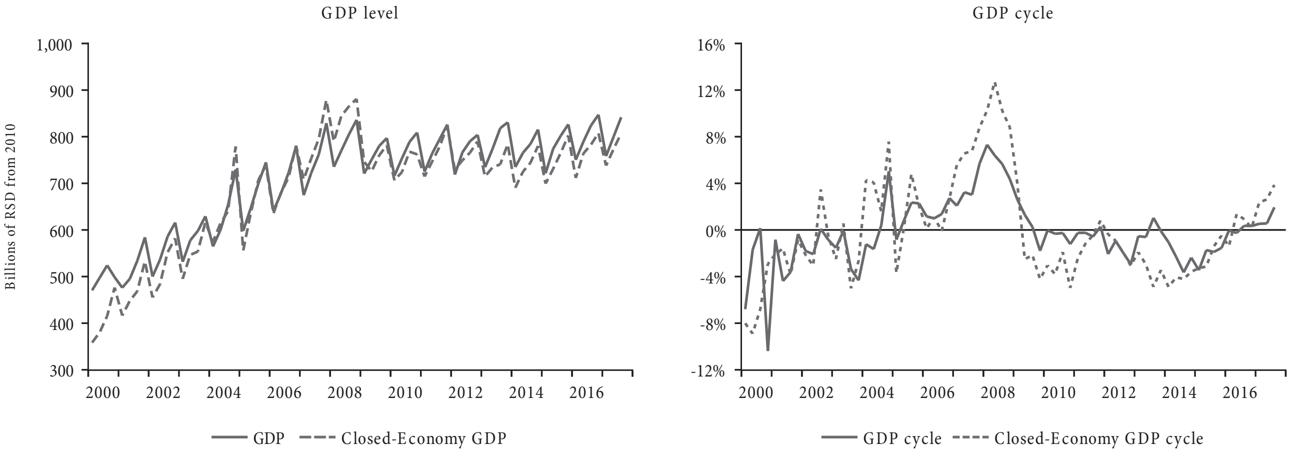


Table 1A: Estimated parameters for the economies in the region

	β	δ	θ	γ	ρ	Σa	Σi
Serbia	0.9910	0.0434	0.3478	0.7806	0.9996	0.0361	0.05385
Slovenia	0.9910	0.0296	0.3480	0.7808	0.9997	0.0147	0.02139
Croatia	0.9909	0.0313	0.3483	0.7806	0.9999	0.0132	0.02439
Bulgaria	0.9910	0.0290	0.3480	0.7806	0.9999	0.0259	0.04237
Romania	0.9909	0.0256	0.3482	0.7813	1.0000	0.0220	0.05176
Hungary	0.9918	0.0171	0.3478	0.7910	1.0000	0.0151	0.04323

Table 2A: Policy functions equ. (17) for economies in the region other than Serbia

Croatia

$$\begin{bmatrix}\hat{a}_t\\ \hat{k}_t\\ \hat{c}_t\\ \hat{h}_t\\ \hat{y}_t\\ \hat{\imath}_t\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}=\begin{bmatrix}0.9989 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0.1107 & 0.9294 & 0 & 0 & 0 & 0 & 0.1108 & -0.0298\\ 0.7701 & 0.4931 & 0 & 0 & 0 & 0 & 0.7710 & -0.0158\\ 0.6563 & -0.4145 & 0 & 0 & 0 & 0 & 0.6570 & 0.0454\\ 1.4264 & 0.0786 & 0 & 0 & 0 & 0 & 1.4280 & 0.0296\\ 3.1592 & -1.0158 & 0 & 0 & 0 & 0 & 3.1626 & 0.1493\\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1\end{bmatrix}\cdot\begin{bmatrix}\hat{a}_{t-1}\\ \hat{k}_{t-1}\\ \hat{c}_{t-1}\\ \hat{h}_{t-1}\\ \hat{y}_{t-1}\\ \hat{\imath}_{t-1}\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}$$

Bulgaria

$$\begin{bmatrix}\hat{a}_t\\ \hat{k}_t\\ \hat{c}_t\\ \hat{h}_t\\ \hat{y}_t\\ \hat{\imath}_t\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}=\begin{bmatrix}0.9995 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0.0710 & 0.9542 & 0 & 0 & 0 & 0 & 0.0711 & -0.0166\\ 0.7440 & 0.5101 & 0 & 0 & 0 & 0 & 0.7443 & -0.0089\\ 0.7381 & -0.4732 & 0 & 0 & 0 & 0 & 0.7385 & 0.0256\\ 1.4821 & 0.0369 & 0 & 0 & 0 & 0 & 1.4828 & 0.0167\\ 3.8604 & -1.4876 & 0 & 0 & 0 & 0 & 3.8622 & 0.0991\\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1\end{bmatrix}\cdot\begin{bmatrix}\hat{a}_{t-1}\\ \hat{k}_{t-1}\\ \hat{c}_{t-1}\\ \hat{h}_{t-1}\\ \hat{y}_{t-1}\\ \hat{\imath}_{t-1}\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}$$

Slovenia

$$\begin{bmatrix}\hat{a}_t\\ \hat{k}_t\\ \hat{c}_t\\ \hat{h}_t\\ \hat{y}_t\\ \hat{\imath}_t\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}=\begin{bmatrix}0.9993 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0.0849 & 0.9456 & 0 & 0 & 0 & 0 & 0.0850 & -0.0209\\ 0.7522 & 0.5045 & 0 & 0 & 0 & 0 & 0.7528 & -0.0112\\ 0.7109 & -0.4519 & 0 & 0 & 0 & 0 & 0.7114 & 0.0322\\ 1.4631 & 0.0527 & 0 & 0 & 0 & 0 & 1.4642 & 0.0209\\ 3.5809 & -1.2934 & 0 & 0 & 0 & 0 & 3.5835 & 0.1168\\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1\end{bmatrix}\cdot\begin{bmatrix}\hat{a}_{t-1}\\ \hat{k}_{t-1}\\ \hat{c}_{t-1}\\ \hat{h}_{t-1}\\ \hat{y}_{t-1}\\ \hat{\imath}_{t-1}\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}$$

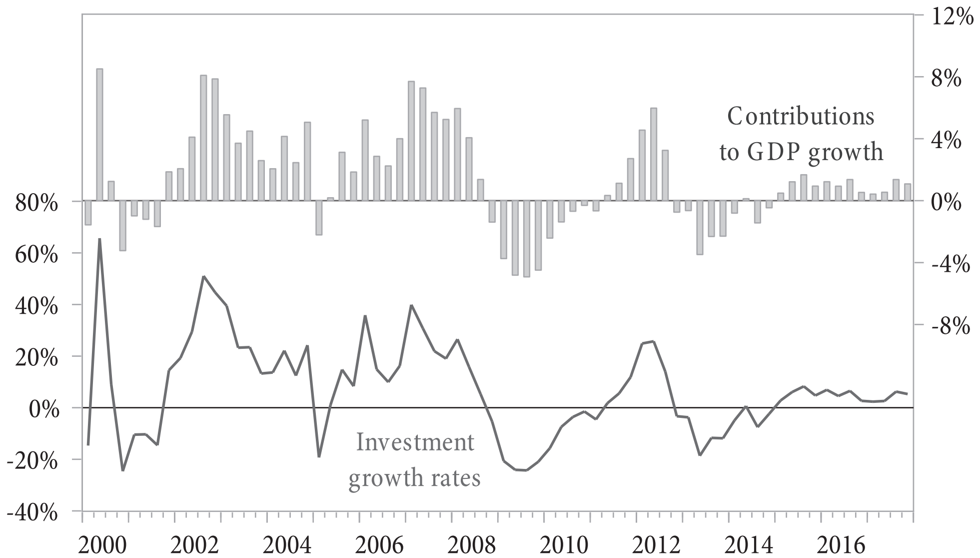
Hungary

$$\begin{bmatrix}\hat{a}_t\\ \hat{k}_t\\ \hat{c}_t\\ \hat{h}_t\\ \hat{y}_t\\ \hat{\imath}_t\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}=\begin{bmatrix}0.9993 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0.0729 & 0.9537 & 0 & 0 & 0 & 0 & 0.0730 & -0.0176\\ 0.7407 & 0.5137 & 0 & 0 & 0 & 0 & 0.7413 & -0.0095\\ 0.7370 & -0.4644 & 0 & 0 & 0 & 0 & 0.7375 & 0.0270\\ 1.4777 & 0.0049 & 0 & 0 & 0 & 0 & 1.4788 & 0.0175\\ 3.7335 & -1.3719 & 0 & 0 & 0 & 0 & 3.7362 & 0.1001\\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1\end{bmatrix}\cdot\begin{bmatrix}\hat{a}_{t-1}\\ \hat{k}_{t-1}\\ \hat{c}_{t-1}\\ \hat{h}_{t-1}\\ \hat{y}_{t-1}\\ \hat{\imath}_{t-1}\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}$$

Romania

$$\begin{bmatrix}\hat{a}_t\\ \hat{k}_t\\ \hat{c}_t\\ \hat{h}_t\\ \hat{y}_t\\ \hat{\imath}_t\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}=\begin{bmatrix}0.9989 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0.0868 & 0.9450 & 0 & 0 & 0 & 0 & 0.0869 & -0.0212\\ 0.7482 & 0.5058 & 0 & 0 & 0 & 0 & 0.7491 & -0.0113\\ 0.7186 & -0.4502 & 0 & 0 & 0 & 0 & 0.7194 & 0.0325\\ 1.4668 & 0.0556 & 0 & 0 & 0 & 0 & 1.4685 & 0.0212\\ 3.6107 & -1.2874 & 0 & 0 & 0 & 0 & 3.6148 & 0.1182\\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1\end{bmatrix}\cdot\begin{bmatrix}\hat{a}_{t-1}\\ \hat{k}_{t-1}\\ \hat{c}_{t-1}\\ \hat{h}_{t-1}\\ \hat{y}_{t-1}\\ \hat{\imath}_{t-1}\\ \varepsilon_t^a\\ \varepsilon_t^i\end{bmatrix}$$

Figure A2: Gross investment as a component of the Serbian real quarterly GDP



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was Professor of Economics at the Faculty of Law, University of Belgrade, until he retired in October 2015, and former Deputy Prime Minister of Serbia. He has received BA in law and PhD in economics from the University of Belgrade. Miroljub Labus' current research is focused on dynamic macroeconomics, and economic analysis of anti-trust cases. He has valuable experience in statistics and applied general equilibrium modelling (CGE and DSGE). He set up statistical journal Economic trend, business survey Market barometer, and served as editor of the Annals of the Faculty of Law in Belgrade. As Deputy Prime Minister, Miroljub Labus was instrumental in negotiating Serbia's return to international financial institutions after a period of sanctions, settling the Country's huge foreign debts, and promoting the SAA with the EU. After resigning from politics, Miroljub Labus founded in 2007 consulting firm Belox Advisory Services. He has been since 2010 a senior advisor to the PricewaterhouseCoopers in Belgrade.