Business cycle regimes in a group of South East European Economies. Evidence from a threshold SUR approach

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Abstract: This study investigates the degree of economic integration that the group of selected South East European countries have achieved with the euro area. The evidence of this study suggests that all four selected South East European economies are in sync with the euro area cycle, and respectively form a homogenous group of countries. Still, as it was expected, higher implied growth rates are found in countries where greater internationalisation of enterprises and greater product and financial sector linkages to European Union (EU) markets are present. In addition, the overall findings of these countries’ business cycle synchronisation with the euro area say nothing about the desirability of these countries adopting an early peg against the Euro and joining the Eurozone, but they do raise questions of the feasibility of doing so. With respect to the patterns in business cycle co-movement before and after the beginning of the global financial crisis this study clearly shows that synchronisation of business cycles is particularly strong during the downturn, i.e., up to mid-2009. Conversely, a decline in the synchronisation is observed in the early recovery phase after a recession.

Keywords: optimal currency area; OCA; threshold seemingly unrelated regressions; TSUR; discrete wavelet transform; DWT; financial crisis; business cycle synchronisation.


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1 Introduction

This study investigates the degree of economic integration that the group of selected South East European countries have achieved with the euro area economy. Namely, the successful enlargement of European Monetary Union (EMU) requires a number of criteria to be satisfied. Those are optimum currency area (OCA) criteria and Maastricht criteria, which partly reflect the OCA criteria. The Maastricht criteria are not identical to
the OCA criteria as derived from economic literature. The Treaty of Maastricht lays down the criteria every country has to fulfil, if it wants to join EMU. In other words, the blueprint for the EMU was formalised in provisions of the 1992 Maastricht Treaty, the founding document of the present-day European Union (EU). The Treaty established the conditions, or ‘convergence criteria’, that countries are required to meet before they join the EMU. By requiring the members to adhere to similar economic policies, the convergence criteria are meant to promote more balanced economic growth and development among the various members of the Eurozone. This, in turn, was thought to make it easier for diverse economies to share a single currency.

On the other hand, the OCA literature dates from 1961 when Mundell introduced in his seminal paper the theory of optimum currency area. An OCA is characterised by a group of countries for which forgoing the exchange rate mechanism (ERM), as an instrument of correcting asymmetric shocks, is compensated by other economic policy instruments.

“Nearly half a century has passed since publication of the first academic contribution to OCA theory. During this period, several criteria were suggested in the literature that a region should meet before establishing an OCA. These include

1. price and wage flexibility
2. high factor mobility, in particular for the labour market
3. a high degree of financial integration
4. a high degree of openness of the economy
5. a high diversification of production and consumption
6. similar inflation rates and stable terms of trade
7. a high degree of fiscal integration or a coordinated economic policy
8. political integration or the political will to found such a currency area.

In particular, “the synchronization of business cycles has become established as a key OCA criterion” [Gächter et al., (2012), p.35]. “If business cycles are not synchronized, possibly as a result of asymmetric shocks or differences in the transmission of common shocks due to different economic structures and policies, a common monetary policy whose task is to monitor aggregate inflation and output may create conflicts across countries about the preferred conduct of monetary policy, and an early enlargement of a monetary union may be very costly” [Eickmeier and Breitung, (2005), p.11].

Therefore, “according to the optimum currency area theory, a high degree of business cycle synchronization should be an important criterion for participation in a monetary union. This criterion is generally applied to questions related to euro adoption and exchange rate regimes in the new member states of the EU, but, as well as to other countries having intensive trade and economic relations with the EU (including prospects for eventual EU membership)” [Fidrmuc and Korhonen, (2006), p.3]. The South East European countries are relatively small when compared to the euro area and generally expected to be strongly affected by the business cycle of their most important trading partner, the euro area. Therefore, in this paper, we address the issue whether the group of South East European economies are a part of a European OCA or not.
A threshold seemingly unrelated regressions (TSUR) specification is employed in assessing whether the selected South East European countries are synchronised in their business cycles to the euro-area. “The TSUR specification can be seen as an extension of the TAR models (Threshold Auto Regressive models), initially proposed by Tong (1978) and Tong and Lim (1980) and subsequently developed in Tsay (1989) and Tong (1990). In the present context, the TSUR model captures the business cycle asymmetries by allowing for the presence of two distinct regimes. As these economies are strongly affected by the euro area, these regimes may be associated with euro area expansions and contractions” [Aslanidis, (2006), pp.3–4]. TSUR specification takes into account the common institutional factors and the similarities across the countries in the process of economic transition. Accordingly, we believe that TSUR system estimation would provide gain in efficiency by taking into consideration the correlation between errors in the individual equations. The methodology is illustrated using monthly industrial production indices. Given that these countries are ‘catching up’ with the euro area, the employed model shows that all of them are synchronised to the euro area cycle.

In order to detect the threshold value, the simplest non-linear wavelet shrinkage, i.e. thresholding is employed. “When it comes to the wavelets, understood as a systematic way of producing local orthogonal bases, are a recent unification of existing theories in various fields” (Vidakovic, 2009). “In the early 1990s, a series of papers by Donoho and Johnstone and their co-authors demonstrated that wavelets are appropriate tools in problems of denoising, regression, and density estimation” [Vidakovic, (2009), p.8].

The organisation of this research is as follows: Section 1 introduces the relevance of the topic. Section 2 gives a literature review and describes the methodology employed. Section 3 is a discussion of the estimated models. Conclusions in Section 4 complete the research.

2 Literature review and methodological notes

This research paper is related to the burgeoning empirical literature on business cycle synchronisation between the new member states (NMS) and the euro area. A comprehensive survey is given by Fidrmuc and Korhonen (2004).

Most empirical studies compute static correlations between real economic activity in the NMS and the euro area or Germany (for example, Darvas and Szapáry, 2004; Demanyk and Volosovych, 2005). Just for an illustration, Darvas and Szapáry (2004) examine the synchronisation of business cycles between new and old EU members with Hungary, Poland, and Slovenia and show strong improvement in cyclical correlations as moving from 1993–1997 to 1998–2002.

Another part of the literature in this field employs small-scale VAR models with the help of which it estimates supply and demand shocks in the euro area and in individual NMS and assesses their correlations (see for example, Frenkel and Nickel; 2005; Fidrmuc and Korhonen, 2004).

A third strand of the literature investigates the transmission of euro area shocks in a VAR modelling framework (for example, Korhonen, 2003). The most widely used approach in this field of the literature was the bivariate Blanchard and Quah (1989) type SVAR decomposition of supply and demand shocks based on output and inflation data. The first application of this method to CEECs was made by Frenkel et al. (1999). However, the use of SVARs is debated even for countries having much longer sample
periods (see for instance Cooley and Dwyer, 1998). Imposing long-run identifying restriction for countries having short datasets would not make much sense in the framework of the SVAR model (Darvas and Szapáry, 2004).

The fourth strand of the literature was launched by Savva et al. (2007). Their setup employs a bivariate VAR-GARCH specification that models the conditional volatility of the business cycle and allows for a single smooth transition in the correlation specification (STCC-GARCH). These authors test whether none, one, or two structural changes have occurred in the time profile of business cycle synchronisations. With this methodology, they are able to identify endogenously the time period of such changes, if any, and also characterise the transition path to the new regime in terms of its smoothness. These authors consider their modelling strategy as a step forward in the examination of business cycle co-movements. Their main results suggest that conditional correlation patterns between the euro area and all the newly accessed member states and negotiating countries have substantially increased over the last two decades. Specifically, they find that correlations have more than tripled for the majority of the countries. These changes are generally abrupt and the dates of change vary widely across countries. Their results point to great variety in the timing and speed of the correlation shifts across their country sample. For the majority of the countries they identify an abrupt transition to the new regime. The dates of the structural change also seem to differ with most of the new EU members experiencing a change around or after the completion of their admission negotiations at the end of 2002. As such, only Hungary and Slovenia have been better prepared in joining the EU sooner than 2004 since their regime shifts took place well before 2002. These findings are consistent with the notion that the structural shifts toward a greater degree of synchronisation between the EU and its associate states is not solely driven by EU-related factors, but that country-specific factors also have a substantial impact.

The work of Eickmeier and Breitung (2005) for instance, contributes to both, the first and the third strands of this literature. They investigate the economic linkages between NMS and the euro area with dynamic correlations and cohesion. These measures account not only for contemporaneous covariances, but also for covariances at leads and lags. Their study is the first to examine the transmission of euro area shocks to the NMS in a large-dimensional structural factor framework. Their findings show how much of the variance of output and inflation growth in CEECs and EMU countries is explained by the euro area factors. On average, the common factors explain a larger part of output and inflation growth in EMU economies (44% and 37%) compared to the CEECs (27% and 25%).

The work of Jagric (2003, pp.6–23) for instance, could be associated to the fifth strand of the business cycle literature. The author examines international divergence in business cycles and synchronisation between the CEEC-7 and Germany as a proxy for the EU business cycle. Using multivariate wavelet analysis, the author compares the duration, volatility, and timing of business cycles. He found that three countries could be classified in the group where some synchronisation with a time lag is present: Croatia with a two-month lag, the Czech Republic with a four-month lag, and Slovakia with a five-month lag. This group shows that adaptation to the EU is increasing. Perfect synchronisation was found for Hungary, Poland and Slovenia. All countries under review in this group experienced good or improving nominal and real convergence to the EU. A major advantage of wavelet techniques is their ability to decompose a time series locally both in frequency and time. Jagric emphasises that as is known from Fourier analysis,
jointly using two time series with coherent signals can reveal additional information on analysed time series. Therefore, Jagric introduced the wavelet cross-spectrum, or, more formally, the wavelet cross-covariance.

The sixth strand of this literature can be associated with the two main classes of statistical models have been proposed, which formalise the idea of the existence of different regimes. The first class is the Markov-switching models originally employed in the business cycle context by Hamilton (1989), and these assume that the regime cannot be observed, but is governed by an underlying stochastic process. This implies that one can never be certain that a particular regime is in place at a particular point in time, but can only assign probabilities for the occurrence of the different regimes. The second class of statistical models which formalise the idea of the existence of different regimes refers to the TAR models (or STAR or SETAR). In the business cycle synchronisation literature, for instance, Aslanidis (2007) propose a TAR approach to measure synchronisation of business cycles between the CEECs and the euro area. He estimates a threshold seemingly unrelated regressions (TSURE) specification as an extension of the TAR literature. Aslanidis uses Hensen’s algorithm to obtain maximum likelihood (ML) estimators for the complete TSUR model. This algorithm is based on a combination of grid search procedures and iterated feasible generalised least squares (IFGLS) methods.

This study belongs to the sixth strand of this literature, but goes beyond the existing business cycle synchronisation research work, with respect to the employed threshold detection method. This work considers the problem of detecting the threshold in time series data and proposes a general detection method based on wavelets. Consequently, this study is following the work of Bilen and Huzurbazar (2002, pp.311–327) which addresses the problem of detecting the location of the outliers, where the threshold detection is an intermediate step. Unlike other threshold detection procedures found in the literature, this method does not require that a model be specified for the data.

Modelling the business cycle in the selected South East European countries within the threshold context can be motivated by the fact that the transition mechanism could be controlled by the euro area cycle. Therefore, it would be of interest to see if contractions and expansions in the euro area activity may have distinct effects on the business cycle in the selected South East European countries. The results support the hypothesis that the euro area cycle implies interesting asymmetries for the business cycle in these countries. Particularly, all of the selected South East European countries grow slower (except for Macedonia and Serbia which record negative growth rate) when the euro area economy contracts but appear to experience higher growth rates when the euro area economy starts expanding. In addition, the employed SUR estimation method takes into account the factors that are common to all of the selected South East European countries, such as area-wide factors as a result of transition economies and recent EU membership, and employs estimation procedures that simultaneously estimate the parameters of the models [Aslanidis, (2006), pp.3–4].

2.1 Model

“The linear seemingly unrelated regressions (SUR) model has the following representation:
\[ y_m = x'_m \beta_m + u_m \]

more compactly

\[ y_m = X_m \beta_m + u_m \quad \text{for} \quad i = 1, \ldots, M \]

where \( y_m \) is a \( T \times 1 \) vector and measures economic activity (e.g., industrial production) in country \( m \) and \( X_m \) is a \( T \times k_m \) matrix of explanatory variables in country \( m \). Essentially, autoregressive lags are included to sufficiently reduce the errors to white noise. In principle, \( X_m \) can be extended to also include exogenous variables. The vector \( \beta_m \) is the \( k_m \times 1 \) vector of coefficients and \( u_m \) is a \( T \times 1 \) error vector in country \( m \). The usual error structure for the classical linear regression formulation for \( i = 1, \ldots, M \) is:

\[ E[u_m] = 0, E[u_m u'_m] = \sigma^2_m I_T \]

The above set of equations can be stacked and represented as the system

\[ y = X \beta + u \]

where \( y \) is \( TM \times 1 \), \( X \) is \( TM \times K \), \( \beta \) is \( K \times 1 \), \( u \) is \( TM \times 1 \), \( K = \sum_{m=1}^M k_m \), and \( E[u] = 0 \).

If the errors across equations are contemporaneously correlated then

\[ E[u u^T] = \begin{bmatrix} \sigma^2_1 I_T & \sigma_{12} I_T & \cdots & \sigma_{1M} I_T \\ \sigma_{21} I_T & \sigma^2_2 I_T & \cdots & \sigma_{2M} I_T \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{M1} I_T & \sigma_{M2} I_T & \cdots & \sigma^2_M I_T \end{bmatrix} = \sum \otimes I_T \]

In the present context, the effect of common institutional factors and the similarities across South East European countries in their process of economic transition may be picked up by \( \Sigma \). If \( \Sigma \) is known, parameter estimates can be obtained by using the generalised least squares (GLS) estimator

\[ \hat{\beta}_{GLS} = \left( X' \left( \sum^{-1} \otimes I_T \right) X \right)^{-1} X' \left( \sum^{-1} \otimes I_T \right) y. \]

In practice, however, \( \Sigma \) is rarely known and for this case feasible generalised least squares (FGLS) estimators have been proposed. The equation-by-equation ordinary least squares (OLS) residuals can be used to consistently estimate \( \Sigma \). Both these estimators are due to Zellner (1962, 1963). Iterating on this FGLS procedure (IFGLS) produces ML estimates with equivalence conditions given in Oberhofer and Kmenta (1974).

As an extension of model (1), the two-regime TSUR model is given by:
\[ y_{it} = (x_{it}'\beta)^{+}_{i}(\gamma) + (x_{it}'\theta)d_{2i}(\gamma) + u_{it} \]

\[ y_{Mt} = (x_{Mt}'\beta_{Mt})d_{1i}(\gamma) + (x_{Mt}'\theta_{Mt})d_{2i}(\gamma) + u_{Mt} \]

\[ d_{1i}(\gamma) = 1 \quad (s_{i} \leq \gamma) \]

\[ d_{2i}(\gamma) = 1 \quad (s_{i} > \gamma) \]

where \( \gamma \) is the threshold parameter and \( s_{i} \) is the (common) threshold variable (e.g., euro area production). For exposition the stacked model is given by:

\[ y = X\beta d_{1}(\gamma) + X\theta d_{2}(\gamma) + u \]

As in the linear context, the errors are contemporaneously correlated through a covariance matrix \( \Sigma \) [Aslanidis, (2006), pp.4–6]. The TSUR model can capture business cycle asymmetries by allowing for the presence of different regimes for the selected South East European countries. These regimes may be associated with euro area expansions and contractions. When \( s_{i} \leq \gamma \) (associated with contractions in the euro area production) we are in Regime 1 and the SUR model for the South East European countries is \( y = \gamma + X\beta + u \). On the other hand, when \( s_{i} > \gamma \) (associated with expansions in the euro area production) we are in Regime 2 and the SUR model for the South East European countries is \( y = X\theta + u \). In principle, the threshold variable could be different across equations. However, as existing research shows the South East European countries are strongly affected by the euro area since they are collectively smaller both geographically and economically. Thus, in the present context it is more intuitive to focus on asymmetries in the South East European countries production initiated by the euro area.

### 2.2 Estimation

"The parameters of interest are the vectors \( \beta \) and \( \theta \), the matrix \( \Sigma \) and the threshold \( \gamma \). Estimation of model (2) is carried out by ML under the assumption that the errors are normal \( u \sim N(0, \Sigma \otimes I) \). The Gaussian likelihood is

\[ \ln L(\beta, \theta, \Sigma, \gamma) = -\frac{T}{2} \ln \left| \Sigma \right| - \frac{1}{2} \sum_{i=1}^{T} u_{i}' \sum_{i}^{-1} u_{i} \]

The MLE \(( \hat{\beta}, \hat{\theta}, \hat{\Sigma}, \hat{\gamma} )\) maximizes \( L(\beta, \theta, \Sigma, \gamma)\) Aslanidis (2006, p.6).

Gallant (1975, pp.35–50) showed that the non-linear FGLS estimator obtained for the seemingly unrelated non-linear regressions is consistent and asymptotically normal even in the absence of normality of the error distribution. Furthermore, if in addition the errors are multivariate normal, Gallant (1975) showed that iterating the non-linear FGLS estimator between \( \Sigma \) and the slope parameters converges to the ML estimator (i.e., IFGLS is tail equivalent to ML estimation), and thus for any theoretical purpose can be regarded as if it were the ML estimator (the proof for the strong consistency and asymptotic normality of IFGLS can be found in section 7 of the Gallant’s paper from 1975). Gallant
(1987, p.357) is also saying that: “As a practical matter one may prefer some other algorithm to iterated least squares as a means to compute the maximum likelihood estimator. In a direct computation, the number of arguments of the objective function that must be minimized can be reduced by ‘concentrating’ the likelihood function” [equation (3)].

“It is computationally convenient to first concentrate out \((\beta, \theta, \Sigma)\). That is, holding \(\gamma\) fixed the IFGLS estimator computes the constrained ML estimator for \((\beta, \theta, \Sigma)\). This yields the ‘concentrated’ likelihood function

\[
\ln L(\hat{\beta}, \hat{\theta}, \hat{\Sigma}, \gamma) = -\frac{T}{2} \ln |\hat{\Sigma}(\gamma)| - \frac{Tm}{2}
\]

Thus, the ML estimator \(\gamma\) minimizes \(\ln |\hat{\Sigma}(\gamma)|\) subject to the constraint ensuring that

\[
\pi_0 \leq P(s, \gamma) \leq 1 - \pi_0
\]

where \(\pi_0 > 0\) is a trimming parameter. For the empirical application, \(\pi_0\) is set to 0.1” [Aslanidis, (2006), p.6].

The criterion function (3) is not continuous, i.e. the underlying process is discontinuous in the neighbourhood of the threshold, discontinuity that is present in these models via the indicator function. Chan (1993) and Hansen (1997) showed that the LS estimator of the threshold \(\gamma\) is super-consistent, and that its asymptotic distribution is highly non-standard. According to Hansen (1997), all estimated autoregressive coefficients in TAR models are functions of the estimated threshold value, which is well known to follow a non-standard distribution. Similarly, in the TSURE model, the IFGLS estimator of \(\gamma\) is also expected to be super-consistent. Therefore, due to the super-consistency of the threshold, the analysis could proceed as in Hansen (1997) (Theorem 1). Hansen (1997) proposes a procedure for forming confidence intervals for \(\gamma\) based on the ‘no-rejection region’ of the likelihood ratio statistic for tests on \(\gamma\). But also, we could follow Gallant (1975) and the practice “that for some problems of statistical inference we can treat the estimated threshold value as the true value (its super consistency feature) and ignore its sampling variability” [Li, (2009), p.2].

Since, the threshold SUR in (2) falls in the class of models considered by Gallant, therefore, it can be argued that the IFGLS estimator is strongly consistent and classical asymptotic hypothesis testing is plausible. To summarise, we proceed with the iterative FGLS (IFGLS) due to its strong consistency property, and we calculate the threshold using a general detection method based on wavelets, as a fairly new family of basis functions that are used to express and approximate other functions.

2.3 The simplest non-linear wavelet shrinkage: thresholding

In this section we focus on the simplest, yet most important shrinkage strategy – wavelet thresholding. “In discrete wavelet transform the filter \(H\) is an ‘averaging’ filter while its mirror counterpart \(G\) produces details. The wavelet coefficients correspond to details. When detail coefficients are small in magnitude, they may be omitted without substantially affecting the general picture. Thus the idea of thresholding wavelet coefficients is a way of cleaning out unimportant details that correspond to noise. As a consequence, wavelet shrinkage acts as a smoothing operator” [Kvam and Vidakovic,
“Why does wavelet thresholding work? Informally, the ‘energy’ in data set (sum of squares of the data) is preserved (equal to sum of squares of wavelet coefficients) but this ‘energy’ is packed in a few wavelet coefficients. This *disbalancing property* ensures that the function of interest can be well described by a relatively small number of wavelet coefficients. The normal *i.i.d.* noise, on the other hand, is invariant with respect to orthogonal transforms (e.g., wavelet transforms) and passes to the wavelet domain structurally unaffected. Small wavelet coefficients likely correspond to a noise because the signal part gets transformed to a few big magnitude coefficients” [Kvam and Vidakovic, (2007), pp.274–275].

2.4 Proposed wavelet-based threshold detection procedure

“In computing the discrete wavelet transform of the data I use the Haar wavelet. Since the wavelet coefficients indicate the content of the signal at various translations and scales, use of the Haar wavelet yields wavelet coefficients that are expected to be large in magnitude at times where there are jumps or outliers in the original series. Threshold limits are computed using the value $\tau = \sigma((2 \log(n)))^{1/2}$, originally suggested by Donoho and Johnstone (1994) and later by Wang (1995)” [Bilen and Huzurbazar, (2002), pp.311–327, 317].

“In practice, to use the threshold limit, the unknown noise level, $\sigma$, needs to be estimated from the wavelet coefficients. Donoho and Johnstone (1994) and Wang (1995) suggested estimating $\sigma$ using the median absolute deviations (MAD) of the wavelet coefficients. Bilen and Huzurbazar (2002) suggest using another well-known robust measure, the mean of the absolute deviations from the median (AD), which is more efficient for Gaussian data than MAD. When the noise level in the data is auto correlated, the variance of the wavelet coefficients depends on the level in the wavelet decomposition but not on the location (Johnstone and Silverman 1997). Therefore, in computing the threshold limits and estimating the noise level we could use a level-dependent approach. For each level of the decomposition, $j$, we can estimate $\sigma_j$, using the AD of the wavelet coefficients, $D(j)$, and then compute the threshold, ($\tau_j$). For each level, wavelet coefficients can be compared to the threshold limits, with the locations whose coefficients fall outside the limits being considered as potential outlier locations. However, using coefficients at all $J$ levels is not necessary, i.e. the threshold can be detected using only the first level coefficients, $D(J-1)$.

The three steps in the procedure are:

Step 1  Apply the wavelet transform to the observed series {$Z_t$} to obtain the first level of wavelet coefficients $D(J-1)$.

Step 2  Estimate $\sigma_1$ from the data by taking the mean absolute deviations from the median of the wavelet coefficients:

$$\hat{\sigma}_1 = AD(D(J-1)) = \frac{1}{n_1} \sum_{k=1}^{n_1} |d_{k}(1) - \hat{M}_1|$$

where $d_k(1)$ denotes the wavelet coefficient at location $k$, in the first level of the decomposition and $\hat{M}_1$ is the median of the level 1 coefficients, $D(J-1)$. 

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Step 3 Calculate the threshold limit \( \tau_1 \) using the estimated \( \sigma_1 \):

\[
\tau_1 = \hat{\sigma}_1 \sqrt{2 \log(n)} \quad \text{[Bilen and Huzurbazar, (2002), pp.318–319]}
\]  

(5)

3 Empirical analysis

3.1 Data

The analysis is based on monthly industrial production index (2005=100) series. Specifically, I use the seasonally adjusted values of the logarithmic indices of industrial production \( IP_t \) for Macedonia (MK), Croatia (HR), Serbia (RS), and Bulgaria (BG). Seasonal adjustment is done using X-12 ARIMA procedure. Data source is international financial statistics (IFS). The sample is monthly from 1999:2 through 2011:12. The original series are made approximately stationary by one-month differencing

\[
\Delta IP_t = \ln(IP_t) - \ln(IP_{t-1})
\]

The euro area industrial production index (2005 = 100, seasonally adjusted) is considered to act as the threshold variable \( s_t \) and particularly the following choice for this variable, i.e. the long difference (12th difference) of the logarithm of this variable.

\[
s_t = \Delta_{12} IP^\text{EURO}_t = \ln(IP^\text{EURO}_t) - \ln(IP^\text{EURO}_{t-12})
\]

This long difference for the threshold variable proves useful as a business cycle indicator for the euro area. The series is graphed in Figure 2 in the Appendix. As can be seen, the principal period of decline for this variable is from mid-2000 until the end of 2001, as well as from mid-2008 until the end of 2009, which effectively captures the German recession of 2001 as well as the global financial crisis of 2008–2009, consequently, with their macroeconomic context.

3.2 Discussion of the estimated model

This section presents the estimated models. I start by estimating a symmetric TSUR specification. The next step is to clean up the estimation from non-significant lags, i.e. estimating an asymmetric TSUR specification. Notice that, due to the sample size, we nested the number of lags in each regression up to 4. Also, in principle, all coefficients could be allowed to switch between the regimes. In the present context, however, in order to impose greater parsimony on the model I am allowing only the constants and the coefficients on first lags to switch between the regimes.

“\( E(y_{it} / I_{i,t-1}) = \beta_{t0} + \beta_{t1} y_{i,t-1} + \ldots + \beta_{tk} y_{i,k-1} \) for \( i = 1, \ldots, M \)

the implied growth rate for each series is given by
\[
\mu_i = \frac{\beta_0}{1 - \beta_1 - \ldots - \beta_k}
\]

where \( E(y_i) = \mu_i \) for \( \forall t \) [Aslanidis, (2007), p.13]

The estimates of the asymmetric non-linear SUR model are given in the Table 1. Table 1 clearly shows that the implied (annualised) growth rates vary across the selected South East European countries during 1999–2011 period. For instance, Bulgaria grows much faster, while Croatia, Serbia and Macedonia grow relatively slower.

<table>
<thead>
<tr>
<th></th>
<th>RS Reg1</th>
<th>RS Reg2</th>
<th>HR Reg1</th>
<th>HR Reg2</th>
<th>MK Reg1</th>
<th>MK Reg2</th>
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<th>BG Reg2</th>
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<td>(0.32)</td>
<td>(0.21)</td>
<td>(1.89)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-3.04)</td>
<td>(-3.04)</td>
<td>(-3.46)</td>
<td>(-3.46)</td>
<td>(2.65)</td>
<td>(2.65)</td>
<td></td>
</tr>
<tr>
<td><strong>dl_ip(-4)</strong></td>
<td>-0.258</td>
<td>-0.258</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-3.45)</td>
<td>(-3.45)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Steady state</strong></td>
<td>-0.0018</td>
<td>0.0018</td>
<td>0.0005</td>
<td>0.0028</td>
<td>-0.0020</td>
<td>0.0012</td>
<td>0.0006</td>
<td>0.0057</td>
</tr>
<tr>
<td><strong>Steady state (in %)</strong></td>
<td>-0.18</td>
<td>0.18</td>
<td>0.05</td>
<td>0.28</td>
<td>-0.20</td>
<td>0.12</td>
<td>0.06</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Implicit annualised growth rate (in %)</strong></td>
<td>-2.2</td>
<td>2.2</td>
<td>0.6</td>
<td>3.4</td>
<td>-2.4</td>
<td>1.4</td>
<td>0.7</td>
<td>6.8</td>
</tr>
</tbody>
</table>

**Source:** Author’s calculations

Note: t-statistics is in parentheses.

Turning to the residual correlation matrix, the results show that there seem to be some relationships between the errors of the analysed countries. For example, the estimated correlation between the errors obtained from the Bulgarian model and the errors obtained from the Croatian model is 0.38, is 0.37 for Croatian and Serbian equations, and 0.32 for the Macedonian and Bulgarian equations. These correlations may be explained by the common institutional factors and the similarities across the selected South East European countries in their process of economic transition, and indicate that there is a gain in efficiency from the system estimation.

What is more interesting about this model, however, is that there are two distinct regimes for the selected South East European countries. The first regime (Regime 1), is
when \( \Delta_{12} IP_{EURO}^t \leq 0.0257057 \) and may be associated with contractions in the euro area production. From the implied (annualised) growth rates, it is seen that in this regime Bulgaria and Croatia experience positive growth, while exceptions are Macedonia and Serbia, which experience negative growth in this regime. In this light, Regime 1 may be called the ‘normal’ growth regime for Croatia and Bulgaria. On the other hand, a second regime (Regime 2) is identified when \( \Delta_{12} IP_{EURO}^t > 0.0257057 \), which may be associated with expansions in the euro area. Interestingly in Regime 2, the implied (annualised) growth rates in all South East European countries accelerates, and therefore, we may call this regime the ‘high’ growth regime. Differences in regime-dependent growth rates across the regimes can be large for some countries. For instance, Bulgaria grows at a rate of 6.8% in the ‘high’ growth regime, but 0.7% in the ‘normal’ growth regime. Macedonia grows at a rate of 1.4% in the ‘high’ growth regime, whereas drops by 2.4% when euro area contracts. Serbia grows at a rate of 2.2% in the ‘high’ growth regime, whereas drops by 2.2% when euro area contracts. For Croatia, on the other hand, the difference between the regime-dependent implied growth rates is relatively smaller (0.6% and 3.4%, respectively in the ‘normal’ and ‘high’ growth regime). Given that the selected South East European countries are ‘catching up’ with the euro area this result shows that South East European countries’ business cycle seem synchronised to the euro area cycle. The achieved degree of synchronisation of Macedonia and Serbia implies that when euro area contracts, both, Macedonian and Serbian growth go negative. The rest of the analysed South East European countries, i.e., Bulgaria and Croatia experience ‘normal’ growth when the euro area contracts and ‘high’ growth when the euro area expands. Still, as it was expected, higher implied growth rates are found in countries where greater internationalisation of enterprises and greater product and financial sector linkages to EU markets are present\(^3\) (i.e., Bulgaria and Croatia). The achieved degree of synchronisation implies that the group of analysed states would probably not suffer from asymmetric shocks in the euro area.

### 3.2.1 Has the business cycle synchronisation changed since the onset of the financial crisis?

This section analyses whether the synchronisation pattern of business cycles of the individual countries with the euro area cycle has systematically changed since the outbreak of the global financial crisis in 2008. In order to examine the effects of the current financial crisis since 2008 this study employs a purely statistical concept, i.e. correlations of the cyclical component of countries’ industrial production gaps with the euro area gap.\(^4\) The main reason behind is that only a fairly short time series on the crisis is available at the end of the sample, which makes it difficult to draw meaningful conclusions if a modelling approach is to be employed. Country-specific differences in the terms of trade and fiscal imbalances may have caused asymmetric reactions of these countries to the global shock. On the other hand, the business cycles of individual countries may have become more closely synchronised, as all countries slipped into recession at the same time (adapted from Gächter et al., 2012).

To better judge the developments over time, Figure 1 presents the course of the correlations of country-specific cycles with the euro area cycle in sliding two-year spans. Figure 1 clearly shows that the correlations with the euro area around 2005 when the euro area output gap was negative may be observed to be much more heterogeneous. At that
period, Macedonia and Croatia faced strong declines in the correlation coefficients which even slipped well into negative territory. Unlike Macedonia and Croatia, Bulgaria’s and Serbia’s synchronisation with the euro area cycle around 2005 is positive and augmented even further in this period. Starting from end-2006 until mid-2009, bilateral correlation patterns had been moving in a homogenous manner. With respect to the patterns in business cycle co-movement before and after the beginning of the global financial crisis whose official start is associated with the Lehman Brothers’ collapse at end-2008, Figure 1 shows that synchronisation of business cycles is particularly strong during the downturn, i.e., up to mid-2009. Conversely, a decline in the synchronisation of business cycles is observed in the early recovery phase after a recession. Moreover, mid-2011 is characterised by increased heterogeneity among the bilateral correlation coefficients. This pattern might be related to the fact that the onset of the global financial crisis was nearly simultaneous in all selected countries and the euro area, albeit at different strengths. On the other hand, the subsequent recovery until at least mid-2011, was quite heterogeneous in the individual countries. Therefore, synchronisation of cycles is particularly strong during the downturn but highly heterogeneous during the upswing. Namely, whereas most of the countries were beset by the downturn at nearly the same time, the subsequent recovery started at different times in different countries, and was weaker in some, stronger in others. While the triggering events were the same, individual countries started from disparate starting points and reacted with different policies. For instance, different debt levels weighed on individual countries to different degrees: countries with less debt were able to successfully wield an expansionary fiscal policy to effect a change in trend, whereas the more heavily indebted countries had considerably less room for manoeuvre. Also, structural weaknesses such as low competitiveness are factors for slower recovery in some of the countries. To address some selected structural and economic indicators of the analysed countries please refer to Table 4 and Table 5 in the Appendix (adapted from Gächter et al., 2012).

**Figure 1** Temporal development of bilateral correlation coefficients for a moving two-year window (see online version for colours)

![Temporal development of bilateral correlation coefficients for a moving two-year window](image-url)

**Source:** IFS and author's calculations
While growth in candidate countries was generally robust prior to the global recession of 2009, this tended to be associated with increasing external and domestic imbalances, which proved unsustainable in the face of an external shock on the scale of the global financial crisis. The drying-up of external finance following Lehman Brothers’ collapse also exposed other long-standing vulnerabilities in candidate countries which had not been addressed in the context of the rapid financial expansion seen prior to the crisis. Policy responses to the crisis were conditioned by the monetary policy frameworks and exchange rate regimes chosen by the respective authorities. “The recent crisis, coupled with the ongoing turbulence in some parts of the euro area, serves as a reminder that lasting and sustainable convergence requires sustained policy efforts. In this regard, both membership of the EU and the eventual adoption of the euro should be seen as means to an end – namely real convergence, stability and prosperity – rather than as objectives in themselves (adapted from ECB Monthly Bulletin, 2012).”

Large euro area imbalances have resulted in vulnerabilities exposed by the current crisis. While capital flows across the monetary union were part of convergence and anticipated, key imbalances resulted largely from overly optimistic expectations, mispricing of risks, inadequate adjustment to shocks, insufficient oversight or governance in recent years as well as cyclical factors. Fundamentally, there was no effective constraint on borrowing in good times and no effective crisis management mechanism in place for bad times. With monetary policy and the exchange rate responding to area-wide conditions, adjustment to country-specific shocks proved inadequate. The Eurozone crisis has highlighted cracks in the architecture of the currency union. Efforts to make the currency union more stable and sustainable in the long run represent one of the most fundamental challenges. European proposals to date to reform the currency union centre heavily on increasing fiscal coordination and integration. Still, apart from the stronger fiscal integration, efforts on several additional fronts are needed to build a better functioning monetary union:

1. extending institutional monitoring and constraints on excessive imbalances beyond the fiscal realm
2. centralised powers in banking supervision and resolution, and common deposit insurance would imply a step toward a pan-euro-area financial stability framework
3. structural reform to strengthen competitiveness and improve the ability to adjust to shocks would be essential.

The current tensions in parts of the euro area also serve as a reminder that adoption of the Euro does not in itself guarantee continued convergence if the appropriate policies are not followed and the necessary reforms are not implemented (Euro Area Imbalances).

4 Concluding remarks

The overall positive findings that the selected South East European countries are in sync with the euro area cycle “say nothing about the desirability of these countries adopting an early peg against the euro and joining the Eurozone, but they do raise questions of the feasibility of doing so. If these countries prove unable to maintain a level of macroeconomic discipline consistent with a peg to the euro, then whatever the benefits of
being in a euro-centred optimal currency area may be, the transition economies will be unable to remain a part of it for long” [Brada and Kutan, (2002), p.6].

Also, the degree of business cycle synchronisation may have resulted from the fact that some of the selected countries (Macedonia and Bulgaria) have already pegged their currencies to the euro. Currency pegs actually promote a shift of business cycle affiliation to that of the anchor country, i.e., currency area. Therefore, “the causes of macroeconomic shock correlation may reflect exchange rate regimes which, due to the currencies being pegged to the euro, make the cycle coordination endogenous. The reasons, however, may be of a much deeper, structural nature: historical connections, transfers, the structure of trade in goods, services and factors of production. All of these influence cyclical coordination” [Sonje and Vrbanc, (2000), p.8]. Still, this type of argumentation goes beyond the scope of this paper in which the applied method does not make possible the analysis of the causes of cyclical coordination. The aim of this research is in fact to show that the analysed economies are very sensitive to exogenous macroeconomic shocks coming from the euro area, as well as to point out to the lessons for the prospective EU and EMU candidates arising from the current crisis. With respect to the patterns in business cycle co-movement before and after the beginning of the global financial crisis, this study clearly shows that synchronisation of business cycles is particularly strong during the downturn, i.e. up to mid-2009. Conversely, a decline in the synchronisation of business cycles is observed in the early recovery phase after a recession. Moreover, mid-2011 is characterised by increased heterogeneity among the bilateral correlation coefficients. The recent crisis, coupled with the ongoing turbulence in some parts of the euro area, serves as a reminder that lasting and sustainable convergence requires sustained policy efforts. In this regard, both membership of the EU and the eventual adoption of the euro should be seen as means to an end – namely real convergence, stability and prosperity – rather than as objectives in themselves. The current tensions in parts of the euro area also serve as a reminder that adoption of the euro does not in itself guarantee continued convergence if the appropriate policies are not followed and the necessary reforms are not implemented.

References


Notes

1 I.e. Macedonia, Croatia, Serbia and Bulgaria. At present, within the analysed group of countries, Macedonia and Serbia have a status of candidate countries. Macedonia has been a candidate for accession to the EU since 2005 but has not yet been allocated a date for accession negotiations. Serbia officially applied for EU membership on 22 December 2009 and the European Commission recommended making it an official candidate on 12 October 2011. Croatia applied for EU membership in 2003 and the European Commission recommended making it an official candidate in early 2004. Croatia finished accession negotiations on 30 June 2011 and on 9 December 2011 signed the Treaty of Accession to become the bloc’s 28th member. Bulgaria joined the EU on 1 January 2007. The rationale behind the selection of the countries is twofold: first, there are common institutional factors and similarities across the selected countries in their process of economic transition, and second, the fact that all these countries are prospective EU or EMU countries. Therefore, an evidence of non-convergence would imply that such institutional linkages with the EU do not necessarily promote macroeconomic convergence.

2 To participate in the initial formation of the EMU, each member had to meet the following five convergence criteria by 1998:
   1 national legislation governing the country's financial system had to be compatible with the treaty provisions controlling the European System of Central Banks
   2 a rate of inflation within 1.5% of the rates in the three participating countries with the lowest rates
   3 reduction of its government deficits to below 3% of its gross national product
   4 currency exchange rates within the limits defined by the ERM (an intermediary step toward a single currency that attempted to stabilise exchange rates by fixing rates through variable bands) for at least two years
   5 interest rates within 2% of the rates in the three participating countries with the lowest rates.

3 Supporting literature behind the statement for greater product and financial sector linkages to EU markets for Bulgaria would be ‘Convergence Report 2012’, European Commission. A supporting reference on financial sector integration with the EU, as well as on financial sector stability in surroundings of the current financial crisis for Croatia would be Stojanović and Krišto (2011).

4 The measure of the output gap is a purely statistical decomposition process in which a trend is extracted from the time series (in this case of industrial production data) that can be interpreted as potential output. The cyclical component is obtained by subtracting potential output from the original variable and is thus an estimate of the output gap. A Hodrick-Prescott filter (HP filter; Hodrick and Prescott, 1997) is employed as business cycle extraction method.

5 Still, there are limits to the robustness of statements about the synchronisation of business cycles at the end of the sample due to the well known end-sample bias of the HP filter.
Appendix

Figure 1  One-month difference of the logarithm of seasonally adjusted industrial production (see online version for colours)

Note: Bulgaria (BG), Croatia (HR), Serbia (RS) and Macedonia (MK).

Figure 2  Twelve-month difference of the logarithm of seasonally adjusted euro area industrial production (see online version for colours)
### Table 1  Summary statistics of the logarithm of seasonally adjusted industrial production

<table>
<thead>
<tr>
<th></th>
<th>BG</th>
<th>HR</th>
<th>MK</th>
<th>RS</th>
<th>EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.473</td>
<td>4.572</td>
<td>4.612</td>
<td>4.589</td>
<td>4.591</td>
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<tr>
<td>Median</td>
<td>4.558</td>
<td>4.594</td>
<td>4.626</td>
<td>4.593</td>
<td>4.582</td>
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<tr>
<td>Maximum</td>
<td>4.816</td>
<td>4.779</td>
<td>4.859</td>
<td>4.747</td>
<td>4.713</td>
</tr>
<tr>
<td>Std. dev.</td>
<td>0.232</td>
<td>0.102</td>
<td>0.088</td>
<td>0.096</td>
<td>0.055</td>
</tr>
<tr>
<td>Skewness</td>
<td>–0.566</td>
<td>–0.479</td>
<td>–0.086</td>
<td>–2.563</td>
<td>0.318</td>
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<tr>
<td>Kurtosis</td>
<td>2.209</td>
<td>2.687</td>
<td>3.137</td>
<td>16.683</td>
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<tr>
<td>Jarque-Bera</td>
<td>12.223</td>
<td>6.525</td>
<td>0.309</td>
<td>1370.058</td>
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<tr>
<td>Probability</td>
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<td>0.038</td>
<td>0.857</td>
<td>0.000</td>
<td>0.168</td>
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<tr>
<td>Sum</td>
<td>688.870</td>
<td>704.115</td>
<td>710.300</td>
<td>706.647</td>
<td>706.951</td>
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<tr>
<td>Sum sq. dev.</td>
<td>8.221</td>
<td>1.606</td>
<td>1.197</td>
<td>1.411</td>
<td>0.457</td>
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<tr>
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<td>154</td>
<td>154</td>
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<td>154</td>
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</tbody>
</table>

Note: Bulgaria (BG), Croatia (HR), Serbia (RS) and Macedonia (MK).

### Table 2 Correlations of errors from threshold SURE model

<table>
<thead>
<tr>
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<th>HR</th>
<th>MK</th>
<th>RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG</td>
<td>1</td>
<td>0.366</td>
<td>0.327</td>
<td>0.256</td>
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<td>HR</td>
<td>1</td>
<td>0.154</td>
<td>0.127</td>
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<tr>
<td>MK</td>
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<td>0.127</td>
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<tr>
<td>RS</td>
<td>1</td>
<td>0.127</td>
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### Table 3 Average growth of potential output (approximated by industrial production trend extracted by HP filter)

<table>
<thead>
<tr>
<th></th>
<th>2001 to 2011</th>
<th>2001 to September 2008</th>
<th>October 2008 to 2011</th>
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<tbody>
<tr>
<td><strong>Annual change in %</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>BG</td>
<td>4.5</td>
<td>7.8</td>
<td>–3.2</td>
</tr>
<tr>
<td>HR</td>
<td>1.3</td>
<td>3.1</td>
<td>–3.0</td>
</tr>
<tr>
<td>MK</td>
<td>0.3</td>
<td>1.4</td>
<td>–2.3</td>
</tr>
<tr>
<td>RS</td>
<td>0.7</td>
<td>1.9</td>
<td>–2.3</td>
</tr>
<tr>
<td>EA</td>
<td>0.5</td>
<td>1.1</td>
<td>–3.2</td>
</tr>
<tr>
<td>Candidate countries</td>
<td>Population (millions)</td>
<td>GDP per capita (US dollars, PPP terms)</td>
<td>Agriculture</td>
</tr>
<tr>
<td>---------------------</td>
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<tr>
<td>Croatia</td>
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<td>Macedonia</td>
<td>2.1</td>
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<td>11.3$^3$</td>
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<tr>
<td>Serbia</td>
<td>7.4</td>
<td>10,642</td>
<td>9.0</td>
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<tr>
<td>Memorandum item</td>
<td>EU 10$^4$</td>
<td>19,991</td>
<td>4.2$^5$</td>
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</table>

Notes: 1) The EBRD’s transition indicator measures a country’s progress from a rigid centrally planned economy (score of 1.0) to an industrialised market economy (score of 4.3). The figures shown in the table represent average scores across nine areas assessed by the EBRD.
2) The World Bank’s governance indicator measures six aspects of governance, with scores ranging from –2.5 (worst) to +2.5 (best). The figures shown in the table represent unweighted averages across the six aspects assessed.
3) Data for 2010.
4) Unweighted average of Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.
5) Data for 2010; average excludes the Czech Republic and Estonia.
6) Average excludes the Czech Republic.

Table 5
Economic indicators for candidate countries
(Annual averages; percentages; percentages of GDP)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Croatia</td>
<td>4.3</td>
<td>–6.0</td>
<td>–0.6</td>
<td>3.1</td>
<td>1.9</td>
<td>2.0</td>
<td>–6.7</td>
<td>–5.0</td>
<td>–0.1</td>
<td>–2.7</td>
<td>–4.1</td>
<td>–5.2</td>
<td>34.4</td>
<td>35.1</td>
<td>43.4</td>
</tr>
<tr>
<td>Macedonia</td>
<td>4.7</td>
<td>–0.9</td>
<td>2.4</td>
<td>2.8</td>
<td>–1.7</td>
<td>2.9</td>
<td>–6.5</td>
<td>–6.8</td>
<td>–2.5</td>
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<td>–2.7</td>
<td>–2.5</td>
<td>30.5</td>
<td>23.8</td>
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<tr>
<td>Serbia</td>
<td>5.0</td>
<td>–3.5</td>
<td>1.4</td>
<td>10.6</td>
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<td><strong>5.2</strong></td>
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<td><strong>–0.9</strong></td>
<td><strong>–1.9</strong></td>
<td><strong>–5.9</strong></td>
<td><strong>–4.2</strong></td>
<td><strong>27.5</strong></td>
<td><strong>34.4</strong></td>
</tr>
</tbody>
</table>

Notes: 1) General government net lending/borrowing.
2) Unweighted average of data for Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.