

ARE THE NEW MEMBER STATES READY TO JOIN THE EURO AREA? A BUSINESS CYCLE PERSPECTIVE

The present research employs a vector autoregression (VAR) approach to assess the degree of business cycle synchronization between the new member states (NMS), which have not adopted the single European currency, and the Euro area (EA). The main fiscal and monetary factors affecting the business cycle coordination between the NMS and the EA have been identified. The causality between the business cycle convergence of the NMS and the EA and the implemented fiscal and monetary policies has been investigated in the short and in the long term. Recommendations and conclusions on the readiness of the NMS to join the EA have been made.

JEL: E32; E42; E50

Introduction

In 2004, 2007 and 2013, thirteen new Member States (NMS) – Poland, the Czech Republic, Hungary, Slovakia, Slovenia, Lithuania, Latvia, Estonia, Malta, Cyprus, Bulgaria, Romania and Croatia, were admitted to the European Union (EU). Seven of these countries – Slovenia, Malta, Cyprus, Slovakia, Estonia, Latvia and Lithuania, have already joined the Euro area (EA). The rest six countries – Poland, the Czech Republic, Hungary, Romania, Bulgaria and Croatia, are also required to introduce the single European currency after meeting certain requirements (the Maastricht convergence criteria). Hence, the question is not whether, but when these six countries will become members of the EA.

When assessing a country's readiness for a EA membership, it is advisable that not only the Maastricht convergence criteria but also the optimal currency area theory criteria be employed. The simultaneous use of the two groups of criteria contributes to combining their strengths, to avoiding their weaknesses and to obtaining a complete and credible assessment of the readiness of the Economic and Monetary Union (EMU) candidate countries.

One of the most important criteria for a currency area's optimality is the similarity between the economic cycles of the participating countries. If these cycles are not synchronized, it is

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likely that the currency union will be affected by asymmetric shocks. Asymmetric shocks make common monetary policy ineffective and pro-cyclical in countries whose cycles are not converged with the aggregate cycle of the currency area. During an economic expansion, common monetary policy will create inflationary „bubbles” and danger of „overheating” the economy, and in a downturn will further exacerbate the recession in countries with divergent economic cycles. It is not recommended that countries whose individual business cycles are not sufficiently correlated with the aggregate currency area cycle join the currency union. One of the reasons for the debt crisis in the EA was the insufficient synchronization of economic cycles of peripheral countries with the aggregate currency union cycle.

The objective of this research is to estimate the degree of readiness of Bulgaria, Romania, the Czech Republic, Poland, Hungary and Croatia for a EA membership from the standpoint of the convergence of their individual business cycles with the aggregate EA cycle. To achieve this goal, the study is structured as follows:

- Review and systematization of the theoretical and empirical studies on the coordination of the economic cycles of the NMS with the EA aggregate cycle (section one);
- Empirical estimation of the degree of convergence of the business cycles of Bulgaria, Romania, the Czech Republic, Poland, Hungary and Croatia with the aggregate EA cycle (section two);
- Identification of the fiscal and monetary factors influencing the convergence of each country's cycle with that of the EA (section three);
- Formulation of inferences and recommendations on the readiness of the NMS to join the EA (conclusion).

In the present study, the methods of vector autoregression (VAR), Hodrick-Prescott filter, and formulation of inferences and recommendations on the readiness of the NMS to join the EA have been applied. Quarterly seasonally adjusted Eurostat data for the period from the first quarter of 2000 to the fourth quarter of 2017 have been used. All indicators have been calculated as a percentage of real Gross Domestic Product (GDP), except for the output gap, which has been calculated as a percentage of potential GDP. Potential output has been estimated using a Hodrick-Prescott filter. The economic cycles of the NMS and the EA have been dated and their phases (expansions and contractions) and positions (inflationary and deflationary gaps) have been determined.

The empirical evaluation of the degree of convergence of the economic cycles of the NMS and the EA has been carried out through three indicators:

- The percentage of coincident business cycle phases of the NMS and the EA;
- The percentage of coincident cyclical positions of the NMS and the EA;
- The correlations between the output gaps of the NMS and output gap of the EA.

All variables have been tested for stationarity. If they had been found to be integrated of the first order, tests have been made for the optimal number of lags and co-integration of

Johansen. The optimal number of lags has been used in the Johansen co-integration test and later in the construction of the vector autoregression. If the Johansen test had demonstrated a co-integration connection between variables, a restricted VAR, also known as Vector Error Correction (VEC), has been applied. Otherwise, an unrestricted VAR has been used.

The short-term cause-and-effect relationships between the variables have been analyzed via the Pairwise Granger Causality Tests, and long-term causal links through the Granger Causality / Block Exogeneity Wald Tests.

Inferences and recommendations have been made on the readiness of the NMS to adopt the Euro. When selecting the explanatory fiscal and monetary variables for the vector autoregression, the specificities of macroeconomic policies under different exchange rate regimes and in a currency union have been taken into consideration.

1. Review and systematization of the theoretical and empirical studies on the coordination of the economic cycles of the NMS with the EA aggregate cycle

There are many studies on the coordination of economic cycles of the NMS with the aggregate EA cycle.

According to Frankel and Rose (1998), patterns of international trade and international business cycles are endogenous. Using data over a period of thirty years and twenty industrialized countries, Franklin and Rose inferred that countries with closer commercial ties had more coordinated economic cycles.

Kutan and Yigit (2005) found evidence of the cyclical convergence of the new member states and the euro area. The authors concluded that the NMS managed to adapt to various shocks in the euro area.

Brada et al. (2005) claimed that the NMS could adopt the euro quickly after joining the European Union (EU), but the benefits of such a step would have been limited.

Fidrmuc and Korhonen (2006) made a meta-analysis of thirty-five publications on the synchronization of business cycles between the NMS and the EA. Some NMS have a high correlation of their cycles with that of the Euro area. The analytical methodologies have a significant impact on the results of the research.

Zapodeanu (2012) concluded that the degree of synchronization of the business cycles between the old Member States on the one hand and Slovenia, Slovakia, Cyprus and Estonia, on the other hand, had increased in the period 1995-2011, but the adoption of the euro had not affected it.

Eickmeier and Breitung (2005) found that there was considerable heterogeneity among the NMS, meaning that for some countries the EA membership would be more expensive than for others. Poland, Slovenia, Hungary and Estonia are more suitable candidates for EA than other NMS.

Rinaldi-Larribe (2008) tried to determine whether there was a sufficiently high correlation between the NMS and the EA business cycles, which would have been a reason for the NMS to quickly adopt the euro.

Stanisic (2013) concluded that there was a strong trend of convergence of the business cycles of the NMS with that of the Euro area.

Dizdarević and Volčjak (2012) argued that the business cycles of most NMS were not synchronized with the EA cycle and that these countries could have experienced some difficulties if they had joined the euro too soon.

Tomic and Demanuele (2017) concluded that Croatia's economic cycle was highly synchronized with the EA cycle.

Todorov (2013) analyzed the nominal convergence of the NMS, their fulfillment of the optimum currency area criteria and the experience of the NMA who had already adopted the euro.

Weimann (2003) inferred that the countries of Central and Eastern Europe (CEE) had a high degree of readiness for an EMU membership.

Damyanov and Stefanov (2010) analyzed the level of synchronization of Bulgaria's business cycle with the EA cycle for the period 1995-2009. During 1995-2002 Bulgaria did not form an optimal currency area with none one of the EMU member states and probably suffered serious negative effects from the introduction of the currency board. In 2002-2009 the synchronization of the Bulgarian economic cycle with the cycle of the EA considerably increased compared to the period 1995-2002.

Christos et al. (2007) found that all NMS had significantly increased the synchronization of their business cycles with that of the Euro area since the early 1990s.

Carmignani (2005) concluded that the degree of synchronization of national business cycles with the Euro area business cycle was weak in all NMS, with the exception of Hungary and Poland.

Matkowski and Prochniak (2004) inferred that the NMS converged with each other with the EA in terms of income levels and cyclical fluctuations.

Daianu et al. (2017) identified problems in the NMS competitiveness in terms of infrastructure, institutional development and innovation. It is recommended that the NMS adopt the euro after reaching a minimum of 75% of the EA average per capita GDP and after carrying out a series of structural reforms.

Van De Coevering (2003) concluded that structural convergence was progressing significantly more slowly than the nominal one and that the euro was not to be adopted before a country had achieved a high degree of structural convergence with the EA.

Frenkel and Nickel (2002) found that there were differences in the shocks and in the process of adapting to them in the EA and in the NMS.

According to Hallett and Richter (2012), there is a high degree of nominal convergence and a low degree of real convergence between the NMS and the EA, which causes a high

degree of synchronization of the short-term fluctuations and a low degree of synchronization of the long-term fluctuations of the economy.

Darvas et al. (2005) found that fiscal convergence (the convergence of the fiscal balance to GDP ratio) increased the synchronization of business cycles among countries both within the EU and the EA.

Rinaldi-Larribe (2008), Daianu et al. (2017), Eickmeier and Breitung (2005), Szeles and Marinescu (2010), Weimann (2003), Damyanov and Stefanov (2010) and Hallett and Richter (2012) argue that the euro should be adopted as soon as possible, while Brada, et al. (2005), Dizdarević and Volčjak (2012), Kontolemis and Ross (2005) and Van de Coevering (2003) claim that the NMS should not rush to enter EMU.

Todorov (2012, 2013 and 2014) and Todorov and Patonov (2012) consider that the adoption of the single European currency should take into account the individual specificities of each country and the changes that occurred in the EMU as a result of the debt crisis.

The reviewed studies may be classified according to different criteria – research methods, territorial scope, results, conclusions and recommendations.

According to research methods, the literature reviewed may be separated into two large groups – theoretical and empirical studies. Rinaldi-Larribe (2008), Van De Coevering (2003) and Todorov (2013) may be included in the group of theoretical research. The investigations of Frankel and Rose (1998), Kutun and Yigit (2005), Fidrmuc and Korhonen (2006), Zapodeanu (2012), Stanisic (2013), Dizdarević and Volčjak (2012), Matkowski and Prochniak (2004), Tomić and Demanuele (2017), Damyanov and Stefanov (2010), Christos et al. (2007), Darvas et al. (2005), Carmignani (2005), Daianu, et al. (2017), Frenkel and Nickel (2002) and Hallett and Richter (2012) can be considered empirical.

According to territorial scope, the reviewed research can be classified as studies on one country and studies on more than one country. The first group includes the investigations of Tomić and Demanuele (2017) and Damyanov and Stefanov (2010). The authors, who analyze more than one country, are Frankel and Rose (1998), Kutun and Yigit (2005), Fidrmuc and Korhonen (2006), Zapodeanu (2012), Stanisic (2013), Dizdarević and Volčjak (2012), Matkowski and Prochniak (2004), Christos et al. (2007), Darvas et al. (2005), Carmignani (2005), Daianu, et al. (2017), Van de Coevering (2003), Frenkel and Nickel (2002) and Hallett and Richter (2012).

According to their results, studies can be grouped into:

- Literature, which find a high degree of synchronization of the NMS business cycles with that of EA. Here are included Frankel and Rose (1998), Kutun and Yigit (2005), Fidrmuc and Korhonen (2006), Zapodeanu (2012), Stanisic (2013), Dizdarević and Volčjak (2012), Matkowski and Prochniak (2004), Tomić and Demanuele (2017), Damyanov and Stefanov (2010), Christos et al. (2007) and Darvas et al. (2005);
- Research, which show a low degree of convergence of the economic cycles of the NMS with the aggregate cycle of the EA – Carmignani (2005), Daianu et al. (2017), Van de Coevering (2003), Frenkel and Nickel (2002) and Hallett and Richter (2012).

According to the conclusions and recommendations they make, the reviewed literature sources can be divided into:

- Studies, which recommend that the NMS adopt the euro as soon as possible – Rinaldi-Larribe (2008), Daianu et al. (2017), Eickmeier and Breitung (2005), Szeles and Marinescu (2010), Weimann (2003), Damyanov and Stefanov (2010) and Hallett and Richter (2012);
- Analyzes according to which the NMS should not rush to enter the EMU – Brada et al. (2005), Dizdarević and Volčjak (2012), Kontolemis and Ross (2005) and Van de Coevering (2003);
- Research stating that the adoption of the single European currency should take into account the individual specificities of each country and the changes that occurred in the EMU as a result of the debt crisis – Todorov (2012, 2013 and 2014) and Todorov and Patonov (2012).

It should be considered that the results and the conclusions of the reviewed studies might have been influenced by their period of investigation, territorial scope and research methodology. For example, recent research found a higher degree of business cycle convergence between the NMS and the EA than earlier investigations, which may be due to the intensification of the commercial and financial relations between the NMS and the EA countries in the course of time. The empirical studies employ either least squares (LS) or vector autoregression (VAR) methodologies. This research has chosen a VAR approach because of the opportunity to explore the causal links between variables in short and in long run.

2. Empirical estimation of the degree of convergence of the NMS business cycles with the aggregate EA cycle

The degree of convergence of the NMS economic cycles with the EA aggregate cycle is empirically estimated by three indicators: percentage of coincident business cycle phases, percentage of coincident cyclical positions and correlation between the output gaps of the NMS and the EA. The analysis of the dynamics of the output gaps of the NMS and EA helps to determine the turning points (peaks and troughs), phases (contractions and expansions) and positions (inflationary and deflationary gaps) in their economic cycles. The dynamics of the GDP gaps of each NMS and the EA can be seen on figures in the Appendix. When determining the turning points, the rule is that there must be at least three and at most eight years between two peaks (two troughs). A phase from a peak to a trough is a contraction and a phase from a trough to a peak is an expansion. Positive output gaps are inflationary, and negative – deflationary. The turning points of the economic cycles of the NMS and the EA are shown in tables in the Appendix.

According to the indicator "percentage of coincident phases", the national cycles of Bulgaria, the Czech Republic and Hungary converged to the aggregate EA cycle, and those of Romania, Poland and Croatia diverged from it (see Table 1). For the first three countries, the percentage of coincident phases with EA increased in the period 2009-2017 compared

Durova, K. (2019). Are the New Member States Ready to Join the Euro Area? A Business Cycle Perspective.

to the period 2000-2008. The second three countries demonstrate the opposite trend – a decrease in the percentage of coincident phases with EA in 2009-2017 compared to 2000-2008.

The indicator "percentage of coincident cyclical positions" shows a convergence of the aggregate currency union cycle with the individual cycles of all NMS except for Romania (see Table 2). For Romania, the percentage of coincident cyclical positions with the EA was lower in the 2009-2017 period than in 2000-2008.

Over the period 2009-2017, there was an increase in the correlation of the output gaps of Bulgaria, the Czech Republic, Poland and Hungary with the EA output gap compared to the period 2000-2008. The opposite trend was observed in Romania and Croatia, whose output gaps were less correlated with the EA in the period 2009-2017 than in the period 2000-2008 (see Table 3).

Table 1

Percentage of coincident phases in the business cycles of the NMS and the EA

Year	2000 – 2008	2009 – 2017
Bulgaria	62,5	84,4
Romania	69,4	44,4
Czech Republic	83,3	86,1
Poland	87,5	78,1
Hungary	61,1	86,1
Croatia	94,4	72,2

Source: Own calculations based on Eurostat data

Table 2

Percentage of coincident positions in the business cycles of the NMS and the EA

Year	2000 – 2008	2009 – 2017
Bulgaria	67,5	87,5
Romania	66,7	55,6
Czech Republic	75	94,4
Poland	75	78,1
Hungary	58,3	72,2
Croatia	61,1	75

Source: Own calculations based on Eurostat data

Table 3

Correlation between the output gaps of the NMS and the EA

Year	2000 – 2008	2009 – 2017
Bulgaria	0,60	0,86
Romania	0,63	0,07
Czech Republic	0,75	0,87
Poland	0,64	0,86
Hungary	0,60	0,73
Croatia	0,72	0,62

Source: Own calculations based on Eurostat data

The aggregation of the results from the three indicators allows the NMS to be ranked according to the degree of synchronization of their business cycles with that of the EA. The economic cycle of the Czech Republic is the most synchronized with the currency union cycle, followed by the cycles of Bulgaria, Poland, Hungary, Croatia and Romania. It can be inferred that the Czech Republic, Bulgaria, Poland and Hungary have a sufficiently high degree of convergence of their business cycles with the EA for a successful membership in the currency union. The cycles of Croatia and Romania are not yet sufficiently synchronized with the EA cycle to allow a trouble-free adoption of the single European currency.

The strong synchronization of the economic cycles of the Czech Republic, Poland and Hungary with that of the EA can be explained by the high degree of real and structural convergence of these states with the countries of the monetary union. Nominal convergence (the fulfillment of the Maastricht criteria) and the peg of the Bulgarian lev to the euro are the main contributors to the high degree of similarity between the business cycles of Bulgaria and the EA. After the global crisis, the economic cycles of Croatia (according to two of the three indicators used) and Romania (according to all indicators) has diverged from the EA. In Croatia, divergence can be explained by the high level of government debt, the need for large-scale structural reforms in the economy and the existence of excessive macroeconomic imbalances, and for Romania – with the large fluctuations of the euro-leu exchange rates, the non-compliance with the convergence criterion for long-term interest rates and the political instability in the country (ECB Convergence Report, 2018).

3. Fiscal and monetary factors influencing the convergence of the NMS cycles with that of the EA

3.1. Stationarity, optimal lag length and estimation of the VAR models

The group unit root tests of Im, Pesaran and Shin, Dickey-Fuller and Phillips-Perron showed that the variables in the VAR model for each NMS were stationary (integrated of order zero), which required the application of an unrestricted vector autoregression (see Table 4).

Table 4

Group unit root tests of the variables in the VAR models of the separate NMS – probabilities

NMS	Im, Pesaran and Shin W-stat	ADF – Fisher Chi-square	PP – Fisher Chi-square
Null: Unit root (assumes individual unit root process)			
Bulgaria	0,0000	0,0000	0,0000
Romania	0,0000	0,0000	0,0000
Czech Republic	0,0000	0,0000	0,0000
Poland	0,0000	0,0000	0,0000
Hungary	0,0000	0,0000	0,0000
Croatia	0,0000	0,0000	0,0000

Source: Prepared by the author.

Durova, K. (2019). *Are the New Member States Ready to Join the Euro Area? A Business Cycle Perspective*.

The optimal lag length in the VAR model for each country has been selected on the basis of the Phillips-Perron criterion. For Bulgaria, the optimal number of lags is five, for Romania – three, for the Czech Republic – four, for Poland – six and for Hungary and Croatia – two (see Table 5).

Table 5

Optimal number of lags in the VAR models for the separate NMS according to the Phillips-Perron criterion

NMS	Optimal number of lags
Bulgaria	5
Romania	3
Czech Republic	4
Poland	6
Hungary	2
Croatia	2

Source: Prepared by the author.

3.1.1. Bulgaria

The fiscal and monetary determinants of the convergence of the Bulgarian cycle with the EA's cycle have been identified by a vector autoregression with the following variables: **BCS** – difference between the output gaps of Bulgaria and the EA; **FISC_BAL_DIF** – difference between the fiscal balances of Bulgaria and the EA; **FOREX_RES_BG** – foreign exchange reserves of Bulgaria (total assets of the Issue Department of the Bulgarian National Bank); **GOV_DEBT_DIF** – difference between government debt in Bulgaria and the EA; **GOV_DEP_BG** – government deposit on the balance sheet of the Issue Department of the Bulgarian National Bank; **INT_RATE_EA** – interest rate on the main refinancing operations of the European Central Bank; **MRR_DIF** – difference between minimum required reserve ratios in Bulgaria and the EA. The target variable is **BCS**.

The equation for the target variable **BCS** in the VAR model after the step-by-step elimination of the statistically insignificant variables is

$$(1) \text{ BCS} = 0.05*\text{FISC_BAL_DIF}(-1) + 0.07*\text{FISC_BAL_DIF}(-2) + 0.06*\text{FISC_BAL_DIF}(-3) + 0.06*\text{FISC_BAL_DIF}(-5) + 0.03*\text{FOREX_RES_BG}(-1) - 0.03*\text{FOREX_RES_BG}(-3) + 0.03*\text{FOREX_RES_BG}(-4) - 0.04*\text{FOREX_RES_BG}(-5) + 0.01*\text{GOV_DEBT_DIF}(-5) + 0.03*\text{GOV_DEP_BG}(-3) + 0.02*\text{GOV_DEP_BG}(-5) + 0.66*\text{INT_RATE_EA}(-1) - 0.94*\text{INT_RATE_EA}(-2) + 1.64*\text{INT_RATE_EA}(-3) - 1.07*\text{INT_RATE_EA}(-4) + 0.29*\text{MRR_DIF}(-2) + 0.34*\text{MRR_DIF}(-3) + 0.27*\text{MRR_DIF}(-5) - 8.01$$

The convergence of the economic cycle of Bulgaria with that of the EA is influenced by the lagged values of the following variables (see Table 6): difference between the fiscal balances in Bulgaria and the EA; foreign exchange reserves of Bulgaria; difference between government debt in Bulgaria and the EA; government deposit on the balance sheet of the Issue Department of the Bulgarian National Bank; interest rate on the main refinancing operations of the European Central Bank; difference between minimum required reserve ratios in Bulgaria and the EA. The empirical results in Table 1 confirm the importance of the Maastricht convergence criteria of fiscal deficit, government debt and interest rates for

the business cycle synchronization between Bulgaria and the EA. They also outline the options of macroeconomic management to influence the similarity of Bulgaria's cycle with that of the EA through traditional macroeconomic instruments (fiscal balance, minimum required reserve ratio) and through the specific features of the Bulgarian currency board arrangement (possibilities for discretionary monetary policy through the government deposit on the balance sheet of the Issue Department of the BNB).

Table 6
Standardized regression coefficients and probabilities in Equation (1)

Variable	Standardized regression coefficient	Probability
FICS_BAL_DIF(-1)	0.158398	0.0019
FICS_BAL_DIF(-2)	0.252337	0.0000
FICS_BAL_DIF(-3)	0.211233	0.0002
FICS_BAL_DIF(-5)	0.197884	0.0001
FOREX_RES_BG(-1)	1.174900	0.0000
FOREX_RES_BG(-3)	-1.129333	0.0075
FOREX_RES_BG(-4)	1.086920	0.0056
FOREX_RES_BG(-5)	-1.395361	0.0000
GOV_DEBT_DIF(-5)	0.249715	0.0151
GOV_DEP_BG(-3)	0.289618	0.0029
GOV_DEP_BG(-5)	0.160607	0.0384
INT_RATE_EA(-1)	0.869148	0.0063
INT_RATE_EA(-2)	-1.231307	0.0338
INT_RATE_EA(-3)	2.146101	0.0002
INT_RATE_EA(-4)	-1.392275	0.0000
MRR_DIF(-2)	0.350934	0.0090
MRR_DIF(-3)	0.417689	0.0075
MRR_DIF(-5)	0.340882	0.0113

Source: Prepared by the author

3.1.2. Romania

The fiscal and monetary determinants of the convergence of the Romanian cycle with that of the EA have been identified by a vector autoregression involving the following variables: **BCS** – the difference between the output gaps of Romania and the EA; **FISC_BAL_DIF** – difference between fiscal balances in Romania and EA; **GOV_DEBT_DIF** – difference between government debt in Romania and the EA; **INT_RATE_DIF** – difference between the base interest rates of the National Bank of Romania and the European Central Bank; **MRR_DIF** – difference between minimum required reserve ratios in Romania and the EA; **M3_DIF** – difference between the growth rates of the M3 monetary aggregate in Romania and the EA; **ER** – percentage change in the euro-leu exchange rate on the previous period. The target variable is **BCS**. Fiscal and debt variables have been calculated as a percentage of gross domestic product, but the monetary aggregate **M3** and the exchange rate – as a rate of change on the previous period.

The equation for the target variable **BCS** in the VAR model after the step-by-step elimination of the statistically insignificant variables is

Durova, K. (2019). *Are the New Member States Ready to Join the Euro Area? A Business Cycle Perspective.*

$$(2) \text{BCS} = 0.85 \cdot \text{BCS}(-1) - 0.23 \cdot \text{BCS}(-2) + 0.15 \cdot \text{ER}(-2) + 0.23 \cdot \text{GOV_DEBT_DIF}(-1) - 0.58 \cdot \text{GOV_DEBT_DIF}(-2) + 0.47 \cdot \text{GOV_DEBT_DIF}(-3) - 0.18 \cdot \text{INT_RATE_DIF}(-3) + 0.16 \cdot \text{M3_DIF}(-2) + 0.10 \cdot \text{MRR_DIF}(-3) + 5.61$$

Table 7

Standardized regression coefficients and probabilities in Equation (2)

Variable	Standardized regression coefficient	Probability
BCS(-1)	0.851073	0.0000
BCS(-2)	-0.227286	0.0606
ER(-2)	0.226859	0.0029
GOV_DEBT_DIF(-1)	0.365158	0.0631
GOV_DEBT_DIF(-2)	-0.979458	0.0009
GOV_DEBT_DIF(-3)	0.823842	0.0003
INT_RATE_DIF(-3)	-0.563853	0.0004
M3_DIF(-2)	0.298441	0.0010
MRR_DIF(-3)	0.181820	0.0689

Source: Prepared by the author

The business cycle synchronization between Romania and the EA is affected by the lagged values of the following explanatory variables: change of the euro-leu exchange rate; difference between government debt in Romania and the EA; difference between the base interest rates in Romania and the EA; difference between money supply growth in Romania and the EA (see Table 7). The validity of the Maastricht criteria for the exchange rate, government debt, interest rates and inflation in the case of Romania has been proven (the difference between money supply growth rates can be assumed as an approximation of the inflation differential). Romanian macroeconomic strategists can impact the convergence of the Romanian and EA cycles through the exchange rate and monetary policy (the base interest rate and the minimum required reserve ratio). The empirical results for Romania has not confirmed the hypothesis that under a floating exchange rate monetary policy is more effective than fiscal policy (the standardized coefficients before the government debt differences are higher in absolute terms than the standardized coefficients before the interest differential and the difference in the MRR).

3.1.3. Czech Republic

The fiscal and monetary determinants of the business cycle convergence between the Czech Republic and the EA have been identified by a vector autoregression with the following variables: **BCS** – difference between the Czech and EA output gaps; **FISC_BAL_DIF** – difference between fiscal balances in the Czech Republic and the EA; **GOV_DEBT_DIF** – difference between government debt in the Czech Republic and the EA; **INT_RATE_DIF** – difference between base interest rates of the Czech National Bank and the European Central Bank; **M3_DIF** – difference between the growth rates of the M3 monetary aggregate in the Czech Republic and the EA; **ER** – percentage change in the euro-krone exchange rate on the previous period. The target variable is **BCS**. Fiscal and debt variables

have been calculated as a percentage of gross domestic product but the monetary aggregate M3 and the exchange rate – as a rate of change on the previous period.

The equation for the target variable **BCS** in the VAR model after the step-by-step elimination of the statistically insignificant variables is

$$(3) \text{ BCS} = 0.66 \cdot \text{BCS}(-1) - 0.13 \cdot \text{ER}(-1) - 0.07 \cdot \text{ER}(-3) - 0.03 \cdot \text{GOV_DEBT_DIF}(-2) - 0.33 \cdot \text{INT_RATE_DIF}(-2) - 1.38$$

Table 8
Standardized regression coefficients and probabilities in Equation (3)

Variable	Standardized regression coefficient	Probability
BCS(-1)	0.680842	0.0000
ER(-1)	-0.283443	0.0001
ER(-3)	-0.165631	0.0095
GOV DEBT DIF(-2)	-0.119371	0.0987
INT RATE DIF(-2)	-0.177824	0.0382

Source: Prepared by the author

The convergence of the business cycle of the Czech Republic and the EA is impacted by the difference between the Czech government debt and the EA government debt, the difference between the base interest rates in the Czech Republic and the EA, and the fluctuations of the euro-krone exchange rate (see Table 8). The importance of the Maastricht criteria for the exchange rate, government debt and interest rates has been proven. In the case of the Czech Republic, the hypothesis of a higher efficiency of monetary policy compared to fiscal policy under a floating exchange rate has been confirmed empirically (the standardized coefficient before the interest differential is higher in absolute value than the standardized coefficient before the government debt difference).

3.1.4. Poland

The fiscal and monetary determinants of the convergence of the Polish cycle with that of the EA have been identified by a vector autoregression involving the following variables: **BCS** – difference between Polish and EA's output gaps; **FISC_BAL_DIF** – difference between fiscal balances in Poland and EA; **GOV_DEBT_DIF** – difference between government debt in Poland and the EA; **INT_RATE_DIF** – difference between base interest rates of the National Bank of Poland and the European Central Bank; **MRR_DIF** – difference between minimum required reserve ratios in Poland and the EA; **M3_DIF** – difference between the rate of growth of the M3 monetary aggregate in Poland and the EA; **ER** – percentage change in the euro-zloty exchange rate on the previous period. The target variable is **BCS**. Fiscal and debt variables have been calculated as a percentage of the gross domestic product but the monetary aggregate M3 and the exchange rate – as a rate of change on the previous period.

The equation for the target variable **BCS** in the VAR model after the step-by-step elimination of the statistically insignificant variables is

Durova, K. (2019). *Are the New Member States Ready to Join the Euro Area? A Business Cycle Perspective.*

$$(4) \quad BCS = 0.13*ER(-1) + 0.09*ER(-3) + 0.15*FISC_BAL_DIF(-1) + 0.30*INT_RATE_DIF(-1) - 1.32$$

Table 9

Standardized regression coefficients and probabilities in Equation (4)

Variable	Standardized regression coefficient	Probability
ER(-1)	0.575664	0.0000
ER(-3)	0.389100	0.0001
FISC BAL DIF(-1)	0.180623	0.0490
INT RATE DIF(-1)	0.370337	0.0001

Source: Prepared by the author.

The similarity of the economic cycle of Poland with that of the EA is affected by the lagged values of the difference between fiscal balances in Poland and the EA, the difference between base interest rates in Poland and the EA and the change of the euro-zloty exchange rate (see Table 9). The validity of the Maastricht criteria for the exchange rate, budget deficit and interest rates has been proven. In the case of Poland, the hypothesis that, under a floating exchange rate, monetary policy is more effective than fiscal policy has been empirically confirmed (the standardized coefficient before the interest rate differential is higher in absolute value than the standardized coefficient in front of the difference in fiscal balances).

3.1.5. Hungary

The fiscal and monetary determinants of the convergence of the Hungarian cycle with that of the EA have been identified by a vector autoregression with the following variables: **BCS** – difference between Hungarian and EA's output gaps; **FISC_BAL_DIF** – difference between fiscal balances in Hungary and the EA; **GOV_DEBT_DIF** – difference between government debt in Hungary and the EA; **INT_RATE_DIF** – difference between base interest rates of the National Bank of Hungary and the European Central Bank; **MRR_DIF** – difference between minimum required reserve ratios in Hungary and the EA; **M3_DIF** – difference between the rate of growth of the M3 monetary aggregate in Hungary and the EA; **ER** – percentage change in the euro-forint exchange rate on the previous period. **BCS** is the target variable. The fiscal and debt variables are calculated as a percentage of GDP, but the monetary aggregate **M3** and the exchange rate – as a rate of growth on the previous period. The target variable is **BCS**. Fiscal and debt variables have been calculated as a percentage of gross domestic product but the monetary aggregate M3 and the exchange rate – as a rate of change on the previous period.

The equation for the target variable **BCS** in the VAR model after the step-by-step elimination of the statistically insignificant variables is

$$(5) \quad BCS = 0.72*BCS(-1) + 0.06*ER(-2) + 0.06*GOV_DEBT_DIF(-1) - 0.08*GOV_DEBT_DIF(-2) - 0.36*INT_RATE_DIF(-1) + 0.35*INT_RATE_DIF(-2) + 0.12*MRR_DIF(-1) - 0.34$$

Table 10
Standardized regression coefficients and probabilities in Equation (5)

Variable	Standardized regression coefficient	Probability
BCS(-1)	0.730689	0.0000
ER(-2)	0.181972	0.0149
GOV DEBT DIF(-1)	0.290923	0.0683
GOV DEBT DIF(-2)	-0.389613	0.0190
INT RATE DIF(-1)	-0.736442	0.0010
INT RATE DIF(-2)	0.716736	0.0008
MRR DIF(-1)	0.139803	0.0901

Source: Prepared by the author

The convergence of Hungary's economic cycle with that of the EA is impacted by lagged values of the difference between the government debt in Hungary and the EA, the difference between the base interest rates in Hungary and the EA and the change in the euro-forint exchange rate. The validity of the Maastricht criteria for the exchange rate, government debt and interest rates has been confirmed. In the case of Hungary, an empirical confirmation has found the hypothesis that monetary policy is more effective than fiscal policy under a floating exchange rate (the standardized coefficients in front of the interest rate differential are higher in absolute terms than the standardized coefficients in front of the difference in government debt).

3.1.6. Croatia

The fiscal and monetary determinants of the convergence of the Croatian cycle with that of the EA have been identified by a vector autoregression with the following variables: **BCS** – difference between Croatian and EA's output gaps; **FISC_BAL_DIF** – difference between fiscal balances in Croatia and the EA; **GOV_DEBT_DIF** – difference between government debt in Croatia and the EA; **INT_RATE_DIF** – difference between base interest rates of the National Bank of Croatia and the European Central Bank; **MRR_DIF** – difference between minimum required reserve ratios in Croatia and the EA; **M3_DIF** – difference between the rates of growth of the M3 monetary aggregate in Croatia and the EA; **ER** – percentage change in the euro-forint exchange rate on the previous period. The target variable is **BCS**. Fiscal and debt variables have been calculated as a percentage of gross domestic product but the monetary aggregate M3 and the exchange rate – as a rate of change on the previous period.

The equation for the target variable **BCS** in the VAR model after the step-by-step elimination of the statistically insignificant variables is

$$(6) \text{ BCS} = 0.45 \cdot \text{BCS}(-1) - 0.04 \cdot \text{GOV_DEBT_DIF}(-2) - 0.36 \cdot \text{INT_RATE_DIF}(-2) + 1.12$$

Table 11

Standardized regression coefficients and probabilities in Equation (6)

Variable	Standardized regression coefficient	Probability
BCS(-1)	0.453001	0.0000
GOV DEBT DIF(-2)	-0.318037	0.0030
INT RATE DIF(-2)	-0.543040	0.0000

Source: Prepared by the author

The similarity of the economic cycles of Croatia and the EA is influenced by the difference between government debt in Croatia and the EA and the difference between base interest rates in Croatia and the EA. The importance of interest rate and debt convergence for the synchronization of the Croatian and EA's cycles has been proven. The absolute value of the standardized coefficient in front of the interest rate differential is higher than the absolute value of the standardized coefficient in front of the debt differential, which supports the hypothesis of more efficient monetary than fiscal policy under a floating exchange rate.

3.2. Diagnostics of the equations for the target variable BCS in the VAR models

The coefficients of determination of the target equations for individual NMS vary from 0.58 for Poland to 0.95 for Bulgaria (see Table 12). They show what percentage of the change of the dependent variable (**BCS**) can be explained by changes in the independent variables in the target equations.

Table 12

Coefficients of determination and probabilities of the F-statistic of the target equations for individual NMS

NMS	Coefficient of determination	Probability of the F-statistic
Bulgaria	0.954556	0.000000
Romania	0.796991	0.000000
Czech Republic	0.834059	0.000000
Poland	0.584322	0.000000
Hungary	0.791661	0.000000
Croatia	0.686437	0.000000

Source: Prepared by the author

The probability of the F-statistic (0.00) for all NMS gives reason to accept the alternative hypothesis of adequacy of the models used (see Table 12). However, it should be specified that this does not mean that the models are the best possible, but simply reflect adequately the relationship between the dependent and the independent variables.

The probability of the Jarque-Bera statistics supports the null hypothesis of a normal distribution of residuals in the target equations for Bulgaria, Romania, the Czech Republic and Croatia. In the target equations for Poland and Hungary, the alternative hypothesis for the absence of normal distribution of residuals is accepted.

Table 13

Tests for normal distribution of residuals in the target equations for individual NMS

NMS	Jarque-Bera Probability
Bulgaria	0,598912
Romania	0,464630
Czech Republic	0,637960
Poland	0,000007
Hungary	0,000395
Croatia	0,813933

Source: Prepared by the author

Table 14

Serial correlation tests on the residuals in the target equations for individual NMS

NMS	Probability Chi-Square
Bulgaria	0.0361
Romania	0.4891
Czech Republic	0.7538
Poland	0.4126
Hungary	0.0891
Croatia	0.1672

Source: Prepared by the author

The null hypothesis for the absence of serial correlation of residuals is confirmed at a critical level of significance of 10% for the target equations of Romania, the Czech Republic, Poland and Croatia, at a critical level of 5% for the target equation of Hungary and at a critical level of 1% for the target equation of Bulgaria (see Table 14).

Table 15

Heteroscedasticity tests on the residuals of the target equations for individual NMS

NMS	Probability Chi-Square
Bulgaria	0.6539
Romania	0.0750
Czech Republic	0.4957
Poland	0.6425
Hungary	0.3801
Croatia	0.0567

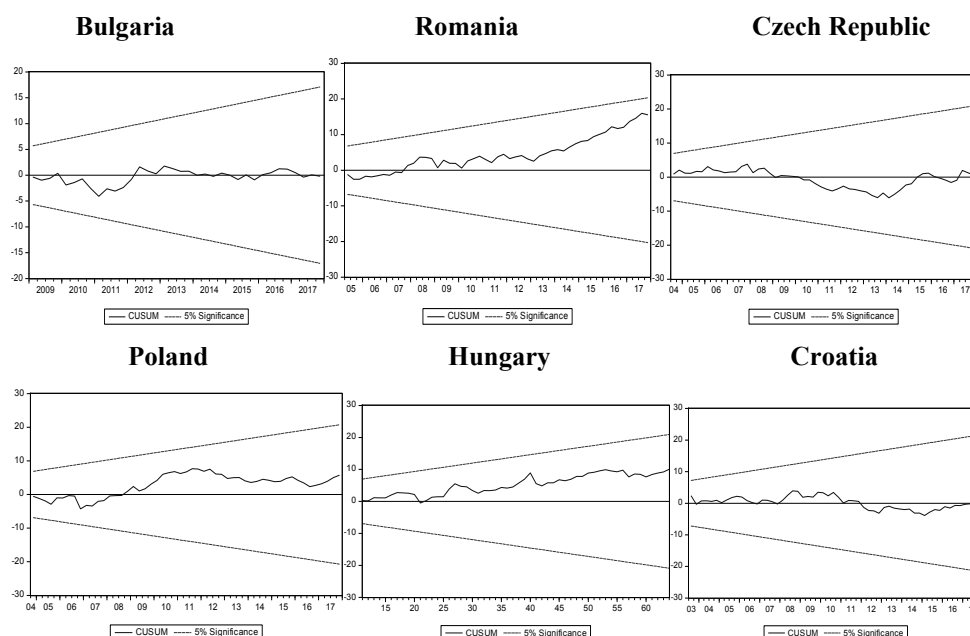
Source: Prepared by the author

The results of the heteroscedasticity tests on the residuals in the target equations of Bulgaria, the Czech Republic, Poland and Hungary support the null hypothesis of lack of heteroscedasticity at a critical level of significance of 10%. For the target equations of Romania and Croatia, the null hypothesis for the absence of heteroscedasticity of the residuals is accepted at a critical level of significance of 5%.

The target equations of all NMS are dynamically stable as actual CUSUM values are within the confidence interval at a 5% level of significance (see Figure 1).

Figure 1

Tests for dynamic stability of the target equations for individual NMS (CUSUM)



Source: Prepared by the author

The results of the Pairwise Granger Causality Tests show that in the short term at a critical level of significance of 10%:

- In Bulgaria there are causal links from the difference between the fiscal balances of Bulgaria and the EA, the foreign exchange reserves of Bulgaria, the government deposit in the Issue Department of the BNB, the base interest rate in the EA and the difference between the minimum required reserve ratios in Bulgaria and the EA to **BCS**;
- For Romania, no independent variables cause **BCS**;
- For the Czech Republic there is causality from the euro-krone exchange rate to **BCS**;
- For Poland, the euro-zloty exchange rate causes **BCS**;
- For Hungary, there are causal links from the difference between the government debt in Hungarian and the EA and the difference between the base interest rates in Hungary and the EA to **BCS**;

- For Croatia, there is a causality from the difference between the base interest rates in Croatia and the EA to **BCS**.

The results of the Granger Causality / Block Exogeneity Wald Tests show that in the long run at a critical level of significance of 10%:

- For Bulgaria, there are causal links from the difference between fiscal balances in Bulgaria and the EA, the foreign exchange reserves of Bulgaria, the base interest rate in the EA and the difference between the minimum required reserve ratios in Bulgaria and the EA to **BCS**;
- For Romania, the difference between the base interest rates in Romania and the EA and the difference between the money supply growth rates in Romania and the EA cause **BCS**;
- There is causality in the Czech Republic from the euro-krona exchange rate to **BCS**;
- For Poland there are no causal links from the independent variables to **BCS**;
- For Hungary, the difference between the base interest rates in Hungary and the EA, the difference between government debt in Hungary and the EA and the change in the forint exchange rate cause **BCS**;
- For Croatia there is causality from the difference between the base interest rates in Croatia and the EA to **BCS**.

Conclusions

The empirical estimation of the degree of convergence of the NMS economic cycles with the EA aggregate cycle by three indicators – percentage of coincident cyclical phases, percentage of coincident cyclical positions, and correlations between output gaps allows NMS to be ranked according to the degree of synchronization of their business cycles with the monetary union as follows: Czech Republic, Bulgaria, Poland, Hungary, Croatia, Romania. The top four countries in this ranking – the Czech Republic, Bulgaria, Poland and Hungary – have a high degree of business cycle similarity with EA, which would allow them to successfully join the EMU. The Czech Republic, Poland and Hungary are excellent in the real, and Bulgaria in the nominal convergence with the EA, so the close proximity of the four countries' cycles to that of EMU is not surprising. Fixing the Bulgarian lev to the euro has also contributed to increasing the similarities between the national cycle of Bulgaria and the aggregate cycle of the EA. Under a fixed exchange rate, the convergence of business cycles is facilitated because the economic effects from the Euro area directly flow into Bulgaria through different channels – interest rates, foreign direct investment, etc. The nominal exchange rate cannot be used as an absorber of shocks from the EA and these shocks are absorbed by other macroeconomic variables. The smaller the fluctuations in the exchange rate, the higher the synchronization of economic cycles.

Croatia and Romania have not yet achieved a sufficiently high degree of convergence of their business cycles with the aggregate EA cycle which would not allow a smooth

adoption of the single European currency. Moreover, the cycles of the two countries have reduced their likeness to the EMU cycle after the global crisis (2009-2017) in comparison with the pre-crisis period (2000-2008) – Croatia according to two, and Romania according to all three indicators used to assess the similarity of economic cycles. In Croatia, the high indebtedness of the government, the need for large-scale structural reforms in the economy and the presence of excessive macroeconomic imbalances contribute to the divergence of the business cycle from that of the EA. In Romania divergence from the EA business cycle can be attributed to the volatility of the euro-leu exchange rate, the lack of interest rate convergence and the political instability in the country (ECB Convergence Report, 2018).

The empirical analysis in section three confirms the importance of the fulfillment of the Maastricht criteria for the convergence of the economic cycles of the NMS with that of the EA. The hypothesis of higher efficiency of the monetary policy compared to fiscal policy under a floating exchange rate is confirmed in the cases of Poland, the Czech Republic, Hungary and Croatia, but not in the case of Romania. Possible reasons for the rejection of this hypothesis in Romania are the serious institutional changes and the political instability in recent years that may create structural breaks in time series and alter the nature of the links between macroeconomic variables.

It should be considered that the above-stated conclusions are based solely on the criterion „degree of business cycle synchronization” of the optimum currency area theory. The present study does not claim to be comprehensive as it does not include the remaining criteria of the optimum currency area theory, the compliance with the Maastricht convergence criteria and the requirements imposed in recent years as a result of the EA debt crisis (lack of excessive macroeconomic imbalances and a Banking Union membership). In addition to the above-mentioned economic criteria, there are also political motives that play an important role in deciding whether a country to join a currency union or not. Bulgaria explicitly declared its intention to adopt the single European currency, but this declaration was reluctantly accepted in Frankfurt and Brussels. For the time being, Poland, the Czech Republic, Hungary, Croatia and Romania do not want to give up their autonomous monetary and exchange rate policies and are in not in a hurry to join ERM II and the EA.

This study has the following contributions:

- A new combination of indicators has been employed to empirically estimate the degree of similarity between the business cycles of the NMS and the EA;
- The NMS has been ranked according to the degree of convergence of their economic cycles with that of the EA. It has been found out which of them are ready to adopt the euro on the basis of business cycle synchronization with the EA;
- The importance of the Maastricht criteria for the business cycle similarity between the NMS and the EA has been confirmed by including approximations of the Maastricht criteria as explanatory variables in the VAR models;
- The hypothesis that monetary policy is more effective than fiscal policy under a floating exchange rate has been tested for five NMS – the Czech Republic, Poland, Hungary, Romania and Croatia.

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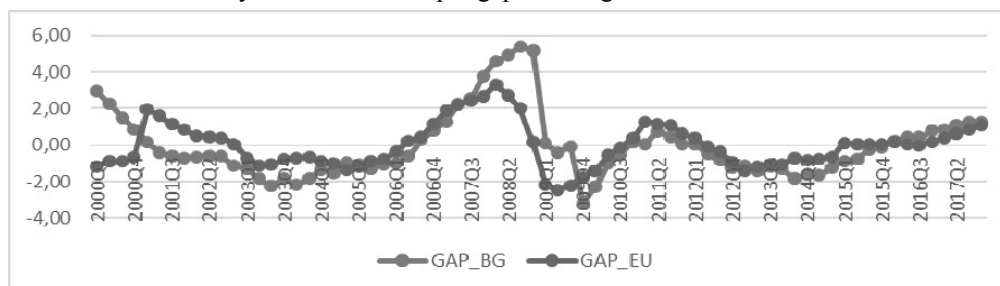
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Appendix

Figure A1

Dynamics of the output gaps of Bulgaria and the EA



Source: Own calculations based on Eurostat data

Table A1

Turning points of the business cycle of Bulgaria

Peaks	2000 – Quarter 1	2008 – Quarter 3	2011 – Quarter 2	2017 – Quarter 4
Troughs	2003 – Quarter 3	2009 – Quarter 4	2014 – Quarter 1	

Source: Own calculations based on Eurostat data

Table A2

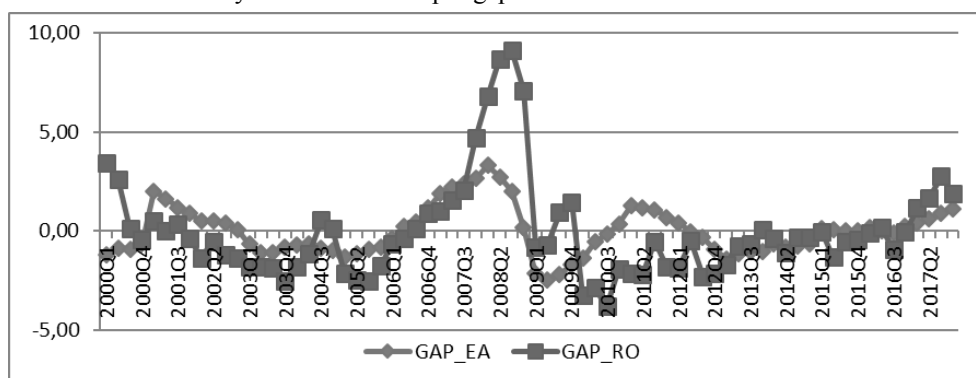
Turning points of the business cycle of the EA

Peaks	2001 – Quarter 1	2008 – Quarter 1	2011 – Quarter 1	2017 – Quarter 4
Troughs	2000 – Quarter 1	2005 – Quarter 1	2009 – Quarter 2	2013 – Quarter 1

Source: Own calculations based on Eurostat data

Figure A2

Dynamics of the output gaps of Romania and the EA



Source: Own calculations based on Eurostat data

Table A3

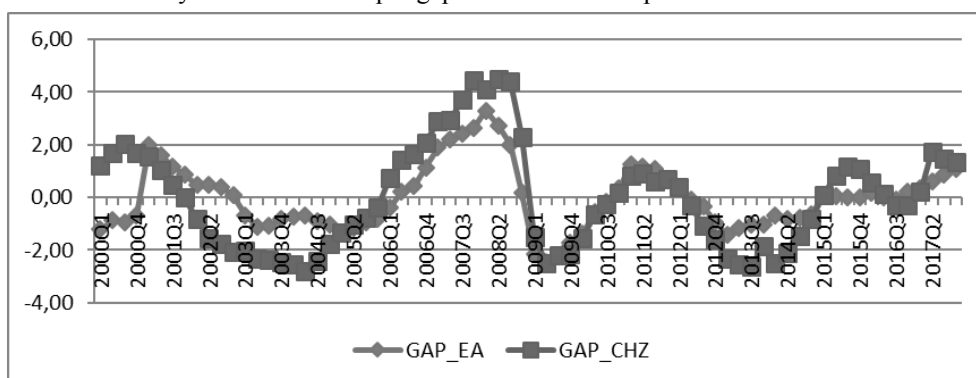
Turning points of the business cycle of Romania

Peaks	2000 – Quarter 4	2008 – Quarter 2	2011 – Quarter 3	2017 – Quarter 3
Troughs	2005 – Quarter 1	2009 – Quarter 3	2014 – Quarter 3	

Source: Own calculations based on Eurostat data

Figure A3

Dynamics of the output gaps of the Czech Republic and the EA



Source: Own calculations based on Eurostat data

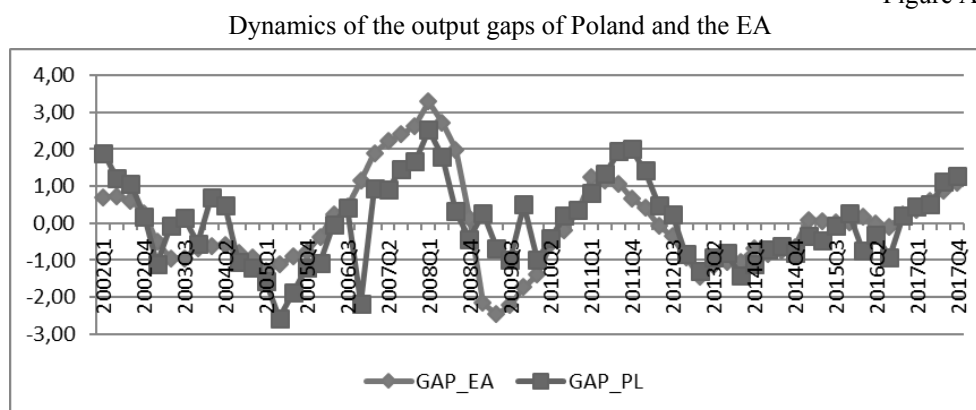
Table A4

Turning points of the business cycle of the Czech Republic

Peaks	2000 – Quarter 3	2008 – Quarter 2	2011 – Quarter 2	2017 – Quarter 2
Troughs	2004 – Quarter 2	2009 – Quarter 2	2013 – Quarter 3	

Source: Own calculations based on Eurostat data

Figure A4



Source: Own calculations based on Eurostat data

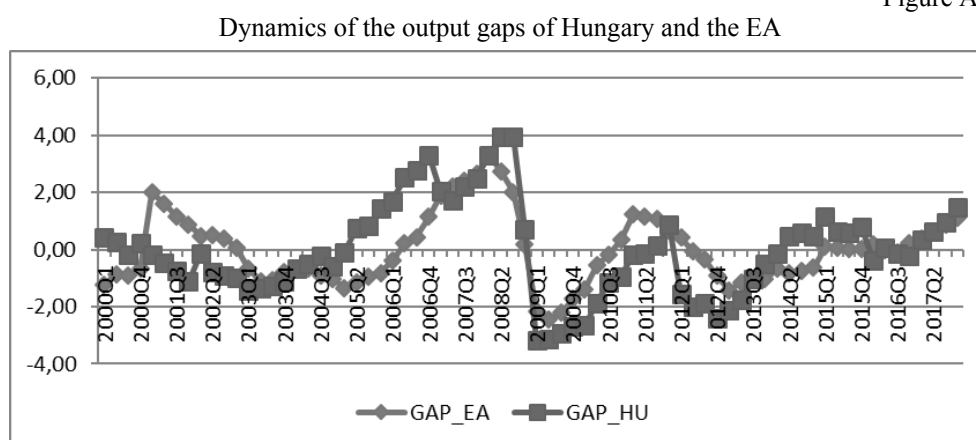
Table A5

Turning points of the business cycle of Poland

Peaks	2002 – Quarter 1	2008 – Quarter 1	2011 – Quarter 4	2017 – Quarter 4
Troughs	2005 – Quarter 2	2010 – Quarter 1	2013 – Quarter 4	

Source: Own calculations based on Eurostat data

Figure A5



Source: Own calculations based on Eurostat data

Table A6

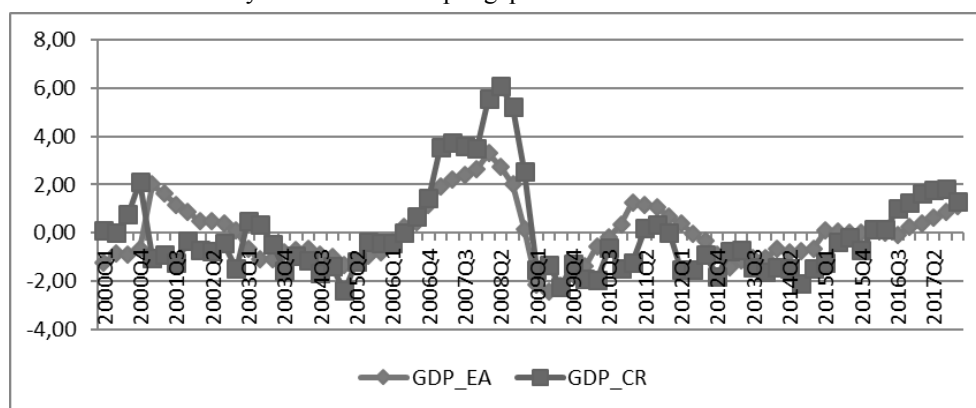
Turning points of the business cycle of Hungary

Peaks	2000 – Quarter 1	2008 – Quarter 3	2011 – Quarter 4	2017 – Quarter 4
Troughs	2003 – Quarter 1	2009 – Quarter 1	2012 – Quarter 4	

Source: Own calculations based on Eurostat data

Figure A6

Dynamics of the output gaps of Croatia and the EA



Source: Own calculations based on Eurostat data

Table A7

Turning points of the business cycle of Croatia

Peaks	2000 – Quarter 4	2008 – Quarter 2	2011 – Quarter 3	2017 – Quarter 3
Troughs	2005 – Quarter 1	2009 – Quarter 3	2014 – Quarter 3	

Source: Own calculations based on Eurostat data