THE IMPACT OF DEMAND AND SUPPLY SHOCKS FROM EMU ON BUSINESS CYCLES OF CENTRAL AND EASTERN EUROPEAN COUNTRIES[1]

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ABSTRACT

This paper aims at analysing correlation of demand and supply shocks between the EMU and the CEECs in order to see whether there is some degree of business cycles coordination between them. The main interest will be to investigate the impact on Croatia and compare it with other CEECs. Croatia will be of interest in this paper since there is a lack of empirical research on this topic which include Croatia in their sample. Information on the correlation of demand and supply shocks between the European monetary union and CEECs is important if a country wants to join a monetary union, since synchronisation of business cycles and policy coordination will have significant impact on willingness to enter to the monetary union (except if the decision is political one). And since Croatia has started its road towards the EU, it should be expected that Croatia will join the EMU, since there is no opt out clause for new members. In order to gather results, supply and demand shocks are extracted from data using Blanchard and Quah (1989) methodology and then correlations of shocks between EMU and CEECs are calculated as well as size of shocks and speed of adjustments. Results indicate that Croatia is at the moment far from being ready for the common monetary policy with the EMU, while among other CEE countries Slovenia and Latvia, which in fact first applied for the EMU, have the closest connection of their business cycle with the EMU.

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1. Introduction

The primary objective of the paper is to better understand business cycle synchronisation between the European monetary union and central and eastern European countries, with special emphasis on Croatia. Research will be conducted based on the output and inflation data from 1995 until 2006 using a bivariate Blanchard – Quah type structural vector autoregression (SVAR) decomposition of supply and demand shocks. Then correlation of shocks between the euro area and individual countries will be calculated, as well as size of shocks and speed of adjustments.

This research will shed light on the question how close are CEE countries to the old EU members in terms of business cycle synchronisation. The more the shocks are correlated, the easier it is to conduct monetary policy that is suitable to all members. Idiosyncratic shocks would indicate that a country would be better of having its own independent monetary policy with which it could alleviate the adverse effects of the underlying shocks.

Croatia is of interest to this study since there is a lack of empirical research on this topic that includes Croatia. Since Croatia has started its road towards the EU, it should be expected that Croatia will join the EMU, since there is no opt out clause for the new members.[2] It is of interest to determine how connected Croatian and EMU's business cycles are and hence whether the future Croatian adoption of euro would be of benefit to Croatia.[3]

All of this will help to better understand the Croatian (and CEECs) position with respect to the EMU. The problem still remains, however, that there is no widely accepted algorithm or index which would indicate unambiguously whether a country should join a common currency area or not. Business cycle analysis provides only a partial answer.

Results reveal that Slovenia and Latvia should benefit the most from the common monetary policy of the ECB, or rather, we can say that they should experience the smallest adjustment cost among CEE countries. According to this study, Croatia is far from having a correlated business cycle with the euro area. With further economic development and integration with

[2] Technically, if a country never fulfils the Maastricht criteria, it can stay out of European monetary union forever.
[3] We have to bear in mind, however, that this is only one part of the cost-benefit calculation.

the EU, however, we can expect correlation increase, moving Croatia in the direction of embracing the common monetary policy within the euro area.

This paper differs form the rest of the literature not just by examining the position of Croatia, but also in the following key issues. In exploring some characteristics of the data before going to the supply and demand shocks analysis instead of correlating raw data of inflation and GDP growth between the euro area and individual countries, such as Bayoumi and Eichengreen (1993),[4] we correlated their cyclical components. This is important because in this way we removed trend components from the data. Since the cyclical component of GDP can be viewed as GDP gap, correlation of cyclical components can tell us how expansions and recessions are correlated between the euro area and the individual country. Second, when we calculated correlation coefficients between the euro area and one of its members, we calculated the euro area aggregate without a country with which correlations are being made (unlike for example Fidrmuc and Korhonen, 2003 and Frenkel and Nickel, 2002). This is important because otherwise a part of the correlation would come from the fact that we are correlating a country with itself and the rest of the euro area. By excluding the country from the euro area aggregate, we were able to produce true correlations.

2. Short overview of selected literature

In Europe, but also in other parts of the world, in recent time there has been growing interest in monetary unions. There are many examples where a country decided to abandon its currency and adopt a different one. The largest experiment of this type was the formation of European monetary union. For that reason researchers all over the world became interested again in the determination of optimum currency areas. A similarity of business cycles is one of the key criteria for testing if certain countries or regions form an optimum currency area. This is very important for the new EU members as well as for 3 old members and prospective future members.

If a common currency area is hit by an asymmetric shock, affecting only one part of it (i.e. correlation of shocks between regions is low), it is necessary that there is some sort of

[4] Bayoumi and Eichengreen (1993) used Germany as a standard of comparison.

mechanism to help the affected area adjust. This will decrease the costs of having the same currency and therefore the same monetary policy. Insurance mechanisms can be income transfers, either through social transfers or through financial markets or adjustment mechanisms, such as flexible prices and wages as well as labour mobility.

A very important paper on the correlation of business cycles is Bayoumi and Eichengreen (1993), who employed the methodology from Blanchard and Quah (1989) in order to identify demand and supply shocks. They are interested in whether the European monetary unification that was scheduled for the second part of the '90s was justifiable by economic reasoning. As a benchmark they have the USA, which for the purpose of this paper was divided into 8 regions. Their findings show that countries in the EU can be divided in two groups: a "core" which is characterised by relatively symmetric shocks and correlated business cycles, and a "periphery" which is characterised by loosely correlated shocks. According to that research, the "core" countries were Germany, France, Belgium, the Netherlands, Denmark and Luxemburg, while the "periphery" countries were comprised of the UK, Italy, Spain, Portugal, Ireland and Greece. They showed, however, that supply and demand shocks tend to be more highly correlated in the USA than in the EU. Bayoumi and Eichengreen (1993) also explored the size of shocks and the speed of adjustment and concluded that shocks tended to be larger in the "periphery" countries while the "core" had somewhat higher speed of adjustment to shocks. Their findings indicate that the euro area could have more difficult start than if shocks were more correlated as in the USA.

In investigating business cycle synchronisation in the "old" EU countries, Boone (1997) and Bayoumi and Eichengreen (1996), among others, have shown that periphery countries have less synchronised business cycles than the core EU countries. This could be very important for new members, as well as Croatia, since most of these countries are even more on the periphery then the "old" EU periphery countries, such as Greece, Portugal and Spain. It seems that the most advanced new members, however, are showing more synchronised business cycles with the core countries then the "old" periphery members (e.g. Darvas and Szapary, 2004). This is good news for Croatia, because this means that even if Croatia does not now have business cycles that are closely synchronised with the EMU, further economic development and integration within EU should lead Croatia in that direction.

Since central and eastern European countries started the accession process to the European Union, economists have been interested in how their economic structures can cope with the more developed western European economic structures. The reason for this interest is that the new member states have no opt out clause. They will sooner or later have to adopt the euro and cope with a common monetary policy. In order to respond well to the same currency and common monetary policy, it is desirable to satisfy at least some of the OCA criteria including similarity of shocks and business cycles. Moreover, some of the countries that joined the EU in the last round of enlargement are already rushing to enter the euro area and some have already entered. Even though formal requirements are the Maastricht criteria, the more important question is how a common currency and common monetary policy will affect them. For that reason it is necessary to explore the similarities of central and eastern European business cycles with euro area's and to find out whether future members of the euro area would benefit from adopting the euro.

Frenkel and Nickel (2002) use structural vector autoregression in order to compare shocks between the euro area and central and eastern European countries. Using data for quarterly output and prices for a total of 21 countries from 1993 until 2001, they find that there are still differences in the shocks and adjustment processes between the euro area and many central and eastern European countries. On the other hand, they find that more advanced CEE countries (such as Hungary, Estonia, Latvia and Slovenia) experience shocks and adjustments to them that are fairly similar to some euro area countries.

Boone and Maurel (1999) study whether business cycle fluctuations in central and eastern European countries[5] are close enough to euro area's that a common monetary policy would not prevent the success of structural reforms, but rather enhance it by favouring the emergence of a sound macroeconomic environment. In order to test this, they used two criteria: the percentage of domestic business cycles explained by a common German or EU shock and the correlation of the domestic impulse responses to this shock with the EU member countries' impulse responses. Results show that there is a correlation between German and CEE countries' business cycles as well as a lower, but still positive, correlation between EU and CEE countries' business cycles.

[5] CEE countries in the sample include Czech Republic, Hungary, Poland and Slovak Republic.

Darvas and Szapáry (2004) are also interested in the degree of business cycle synchronisation between CEE countries[6] and the euro area. Unlike many papers which use total GDP or industrial production in dealing with business cycle synchronisation, Darvas and Szapáry (2004) want to see below the surface and study major expenditure and sectoral components of GDP. Hungary, Poland and Slovenia show the most synchronised business cycles with the EMU in the region, while the Baltic countries are not synchronised at all. The authors explain the lack of synchronisation of Baltic countries with the shocks they experienced during the Russian crisis. On the other hand, the authors find quite remarkable that the most synchronised CEE countries with the EMU were able to restructure their production and orient their exports toward the EU, which then led to higher correlation with the euro area business cycle. They assume that privatisation and FDI inflows played a central role in that process.

Benczúr and Rátfai (2005) investigate comovements among output and other major real and nominal variables in 12 CEE countries and find that fluctuations are higher than in typical industrial countries. Traistaru (2004) finds that business cycles in Hungary, Poland and Slovenia are most correlated with the economic activity in the euro area. Belullo, Šonje and Vrbanc (2000) investigate whether central Europe has similar business cycles with Germany. Results show that there exist a close correlation of business cycles between central Europe and Germany.

Fidrmuc and Korhonen (2003) continue the analysis of Bayoumi and Eichengreen (1993) in a way that included CEE countries instead of regions of the USA. Their benchmark is the euro area, so they implicitly assume that the euro area is an optimum currency area and they want to determine whether the former accession countries belong to it. Results show that Hungary and Estonia have the most correlated supply shocks with the euro area, which the authors explain them having the highest FDI per capita inflows among former accession countries and extensive trade relations with the countries of the euro area. The degree of correlation for the other CEE countries is lower, including that for many advanced transition countries such as Slovenia and the Czech Republic.

[6] CEE countries in the sample include Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland Slovak Republic and Slovenia.

A meta-analysis of the business cycle correlations between the euro area and the transition countries (Fidrmuc and Korhonen, 2004) suggests that Hungary, Poland and Slovenia have already achieved a relatively high degree of business cycle synchronization with the euro area's business cycle.[7] Moreover, these countries demonstrated the correlation of their business cycles with the euro area comparable to the euro area's core members. They also show that Bulgaria and Romania demonstrate a lower, but positive correlation of their business cycles with the EU. Croatia was not included in their analysis due to the fact that majority of literature does not refer to it.

3. Methodology, data and introductory facts

In this paper we examine supply and demand shocks in order to determine to what extent Croatia and other CEE countries have similar structure to the euro area. In order to do this, the methodology from Blanchard and Quah (1989) as well as Bayoumi and Eichengreen (1993) are followed. Unlike Blanchard and Quah (1989), who used GNP and unemployment series in their analysis, we use GDP and prices, because this will enable us to interpret results using aggregate supply and demand model as in Bayoumi and Eichengreen (1993).

Blanchard and Quah (1989) realised that more than one disturbance can affect macroeconomic series such as GDP. Hence, it is possible to impose *a priori* restrictions on the response to each of the disturbances. Even though it is possible to have more restrictions, in this paper we focus on only two: demand disturbances (shocks), which have only a permanent effect on prices, and supply disturbances (shocks), which have permanent effect both on prices and GDP. The effect of permanent change in output due to supply shocks and temporary due to demand shocks are used to decompose a structural VAR as suggested by Blanchard and Quah (1989), while the effects of supply and demand shocks on prices are viewed as over-identifying restriction (as in Bayoumi and Eichengreen, 1993).

[7] In the earlier paper they conducted their own analysis, which showed that Slovenia has a lower degree of correlation with the euro area. In this paper they used results from the existing papers in order to see which countries the majority of literature considers to be the most synchronised with the euro area, and Slovenia is one of them.

Data

The data used in this paper are quarterly nominal and real GDP obtained from Eurostat, except for Croatia, where data are obtained from Croatian Central Bureau of Statistics.[8] Instead of using change in the CPI as a measure of inflation, we used the change in the implicit GDP deflator, which is calculated as the ratio of nominal to real GDP. The reason for not using the CPI as a measure of inflation is that the CPI reflects only consumption prices while the GDP deflator reflects the price of total output. Data were collected for the euro area,[9] 13 old EU members,[10] 10 new EU members[11] and Croatia. In most cases data span from the first quarter of 1995 until the last quarter of 2006. Analysis is conducted using data in domestic currencies and real GDP growth and inflation are calculated as the first differences of the natural logarithms of the real GDP and implicit GDP deflator. All variables used in the analysis are seasonally adjusted.

There is one problem, however, with using the euro area aggregate variables in calculating correlations. The euro area aggregate variables are composed of variables from individual countries. Hence, if we calculate correlations, the correlation between the euro area and Germany will be high, since Germany has a large weight in the euro area. In order to correct this, we calculated the euro area variables without each country with which a correlation has being made. Hence, we produced true correlations between, for example, Germany and the rest of the euro area.

Introductory facts about the selected variables

First it has to be noted that countries in the sample are heterogeneous. The 10 new CEE member states and Croatia have been market economies for a relatively short period of time and have gone through a severe transition period. Due to the fact that they did not have the same level of development as the old EU members while they were planned economies (and, in fact, a diverging process was under way), in recent years they had to have high growth rates

[8] Croatian Central Bureau of Statistics has data on quarterly GDP only from 1997, so data for prior period are obtained from Lovrinčević and Mikulić (2000). They estimated the quarterly GDP from the official yearly data using Bassie methodology.
[9] Data on the euro area does not include new members from the 5th round of enlargement, since they joined the euro area only after out sample period ends.
[10] Data on Portugal and Greece's GDP are not available.
[11] Excluding Malta and Cyprus.

in order to begin the convergence process. This fact that transition countries have different growth rates than the euro area members could be an early warning signal that a common monetary policy might not be suitable for them.

Croatia is in a specific situation. While all other CEE countries in the sample are already EU members, and can adopt euro as soon as they satisfy the Maastricht criteria, Croatia first needs to join the EU. There are also other differences between Croatia and the new EU members. In the first part of the 90's there was a war for independence in Croatia. The war caused more severe economic conditions in Croatia than in other CEE countries. On the other hand, unlike the other CEE counties, which were centrally planned economies, Croatia as a part of Yugoslavia had some aspects of a market, which made it easier to introduce a market economy.

The transformation process in CEE countries together with the specific problems described for Croatia means that it would not be recommendable to use data for the prior period. Hence, the sample period starts in the first quarter 1995.

It is useful to examine some characteristics of the data before conducting the analysis of supply and demand shocks. First we will take a look at growth rates and inflation and then we will calculate correlations of cyclical components of GDP growth and inflation between the euro area and selected countries. As it can be seen from Table 1, most CEE countries had higher growth rates and greater inflation than the old EU countries in the selected period. However, except Romania, annual inflation rates from other CEE countries did not exceed 10 percent. The reason is quite obvious: we excluded from the analysis data until 1995, and after that period inflation was stabilised in most CEE countries. Inflation from the euro area countries exhibited lower values, even though the difference is not as pronounced as it would be if we included the earlier period. A similar situation exists with the standard deviation – CEE countries typically have a higher standard deviation of GDP growth and inflation (average is 2.05 percent for inflation and 1.43 for GDP growth) than the euro area countries (average is 0.67 percent for inflation and 0.89 percent for GDP growth). Again, Romania is an outlier. These variations in GDP growth and inflation suggest substantial differences in the business cycles between CEE countries and the euro area countries. If we were to judge only according to similarities of GDP growth and inflation, then however, the Czech Republic would be the first candidate for adopting the euro.

Table 1: Average quarterly GDP growth and inflation and standard deviation

	GDP growth	Standard deviation of GDP	Inflation	Standard deviation of inflation
Austria	0.57	0.70	0.30	0.36
Belgium	0.54	0.63	0.40	0.32
Finland	0.88	1.12	0.38	0.76
France	0.51	0.50	0.39	0.21
Germany	0.37	0.79	0.15	0.29
Ireland	1.63	1.93	1.03	1.16
Italy	0.33	0.63	0.71	0.59
Luxembourg	1.14	1.71	0.63	2.06
Netherlands	0.64	0.60	0.59	0.56
Spain	0.89	0.61	0.88	0.70
Average EMU	**0.73**	**0.89**	**0.54**	**0.67**
Denmark	0.50	1.12	0.51	0.39
Sweden	0.68	0.98	0.35	0.52
UK	0.69	0.74	0.63	0.62
Bulgaria	1.03	1.07	1.83	3.67
Croatia	**0.97**	**1.91**	**1.04**	**0.94**
Czech Republic	0.73	1.27	1.08	1.31
Estonia	1.80	1.58	1.86	2.34
Hungary	0.95	0.78	2.26	2.12
Latvia	1.74	1.20	1.57	1.95
Lithuania	1.52	2.09	1.27	2.57
Poland	1.14	1.53	1.47	2.16
Romania	1.45	2.07	5.16	3.57
Slovakia	1.14	1.26	1.19	0.99
Slovenia	0.99	0.96	1.44	0.94
Average CEEC[12]	**1.22**	**1.43**	**1.83**	**2.05**

Source: Author's calculation

[12] We calculated simple averages throughout the paper. An alternative could be using weighted average, but we believe that using simple average here is more methodologically sound, because we are interested in how joining the euro area would affect single country independently of other CEE countries. Using weighted average would imply that CEE countries would join the euro area at the same time and hence would have different voting power in the ECB according to their size (which is still lower than many old euro area members).

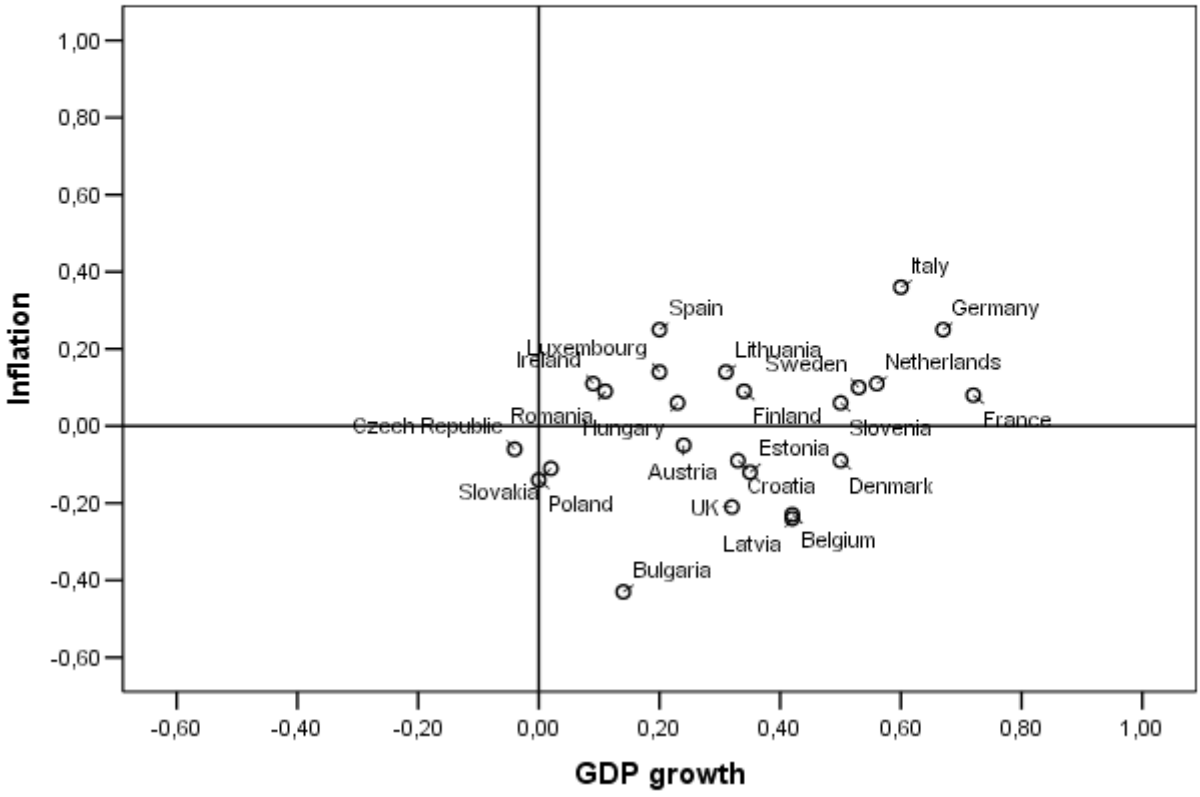
Table 2: Correlations of cyclical components of GDP growth and inflation

	Correlation of GDP growth with the euro area	Correlation of inflation with the euro area		Correlation of GDP growth with the euro area	Correlation of inflation with the euro area
Austria	0.24	-0.05	Bulgaria	0.14	-0.43
Belgium	0.42	-0.23	**Croatia**	**0.33**	**-0.09**
Finland	0.34	0.09	Czech Republic	-0.04	-0.06
France	0.72	0.08	Estonia	0.35	-0.12
Germany	0.67	0.25	Hungary	0.23	0.06
Ireland	0.09	0.11	Latvia	0.42	-0.24
Italy	0.60	0.36	Lithuania	0.31	0.14
Luxembourg	0.20	0.14	Poland	0.00	-0.14
Netherlands	0.56	0.11	Romania	0.11	0.09
Spain	0.20	0.25	Slovakia	0.02	-0.11
			Slovenia	0.50	0.06
Average EMU	**0.40**	**0.11**	**Average CEEC**	**0.22**	**-0.08**
Denmark	0.50	-0.09			
Sweden	0.53	0.10			
UK	0.32	-0.21			

Source: Author's calculation

Note: when calculating correlations between the euro area aggregate and individual euro area member, euro area aggregate was adjusted not to include that specific individual member.

Figure 1: Correlation of cyclical components of GDP growth and inflation between the euro area and selected countries



Next, we correlated inflation and GDP growth between the euro area and individual countries (Table 2 and Figure 1). Instead of correlating the seasonally adjusted logarithm of the GDP growth and inflation between pairs of countries, however, we correlated seasonally adjusted cyclical components of GDP growth and inflation between the euro area and individual countries. We used cyclical components in calculating correlations and not plain data, because we wanted to remove trend component from the series. Since the cyclical component of GDP can be viewed as the GDP gap, correlation of cyclical components can tell us more about synchronisation of business cycles, or more precisely, how expansions and recessions are correlated in pairs of countries. Cyclical components were extracted using a Hodrick – Prescott filter (HP).[13]

As it can be seen from Table 2 and Figure 1, among the old EU members, there is a relatively high (above the EMU average) correlation of cyclical components of GDP growth between the euro area and Belgium, Denmark, France, Germany, Italy, the Netherlands and Sweden. According to this measure, those countries would be the most suited for forming a currency union. On the other hand, in the new member states, only Slovenia and Latvia are above the euro area average. When comparing the new member states with Croatia, however, Croatia has a relatively high correlation of the cyclical component of its GDP growth with the euro area (0.33). This is relatively close to the average of the old EU members of 0.40 and much higher than the new member states' average of 0.22.

Correlation of the cyclical components of inflation is not as high across as that of GDP growth, probably due to the fact that even the euro area countries did not have a common currency through the entire sample period. Through time, however, the correlation of inflation should increase between the euro area members, due to the fact that they are sharing a common currency and monetary policy. In fact, when we split the sample into pre and post EMU periods, results show that in the post-EMU period the average correlation of cyclical components of inflation was twice as high (0.16) as in the pre-EMU period (0.08).

From Table 2, it can be seen that Italy has the highest correlation of inflation with the euro area, while four old EU members even have negative correlation. The situation is even worse

[13] We also used Baxter-King filter, but the results are similar, so we reported here only results with the HP filter.

for CEE countries, where two thirds of countries, including Croatia, exhibits negative correlation of cyclical components of inflation with the euro area.

4. Demand and supply shock analysis

In order to identify disturbances, a bivariate VAR was estimated for every country in the sample.[14] Before going to the VAR analysis, we examined the optimal lag structure. Using the Hannan – Quinn information criterion, it is shown that for most of the countries in the sample the number of lags should be set to 1. Other suggested lags range from 3 to 10. However, since for more countries lag structure analysis showed 1 lag and since we believe that we should use the same number of lags for all VARs in order to maintain symmetry of specification across countries, we decided to use lag length of 1.[15] It is important to maintain the symmetry of specification, because in this way the correlations that will be calculated following shocks extraction will be made with the same number of observations (except for 2 out of 24 countries, Ireland and Romania, for which we do not have data for the entire period). This will also help us to break the sample period into three sub-samples in order to see whether correlations are changing with the time.[16]

For a start we wanted to see whether results concur with the aggregate demand – aggregate supply framework, more precisely with the over-identifying restriction. This restriction implies that temporary shocks, in order to be interpreted as demand disturbances, should be associated with increases in prices, while permanent shocks, in order to be interpreted as supply disturbances, should be associated with a decrease in prices. This was generally observed. In only 6 out of 24 cases, it was not possible to interpret the results using this framework. These include Denmark, Ireland, Latvia, Austria, Poland and Croatia. However, since Croatia started to officially calculate a GDP series only in 1997, before which time GDP

[14] Unit root tests were performed before estimating the VAR. Most variables are nonstationary in levels and stationary in first differences. Some variables are stationary in levels, but we checked if they are also stationary in first differences, because we wanted to make all VARs with differentiated variables. Only for Germany's prices there is a potential problem, because this variable could be borderline integrated of order 2.

[15] We also performed the analysis using the number of lags suggested by the Hannan-Quinn information criterion for each country. Large differences in results are only observable for countries where the Hannan-Quinn information criterion suggested using a large number of lags. We have to bear in mind, however, that in this situation we lost more than two years of data and that the difference could be coming from this lost of data.

[16] We also made rolling window correlation using four years of data, but their graphical analysis here would be too space demanding. However, they can be obtained from the author.

was calculated unofficially, it could be that this period influenced the results for Croatia.[17] For this reason we re-estimated the VAR using only data from the first quarter of 1997 onwards in which case the over-identifying restriction holds. Also, for Austria the initial period after a supply shock starts with decrease in prices, while the later impulse response becomes small but positive.

Bayoumi and Eichengreen (1993) used a different sample of countries and a different time period, but when comparing the countries included in both analyses it can be seen that for Ireland the over-identifying restriction did not hold in either study. The only difference is for Denmark, for which the over-identifying restriction holds in Bayoumi and Eichengreen's paper, but not in the current analysis.

Since in most cases, however, it is possible to interpret the results using the aggregate demand – aggregate supply framework, hereafter we refer to the permanent shocks as supply shocks and to the temporary shocks as demand shocks. Examples of supply shock are wars, good/bad weather conditions and oil crisis, and examples of demand shocks are change in the export demand, change in the consumer preferences and changes in the tax policies.

Supply and demand shocks

Before calculating correlations of supply and demand shocks between pairs of countries, it is of interest to show the underlying shocks. Figures 2 and 3 show supply and demand shocks for the euro area and Croatia.

[17] This series shows less variability in the period from 1995 until 1997 then in the period when quarterly GDP is calculated officially.

Figure 2: Supply and demand shocks for the euro area

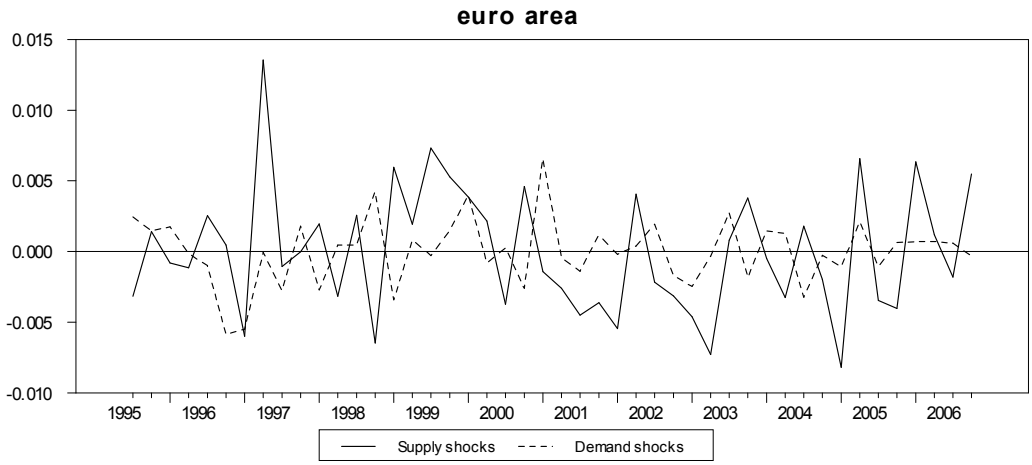
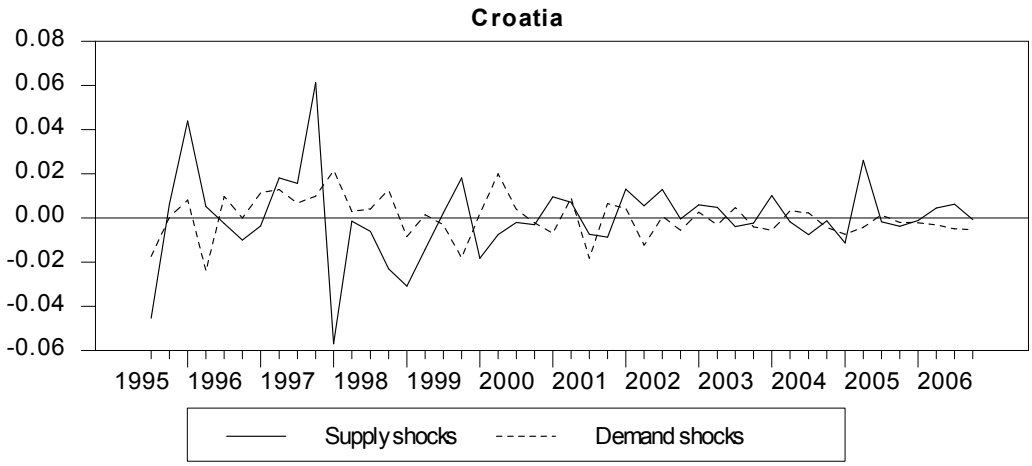


Figure 3: Supply and demand shocks for Croatia



It is normally very difficult to interpret every particular change in the demand and supply shocks. The relatively large shocks that are observed for Croatia at the beginning of the sample period, however, probably can be attributed to the transition, war disruption and the bank crises. For example, the largest positive supply shock in 1997 can probably be attributed to the liberal policy of bank foundation, which caused very strong increase in credits, which were, however, often not of good quality. Large negative supply shock in 1995 can be ascribed to the destruction of many industrial sites and other large negative supply shocks in 1998 and 1999 probable can be connected to the bank crises in Croatia, when 14 (mostly newly founded) banks went bankrupt and two large (at that time) state banks were rehabilitated. Also, as can be seen from Figure 3, the amplitude of the underlying shocks

decreased with time, a trend that is also observed in all CEE countries except for Hungary, Slovenia and Slovakia.[18]

In order to get a clearer picture of the similarities between the members of the euro area and the prospective new members, we now turn to examining the correlations of demand and supply shocks between pairs of countries. Since the old members of the EU have been trying to align their economies for decades, it is reasonable to expect that their business cycles are more correlated with each other than with the new entrants. Also, since CEE countries that have already joined the EU and Croatia, which has started the negotiation process, need to implement and adopt the EU and the euro area rules, which will hopefully help them to have structures more similar to the old EU members, the impact should flow from the EU / euro area to the CEE countries. Indeed, in more than half CEE countries in the sample, the correlation of supply shocks is higher when we correlated lagged values of the euro area shocks (t-1) with the individual CEE countries (t). Moreover, this increase in correlation is observed mostly in the more advanced CEE countries, such as Slovenia, Hungary and Poland. Croatia is also in this group of countries. In contrast, the increase in correlation of demand shocks when using lags is not that pronounced.

Correlations of supply and demand shocks

Table 3 contains correlation coefficients between the euro area and selected countries for sub-periods as well as the overall. Supply shocks for the euro area are highly correlated with those in Belgium, Denmark, France, Germany, Italy, the Netherlands and Sweden. Germany has among the highest correlation coefficients with the euro area, not a surprising relationship given the size and importance of Germany in the euro area. Quite surprising is the relatively high correlation with the euro area of Denmark and Sweden,[19] which have not yet adopted the common currency. Since the disaggregated analysis shows that the correlation between the euro area and Denmark and Sweden is increasing, however, it seems that it may become desirable for them to reconsider the adoption of euro. The identified core countries comprise those used by Bayoumi and Eichengreen (1993),[20] plus additional countries, that are also found to be the core in Fidrmuc and Korhonen (2003) (Italy) and Frenkel and Nickel (2002)

[18] All figures with the demand and supply shocks can be obtained from the author.
[19] A result similar to that of Bayoumi and Eichengreen (1993) for Denmark (Sweden was not n their sample).
[20] France, Netherlands, Denmark and Belgium.

(Italy and Sweden).[21] The simple average of supply shocks correlations for "core" and "periphery" countries is 0.58 for the "core" and 0.28 for the "periphery".

Table 3: Correlation coefficients between the euro area and selected country

	Correlations of supply shocks with the euro area					**Correlations of demand shocks with the euro area**			
	1995-1998	1999-2002	2003-2006	**1995-2006**		1995-1998	1999-2002	2003-2006	**1995-2006**
Austria	-0.10	0.42	0.29	**0.22**		0.02	0.05	-0.39	**0.00**
Belgium	0.56	0.71	0.70	**0.65**		-0.26	-0.46	-0.44	**-0.33**
Finland	0.50	0.18	0.10	**0.23**		-0.30	0.76	0.46	**0.25**
France	0.31	0.85	0.59	**0.56**		-0.06	0.54	0.44	**0.27**
Germany	0.59	0.56	0.82	**0.65**		0.07	0.30	0.75	**0.25**
Ireland		0.52	0.20	**0.43**			0.29	0.00	**0.02**
Italy	0.14	0.57	0.79	**0.45**		0.20	0.67	0.14	**0.22**
Luxembourg	0.15	0.67	0.27	**0.34**		0.39	-0.39	-0.28	**-0.01**
Netherlands	0.60	0.82	0.66	**0.64**		0.09	0.79	-0.17	**0.29**
Spain	0.21	0.32	0.36	**0.29**		0.19	0.11	-0.40	**0.11**
Average EMU	**0.33**	**0.56**	**0.48**	**0.45**		**0.04**	**0.27**	**0.01**	**0.11**
Denmark	0.57	0.66	0.61	**0.59**		0.17	-0.16	-0.06	**0.06**
Sweden	0.33	0.63	0.65	**0.50**		0.13	0.28	-0.23	**0.13**
UK	0.28	0.22	0.03	**0.16**		0.01	-0.17	0.14	**-0.07**
Bulgaria		0.17	0.12	**-0.05**			0.28	0.45	**0.07**
Croatia	**0.19**	**-0.27**	**0.33**	**0.09**		**-0.17**	**0.00**	**-0.05**	**-0.12**
Czech Republic	-0.19	0.12	0.11	**-0.10**		-0.03	0.02	0.05	**-0.02**
Estonia	0.10	0.26	0.07	**0.14**		0.06	-0.50	-0.16	**-0.18**
Hungary	0.20	0.25	0.33	**0.25**		-0.17	0.23	0.12	**0.03**
Latvia	0.58	0.16	0.59	**0.39**		0.36	-0.63	-0.14	**-0.03**
Lithuania	0.28	-0.33	0.04	**-0.04**		0.09	0.28	-0.08	**0.03**
Poland	0.02	0.48	-0.11	**0.09**		-0.20	0.29	-0.32	**-0.13**
Romania		-0.15	0.00	**-0.10**			0.53	-0.41	**0.24**
Slovakia	0.39	-0.26	0.08	**0.03**		-0.38	-0.03	-0.01	**-0.13**
Slovenia	0.50	0.21	0.66	**0.47**		0.43	0.06	-0.61	**0.02**
Average CEEC	**0.23**	**0.06**	**0.20**	**0.11**		**0.00**	**0.05**	**-0.11**	**-0.02**

Source: Author's calculation

Note: when calculating correlations between the euro area aggregate and individual euro area member, euro area aggregate was adjusted not to include that specific individual member.

Regarding the correlation of supply shocks for CEE countries and the euro area, only the Slovenian correlation coefficient exceeds the EMU average. Latvia has the second highest

[21] However, Frenkel and Nickel (2002) also find that Finland and the UK have a relatively high correlation of supply shocks with the euro area, which means that according to their analysis the UK might benefit from the introduction of euro.

correlation with the euro area, but this is still lower than the EMU average. These relatively high correlations are probably the reason why they applied first for joining the euro area. Slovenia joined the euro area in 2007, while Latvia missed the inflation criterion by less than 0.1 percent. Other CEE countries have relatively low correlation coefficients of supply shocks with the euro area. Some of them, such as Czech Republic and Bulgaria, even exhibit a negative correlation.

The studied CEE countries have a much lower average correlation of supply shocks with the euro area (0.11) than the "periphery" of the old EU members (0.28). In this sense we could say that, in general, new member states (and Croatia) need to do much work to align their business cycles with the euro area.[22]

Croatia is, according to the correlation of supply shocks, very far from being a candidate to introduce the euro (no matter when it enters the EU). Its correlation with the euro area is even lower than the CEEC average. If we take a look only at the last sub-period, however, there is hope that the correlation will increase in the future. There is a question, however, of why correlation turned negative in the second sub-period. In fact, closer inspection shows that in the 5 out of 9 CEE countries for which we have data for the whole sample period,[23] a decrease in correlation with the euro area can be seen in the second sub-period followed by an increase in the third sub-period. At the same time, in 5 out of 9 EMU countries for which we have data for the whole sample period,[24] an increase in correlation can be observed in the second sub-period and a decrease in the third. It could be that the decrease in correlation for the CEE countries in the second sub-period is connected with much stronger co-movements of the business cycles of the euro area members during the years of the introduction of euro. If we say that nothing has changed in the CEE countries in the second sub-period and the old EU members increased their within a group correlation due to positive impacts of euro introduction, this could make a gap between them and CEE countries in the second sub-period.[25]

[22] The assumption here is that alignment of the business cycles is policy based and not natural.
[23] Latvia, Lithuania, Slovakia, Slovenia and Croatia.
[24] Austria, Belgium, France, Luxembourg and Netherlands.
[25] We realise that this is a speculative guess, but it seems plausible. Also, we made an inspection of rolling windows of the correlations of those countries and the reverse trend between two groups of countries is clearly visible. Moreover, averages of those euro area members and CEE countries show that the change in trend in correlation occurs in the last quarter of 2002 in both cases. These findings definitely deserve more analysis, which we will try to cover in future research.

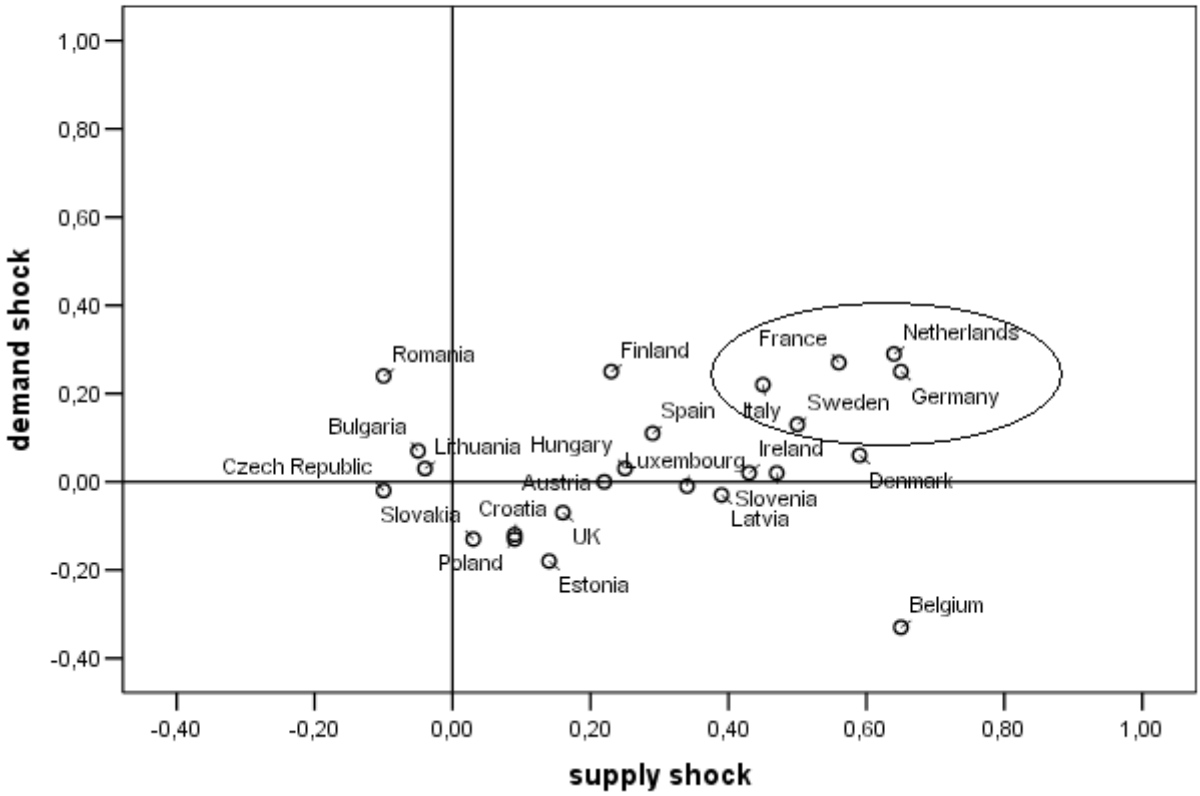
Results for demand shocks are more complicated to characterise. France, Germany, Italy, the Netherlands, Finland and Sweden have the highest correlation of demand shocks with the euro area, although these are much smaller than for supply shocks. There area also many more negatively correlated demand shocks. This suggests that these 5 countries (excluding Finland due to its relatively lower correlation of supply shocks with the euro area) belong to a "super core" group, which should have the fewest problems with the decisions of a single monetary authority. Also, the correlation of demand shocks of CEE countries with the euro area is much less pronounced than for supply shocks, with more countries experiencing a negative correlation than a positive one, while Romania has the highest correlation coefficient (0.24). If we look at "periphery" old EU members and CEE countries, however, there is almost no difference in the average correlation of demand shocks with the euro area (-0.03 for the "periphery" old EU members and -0.02 for CEEC). Much lower correlation of demand shocks in comparison with supply shocks could be explained with the countries' following different policies, such as fiscal policy. With further progress toward the similar economic policies in the EU, however, we might expect to see more similar demand shocks across enlarged EU.

Another interesting point emerges from this analysis. Slovakia is next to adopt euro, but according to this analysis, it does not have correlated business cycle with the euro area, which means that the monetary policy decisions of the ECB will not on average be correlated with its needs. However, if Slovakia has adjustment mechanisms with which it can alleviate the impacts of monetary policy that may not suit it well, then low correlation of their business cycles will be of less importance. On the other hand, if this is not true, then in this case political decision in Slovakia is more important than economic one.

The analysis of supply and demand shocks shows us how misleading the interpretation of similarity of GDP growth and inflation from the previous chapter could be. Those results suggested that the Czech Republic would be the most suitable candidate for the euro area. Deeper analysis, however, showed us that the Czech Republic is among the new EU members least aligned with the euro area.

Figure 4 displays the correlation coefficients of supply and demand shocks. The "super core" group can be observed in the circle, with a relatively high correlation of both supply and demand shocks.

Figure 4: Correlation of supply and demand shocks between the euro area and selected countries



Size of supply and demand shocks

The analysis of the correlation of supply and demand shocks enabled us to determine which countries would be the best candidates for introducing the euro. However, in analysing the best candidates we wanted to go a step further. Hence, beside correlations, we used these shocks to estimate size of the supply and demand shocks as well as speed of adjustment to shocks. This additional step will help us to distinguish shocks from responses, so we will be able to identify variability more clearly. Here we start with the sizes of the shocks.

Table 4: Sizes of supply and demand shocks

	Supply shocks	**Demand shocks**		**Supply shocks**	**Demand shocks**
Austria	0.0069	0.0035	Bulgaria	0.0098	0.0137
Belgium	0.0061	0.0031	**Croatia**	**0.0186**	**0.0093**
Finland	0.0105	0.0075	Czech Republic	0.0111	0.0088
France	0.0045	0.0012	Estonia	0.0151	0.0205
Germany	0.0068	0.0021	Hungary	0.0064	0.0197
Ireland	0.0164	0.0100	Latvia	0.0119	0.0182
Italy	0.0061	0.0055	Lithuania	0.0198	0.0249
Luxembourg	0.0153	0.0200	Poland	0.0137	0.0214
Netherlands	0.0057	0.0053	Romania	0.0173	0.0275
Spain	0.0058	0.0060	Slovakia	0.0080	0.0089
			Slovenia	0.0120	0.0082
Average EMU	**0.0084**	**0.0064**	**Average CEEC**	**0.0131**	**0.0165**
Denmark	0.0094	0.0037			
Sweden	0.0088	0.0045			
UK	0.0059	0.0048			

Source: Author's calculation

Sizes of the shocks are calculated as standard deviations of the underlying shocks. If a country has relatively large shocks relative to the members of the monetary union, then a common currency could make it more difficult for the country to adjust to different size of the shocks. More precisely, even if all members require a response to the shock in the same direction, the members that experience larger shocks would require a stronger reaction than members where the size of the same shock is smaller. This situation is more adverse if supply shocks are of different sizes, since they involve a more difficult adjustment process.

On average, shocks are smaller in the old EU members, than in CEE countries (Table 4). Moreover, if we compare the simple average of euro area member counties and CEE countries, shock sizes are about 50 percent larger in the CEE countries for supply shocks, while demand shocks are about 150 percent larger.

Of more interest here are Slovenia, for which the correlation analysis showed to be among the "core" old EU countries, and Latvia, which is very close to that target. In terms of supply shocks, magnitudes in Slovenia are slightly bellow the CEEC average, but much larger than the euro area average. On the other hand, demand shocks are more similar in size to the euro area. Latvia has a similar situation regarding the size of supply shocks as Slovenia, but it has

relatively large demand shocks. This means that life in the euro area for Slovenia and Latvia will not be without problems, despite the relatively large correlation of shocks, because they would need to have other adjustment mechanisms to ameliorate adverse effects in addition to a common monetary policy. For example, if symmetric shock hits the euro area and Slovenia and Latvia, its size will on average be larger in those two counties, which means that they would advocate stronger response to the shock than the euro area as a whole. Since they are small and will not have great power in the ECB, the response to the shock will not be enough for them to ameliorate it.

Regarding Croatia, it has much larger supply shocks than the both euro area and CEE average. Moreover, after Lithuania, Croatia has the largest supply shocks in the sample, probably due to the war disruption which caused that significant part of Croatian industry was destroyed and bank crises. This fact, together with the low correlation of supply and demand shocks, places Croatia very low on the list of appropriate candidates for the euro area.

Speed of adjustment to supply and demand shocks

Finally, we analysed the speed of output adjustment to supply and demand shocks. Speed of adjustment to supply shocks is calculated as the ratio of the impulse response function in the first year to its long run level. When calculating speed of adjustment to supply shocks, a higher ratio indicates a relatively fast adjustment, while a lower value indicates a relatively slow adjustment process. We chose to calculate the ratio in the first year because most of the adjustment occurs within one year. This is quite surprising, but we have to bear in mind that the sample period chosen excluded the main transformation period in CEE countries, as well as periods of major turbulence such as the oil crisis in the ’70.

As it can be seen in Table 5, on average CEE countries adjust to supply shocks more quickly, even though the difference is rather small. This difference, however, could be explained by the readiness of CEE countries to make reforms in order to join the EU as soon as possible. Also, most of these countries during the sample period had relatively flexible exchange rates, which could have helped them to ameliorate the shocks.

The speed of adjustment to the demand shock is measured by the absolute value of the impulse response function in the first year. Calculating speed of adjustment to demand shock

as a ratio of the absolute value of the impulse response function in a certain year and its long run value would be preferable, but it is not feasible, since the methodology implies that this long run level is zero. A lower value indicates relatively fast adjustment. Table 5 shows that the euro area and CEE countries exhibit almost the same adjustment to demand shocks, while Croatia is adjusting to demand (and supply) shocks much faster than the CEE and EMU average.

Table 5: Speed of adjustment to a supply and demand shocks

	Speed of adjustment to a supply shock	**Speed of adjustment to a demand shock**		**Speed of adjustment to a supply shock**	**Speed of adjustment to a demand shock**
Austria	1.0001	0.00028	Bulgaria	0.9945	0.0029
Belgium	0.9994	0.001232	**Croatia**	**0.9997**	**0.0004**
Finland	0.9959	0.00334	Czech Republic	0.9905	0.01505
France	0.9922	0.01291	Estonia	1.0001	0.000345
Germany	0.9933	0.01296	Hungary	0.9742	0.02918
Ireland	0.9383	0.01148	Latvia	0.9997	0.0003
Italy	1.0000	0.000015	Lithuania	0.9925	0.000588
Luxembourg	0.9866	0.005882	Poland	0.9985	0.002206
Netherlands	1.0001	0.000002	Romania	0.9962	0.009286
Spain	1.0021	0.0149	Slovakia	0.9992	0.000425
			Slovenia	0.9783	0.00839
Average EMU	**0.9908**	**0.0063**	**Average CEEC**	**0.9930**	**0.006279**
Denmark	0.9753	0.026113			
Sweden	0.9872	0.00571			
UK	0.9431	0.031207			

Source: Author's calculation

5. Conclusion

In this paper we examined on the correlation of business cycles between the euro area and CEEC. The emphasis was on Croatia, since there is a lack of research of whether Croatia is prepared for the common monetary policy and currency. The results show that Croatia is at the moment quite far from being prepared to cope with a single monetary authority. One way of potential alignment should go through the endogeniety of optimum currency areas (Frankel and Rose, 1997). This means that a common currency area will help Croatia to significantly increase trade linkages, which will increase the level of development and in turn cause the

Croatian business cycle to be more synchronised with the euro area's. Another mechanism to promote synchronisation would be the alignment of many policies.

Results for the other countries show that there exists a "super core" group of countries within the euro area – Germany, France, Italy, the Netherlands and Sweden, for which a single monetary authority creates much smaller adjustment problems. Those countries should enjoy the most advantages from the common currency area. Among CEE countries, only Slovenia has a higher correlation of supply shocks with the euro area than the average of the euro area members with Latvia being a little bit behind. Hence, it should not have been a surprise that those countries applied first to join the euro area. Other countries have relatively low correlation coefficients of supply shocks with the euro area. Moreover, on average, CEE countries experience larger shocks then the euro area members. This all means that a common monetary policy may not be suitable for them without having some sort of additional adjustment mechanisms.

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