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## Analysis of Shocks Affecting Europe: EMU and some Central and Eastern Acceding Countries

Nabil Ben Arfa \*

**Summary:** This paper deals with the synchronization of business cycles and economic shocks between the euro area and acceding countries. We therefore extract the business cycle component of output by using Hodrick-Prescott filter. Supply and demand shocks are recovered from estimated structural VAR models of output growth and inflation using long run restriction (Blanchard and Quah). We then check the (A) symmetry of these shocks by calculating the correlation between euro area shocks and those of the different acceding countries. We find that several acceding countries have a quite high correlation of demand shocks with the euro area however supply shocks are asymmetric; the correlation between euro area and central and east European countries (CEECs) is negative. We therefore conclude that joining the European Monetary Union is not yet possible: central and east European countries have to make structural changes to join the European Monetary Union.

**Keys words:** Central and East European countries, Euro area, SVAR models, Hodrick-Prescott filter, Symmetric-asymmetric shocks

**JEL:** E32, F42

### Introduction

Our main objective is to evaluate the correlation of business cycles within the Euro area, between the euro area and acceding countries. We want to assess whether the European countries are confronted by symmetrical shocks (if an area, a zone or a country are hit by similar shocks) or rather asymmetrical (i.e., if the shocks and/or their impacts are not similar).

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\* University of Nice - Sophia Antipolis; Faculty of Law, Political Science, Economic and Management; C.E.M.A.F.I; Macroeconomics and International Finance Center: [nabil\\_ar@yahoo.fr](mailto:nabil_ar@yahoo.fr)  
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Our investigation on the nature of business cycles and shocks correlation within Europe leads us to the optimal currency areas theory. The main contributions on optimal currency areas theory are those of Mundell (1961), Mckinnon (1963) and Kenen (1969), considered the base of subsequent studies. Their objective was to identify the main criteria of a possible integration of a country to a monetary area. The strategy consists in identifying benefits and costs a given country faces joining the monetary area. If benefits for each country wishing integration are positive and higher than costs, monetary area is called as optimal.

Our paper is placed in this context; one of our goals is to see whether Europe can form an optimal currency area. To answer this, we will check the way business cycles evolve/move in the euro area and in CEECs. The aim is to asses if a synchronization of business cycles between euro area and small acceding economies in the course of integration exists. Better synchronization means that European countries increasingly converge, and thus a loss of monetary instruments does not constitute a danger to the economy. To conclude this comparative analysis of business cycles, we will use Hodrick-Presscott filtering method.

Thereafter, to improve our results and to be able to clarify synchronization or differences in business cycles evolution found before, we estimate a structural VAR model (SVAR) to discover supply and demand shocks affecting European countries and especially to observe whether these countries are affected by symmetric or asymmetric shocks which is essential in determination of the optimality of the euro area.

The methodology suggested by Bayoumi and Einchengreen (1992), in the line of Blanchard's and Quah's (1989) work, constitutes our base of work. Indeed, the principal assumption of their model is there were two kinds of shocks: shocks affecting the demand curve (for example those due to monetary policy changes) and shocks affecting the supply curve (like technological changes). As for the Blanchard and Quah model, it is clear that demand and supply shocks have different effects on output and prices. If supply shocks have permanent effects on production, demand shocks have only temporary ones; at the same time, the two shocks have permanent effects on price.

One can then introduce these assumptions into a structural VAR model with variables production and prices to check supply and demand shocks and their effects on economic variables (through impulse response function and variance decomposition). Finally, this paper will conclude with results and recommendations.

## 1. Business cycle and optimal currency areas theory

The optimal currency areas theory originally appears with the work of Mundell (1961). Mundell estimates that a country could find it advantageous to peg the external value of its currency to another country when the two countries' business cycles are strongly correlated. In practice, a perfect correlation does not exist, but the problem of asymmetrical shocks will be alleviated if through factors of production mobility between countries and areas. Fiscal policy and labour market flexibility can also replace traditional mechanisms of adjustment.

After the breakdown of the Bretton Woods systems, optimal currency area analysis became a standard tool to evaluate the desirability of a particular country to adopt a fixed exchange rate. In the European case, currency area analysis revealed that labour market mobility is rather low. Important empirical work to evaluate optimal currency area theory preceded the introduction of European Monetary Union. The main objective of these empirical studies was to evaluate business cycle correlation between the German economy and other European economies.

In this section, we survey the literature evaluating the criteria of the optimal currency area, particularly those related to the newest members of the monetary union and to the potential candidates to adhesion. We then apply business cycle correlation criterion to the euro area and to CEEC candidates to join the Euro area.

### 1.1. Review of the literature on business cycles correlation within Europe

**Table 1.** Review of the literature on business cycles correlation between Euro area and acceding countries

Author, year	Country	Method	Frequency	Country of reference	Result
Boone, Maurel (1998)	CZ, HU, PL, SSL	Hodrick- Prescott Filter	Monthly data	Germany	High degree of business cycle synchronization
Frenkel (1999)	CE5, BG, EE, LV	Demand and supply shocks	Quarterly data	Germany	Low correlation
Horvath (2000)	CE5, B3	Demand and supply shocks	Quarterly data	Germany	High correlation
Korhonen (2001,2003)	CE5, B3, RO	VAR	Monthly data	Euro area	High correlation (particularly Hungary)
Fidrmuc (2001, 2004)	CE10	Correlation of GDP and of IPC	Quarterly data	Germany	Divergent results between CEECs

Frenkel, Nickel (2002)	CE5, BG, EE, LV	Demand and supply shocks	Quarterly data	Euro area	Low correlation
Babetski et al. (2002, 2004)	CE5, EE, LV, RO	Demand and supply shocks	Quarterly data	European Union	Integration has increased demand shocks correlation
Fidrmuc, Korhonen (2004)	CE10	Demand and supply shocks	Quarterly data	Euro area	High correlation
Artis et al. (2004)	CE5, B3	Band Pas Filter	Monthly data	Euro area	Business cycle of Poland and Hungary are similar to those of euro area
Demanyk, Volosovych (2004)	CE5, B3	Correlation of GDP growth rate	Quarterly data	Europe of the 25	Asymmetric business cycle
Darvas, Szapary (2004)	CE5, B3	HP and BP Filter	Quarterly data	Euro area	Business cycle correlation increase in a half of the sample and drop in the other one
Ramos, Surinach (2004)	CE5, B3	Demand and supply shocks	Quarterly data	Euro area	Monetary shocks correlation is similar
IMF (2000)	CE10	Correlation of the GDP and of the IPC	Annual data	Germany	Relatively high degree of business cycle synchronization
Boreiko (2002)	CE10	Hodrick- Prescott filter (IP)	Monthly data	Germany	Convergence between euro area and CEECs (particularly for Slovenia and Estonia)

**Source:** Fidrmuc and Korhonen .2004. “The Euro goes East: Implications of the 2000-2002 Economic Slowdown for Synchronization of Business cycles between the Euro-area and CEECs”.

Ind: CE4: Czech Republic, Hungary, Poland and Slovakia, CE5: CE4 plus Slovenia, B3: Estonia, Latvia and Lithuania, BG: Bulgaria, CZ- Czech Republic, EE - Estonia, HU - Hungary, LV - Latvia, LT-Lithuania, PL-Poland, RO-Romania, SSL-Slovenia, CE10- all countries.

Table 1 above lists the studies related to evaluating business cycles correlation between the euro area and the countries applying for accession. We immediately notice the diversity of methods used; while several studies take the simplest method--consisting in filtering the series around their trends to be able to determine business cycles (through several techniques like Hodrick-Prescott filter)--few contributions use the VAR methodology.

To summarize these studies, we can identify three categories of approaches in the literature on cyclical correlation between the euro area and acceding countries. In the first category, work focuses on a simple correlation of an indicator of the incorporated product, for example, GDP or inflation. In the second category, business cycles correlation is analysed mainly through the use of various filters (including, among others, the Hodrick-Prescott filter or the Band-Pass filter). In the third category, structural VAR models identify shocks affecting various countries. While the first approach prevails in older analyses, the last two dominate recent discussions. Consequently, we review the literature working under these last two recent analyses.

In the first group of studies, one uses various measurements of business cycles correlation between the euro area (European Union) and CEECs. Boone and Maurel (1998) calculate the coefficients of correlation between cyclical components of industrial production and unemployment rates for a selection of countries applying for accession compared to those of Germany and the European Union. Cyclical components of the business cycle indicator are obtained with the help of the Hodrick-Prescott filter. They generally find a high degree of business cycles correlation between acceding countries and Germany. This implies a relatively low cost in case of giving up monetary sovereignty and joining a monetary union with Germany. They find a similar result in their 1999 study by using a different method, determining the share of the variation in the unemployment rate explained by a shock occurring in Germany or within European Union.

Artis and Al (2004) and Darvas and Szapary (2004) describe business cycles of acceding countries by using the Band-Pass filter. Artis and Al seek to identify business cycles for each country individually. They find business cycles of Hungary and Poland are generally more similar to those of the euro area. Darvas's and Szapary's (2004) work differs considerably from other investigations. Indeed, they are interested in expenditure behaviour and on the various components of GDP. They find that GDP, industrial production and exports of Hungary, of Poland and of Slovenia started with a high degree of correlation with those of the euro area. However, private consumption and services are not correlated, even within these three countries. Darvas and Szapary are also interested in the evolution of correlation of acceding countries with the euro area through time. Their results are not very conclusive since the correlation of GDP business cycles increases in roughly half of the studied countries whereas it decreases in the other half.

Frenkel al. (1999), Frenkel and Nickel (2002), and Fidrmuc and Korhonen (2001, 2003, 2004) use an approach similar to that of Bayoumi and Eichengreen (1992) to identify supply and demand shocks of various states including the majority of countries applying for accession.

Frenkel and Al (1999) find the correlation of shocks is quite high between the euro area and in the non participating EU member states. However, this correlation is weaker between the euro area (represented by Germany and France) and the acceding countries. Unfortunately, it is difficult to interpret this study's results, probably because of the data used for estimation. Frenkel et al. use quarterly data extending from the first quarter of 1992 to the second quarters of 1998; the time period is quite short to draw robust conclusions. Subsequently, Frenkel and Nickel (2002) use a longer sample for the same group of country. Nonetheless, their conclusions are not very different from those resulting from their basic study.

Fidrmuc and Korhonen (2001) assess supply and demand shocks correlation between ten acceding countries and the EMU countries for a period extending from 1994 to 2000. They find divergent results between acceding countries. While some countries--like Hungary and Estonia--are positively correlated with the euro area, other countries--like Lithuania, Slovakia and the Czech Republic--present a negative correlation with the euro area. They also claim that demand shock correlation is generally weaker than that of supply shocks. Fidrmuc and Korhonen conclude with an interesting remark: they find that supply shocks in some acceding countries are at least as well correlated with euro area shocks as in much of some smaller members of the EMU (like Portugal and Greece).

Korhonen (2003) examines the monthly indicators of industrial production in the euro area and in nine countries applying for accession. To analyse the correlation, he uses separate VAR models on euro area production and each accession country's production. Positive correlation of impulse function with the euro area is considered evidence of business cycle symmetry. Korhonen finds that some applicant countries (particularly Hungary) show a high degree of correlation with the euro area business cycle. In addition, correlation seems to be at least as high as in some smaller EMU members like Portugal and Greece. Ramos and Surinach (2004) introduce monetary shocks as an additional variable on structural VAR models. They suggest two possibilities these shocks' introductions into their structural VAR model: either through the real interest rate, as in Artis (2003b), or through the effective foreign exchange rate, as in Clarida and Gali (1994). Thus, they first estimate a structural VAR model for the GDP growth rate and the inflation rate in order to identify supply and demand shocks. Second, they introduce monetary shocks by considering two different models. The first comprises the GDP growth rate, inflation rate and real interest rate; the second replaces the real interest rate with the effective exchange rate. Their result is surprising, especially for monetary shocks resulting from Artis decomposition. Indeed, they find correlation of these monetary shocks is similar between the euro area and acceding countries.

In summary, empirical work seems to indicate that business cycles in the most advanced acceding countries are strongly correlated with those of the euro area. This is particularly true for Hungary and to a lesser extent for Slovenia.

## **1.2. Business cycles synchronization within Europe: correlation of GDP**

To check if common fluctuations affect the countries chosen for our analysis, it is possible relating the cyclical behaviour of economic aggregates, GDP in particular, to evaluate how these countries evolve/move through time. Business cycles synchronization is therefore regarded as a sign of convergence between a monetary union and countries applying for its adhesion.

Economies tend to fluctuate around a long term trend. Fluctuations around this trend correspond to cyclical fluctuations. One of the most common methods to assess business cycles is the Hodrick-Prescott technique of decomposition (1980). Based on this method we seek determining the nature of the relationship between the euro area business cycle and acceding countries. This analysis enables assessment of the optimality (or otherwise) of a monetary union extended to CEECs. Our analysis uses quarterly data from Eurostat, the International Monetary Fund International Financial Statistics (IFS) and the Organisation for Economic Co-operation and Development (OECD).<sup>1</sup> After filtering the data and their decompositions into trend components/cyclical components--according to the Hodrick-Prescott method--we compare the euro area cyclical components and those of the CEECs. Table 2 displays our results.

**Table 2.** Correlation with euro area business cycle

Country	Correlation
Bulgaria	0.13 *
Croatia	0.15 *
Estonia	0.08 *
Hungary	0.59
Latvia	0.58
Lithuania	0.37
Malta	0.32
Poland	0.58

<sup>1</sup> The Hodrick-Prescott filter is considered a flexible method because the choice of the parameter,  $\lambda$ , depends on the data chronology; for quarterly data--such as our data--we retain a value of  $\lambda = 1600$ .

Czech Republic	0.13 *
Romania	0.57
Slovakia	0.13 *
Slovenia	0.51

\* These values are not significant (prob of 5%).<sup>2</sup>

Source: our estimates.

#### - Results:

Our results indicate all countries are positively correlated with the euro area business cycle. On the one hand, Czech Republic, Slovakia, Bulgaria, Estonia and Croatia represent the weakest correlations and the values of their correlation coefficients are not significant. On the other hand, business cycles in Hungary, Poland and Slovenia<sup>3</sup> seem well correlated with the euro area business cycle; these countries present the highest correlation coefficients. The remainder countries also present positive and significant correlations with the euro area. These countries are characterized by an economic cycle close to that of euro area members; joining the European Monetary Union will undoubtedly accelerate business cycle synchronization with that of the euro area.

In summary, our results are encouraging since synchronization appears underway for most sample countries, even as some business cycles consistently diverge from that of the euro area. Considering cyclical tendency results in the next section, we adopt a different approach. Our purpose is to assess the sources of cyclical fluctuations; in other words, we will identify the sources of disturbances (shocks) and the economic policy responses to these shocks.

## 2. Structural VAR model: (A) Symmetry of demand and supply shocks

To distinguish whether differences observed in cyclical tendencies between the euro area and acceding countries result from differences in shocks or from differences in economic policy responses to these shocks, we apply an alternative econometric method: the structural VAR method. The main objective is to identify shocks, their nature (symmetrical or asymmetrical) and economic aggregates response to these disturbances.

<sup>2</sup> A correlation coefficient lies between -1 and 1; however, this coefficient rarely approaches these limit values, so we often carry out tests of significance (Student's t-test) to draw reliable interpretations.

<sup>3</sup> The accession of Slovenia to the euro area consolidates our result.



We begin with the model of Bayoumi and Eichengreen (1992), considered the standard in this context. We then apply this structural VAR method to the euro area and to acceding countries.

## **2 .1. Model of Bayoumi and Eichengreen (1992)**

This influential contribution to a large empirical literature seeks to test the validity of the optimal currency areas theory. It assumes an economy can be hit either by demand shocks or by supply shocks and identifies such shocks using restrictions on the long run impact of demand shocks on production. Indeed, demand shocks are assumed to have zero effect on long-term production; only supply shocks permanently affect output.

After identifying the nature and effects of various shocks on the economy, Bayoumi and Eichengreen estimate a VAR model of GNP and price in the European Community (the Twelve minus Luxembourg). To transform the residuals of each estimated VAR into demand and supply shock, they apply the decomposition procedure of Blanchard and Quah (1989). This procedure enables distinguishing between temporary and permanent shocks. Shock correlations calculated between countries provide information on the degree of asymmetry of real shocks, while impulse response functions associated to structural VAR facilitate evaluating the speed adjustment of each economy to these various shocks.

To evaluate the relative weight of these shocks, the same econometric procedure is applied to the United States. In addition, Europe and the United States are divided into a “center” of countries or states--characterized by symmetrical behaviour--and a “periphery,” in which shocks are less correlated with those of the center.

The starting point of the model is the following:

$$\begin{bmatrix} \Delta Y_t \\ \Delta P_t \end{bmatrix} = \sum_{i=0}^{\infty} \begin{pmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{pmatrix} \begin{bmatrix} e_{dt} \\ e_{st} \end{bmatrix} \quad (1)$$

Where  $\Delta Y_t$  and  $\Delta P_t$  respectively represent the logarithm of the GNP growth rate and that of prices in time  $T$ ,  $e_{dt}$  and  $e_{st}$  represent demand and supply shocks. Identifying constraints are based on the assumptions already mentioned, related to the nature of the effects of shocks on variables. As the product (output) is represented on first difference, the constraints on demand shocks imply that the cumulative effects of demand shocks must equal zero:

$$\sum_{i=0}^{\infty} a_{11i} = 0 \quad (2)$$

The model defined by equations (1) and (2) also implies that endogenous variables of the VAR model can be explained by various lag variables. If we sup-

pose that  $B_i$  represents the coefficient value of the model, the model can be estimated as follows:

$$\begin{bmatrix} \Delta Y_t \\ \Delta P_t \end{bmatrix} = B_1 \cdot \begin{bmatrix} \Delta Y_{t-1} \\ \Delta P_{t-1} \end{bmatrix} + B_2 \cdot \begin{bmatrix} \Delta Y_{t-2} \\ \Delta P_{t-2} \end{bmatrix} + \dots + \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} \quad (3)$$

Or  $e_{yt}$  and  $e_{pt}$  are the residuals of the VAR model equations.

Equation (3) can also be expressed:

$$\begin{bmatrix} \Delta Y_t \\ \Delta P_t \end{bmatrix} = (I - B(L))^{-1} \cdot \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} = (I + B(L) + B(L)^2 + \dots) \cdot \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} \quad (4)$$

or:

$$\begin{bmatrix} \Delta Y_t \\ \Delta P_t \end{bmatrix} = \sum_{i=0}^{\infty} \begin{pmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{pmatrix} \cdot \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} \quad (5)$$

Combining (1) and (5):

$$\sum_{i=0}^{\infty} \begin{pmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{pmatrix} \cdot \begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{pmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{pmatrix} \cdot \begin{bmatrix} e_{dt} \\ e_{st} \end{bmatrix} \quad (6)$$

Thus, we can find  $C$ , a matrix connecting demand and supply shocks of the VAR model to the residuals.

$$\begin{bmatrix} e_{yt} \\ e_{pt} \end{bmatrix} = \left( \sum_{i=0}^{\infty} \begin{pmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{pmatrix} \right)^{-1} \cdot \sum_{i=0}^{\infty} L^i \cdot \begin{pmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{pmatrix} \cdot \begin{bmatrix} e_{dt} \\ e_{st} \end{bmatrix} = c \cdot \begin{bmatrix} e_{dt} \\ e_{st} \end{bmatrix} \quad (7)$$

From equation (7), it is clear in this second order model, four restrictions are needed to identify the  $C$  matrix elements. Two of these restrictions are drawn from the assumption of normality of the variance of shocks  $e_{dt}$  and  $e_{st}$ . A general assumption retained within the framework of VAR model consists in imposing that the two variances are equal to *one*. These two assumptions combined with that of orthogonality define the third restriction,  $c'c = S$ , where  $S$  represents the covariance matrix of  $E_y$  and  $E_p$ .

The last restriction to enable identifying the  $C$  matrix derives from economic theory; it was previously defined in equation (2).

Introducing (2) in (7) yields the following model:

$$\sum_{i=0}^{\infty} \begin{pmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{pmatrix} \cdot \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} = \begin{pmatrix} 0 & \cdot \\ \cdot & \cdot \end{pmatrix}$$

And thus the resolution of this system will enable us to estimate the series of demand and supply shocks of the structural VAR model.

Bayoumi's and Eichengreen's analysis shows that supply shocks are larger and less correlated between countries (or areas) in Europe compared with the United States. Additionally--and through the impulse response functions of the structural VAR model--they suggest adjustment to supply shocks as well as to demand shocks is faster in the United States than in Europe. Consequently, as the American monetary union constitutes a point of comparison, they consider that a possible EMU would be associated with significant adjustments costs. Moreover, their results reveal a difference between two groups of Europe with regard to supply shocks and, to a lesser extent, demand shocks: a center and a periphery. Indeed, shocks affecting the economies of the center (Belgium, Denmark, France, Germany and Netherlands) are of less amplitude and more correlation to neighbouring countries, while fluctuations in countries of the periphery seem asymmetrical.<sup>4</sup> Further, while the authors suppose there are results favouring convergence, the difference between the center and the periphery does not decrease during the studied period.

## **2.2. Application to the Euro area and to acceding countries**

We have an economy whose growth rate and inflation rate are affected each year,  $T$ , by two orders of shocks: supply impulses ( $\varepsilon_{st}$ ) and demand impulses ( $\varepsilon_{dt}$ ). The model resolution is the same as in Bayoumi and Eichengreen model.

We estimate a structural VAR model in first differences. The variable representing growth rate is the first difference of the GDP logarithm ( $\Delta Y_t$ ); the inflation rate is estimated through the logarithm of the consumer price index in the first difference ( $\Delta P_t$ ).

Quarterly data are obtained from Eurostat, IFS and OECD. We analyse the period from the first quarter of 1995 to the third quarter of 2005 (1995: Q1 - 2005: Q3).<sup>5</sup> The data encompass the euro area as a group and twelve CEECs: Bulgaria, Romania, Slovenia, Slovakia, Czech Republic, Latvia, Lithuania, Malta, Estonia, Hungary, Poland and Croatia.

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<sup>4</sup> This method has certain drawbacks. First, the results may be influenced by the choice of anchor area (Bayoumi's and Eichengreen's "center"). Second, this approach does not produce a decomposition of demand and supply shocks into their structural common and specific components, making interpreting the results concerning the correlation of shocks difficult. To address these deficiencies, recent methods propose using a state-space model. The purpose of the state-space model is to decompose the structural shocks (demand and supply shock) in each country, region or area into two unobservable stochastic components: one common and the other specific. The relative importance of the country-specific component can be interpreted as a measure of the degree of asymmetry.

<sup>5</sup> Romania's and Croatia's data cover first quarter, 1997, to third quarter, 2005.

To our knowledge, the prevailing studies were never done based on a sample composed of so many countries. The studied period, even if it remains quite short, is longer than that of prior investigations. This argument provides our work with a solid base and a significant advantage compared to works relating to the same subject.

### 2.2.1. Study of variables stationnarity

**Table 3.** Study of variables stationnarity of the model

Country	GDP	CPI
Euro area	Integrated of order 1	Integrated of order 2
Hungary	Integrated of order 2	Integrated of order 1
Slovenia	Integrated of order 1	Integrated of order 1
Slovakia	Integrated of order 1	Integrated of order 1
Poland	Integrated of order 1	Integrated of order 1
Malta	Integrated of order 1	Integrated of order 1
Lithuania	Integrated of order 1	Integrated of order 1
Latvia	Integrated of order 2	Integrated of order 1
Czech	Integrated of order 1	Integrated of order 2
Bulgaria	Integrated of order 1	Integrated of order 1
Estonia	Integrated of order 1	Integrated of order 1
Croatia	Integrated of order 2	Integrated of order 1
Romania	Integrated of order 2	Integrated of order 1

**Source:** our estimates.

All variables are integrated of order one except for Latvia whose (log of) GDP is integrated of order *two*, the Czech Republic whose consumer price index is integrated of order *two* and Hungary whose (log of) GDP is also integrated of order *two*.

In all the cases the VAR lag length introduced is *four* as indicated by information criteria. Thus identification diagram will be homogeneous for each country.

After the VAR estimation for the euro area (as a reference) and for each acceding country, we identify structural demand and supply shocks. Our main aim is to check if these economic shocks are symmetrical (or asymmetrical) and if the new candidates to adhesion form--or can form--an optimal currency area with the euro area. Accordingly, after model estimation (for each country) and shock identification, we analyse the correlation of these shocks. Positive correlation is considered favourable for the constitution of a monetary union.

**2.2.2. Symmetry or asymmetry of shocks**

**Table 4.** Correlation coefficients between euro area and acceding countries:  
Shocks specification

Country	Supply shocks	Demand shocks
Euro area	1.000	1.000
Estonia	0.280413	0.376883
Hungary	0.255249	0.366702
Latvia	0.238848	0.395844
Lithuania	0.127847 *	0.361129
Malta	0.359200	0.182020*
Poland	0.033626 *	0.439294
Romania	-0.125608	0.078744 *
Czech Republic	-0.037494	0.509900
Slovenia	0.241872	0.408526
Bulgaria	-0.392937	-0.048359 *
Slovakia	-0.057729	0.099131 *
Croatia	-0.101964	0.389543

\* These values are statistically non significant (5% of probability).

**Source:** our estimates.

Table 4 above represents the coefficient correlation values measuring the relationship between supply and demand shocks in the euro area and acceding countries. The first column indicates correlations between euro area supply shocks and those of CEECs. The second column indicates demand shock correlations.

Concerning demand shocks, only one country, Bulgaria, presents a negative correlation with the euro area. Remaining correlation coefficients are positive, possibly suggesting demand shock symmetry induced by acceding country government policies.<sup>6</sup> In any case, these coefficients are not statistically significant for Romania, Malta and Slovakia. Estonia, Czech Republic, Hungary, Slo-

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<sup>6</sup> A demand shock may originate from, for example, fiscal or monetary policies, insofar as they have no influence on long-run productivity of the economy.

venia, Poland, Croatia, Lithuania and Latvia present the highest correlation values, between 0.3 and 0.51.

At the same time, results concerning supply shocks differ: five countries out of twelve present a negative correlation of their supply shocks with those of the euro area--Croatia, Slovakia, Romania, Czech Republic and Bulgaria. Estonia and Hungary have the best results. In contrast to demand shocks, supply shocks are rather asymmetrical between the euro area and acceding countries.

### 2.2.3. *Shock size and adjustment:*

**Table 5.** Standard deviation (size) of supply and demand shocks

Country	Supply shocks	Demand shocks
Euro area	0.007204	0.001965
Poland	0.043846	0.007287
Romania	0.080451	0.017044
Estonia	0.024354	0.007095
Hungary	0.033221	0.006658
Latvia	0.030718	0.005150
Lithuania	0.049390	0.006288
Malta	0.036359	0.005541
Czech Republic	0.031445	0.008222
Slovenia	0.016287	0.005401
Bulgaria	0.161952	0.225138
Slovakia	0.032196	0.015565
Croatia	0.041250	0.006775

**Source:** our estimates.

In addition to the determination of correlation and the symmetry of shocks, our method can be used to estimate the relative size of shocks. The larger the shock size, the more difficult it is to keep a fixed foreign exchange rate and the more constraining the adherence to a monetary union is. This is particularly true for supply shocks since they require more rigorous adjustment.

Table 5 above presents variation (standard deviation) of demand and supply shocks in the euro area and in acceding countries. The results of our estimation indicate Estonia, Hungary and Slovenia have the smallest supply shock

sizes (variation between 2 and 3 percent). Nonetheless, this shock size remains far from equalling those of euro area countries. Bulgaria and Romania have the largest supply shock sizes. In fact, these two countries are subject to more significant shocks; thus economic policy responses will certainly differ from those of the euro area.

Results are more optimistic regarding demand shocks. Demand shock sizes are similar to those of the euro area, except for Bulgaria, Romania, and Slovakia.

In summary, our estimation presents contrasting results: acceding countries present divergent targets. We deduce Hungary, Estonia and perhaps Slovenia are converging towards the euro area. One result is potentially significant: the positive correlation of demand shocks in most acceding countries. This is perhaps good news, implying acceding countries are making considerable efforts to join the euro area by aligning their economic policies to those of the euro area members.

## **Conclusion**

In light of earlier studies, our results stipulate economic shocks are asymmetrical in acceding countries compared with euro area countries. Regardless, some countries, such as Hungary, Poland, Czech Republic and Estonia, seem ready to adopt the Euro. Indeed, their supply shock correlation coefficients are the highest. In terms of demand shock, our estimation results favour harmonising economic policies and aligning these policies to those of the euro area.

*A priori*, considering the average, correlations between acceding countries and euro area members are far from being close. Constituting an optimal currency area suggests integrating other factors; production factor mobility is essential to maintain the adhesion process.

To conclude from an economic policy point of view, we offer some remarks. First, according to Lucas's (1976) criticism, changes in economic policies can lead to changes in economic structure, which could make difficult *ex ante* interpretation of economic policies based on *ex post* data. Moreover--and in the context of the optimal currency area (OCA) literature--Frankel and Rose (1997) suggest the OCA could be endogenous. Monetary union amplifies trade intensity and can increase the degree of business cycle synchronization between members. In other words, acceding countries can satisfy OCA criteria *ex post* even if they do not satisfy them *ex ante*. Accordingly, our result about supply shock asymmetry emphasizes the diversity of the productive structures. However, if we believe the defenders of the OCA endogeneity hypothesis, these divergences will disappear (will be attenuated) once these countries become euro area members.

The second remark is technical, due to Artis (2003), concerning the problem of “sufficiency.” Most of our empirical results result from shock correlations between countries; however, no economic theory informs us about the sufficient value of the correlation coefficients in order to draw reliable conclusions.

Finally, it is important to emphasize that our analysis concerns a part of the optimal currency area. So, we assess the shocks symmetry between the euro area and acceding countries. Nevertheless, these economies can meet other obstacles in their target of joining the Euro area. We note financial crises risk due to capital surge, for example; this problem was already met by countries whose banking system was not reliable.

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