

4. ANALYSIS OF ASYMMETRIC SHOCKS AMONG THE EU MEMBERS AND ACCESSION COUNTRIES: CAN THE BALTIC SEA CLUSTER BE DISTINGUISHED?

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Introduction

In May 2004 ten new members — Estonia, Cyprus, Lithuania, Latvia, Malta, Poland, Slovakia, Slovenia, the Czech Republic and Hungary (accession countries) will join the European Union. The enlargement of the EU will bring along several challenges both for the accession countries and the existing members. One of these is the challenge of facing in European Economic and Monetary Union (EMU). Namely, upon accession, new member states will become also members of the EMU, although they do not immediately enter the euro zone. In the longer run, and when they have met certain conditions, the accession countries are expected to join the euro zone. All accession countries must join the euro zone (i.e. there is no opt-out clause similar to Denmark or the UK for the accession countries), but there is no fixed time-schedule for the euro zone enlargement.

The question about how strong are the economic ties between the accession countries and the EMU is one of the central issues, when

¹ The views presented herein are entirely those of the author and not of the institution he is affiliated to.

the economic impacts of the EMU enlargement are discussed. The main reason is that the implementation of common economic and monetary policies within the EMU requires that the regions belonging to the EMU should be sufficiently similar. If they are not similar enough, then the implementation of common policies is difficult or may in more severe cases be even undesirable.

This paper analyzes the strength of economic ties between the EMU and the accession countries in the context of asymmetric shocks. The theoretical part is based on the optimal currency area (OCA) theory, pioneered by Mundell (1961), McKinnon (1963) and Kenen (1969). The main aim of the paper is to analyze whether the shocks that hit the accession countries are more idiosyncratic (asymmetric) than those hitting the existing members. This question is relevant mostly in the context of the EMU enlargement.² If the shocks that hit certain regions are similar, then these regions can form a monetary union without severe tensions. However, when the shocks are idiosyncratic, then the flexibility of production factor markets (especially the flexibility of the labour market) and alternative adjustment mechanisms that can replace the flexibility of exchange rate will become more important in forming a successful monetary union. As an additional aspect, the shocks in the Baltic Sea region (BSR) countries (Finland, Estonia, Latvia, Lithuania, Poland, Germany, and Denmark) are compared to one another. The main reason for concentrating on the Baltic Sea region is that the economic co-operation within the Baltic Sea countries is believed to be strong.

The empirical part of the paper uses structural VAR (sVAR) models. In the 1990s, after the seminal work of Bayoumi and Eichengreen (1993), the use of sVAR models became a mainstream method for comparing economic shocks between different regions. For analyzing the results in a broader sense, the estimated structural shocks are herein analyzed by means of cluster analysis.

² Becoming a full member of the EMU is a synonym of the expression “joining the Euro zone”.

Cluster analysis is a useful tool for analyzing the proximity of different countries in a more qualitative way. In addition, cluster analysis is used to assess whether the deemed high integration within the Baltic Sea region enables us to identify the Baltic Sea region cluster also empirically.

The paper consists of five sections. In the first two sections some relevant aspects of the OCA theory and assessing economic similarities by means of structural VAR are reviewed. The third section discusses the model that was used for our empirical exercise. The main empirical results are reviewed in the fourth chapter. Finally, the fifth section discusses whether it is possible to identify the Baltic Sea region cluster on the basis of the results obtained by cluster analysis.

4.1. The theory of optimal currency area

The need for assessing asymmetries in the economic shocks in different regions stems from the theory of OCA. The OCA theory (Mundell 1961, McKinnon 1963, Kenen 1969) investigates the tempting question about what common characteristics must be shared by the regions seeking to form a monetary union. The OCA theory concludes that the independent monetary policy is a necessity for the region only when certain conditions are met. Namely, the exchange rate policy and monetary policy are relevant policy tools in alleviating region-specific (asymmetric) shocks. In case the shocks hitting some region are similar to those hitting some other, or in other words, if the independent exchange rate and monetary policy between these regions are substitutable by some alternative mechanisms that can alleviate the impact of an asymmetric shock, then the need for implementing a different monetary policy among these regions is not so strong. In this case, formation of a monetary union between these regions may be justified. However, also the opposite is true — the more asymmetric the shocks and the less

efficient the alternative stabilization mechanism, the more costly is participation in such a monetary union.

Therefore, the OCA theory gives two directions for assessing the economic usefulness of the existence of optimal currency areas. Firstly, it is possible to assess whether the existing asymmetries between different regions are considerable enough to justify the use of alternative alleviation mechanisms in addition to an independent monetary policy. If this is the case, then the need for an independent monetary policy and a floating exchange rate to isolate external shocks may be more important.

Secondly, it is possible to assess whether the independent monetary and exchange rate policies are substitutable by some other adjustment mechanism that would isolate the impact of an external shock from economy. If at least one of the above-mentioned analyses leads to the conclusion that independent monetary policy and isolation of external shocks with the help of a floating exchange rate are not necessary, then the regions will form an optimal currency area. In this case, formation of a monetary union between these regions will not contain any significant macroeconomic shocks.

The analysis of shock asymmetries may be interesting not only in the context of the EMU, but also when assessing the integration within the Baltic Sea region. The reason is that the economic ties within the BSR are deemed to be traditionally strong. This might also point to the conclusion that the floating exchange rates within the region are economically more costly than fixed exchange rate regimes and the countries in the region should seek closer integration within the framework of the E(M)U. In this context, it is interesting to note that the chosen monetary policy strategies vary within the region — Germany and Finland have joined the euro area, whereas Denmark and Sweden have not. Among the accession countries in the region, Estonia, and more recently also Lithuania are using currency boards vis-à-vis the euro, while Latvia pegs its lat to the IMF special drawing right (SDR) and Poland follows the inflation targeting regime with a floating exchange rate.

Thus the potential risk of exchange rate volatility in intra-regional trade is eliminated only between Germany and Finland, and up to a point also between the latter and Estonia and Lithuania. There are some, although negligible, exchange rate movements vis-à-vis the latter, and Denmark and Sweden. Due to the specifics of the inflation targeting regime and the composition of the IMF SDR, there are more substantial exchange rate fluctuations of the Latvian and Polish currencies exchange rates vis-à-vis the rest of the region. Thus there are some transaction costs involved, if we consider possible strong intra-regional linkages in the Baltic Sea region. At some point in the future, after accession to the EU, Estonia, Latvia, Lithuania and Poland will also join the euro area. Until now, Denmark and Sweden have been more reluctant towards the euro zone, but if the intra-regional ties within the BSR are relatively strong, then the pros of joining the euro area may also find more support in Denmark and Sweden.

4.2. Assessing economic similarities with structural VARs

There have been several attempts to test the validity of the OCA theory in the regions that already belong to some monetary union (see, for example, Vaubel 1978, Bayoumi and Eichengreen 1993, Chada and Hudson 1994, Mazzola *et. al.* 2000). As the measurement of macroeconomic benefits of a monetary union (elimination of transaction costs, better fulfilment of functions of the money,³ etc.) is difficult, most of the empirical research has concentrated on the estimation of a monetary union's possible costs.

³ Most commonly four functions of money are distinguished between — money is a medium of exchange, a standard of measurement, a means of payment and a store of value. It is presumed that the more people use the same kind of money, the better the fulfilment of these functions as they become more universal.

Within this branch of empirical literature, the structural VAR models have gained most popularity. One of the reasons is that when testing the validity of OCA, it is necessary to distinguish exogenous shocks from otherwise endogenous economic time-series. Namely, the movements within the GDP, CPI or most other economic indicators are caused by different economic impacts that may interact with one another. Therefore the correlation between GDP or CPI dynamics does not necessarily reflect the similarity of economic grounds that have caused such dynamics. For example, the co-movement in those indicators may be induced by the reaction of economic policies to external shocks (Kenen 2000, p. 12). As the exchange rate policy itself impacts on GDP movements, the correlation analysis of GDP movements is not an appropriate tool for the analysis of OCA validity. Economists believe therefore that a clear distinction between the correlation of economic indicators and the correlation of underlying structural shocks should be made (Angeloni and Dedola 1999).

To explain the difference between structural shocks and economic indicators, consider a simple IS-LM model with an aggregated supply (AS) curve. When discussing economic shocks in the context of such a model, we usually think about the shift of the IS curve or LM curve as a demand shock, and the shift of the AS curve as a supply shock. These underlying structural (exogenous) shocks will lead to changes in the income and price levels, but the dynamics of the latter is merely endogenous vis-à-vis structural shocks (Jordan and Lenz 1999). Empirically, the underlying demand and supply shocks are not directly measurable, as there are no concrete indicators for them. Fortunately, the structural VAR methodology provides a reasonably simple (although arguable) method for recovering structural shocks from economic data.

Structural VAR models are based on the seminal analysis of Sims (1980), who claimed that a fairly small autoregressive system (VAR) can be an alternative for large-scale macroeconomic models and proved that in some cases it may even outperform large-scale

models. The main criticism of Sims (1980) towards the large-scale models was that the theoretical presumptions for identifying endogenous and exogenous variables in the large-scale model are not transparent. Namely, when estimating a large-scale model, one needs to distinguish between right-side and left-side variables and then estimate the model in a way where the residuals of the model are not linearly dependent. In practice this is not a trivial task, as one needs to incorporate into the model simultaneous relationships between the endogenous variables, which involves introduction of several (usually not formally tested) simplifications that may not be justified *per se*.

As a result, Sims claimed that it is preferable to use the empirical model where all variables are regarded as endogenous and are modelled at the otherwise unrestricted autoregressive system (Sims 1980). As the right side of the model consists only of lagged endogenous variables, a simple ordinary least squares (OLS) can be applied to estimate the model (one has to choose the appropriate number of lags to eliminate autocorrelation from the residuals). The main difference compared to large-scale models is that if in the large-scale model the simultaneous relations are incorporated directly into the model structure, then in VAR models all the information about simultaneous relations consists in the correlation matrix of VAR residuals (Amisano and Gianinni 1997). In addition, the VAR model residuals are not interpreted as white noise, but as unexpected external shocks to the system.

The structural VAR methodology tries to use economic theory to transform VAR model residuals into interpretable structural shocks. The same applies to VAR model impulse reaction functions (IRFs). Contrary to ordinary VAR models, such structural shocks and structural IRFs are deemed to have concrete economic interpretations.

The second appealing advantage of sVAR models in the context of assessing OCA is that exactly the same model can be applied for all regions under investigation. Such approach would be impossible

with the use of structural models, as in practice it is almost impossible to incorporate exactly the same model structure for different regions. In addition to that, the structural shocks of sVAR models are comparable even if the economic policies and economic structures differ, a shock in a VAR model being interpreted as an *unexpected* event that happens in the economy.

These above advantages of sVAR models have made the latter almost exceptional in the empirical applications of the OCA theory.

4.3. Structural VAR applied to the EU members and accession countries

In this paper three-variable sVAR is used for assessing the similarities and differences between the EU members and accession countries. The model is based on the earlier work of Clarida and Gali (1994), Chada and Hudson (1998), Funke (2000) and Zhang, Sato and McAleer (2002). The model incorporates income, real effective exchange rate (REER) and the price level for distinguishing between three types of structural shocks — aggregate supply shocks (AS shocks), real demand shocks (IS shocks) and nominal demand shocks (LM shocks). The identification of structural shocks follows the economic intuition described by the abovementioned papers and seminal methodology of Blanchard and Quah (1989). The latter incorporated long-run restrictions on the VAR in order to distinguish demand shocks from supply shocks. More specifically, the structural shocks in sVAR are identified by means of the assumptions that demand shocks have no long-run impact on the level of output and the nominal demand shock has no long-run impact on REER.

Such assumptions can be easily derived from any standard IS-LM model, where the short-run dynamics follows the Keynesian school, but the long run dynamics follows the classical school. The

reader seeking for a more formal explanation is herein referred to Clarida and Gali (1994) or Chada and Hudson (1998).

The process described above can alternatively be interpreted also as a vector moving average process, where the levels of output y_t , REER q_t and prices p_t reflect the infinitely accumulated effect of three structural shocks — supply shock $\boldsymbol{\varepsilon}^{AS}$, real demand shock $\boldsymbol{\varepsilon}^{IS}$ and nominal (monetary) demand shock $\boldsymbol{\varepsilon}^{LM}$:

$$(1) \quad \Delta \mathbf{X}_t = A_0 \boldsymbol{\varepsilon}_t + A_1 \boldsymbol{\varepsilon}_{t-1} + A_2 \boldsymbol{\varepsilon}_{t-2} + A_3 \boldsymbol{\varepsilon}_{t-3} + \dots = \sum_{i=0}^{\infty} A_i L^i \boldsymbol{\varepsilon}_{t-1},$$

where

\mathbf{X}_t is the vector of differentiated logs of economic indicators $(\Delta \ln y_t, \Delta \ln q_t, \Delta \ln p_t)'$,

$\boldsymbol{\varepsilon}_t$ is the vector of structural shocks $(\boldsymbol{\varepsilon}_t^{AS}, \boldsymbol{\varepsilon}_t^{IS}, \boldsymbol{\varepsilon}_t^{LM})'$,

A_i is the 3 x 3 impact matrix,

And L^i is the lag operator.

The long-run restrictions that are used for identification of the structural VAR — the requirement that demand shocks should have no long-run impact on the output and that the nominal demand shock should have no long-run impact on REER — mean that the accumulated impact of relevant structural shocks on relevant indicators is zero. In other words:

$$(2) \quad \sum_{i=0}^{\infty} a_{12i} = \sum_{i=0}^{\infty} a_{13i} = \sum_{i=0}^{\infty} a_{23i} = 0.$$

Moreover, as customary in the sVAR methodology, it is assumed that the structural shocks are orthogonal:

$$(3) \quad E[\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t'] = \mathbf{I},$$

where \mathbf{I} is the identity matrix.

Equation (1) can be transformed into VAR form:

$$\begin{aligned}
 \Delta \mathbf{X}_t &= B_0 + B_1 \Delta \mathbf{X}_{t-1} + B_2 \Delta \mathbf{X}_{t-2} + \dots + B_n \Delta \mathbf{X}_{t-n} + \mathbf{u}_t \\
 (4) \quad &= B_0 + \sum_{i=1}^n L^i B_i \Delta \mathbf{X}_{t-i} + \mathbf{u}_t.
 \end{aligned}$$

Given that vector X_t is stationary, and assuming that the estimated VAR is invertible to Wold (MA) representation, it holds that:

$$(5) \quad \Delta \mathbf{X}_t = C_0 \mathbf{u}_t + C_1 \mathbf{u}_{t-1} + C_2 \mathbf{u}_{t-2} + C_3 \mathbf{u}_{t-3} + \dots = \sum_{i=0}^{\infty} L^i C_i \mathbf{u}_{t-1}.$$

The covariation matrix of the estimated VAR is $E[\mathbf{u}_t \mathbf{u}_t'] = \Omega$.

Based on equations (1) and (5) we can conclude that the structural shocks from the theory presumed vector moving average process ($\boldsymbol{\varepsilon}_t$) and the residuals of estimated VAR (\mathbf{u}_t) are related to the relation $\mathbf{u}_t = A_0 \boldsymbol{\varepsilon}_t$. Therefore, the structural shocks can be recovered, based on the matrix A_0 and VAR residuals. A_0 can be calculated on the basis of the restrictions presented in equations (2) and (3) and on the notion that $A_i = C_i A_0$ and $\sum_{i=0}^{\infty} A_i = \sum_{i=0}^{\infty} C_i A_0$.

4.4. Empirical results

To estimate the similarities and differences between the EU members and accession countries, the residuals of the relevant VARs were decomposed into three different structural shocks, using the above methodology. The monthly time series of industrial production, consumer price index (CPI) and REER were used for this empirical exercise. The data was mostly obtained from the IMF database *International Financial Statistics*. For the existing EU members, the estimated time series cover 1990–2002, while for the accession countries the estimated time-span is mostly from 1995–96 to 2002. Due to lack of relevant data, Malta and Luxembourg were omitted from our estimations.

Before estimation, some standard procedures were performed in order to remove seasonality⁴ and to take the natural logs from the data. During the estimation of sVARs, the appropriate length of lags was chosen on the basis of the likelihood ratio test and the lack of autocorrelation in the estimated residuals. In most cases the chosen lag was five to seven months. The latter is in line with similar quarterly studies that commonly use two lags at the estimation.

The decomposed structural shocks of the accession countries and EU members were compared to each other, using simple correlation analysis. The results of the comparison are presented in Figure 1.⁵

As can be seen from Figure 1, the average correlation of demand and supply shocks for the accession countries is somewhat smaller than for the current member states. To some extent one can mark off the group of accession countries that consists of Latvia, Estonia, Slovakia and Hungary, in whose case the correlation of demand and supply shocks is not significantly different from the EMU “periphery” (Portugal, Greece, Spain, Sweden, Finland). Despite the fact that the results vary substantially from study to study, such distinction between the accession countries is broadly in line with the previous studies (Frenkel, Nickel and Schmidt (1999), Fidrmuc and Korhonen (2001), Weimann (2002)). The indicated authors also concluded that the correlation of structural shocks vis-à-vis the EMU members (Germany) is generally smaller for the accession countries than for the current members. As an exception, sometimes Estonia and Hungary (Fidrmuc and Korhonen 2001, p. 24), and also Slovenia (Korhonen 2001) are mentioned.

⁴ Multiplicative difference seasonal adjustment method was used in order to remove seasonality.

⁵ For the sake of simplicity, the correlation coefficients in Figure 1 reflect the arithmetic average of shock correlations between individual countries and all the EMU member countries (for the current EMU members, the correlation with oneself was omitted).

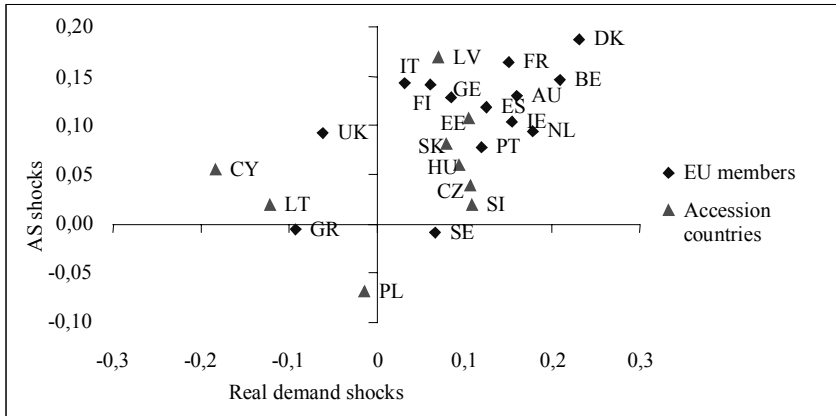


Figure 1. Mean correlation of demand and supply shocks vis-à-vis relevant shocks of the EMU member states.

The analysis indicates that the possible problem of asymmetric shocks may be somewhat more severe in Poland, Cyprus and Lithuania. In those three countries the demand shocks and/or supply shocks are negatively correlated with the majority of the EMU members as well as with the accession countries. On the one hand, one may find some intuitively appealing explanations for such a result. Poland is the largest accession country, where the role of domestic demand and supply shocks may be more relevant than in smaller accession countries. And in Lithuania, the possible impact of oil industry and USD movements may have played a greater role than the EU-specific demand shocks. On the other hand, however, such explanations would be highly speculative and are definitely inconclusive.

Explaining the relatively high asymmetries in the demand shocks of Cyprus is probably easier, which is most likely due to the more tourism-oriented structure of the country's economy by comparison with the other accession countries. It is also interesting to add that

the correlation of the demand shocks of Cyprus with the ones of Greece (and also of the UK) is notably higher.

For all the other accession countries, the supply and demand shocks are correlated with most of the EMU members. In the same vein, the correlation coefficients are generally lower compared to the current members of the euro zone. Thus the existing asymmetries in the accession countries may indeed be higher than in the current EMU. At the same time, the costs of joining the euro zone are not necessarily large either, as the correlations of structural shocks are still positive.

The results for the existing EMU members are also in line with previous studies. Firstly, the EMU peripheral (Portugal, Spain, Italy, Finland, Ireland) and EMU core (Austria, Belgium, Netherlands, France) (see Bayoumi ja Eichengreen 1992, p. 34) are more or less distinguishable also in our results. More surprisingly, the correlation of Germany vis-à-vis the other EMU members is not at the stronger edge of the graph. Of course, one of the possible explanations is that the result reflects the impact of the reunification of Germany in the early 1990s, which was definitely an asymmetric shock for Germany.

The asymmetries in Greece — the latest member to join the EMU — seem to likewise deviate from the general pattern of the EMU. This result may indicate that the monetary union is less appropriate for Greece. Naturally, this conclusion applies only when there are no sufficient alternative adjustment mechanisms in place in Greece.

Similarly to these results, also Fidrmuc ja Korhonen (2001) note that asymmetries are possibly larger in Greece, the UK and Ireland. The present paper does not reconfirm this conclusion for Ireland, though. While the asymmetries of Ireland vis-à-vis Germany (Fidrmuc and Korhonen used Germany as a reference for shock asymmetries) are indeed larger, the structural shocks in Ireland vis-à-vis other European countries are symmetric.

All in all, if we avoid the question about what the appropriate figure for correlation of structural shocks should be in order to form a monetary union, the general conclusion seems to be that the structural shocks in the euro zone seem to be correlated to one another.⁶

When we look at the EU members who do not belong to the euro zone, we can notice relatively large asymmetries vis-à-vis the UK and the euro zone. This probably reflects the fact that the USA has traditionally had a larger impact on the UK than on most other EU countries. More surprisingly, also the demand shocks of Sweden are not correlated with the demand shocks in the rest of Europe. In the case of Estonia, it is even more surprising to note that the correlations of structural shocks of Sweden vis-à-vis Estonia are negative. Given the substantial role that Sweden is playing in Estonian exports as well as in the FDI, this result is surprising. On the other hand, this result is confirmed also by some earlier studies (Luikmel et al. 2002), thus it may be relatively robust.

If we try to compare the demand and supply shocks within the Baltic Sea region (see Tables 1 and 2 in Appendix 1), the results are not encouraging. The results do not differ significantly from those described above — the possible asymmetries in Sweden, Poland and Lithuania vis-à-vis the other countries of the region are distinguishable also in this sub-sample. On the other hand, structural shocks in Finland, Denmark, Estonia and Latvia seem to be correlated to one another. At the same time, one cannot conclude that the existing correlation coefficients in the Baltic Sea region sub-sample are notably different from the correlation coefficients of the whole set.

⁶ It is still worth noting that the sustainability of the EMU is criticized not for asymmetric shocks, but for somewhat weaker correlation of structural shocks when compared to different states in the USA (see e.g., Mongelli 2002).

4.5. Can we distinguish the cluster of the Baltic Sea region?

One additional possibility for analyzing the scope of regional integration is to use cluster analysis. Cluster analysis is a methodology that tries to divide the objects under investigation into smaller subgroups on the basis of some predetermined characteristic.

There are several different methods for clustering based on the concrete principles that are used for grouping. In this paper, a similar hierarchical clustering to Olenko's work (Olenko 2001) is applied. This methodology starts with the notion that each object belongs to different cluster. During the process, pairwise clusters are formed up to the point when only one cluster is left. Then one needs to decide at which step the optimal amount of clusters was formed. Unfortunately, there is no statistical test available for making this decision, i.e. the final choice of optimal clusters is left to the researcher.

With the use of cluster analysis, similar country groups were formed on the basis of the correlation of structural shocks derived from previous sVAR analyses. More specifically, the correlation matrixes of structural shocks (see Lättemäe 2003, pp. 103–105) were used for clustering in order to recognize clusters where structural shocks are linked with other countries of a similar pattern. Clusters were formed on the basis of average linkage, measured as the sum of the squared differences.⁷ The clustering was carried out by means of freeware software AMADA (Xia and Xie 2001), the results being presented as the hierarchic tree in Figure 2 (see Appendix 2).

⁷ The average distance was calculated from the distance between each point in a cluster and all other points in another cluster. The two clusters with the lowest average distance were joined together to form the new cluster. The sum of the squared differences was used as one of the most common methods of measurement; however, results were similar when other methods of measurement were used.

As shown by Figure 2, such clustering is quite difficult to implement. This can be seen from the length of the nodes of the tree — the longer the node, the larger are differences. As the nodes of the tree are relatively long, this indicates that all the countries involved are relatively different from one another.

However, the results may be generalized as follows. Starting from the top of the tree (i.e. from left), two country groups can be distinguished between. The first group consists of Austria, Belgium, France, Denmark, Germany, the Netherlands, Latvia and Portugal. All the other countries belong to the other group. In a very general vein, such grouping broadly reflects the “core” vs. “periphery” concept as well as the results obtained from previous correlation analysis. However, according to our clustering exercise, quite strikingly, also Latvia and Portugal seem to belong into the first group. The so-called “core” group can be broken down into three sub-groups:

1. Austria, Belgium, France and Denmark;
2. Germany and the Netherlands;
3. Latvia and Portugal.

Nevertheless, this grouping reconfirms the “core” concept as Latvia and Lithuania are further distinguished from the “core”. Yet it is surprising that, according to the results, the geographically and economically quite different Latvia and Portugal belong to the same cluster, which cannot be easily explained.

The so-called “periphery” group can be broken down into two to four sub-groups:

1. Cyprus, the United Kingdom, Greece, Lithuania and Sweden;
2. Other countries that can be broken into three:
 - a. The Czech Republic and Poland;
 - b. Estonia, Slovenia, Hungary and Slovakia;
 - c. Spain, Ireland, Finland and Italy.

On the one hand, the results are in line with the conclusions of the correlation analysis. Firstly, most accession countries — the Czech

Republic, Poland, Estonia, Slovenia, Hungary and Slovakia — belong to the same (larger yet distinguishable) cluster. Secondly, the countries that according to correlation analysis incorporated asymmetric shocks vis-à-vis other European countries — Cyprus, Greece, the UK, Lithuania and Sweden — belong to the same cluster. Also, the EMU “periphery” — Spain, Ireland, Finland and Italy are distinguishable.

At the same time, the results are not overly intuitive either as some fairly “strange” cluster pairs are formed. For example, it is quite difficult to explain the pairs of Finland-Italy or Estonia-Slovenia. It would have been more appealing to form cluster-pairs from Sweden and Finland, for instance.

As regards the Baltic Sea region, then our analysis does not seem to support the existence of such a cluster. At the same time, it is worth noting that the derived results seem to contradict also Olenko’s work (Olenko 2001, p. 77–82). Namely, Olenko found that the EMU “core” consists of Italy, France, the UK, Germany and Sweden, but the present analysis does not reconfirm this result. This fact calls for caution when interpreting the results of cluster analysis. The need to exercise caution also stems from the fact, that sVAR was estimated on the basis of monthly data which may involve more additional noise than quarterly or annual time-series. Therefore, reconfirmation of the results on the basis of at least quarterly or annual data would be necessary for drawing more decisive conclusions.

Conclusions

Based on the optimum currency area theory, this paper analyzed the strength of economic ties between the accession countries and the EMU. The analysis was carried out by means of correlation and cluster analysis of structural shocks, obtained using the structural VAR methodology.

The results of the analysis let us conclude that the correlation of structural supply and demand shocks in the accession countries against the other EMU members is existent but somewhat weaker than among the current members of the euro zone. The existence of (although weaker) similarities is not very surprising, given the trade linkages between the accession countries and the current EU members. At the same time, it should be pointed out that this correlation may be somewhat overestimated due to the fact that the estimates are partly based on industrial production data, but industry is usually more integrated than the other economic sectors. Therefore, there may exist asymmetries that may stem from the non-industrial sector.

On the other hand, we should note that the analysis was based on monthly data that may contain some additional noise when compared with quarterly or annual data. Moreover, in small economies the industrial production figures may be strongly influenced by a few large companies, which also may add some noise.

The cluster analysis in the broad sense confirmed the results of the correlation analysis. For instance, the EMU “core” and “periphery” are reasonably clearly distinguishable by the data. At the same time, the results of the cluster analysis were also surprising. Specifically, the cluster analysis indicates the possible existence of clusters that may be difficult to explain intuitively. More strikingly, neither the cluster analysis nor the correlation analysis lend support to the hypothesis that the Baltic Sea region forms a distinguishable cluster within the EU. However, it should be pointed out, that the interpretation of the cluster analysis calls for some caution, as the results do not seem to be robust enough across different studies. In this regard, the results of our correlation analysis seemed to be more robust, as they seemed to reconfirm earlier findings at least to some extent.

According to the above results, the Baltic Sea region does not form a separate cluster in Europe, although the correlation analysis yielded the conclusion that the similarities and differences of

structural shocks among the countries of the Baltic Sea region are comparable to the relevant similarities of the Baltic Sea countries against the other European countries. On the other hand, nor did the cluster analysis confirm the existence of a separate Baltic Sea region cluster. However, these results are too inconclusive to abandon the hypothesis about the existence of such a cluster. Firstly, this result is not robust enough, as it does not reaffirm the earlier studies at least in what concerns the cluster analysis part. In this regard, one may alternatively ask: if the Baltic Sea region cluster does exist, why does it not show up in the analysed data?

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Appendix 1. Correlation of demand and supply shocks in the Baltic Sea region⁸**Table 1.** Correlation of supply shocks

	Germany	Finland	Denmark	Sweden	Estonia	Lithuania	Poland
Finland	0.268						
Denmark	0.309	0.288					
Sweden	-0.133	-0.026	0.020				
Estonia	0.074	0.200	0.113	-0.180			
Lithuania	-0.068	0.032	0.017	-0.038	0.112		
Poland	-0.181	-0.040	0.022	0.091	-0.155	-0.009	
Latvia	0.137	0.147	0.123	-0.081	0.027	-0.004	-0.167

Source: Author's calculations

Table 2. Correlation of demand shocks

	Germany	Finland	Denmark	Sweden	Estonia	Lithuania	Poland
Finland	-0.041						
Denmark	0.121	0.115					
Sweden	0.051	0.010	-0.054				
Estonia	-0.041	0.074	0.104	-0.162			
Lithuania	-0.133	-0.162	-0.156	0.085	0.069		
Poland	-0.025	-0.133	-0.043	-0.055	0.128	-0.178	
Latvia	0.105	0.018	0.027	0.345	-0.229	-0.210	0.050

Source: Author's calculations

⁸ The tables represent correlation between the supply and demand shock time series that were obtained from the structural VAR analysis.

Appendix 2. Cluster analysis of structural shocks

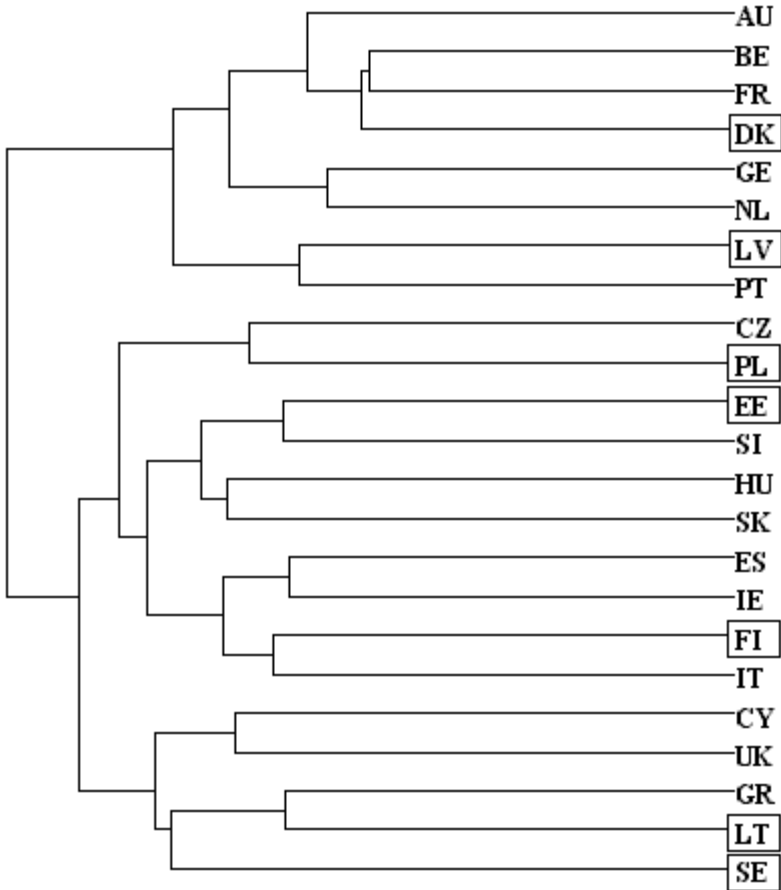


Figure 2. Cluster analysis of structural shocks. The length of the node on the hierarchic tree represents the estimated differences between different countries — the longer the node, the larger the differences. The countries of the Baltic Sea region (except Germany) are marked as framed.