The Academy of Economic Studies
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Demand and supply shocks synchronisation
Evidence from Romania in the context of European Integration

Student: Nora Rusu
Supervisor Professor: PhD. Moisă Altăr

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Abstract

The current paper looks at the degree of demand and supply shocks synchronization between Euro Area and Romania together with three other EMU candidate countries to assess the implications for the economy of joining the single currency area. Shock identification was done using a Structural VAR analysis. I find that Romania has positive correlation of supply shocks with EA and its member countries and zero correlation of demand shocks which is likely to have been triggered by different economic policies Romania followed in the last years. At the same time, the paper supports the view that in light of the optimal currency area, allowing Romania and the other analyzed countries to join EMU would not add to much noise. It is rather a question for the individual aspiring countries to ensure that they have the mechanisms in place to implement adequate fiscal policies and synchronization in their business cycles, lest they find themselves without appropriate demand management.

I. Introduction

Enlargement of the European Union brings many changes and challenges for its old and new members. All the new member states must join the European Monetary union since they do not have an opt-out clause as some of the older member states had. There have been many questions and analyses whether at least the “old” Europe is a real optimum currency area. Most of the results show that even in this “old” Europe there is “core” and there is “periphery”. The ten new member states that joined the European Union in May 2004 are believed to be even further from the “core” than the “old periphery”. At the beginning of 2007 another two countries, namely Romania and Bulgaria joined the EU. Regarding the currency union the only issue that we know for sure is that both of these countries will join the Monetary Union at some time in the future. How close or how far this moment is, it remains to be seen. One may be tempted to say that since these two countries had so many problems when completing the EU adherence criteria, the EMU is only wishful thinking for a long period of time. Even if this were right, there is enough reason to bring this question up and try to include Romania in the list of analyzed countries for possible future Eurozone adherence.

The incentive for individual countries to join EMU rests on the perceived benefits of membership. The benefits are more obvious than the costs of adherence because they mainly reflect direct effects of monetary unification and take the form of a reduction in transaction costs and a stronger integration of markets for goods as well for financial services.

The costs of monetary union are less transparent because they stem from more indirect effects. They result from possible disadvantages of giving up the exchange rate instrument and pursuing an independent monetary policy. This could represent a significant limitation for policy makers if asymmetric shocks occur. In this case, economies have to absorb the shocks without the support of traditional government policies. The only instrument that remains specific for each country although it is part of EMU and that can be used individually to correct different shocks that hit the economy is the fiscal policy. Thus, if a certain economy responds to a specific shock significantly different than the other member states, than the only way to accommodate the shock effects remains through its fiscal policy which may need an abrupt move to compensate for the lack of flexible exchange rate and of independent monetary policy. However, concerns are reinforced to the extent that the internal market places limits on the use of fiscal policy as well. At this moment, one of the Maastricht criteria which are to be completed by all the EMU member states and by the aspiring ones states is that the budget deficit cannot be higher than 3% of GDP. Thus, the compensation of shocks that may be achieved through fiscal policy is limited.

The weight that should be attached to the above mentioned arguments when judging the option of adhering to a single currency zone depends on the incidence of shocks. If disturbances are distributed symmetrically across countries, symmetrical policy response would be sufficient. In response to a negative aggregate demand shock that is common to all EMU countries, for example, a common policy response in the form of a common monetary and fiscal expansion would be adequate. Only if disturbances are distributed asymmetrically across countries will there be a need for asymmetric policy responses which the constraints of the monetary union will limit. This has been widely understood, of course, since the seminal work on the theory of optimal currency areas by Mundell (1961).

At the same time, there is another way for looking at the same problems. That is, if the adherence of a new member state with idiosyncratic shocks in a monetary union could disturb the well-functioning of the union if their business cycles are not correlated. Can diverging business cycles caused by asymmetric shocks threaten the viability of the Monetary Union as a whole?

The major and initial goal of this paper was to investigate business cycles of the Romanian economy and their symmetry to the Euro Area economy using the shock correlation approach. However, I did not limit my analysis to the study of the business cycles of Romania and Euro Area economy but included other countries in the study. First, I chose the so-considered core economies from the Euro Area (EA), namely Germany, France and Italy. The reason behind studying these economies was to see not only the correlation between the Romanian business cycles and the EA as a whole but to be able to distinguish separate correlations. Besides this, including these countries allowed me to make a brief analysis of another interesting hypothesis: Is the "core" of the Euro Area an optimal currency area? Did fixing the exchange rates lead to convergence of business cycles? However, the answers I get to these questions are to be interpreted with care as the country sample is rather small and the conclusion cannot be easily extrapolated to the other member states. In addition to these developed countries I also introduced in my analysis three developing countries that joined the European Union in May 2004: Poland, Hungary and Slovakia. The reason for which I chose to study these countries as well is that they share to a certain extend the same background as Romania being former communist economies. However, the communist regime was significantly different in each of them and nowadays these countries reached different levels of economic development. I chose Hungary as it is often included in analysis and compared to Romania but at the same time because several older papers that studied shock correlation among CEECs found in Hungary the performer of the region in terms of shock correlations with the Euro Area core economies. Bearing in mind the negative development in the Hungarian economy in the last two to three years it is interesting enough to see how these issues influence the shock correlation analysis. In accordance with my expectations, I find that not only that Hungary is no longer the performer but it is the weakest from all the chosen countries in terms of shock correlation with the EA. Once again I stress upon the fact that my analysis includes only eight countries from which three are developed ones and four developing and the Euro Area. The reason for including Slovakia is easy to understand as Slovakia is currently in the ERM II stage of pre-adherence to the EMU with the official promise of joining the single currency area in January 2009. Despite my a priori expectations I cannot formulate a conclusion regarding a strong proven correlation among shocks of Slovak economy and the EA. However, at least the demand shock correlation story is influenced by the change in the exchange rate regime that took place in Slovakia with flexile exchange rate transforming into ERM II and the band being readjusted.

In this paper, I analyze data on output and prices for the eight economies mentioned above in order to extract information on aggregate supply and aggregate demand disturbances. I use the structural vector autoregression approach to isolate disturbances as developed by Blanchard and Quah (1989) and extended by Bayoumi (1991) and Bayoumi and Eichengreen (1992). I examine the time-series behavior of real GDP and the price level. To recover aggregate supply and demand disturbances I impose in the same manner as Blanchard and Quah (1989) the identifying restriction that aggregate demand shock has only a temporary impact on output but a permanent impact on prices while aggregate supply disturbances permanently affect both prices and output.

The empirical study allows a conclusion about the degree of correlation between business cycles (in the shock correlation approach) between Romania and the Euro Area. At the same time, an analysis about the economy's speed of adjustment can be made after identifying the two aggregate demand shock categories. By including the other economies in the study, I will be able to observe the behavior of the core economies in the Euro Area and if they represent or not an optimal currency area. The other developing economies included in the analysis permit a comparison between the degree of correlation in shocks between Romania and EA and the other countries and EA. At the same time, the existence of a correlation between the developing countries included in the study can be affirmed or denied.

The paper is organized as follows. The next session briefly reviews literature on optimum currency area theory and its developing related to the accession countries of the Central and Eastern Europe (CEECs). The third section illustrates the aggregate supply-demand model underlying the empirical exercise and describes the method used for identifying the aggregate supply and demand shocks. In the fourth section I present the data I use and proceed to the empirical estimation, identify the shocks and assess their nature across countries. The fifth section presents some concluding remarks.

II. Brief literature review

The optimal currency area (OCA) theory goes back to Mundell (1961). In the 1950s, a series of papers questioned Bretton Woods exchange rate arrangements under which fixed, but adjustable, exchange rates prevailed. These publications identified adjustment problems under fixed regimes and argued in favour of flexible rates. Mundell (1961) summarizes the argument of proponents of flexible exchange rates: "*Depreciation can take the place of unemployment when the external balance is in deficit, and appreciation can replace inflation when it is in surplus*." If flexible exchange rates are more advantageous than fixed rates, Mundell asks, does it follow that all currencies in the world should be flexible? Furthermore, he inquires, are countries the proper units to take advantage of different exchange rate arrangements?

Mundell concludes that the argument for flexible exchange rates rests on the closeness with which countries correspond to regions. If a nation is an economic region with internal factor mobility and external factor immobility, the argument for flexible exchange rates holds. If nations are dissimilar to regions, fixed exchange rates may do as well as flexible exchange rates.

After the breakdown of the Bretton Woods system, the OCA analysis was regularly used to assess the desirability of having a fixed exchange rate in different countries. Generally, it was found that especially labour movement between countries was extremely slow, making fixed exchange rates undesirable on these grounds.

A revival in the empirical testing of the OCA theory preceded the introductions if the monetary union in Europe. In the empirical studies, the correlation between German business cycle and those of another potential member countries were usually assessed.

Especially influential was the contribution of Bayoumi and Eichengreen (1992) when they used data from 11 European Union member countries to extract information on underlying aggregate supply and demand disturbances using VAR decomposition. The two authors recover the underlying demand and supply disturbances using the technique developed by Blanchard and Quah (1989). The basic idea is that an economy is hit by two types of shocks, demand and supply shocks. Demand shocks are identified with the help of the restriction that their long-term impact on output is zero. Only supply shocks can have a permanent effect on output. Bayoumi and Eichengreen estimate first two-variable vector autoregression (VAR) models for real GDP and GDP deflator. Demand and supply shocks are then recovered from the residuals of the VARs with the help of the aforementioned restriction. Correlation coefficients of different shocks between countries are used to assess the degree of similarity between the business cycles.

Bayoumi and Eichengreen (1992) find that underlying shocks are significantly more idiosyncratic across EU countries than across US regions, result which may indicate that the EU will find it more difficult to operate a monetary union. However, a core of European Union countries made up of Germany and her immediate neighbours, experience shocks of similar magnitude and cohesion as the US regions. EU countries also exhibit a slower response to aggregate shocks than US regions presumably reflecting lower factor mobility.

In another paper that came out an year later Bayoumi and Eichengreen (1993) recovered the underlying demand and supply shocks in the prospective members of the monetary union using the same technique developed earlier by Blanchard and Quah (1989). Bayoumi and Eichengreen place special emphasis on supply shocks as they produce clearer results and find that the correlation in shocks is quite high for countries like France and Belgium, i.e. countries with close geographic and economic ties with Germany. In the end, the two authors conclude that the EU is divided into two groups and that the „core" countries mau represent an optimum currency union.

For the CEECs, the issue of joining the monetary union is becoming more and more topical. When the new member countries join the EU, they are expected to join the monetary union at some point in the future. The European Union, including the Eurosystem has outlined a three-step approach to the monetary integration for candidate countries from Central and Eastern Europe. Basically, applicants first join the European Union, then join the exchange rate mechanism ERM II and finally after they meet the convergence criteria, accede to Economic and Monetary Union (EMU). Therefore, the eventual goal for the accession countries as regards monetary arrangements is clear. The issue is the timing of monetary union membership and the optimal interim exchange rate arrangement. If there is already a significant degree of correlation between the business cycles of the euro area and the accession countries, the costs of giving up monetary independence may not be very high. This could in turn lead to early membership in the monetary union.

The extension to which the CEECs countries are ready from a business cycle correlation point of view for acceding EMU has been a topical issue especially in the latest years. However, the results obtained by different studies that analyzed the same issue are quite different with the correlations between demand and supply shocks in different countries and several regions having a high degree of dispersion.

Using data from mid 1990s to 2000 for ten CEECs , Fidrmuc and Korhonen (2001) found that Hungary has the most correlated demand and supply shocks with the Euro area as a whole, while in the same time, the correlation of shocks varies considerably between EMU and accession countries. When taken individually, Hungary has the highest correlation in supply shocks, while Poland has the maximum correlation among the investigated countries for demand shocks. The least correlated are the Baltic countries namely, Lithuania and Latvia for demand shocks and Lithuania for supply ones.

When investigating the Vishegrad and Baltic countries' shocks having Germany as a benchmark, Horvath (2000) found that the shocks affect the transition economies (Vishegrad and Baltic countries) are largely uncorrelated with those prevailing in Germany. Hungary is found again having the highest correlation for supply shocks and the lowest for demand, while Lithuania has the lowest one, but the highest for demand shocks.

Frenkel and Nickel (2002) conclude their study that "there are still differences in the shocks and in the adjustments process to shocks between the euro area and the CEECs. However several individual CEECs exhibit shocks and shock adjustment processes that are fairly similar to some euro area countries".

Babetski, Boone and Maurel (2003) instead of measuring the correlation shocks as done as in above mentioned papers introduce time varying correlation, thus they differentiate between the overall transition period and the most recent period. Their results show an ongoing process of demand shock convergence and supply shock divergence. Babetski (2003) finds that an increase in trade intensity and a decrease in exchange rate volatility is associated with demand shock convergence and he interprets his result as in support of endogeneity of the optimum currency areas.

Horvath and Ratfai (2004) using 1993-2000 quarterly data show that the degree of correlation among the eight new members of EU is significant but there is a low correlation of these economies shocks with the EMU main economies . Based on these, they argue that the integration of these countries into EMU will be costly.

Fridmuc (2001) tests the Frankel and Rose (1998) endogeneity hypothesis of optimal currency area criteria. He shows that the convergence of business cycles relates to intraindustry trade but has no significant relationship between business cycles and bilateral trade intensity.

III. Theoretical considerations and estimation methodology

The theoretical framework from which shock identification begins is the traditional aggregate demand and aggregate supply model as Chart1. The aggregate demand curve (labelled AD) is downward sloping in the price output plane, reflecting the fact that lower prices, by raising money balance, boost demand. The short run aggregate supply curve (SRAS) is upward sloping, reflecting the assumption that wages are sticky and hence, the higher prices imply lower real wages. The long run supply curve (LRAS) is vertical since, in the long run real wages adjust to price changes. The fact that in the long run aggregate supply (LRAS) is vertical means that output is not influenced by the prices in the long run and it eventually comes back to normal from the short run, preventing aggregate demand shocks to permanently affect the level of output. The idea is that the production capacity of the economy is fixed and can be varied by some other factors such as technological progress but not by prices. The aggregate demand curve is downward sloping meaning that decreases in prices will raise real money and this positive effect will lead to an upward shift in the product demand.

Chart 1

The Aggregate Supply and Demand model

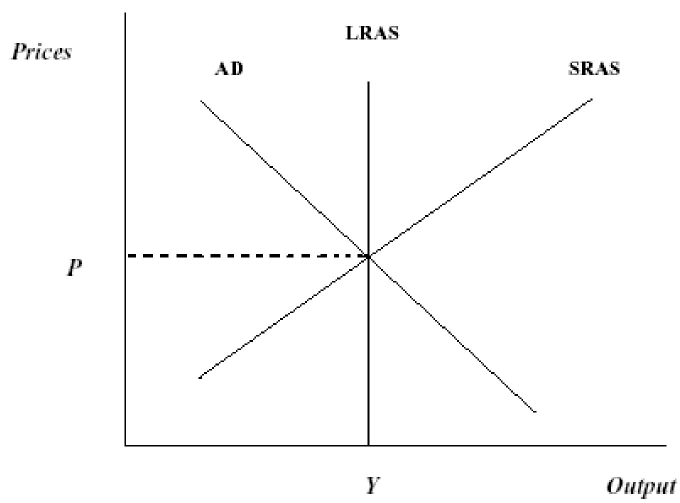
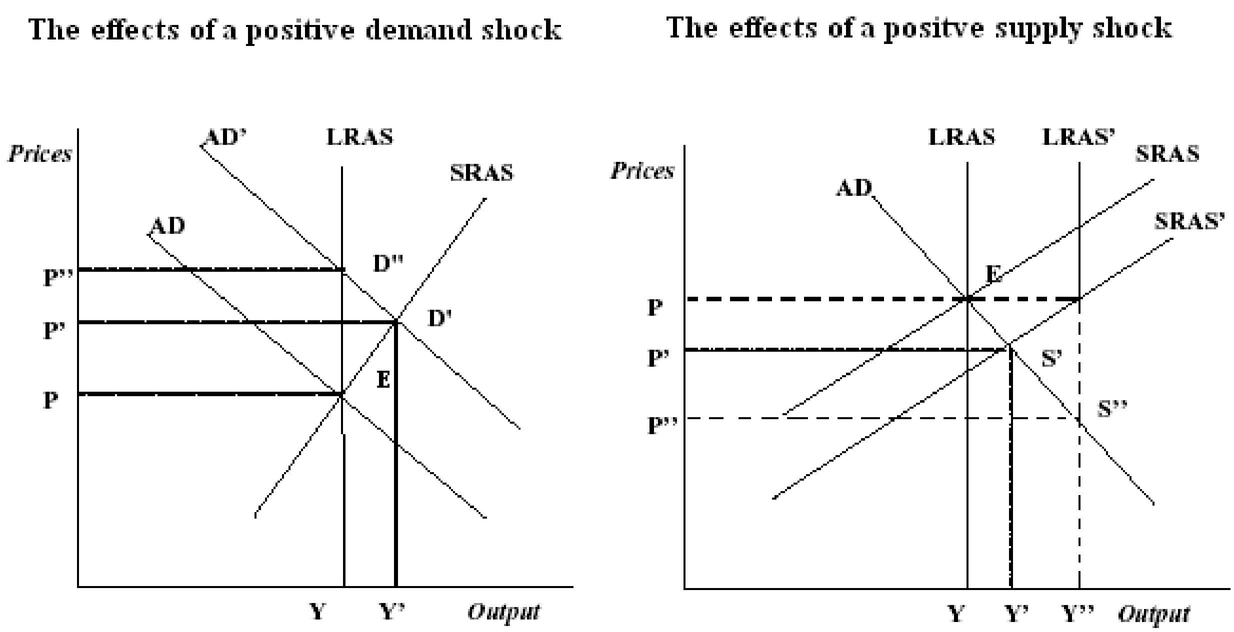


Chart 2

Response to shocks



The effect of a shock to Aggregate Demand is shown in the left hand side of Chart2. The aggregate demand curve shifts to right from AD to AD' resulting in a movement of the equilibrium E to D'. This movement has an effect on both Output and Prices and raises them both. As the aggregate supply curve becomes more vertical over time, the economy gradually moves from its short-run equilibrium D' towards its long-run equilibrium D''. This movement involves the return of output to its initial level Y, while the price level rises to a level which is permanently higher. Hence*, the response to a permanent (positive) demand shock is a short-term rise in output followed by a gradual return to its initial level and a permanent rise in prices.*

The effect of a shock to Aggregate Supply is shown in the right hand side of Chart2. Assume that the long run level of potential output raises say because of a favorable technology shock. Both the short-run and long-run supply curves move rightwards by the same amount as shown by SRAS' and LRAS'. The short-run effect rises output to Y' and lowers prices to P’ shifting the equilibrium of the economy from E to S’. As the supply curve becomes increasingly vertical over time, the output increases further to Y” and the reduction of prices becomes more important to P”. The equilibrium of the economy thus shifts from S’ to S”. Unlike demand shocks, supply shocks result in permanent change in output. In addition, demand and supply have therefore different effect on prices. *A positive demand shock permanently raises prices while a positive supply shock leads to a decline in prices.*

This framework is estimated using a procedure proposed first by Blanchard and Quah (1989) for decomposing permanent and temporary shocks to a variable using a VAR, as extended by Bayoumi (1991) and Bayoumi and Eichengreen (1992).

Blanchard and Quah (1989) provide an alternative way to obtain a structural identification. They develop a macroeconomic model such that real GNP is affected by demand-side and supply-side disturbances. In accordance with the above mentioned theoretical framework, the demand-side disturbances have no long run effect on real GNP. On the supply side, productivity shocks are assumed to have permanent effect on output. Using a bivariate VAR, Blanchard and Quah show how to decompose real GNP and recover the two pure shocks that can not otherwise be quantified. They assume that there are two kind of disturbances, each uncorrelated with the other and that neither has a long run effect on unemployment. They assume however, that the first has a long run effect on output while the second does not. These assumptions are sufficient to just identify the two types of disturbances and their dynamic effects on output and unemployment.

Bayoumi and Eichengreen (1991) examine time series behavior of real GDP and the price level. To identify the structural shocks they impose the restriction that aggregate demand disturbances have only a temporary effect on output but a permanent impact on prices while aggregate supply disturbances permanently affect both output and prices.

They estimate bivariate VAR for 11 European Countries and American grouped countries to identify the two types of shocks and study the correlation between them and the speed of adjustment of the economy.

In the same manner, we consider a Vector Autoregression representation of a system composed by two variables that are the first differences of the logged value of GDP and Prices which is calculated as the ratio of real and nominal GDP.

Thus, the two variables that compose the VAR are:

$$X_t = \begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix}$$

In this particular case, we started by letting the time path of both Δy_t and Δp_t to be affected by the current and past realized values of both Δy_t and Δp_t. Otherwise said, we can re-write the previous classical VAR structure as:

$$\begin{cases} \Delta y_t = b_{10} - b_{12}\Delta p_t + \gamma_{11}^{1}\Delta y_{t-1} + \gamma_{12}^{1}\Delta p_{t-1} + ... + \gamma_{11}^{p}\Delta y_{t-p} + \gamma_{12}^{p}\Delta p_{t-p} + \varepsilon_{dt} \\ \Delta p_t = b_{20} - b_{21}\Delta y_t + \gamma_{21}^{1}\Delta y_{t-1} + \gamma_{22}^{1}\Delta p_{t-1} + ... + \gamma_{21}^{p}\Delta y_{t-p} + \gamma_{22}^{p}\Delta p_{t-p} + \varepsilon_{st} \end{cases}$$

Rearranging the above equations and re-writing them in a matrix form we obtain:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11}^{1} & \gamma_{12}^{1} \\ \gamma_{21}^{1} & \gamma_{22}^{1} \end{bmatrix}\begin{bmatrix} \Delta y_{t-1} \\ \Delta p_{t-1} \end{bmatrix} + ... + \begin{bmatrix} \gamma_{11}^{p} & \gamma_{12}^{p} \\ \gamma_{21}^{p} & \gamma_{22}^{p} \end{bmatrix}\begin{bmatrix} \Delta y_{t-p} \\ \Delta p_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix}$$

And further, in general form it becomes:

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + ... + \Gamma_p X_{t-p} + \varepsilon_t$$

where X_t is a vector of the two considered variables Γ_t are the matrices of coefficients, p lags are considered and ε_t is the vector of error terms.

By multiplying with the inversion of B matrix, provided that it exists $(1 - b_{12}b_{21} \neq 0)$ we obtain:

$$X_t = B^{-1}\Gamma_0 + B^{-1}\Gamma_1 X_{t-1} + ... + B^{-1}\Gamma_p X_{t-p} + B^{-1}\varepsilon_t$$

Making the usual notations we re-write that:

$$X_t = A_0 + A_1 X_{t-1} + ... + A_p X_{t-p} + e_t$$

$$X_t = A(L)LX_t + e_t \ (1)$$

Since the demand-side and supply-side shocks are not observed, the problem is to recover them from a VAR estimation which has the usual representation written above. The critical insight is that the VAR residuals are composites of pure innovations ε_{dt} and ε_{st} respectively.

In the particular bivariate moving average form, the VAR can be written:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} b_{11i} & b_{12i} \\ b_{21i} & b_{22i} \end{bmatrix} \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \ (2)$$

The elements b_{11i}, b_{21i} are the impulse responses of an aggregate demand shock on the time path of the GDP growth and inflation respectively. The coefficients b_{12i}, b_{22i} are the impulse responses of and aggregate supply shock on the time path of GDP growth and inflation respectively.

We know that e_t is the one-step ahead forecast error of y_t as from (1) we know that $X_t = A(L)X_{t-1} + e_t$.

Thus, $e_t = \Delta y_t - E_{t-1}\Delta y_t$.

As written in the BMA form above, the one step forward error is at the same time equal to $b_{k1(0)}\varepsilon_{dt} + b_{k2(0)}\varepsilon_{st}$.

Otherwise said, by combining the two above representations we obtain the following system:

$$\begin{cases} e_{1t} = b_{11(0)}\varepsilon_{dt} + b_{12(0)}\varepsilon_{st} \\ e_{2t} = b_{21(0)}\varepsilon_{dt} + b_{22(0)}\varepsilon_{st} \end{cases} \quad (3) \qquad \text{or} \qquad \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} b_{11(0)} & b_{12(0)} \\ b_{21(0)} & b_{22(0)} \end{bmatrix} \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix}$$

If the *b* coefficients were known, it would be possible to recover ε_{dt} and ε_{st} from the regression residuals e_1 and e_2. Blanchard and Quah show that the relationship between (1) and the BMA model (2) plus the long-run restriction provide exactly four restrictions that can be used to identify these four coefficients. The VAR residuals can be used to construct estimates of $var(e_1)$, $var(e_2)$ and $cov(e_1,e_2)$, meaning that the estimated residuals can be used for constructing the covariance matrix.

Hence, we present the following four restrictions used for the identification of the structural disturbances:

Restriction 1

From (3) we derive that

$$\mathrm{var}(e_{1t}) = \mathrm{var}(b_{11(0)}\varepsilon_{dt} + b_{12(0)}\varepsilon_{st}) \quad (4)$$

Noting that $E\varepsilon_{dt}\varepsilon_{st} = 0$ since the two structural disturbances are not correlated and thus orthogonal, the equation (4) helps us obtain that:

$$\mathrm{var}(e_1) = b_{11(0)}^2 + b_{12(0)}^2 \quad (5)$$

Restriction 2

In the same manner of above, using the other equation of (3) we obtain the second restriction:

$$\text{var}(e_2) = b_{21(0)}^2 + b_{22(0)}^2 \quad (6)$$

Restriction 3

The product of e_{1t} and e_{2t} is :

$$e_{1t}e_{2t} = [b_{11(0)}\varepsilon_{dt} + b_{12(0)}\varepsilon_{st}][b_{21(0)}\varepsilon_{dt} + b_{22(0)}\varepsilon_{st}]$$

Taking the expectations and using again the independence of the structural shocks and the fact that the structural shocks have variance of 1 (as they are subject to normalization) we obtain the covariance of the VAR residuals:

$$Ee_{1t}e_{2t} = b_{11(0)}b_{21(0)} + b_{12(0)}b_{22(0)} \quad (7)$$

The equations (5), (6) and (7) reveal a system with three equations and four unknowns ($b_{11(0)}$, $b_{12(0)}$, $b_{21(0)}$, $b_{22(0)}$). The fourth restriction is embedded in the assumption that the ε_{dt} has no long run effect on GDP.

From (1) we know that $X_t = A(L)LX_t + e_t$

So that $X_t = [I - A(L)L]^{-1} e_t$

If we denote the determinant of $[I - A(L)L]^{-1}$ by D we can obtain further that

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \frac{1}{D} \begin{bmatrix} 1 - A_{22}(L)L & A_{12}(L)L \\ A_{21}(L)L & 1 - A_{11}(L)L \end{bmatrix} \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

Using the definitions of the $A_{ij}(L)$ we get:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \frac{1}{D} \begin{bmatrix} 1 - \sum_{k=0}^{\infty} a_{22}(k) L^{k+1} & \sum_{k=0}^{\infty} a_{12}(k) L^{k+1} \\ \sum_{k=0}^{\infty} a_{21}(k) L^{k+1} & 1 - \sum_{k=0}^{\infty} a_{11}(k) L^{k+1} \end{bmatrix} \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

Thus, the solution for Δy_t in terms of the current and lagged values of e_1 and e_2 is:

$$\Delta y_t = \frac{1}{D} \left\{ \left[1 - \sum_{k=0}^{\infty} a_{22}(k) L^{k+1} \right] e_{1t} + \sum_{k=0}^{\infty} a_{12}(k) L^{k+1} e_{2t} \right\}$$

Now e_1 and e_2 can be expressed in terms of the structural shocks taking into account the equations in (3). If we make these substitutions, the restriction that ε_{dt} has no long-run effect on y_t is:

$$\left[1 - \sum_{k=0}^{\infty} a_{22}(k) L^{k+1} \right] b_{11(0)} \varepsilon_{1t} + \sum_{k=0}^{\infty} a_{12}(k) L^{k+1} b_{21(0)} \varepsilon_{1t} = 0$$

Restriction 4

For all possible realizations of the ε_{dt} sequence, demand shocks will have only temporary effects on the Δy_t sequence if:

$$\left[1 - \sum_{k=0}^{\infty} a_{22}(k) \right] b_{11(0)} + \sum_{k=0}^{\infty} a_{12}(k) b_{21(0)} = 0 \quad (8)$$

With all the restriction expressed in (5), (6), (7) and (8) we now have four equations to obtain the values of four unknowns. With these values we can perfectly identify the structural shocks starting from VAR estimated residuals.

To summarize we need to impose four restrictions in order to be able to exactly identify the structural, initial and accurate shocks. Two out of these four restrictions reflect the assumption of unit variances of ε_{dt} and ε_{st}. The third restriction is the assumption that supply and demand shocks are independent, thus orthogonal, which implies that $\text{cov}(\varepsilon_{dt}, \varepsilon_{st}) = 0$. It is only the fourth restriction that deals with the economic assumption that a demand shock does not have long run effect on output.

It is important to state that the two shocks ε_{dt} and ε_{st} will be independent only if they have separate causes, like for example shifts in macroeconomic policy for the aggregate demand disturbances and technological innovations for the aggregate supply disturbances. If there will be, say, the case of a change in commodity prices for a commodity producer, then the estimated aggregate supply disturbances in this framework will incorporate the analogous consequence on aggregate demand and the whole identification that we aimed through this paper will break down. This is one of the reasons why it is clearly controversial to interpret shocks with permanent impact on output as pure supply disturbances and shocks with temporary effect on output as pure aggregate demand disturbances. And this is because of the multitude of assumptions that should be made in order for this association not to break down in other frameworks.

Connected with this matter, a critical feature of the methodology used as the fundamental of the project comes into play. This is the response to prices, since as we already saw, the AS-AD model predicts that positive demand shocks leads to increases in prices and positive supply shocks leads to decreases in prices. These are the two overidentifying restrictions that helps testing for the interpretation of permanent output disturbances in terms of supply and temporary output disturbances in terms of demand. Hence, the impulse response functions are used as direct means of testing the validity of our interpretation of the structural VAR.

And as the results are showing, these conditions are satisfied for all the countries analyzed Romania, Hungary, Poland, Slovakia, Euro Area, Germany, France and Italy.

IV. Data and empirical evidence

1. Data

There are seven countries and the Euro Area included in the present study for each the demand and supply disturbances are identified and evaluated in comparison with European Monetary Union (EMU). My initial intention was to study this issue on Romania only and to see the correlation of shocks with the EMU. However, I decided to include a few other countries and enlarge my analysis to have a more complete view. I have chosen besides Romania, the three major and so-considered core economies of EMU: Germany, France and Italy and three other countries that joined the European Union in 2004 and are not currently part of Euro Area: Hungary, Poland and Slovakia. From these last three countries Slovakia is the one about which we know that it will join the EMU on January 2009. The reason for choosing this country is exactly to see the correlation of shocks in the case of a country where EMU adherence is imminent. The other two countries Hungary and Poland were chosen as they have basically the same economic background as Romania, being former communist economies though with significant differences in regimes but with an accelerated transition period that pushed them to a more developed economic stage than Romania. These two countries are the ones that are most often included in all kinds of comparison with Romania. From the above argumentation it stands out that this analysis is meant to be centralized on Romania and its correlation in shocks with the EMU from the perspective of a possible future adherence. However, quite often in my analyses I compare the other countries in order to complete the argumentation.

In terms of data I use quarterly GDP in both constant (with 2000 being the base year) and current prices. The data are from *Eurostat* and from *International Financial Statistics*

(IFS) of the International Monetary Fund. For a detailed data description see *Appendix 1*. For Romania, the data are from *National Institute of Statistics (NIS)*.
The time sample is from 1998Q1 to 2008Q1 for seven out of eight countries with only Slovakia having a smaller sample of data availability from 2000Q1 to 2008Q1.

For the real GDP data from *Eurostat* the seasonally adjusted series were chosen in order to avoid the influence of seasonality in the analysis. In order to calculate the GDP deflator as a measure of inflation the nominal quarterly GDP was divided to the real quarterly GDP. Thus I obtained the series of GDP deflators that were under the influence of seasonality. These series were further de-seasonalized by using the European Union program *Demetra* and more specifically the TRAMO SEATS methodology. The same steps were followed for the three countries for which the data were extracted from IFS, i.e. Germany, France and Hungary.
Another way to avoid the influence of the seasonal factors would have been not to eliminate the seasonality in the series but to include dummy variables directly in the estimation. However, I avoided this technique as the number of observation is not that large and in some cases there would have been difficulties as degrees of freedom would have been lost by adding more coefficients to be estimated. This is the main reason I chose to work with variables that are not under the seasonal influence when included in the estimation.

Before estimating and analyzing the supply and demand disturbances, I briefly evaluate the data in their raw form. Table 1 reports the mean and standard deviations of growth measured as the change in the log of real output and inflation measured as the change in the log of GDP deflator. Because growth and inflation are measured in the manner discussed above, a value of 0.01 represents roughly a change of 1%.

Table 1

	Growth		Prices	
Country	Mean	Standard Deviation	Mean	Standard Deviation
EA	0.006001	0.004968	0.004638	0.001430
Germany	0.003855	0.005262	0.002017	0.002060
France	0.005541	0.003789	0.003818	0.003459
Italy	0.003283	0.004395	0.005888	0.001365
Romania	0.010964	0.007787	0.010964	0.007787
Hungary	0.009352	0.003578	0.015097	0.012894
Poland	0.010266	0.007400	0.009495	0.030153
Slovakia	0.012120	0.008560	0.014607	0.022207

The simple averages stress the relatively high levels of growth in all the countries taken into consideration. The Euro Area growth is above the average growth in its so-considered core economies (Germany, France and Italy). This additional growth in the EA is brought by the other member states with a faster growth pace. The country with the highest average growth is Slovakia. This observation comes to confirm the already known fact the rather small Slovak economy had an impressive development. On the second place there is Romania which registered significant GDP growth since 2000. The followers Poland and Hungary still register a significantly higher growth than the Euro Area in the analyzed period, a common characteristic for the fast growing catching-up economy.

In terms of standard deviation, all the included countries have comparable values for the standard deviation. However, as expected, the EU but not EA countries have relative higher values of the volatility of the GDP growth. This comes from the fact that these countries had a period with modest economic growth and structural reforms in the post communist period and only after 2000 year the growth become significantly above the European average. Thus, the volatility in the growth is higher.

As for GDP inflation growth, the three core economies in the Euro Area have the lowest average levels in the group as they shared a common and inflation oriented monetary policy for almost the entire analyzed period. The other countries register significantly higher inflation growth rates with Hungary and Slovak Republic being the leaders. Romania has an average inflation growth rate 2.4 times higher in the analyzed period and Poland is most close to the Euro Area group. In terms of volatility in inflation growth the European Union and non EA countries have the highest volatility with Poland being the group leader.

Table 2

Correlations of real output growth

	EA	Germany	France	Italy	Romania	Poland	Slovakia	Hungary
EA	1							
Germany	0.72	1						
France	0.46	0.35	1					
Italy	0.61	0.55	0.56	1				
Romania	0.00	0.01	-0.21	-0.07	1			
Poland	0.21	0.40	0.33	0.27	0.25	1		
Slovakia	0.09	0.21	-0.31	-0.13	0.71	0.33	1	
Hungary	-0.02	-0.04	0.23	0.35	-0.09	-0.13	-0.55	1

Table 2 presents the cross-country correlation coefficients of real GDP growth rates. As, expected output growth is strongly correlated in the core economies and Euro Area. However, these coefficients indicate at the same time that quarterly output growth is generally not correlated significantly across incumbent and accession countries. Given the strong links in trade, the most surprising fact is that no strong correlation in output growth is found between the countries in the Eastern Europe and Germany. The only notable and strongest correlation with Germany is in the case of Poland. On the other hand, it is notable that relatively high correlation in output growth exists between the Eastern economies.

Table 3

Correlations of inflation

	EA	Germany	France	Italy	Romania	Poland	Slovakia	Hungary
EA	1							
Germany	0.71	1						
France	0.46	0.24	1					
Italy	0.74	0.64	0.36	1				
Romania	0.43	0.19	0.59	0.38	1			
Poland	-0.14	-0.34	0.05	-0.36	0.06	1		
Slovakia	0.04	-0.24	0.18	0.09	0.40	-0.07	1	
Hungary	-0.09	-0.06	-0.10	-0.10	-0.53	0.03	-0.44	1

As shown in Table 3 the correlation in prices is relatively higher between all countries. However, the correlation remains the highest among the core economies and decreases between the Eastern economies and the EMU members. Correlation in prices remains relatively high among Eastern economies.

Figure 1

Correlation of real GDP growth and Inflation

between selected countries and the euro area

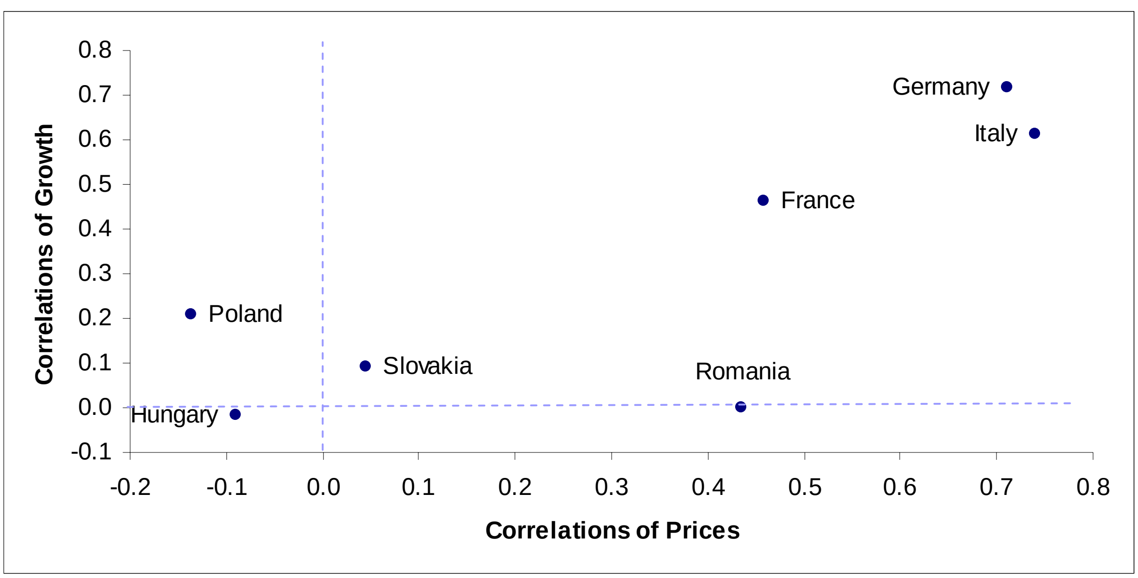


Figure 1 displays a high and positive correlation in both growth and inflation between the core EMU economies and the Euro Area. Romania has a positive correlation in prices with the EA but a null correlation in growth. Slovakia has small but positive correlation in both output growth and inflation. In the negative territory there lays Hungary with both growth and inflation negative correlations with Euro Area. Surprisingly enough, until 2000 – 2002 all similar studies praise the similarity of Hungarian economy and the Euro Area. Until then, Hungary was clearly the performer of the region. The situation changed meanwhile due to a few years of very bad economic performance in Hungary. The Hungarian economy had some years with relatively lower economic growth and strong inflationary pressures that apparently not only reduced its economic correlation with the Euro Area but also turned it negative.

Poland has small but positive correlation in terms of economic growth but negative prices correlation.

2. Empirical evidence

In order to identify supply and demand shocks in the countries included in the study I start by running a bivariate VAR for each country. I use quarterly de-seasonalized data as stated in the section above.

Unit root test

Both variables I include in the VAR analysis, real GDP and GDP deflator, are suspected to have a unit root. To confirm or infirm this, I use the common Unit Root tests Augmented Dickey Fuller and Philips-Perron.

For all the series I work with, I find that the logarithm of GDP has a unit root as the null hypothesis of the unit root tests cannot be ruled out. However, the first difference of logarithm of GDP does not have a unit root and it is stationary as the null hypothesis of the test can be ruled out. The same situation is in the case of prices with them being non-stationary with a unit root in levels and stationary in first difference. Thus, I can conclude

that the variables are I(1). In order to obtain consistent and stable estimations I will difference the variables and introduce the first difference in longs in the VAR analysis.
From an economic point of view the use of first differences of variables instead of their levels is intuitive as we want to establish correlations between economic growth (and not the level of GDP) and inflation (and not the level of GDP deflator). Thus, it makes even more sense to work with the first difference of the logged variables.
The Unit root test results are shown in Appendix 2 for Romania. The tests for the rest of the countries are available upon request.

Lag length criteria

Table 4

Optimal VAR length

Country\Criteria	Sequential LR	AIC	SC	HQ	Chosen
Euro Area	1	1	1	1	1
Germany	1	1	1	1	1
France	2	2	2	2	2
Italy	3	3	1	1	3
Romania	4	4	5	5	4
Slovakia	3	4	3	4	3
Poland	2	3	1	3	3
Hungary	1	2	1	1	2

Table 4 offers the optimal lag length for each country according to the four criteria. It can be observed that the optimal lag length vary from one to five. Although the usual advice is that when quarterly data are available a minimum length of four is necessary, the above optimizing procedure suggests different results. However, it should be taken into account that the data is already seasonally adjusted.
The number of lags for each VAR was chosen according with the information criteria above and by taking into consideration other information from VAR analysis. At the

same time it the autocorrelation of residuals was analyzed to be sure that through the number of chosen lags the residuals do not remain with autocorrelation. Frenkel and Nickel (2002) and Horvath and Ratfai (2004) set an uniform lag length of two to preserve degrees of freedom and the symmetry of specification across countries. As long as the independent variables are the same in each equation, OLS estimates are consistent and asymptotically efficient (Enders, 1995). Hence, the authors imposed a unique lag length of two although in some cases the information criteria indicated longer length. However, Firdmuc and Korhonen (2003) allowed for each VAR to have the number of lags as suggested by the information criteria.

I chose to include in each VAR the number of lags required by the information criteria and that allowed the residuals not to suffer of autocorrelation.

Further on, all the eight VAR verify **the stability condition**. Since each VAR represents a system of linear first-order difference equations, it is stable only if the absolute values of all eigenvalues of the system matrix lie inside the unit circle. This condition is fulfilled by all the eight VARs and the results are available upon request.

I proceed with the tests for the residuals of the VARs, residuals that ought to be **uncorrelated, normally distributed and characterized by homoskedasticity**. In the large majority of the cases all of these assumptions are respected by the residuals in all eight estimated VARs. For testing the autocorrelation in residuals I use the LM autocorrelation test which reveals some correlation at some lags in some cases. However a general explanation for this is that the variables included in the VAR can not completely explain one another, and thus some additional information remains unexplained in the residuals inducing autocorrelation at some lags. The normality Cholesky (Lutkepohl) is run to test the normality in residuals. For testing the heteroskedasticity the White test is used.

In Appendix 3 I present the layout of the above mentioned tests in the case of the VAR estimated for the Romanian data. All the other results are available upon request.

After the final VAR form is established I impose the structural restriction, namely the restriction that the aggregate demand shock does not have a permanent effect on output. Further on I compose the series of the structural aggregate demand and supply shock for each of the eight countries and study the relations among them.

3. Estimation results

I present below the accumulated impulse response functions of both output and prices both to demand and supply shocks in the case of Euro Area and Romania while the remaining graphs can be seen in Appendix 4.

First, the prescription of the general Aggregate Demand – Aggregate Supply model were observed as results of the VAR methodology. *The overidentifying restrictions that positive aggregate demand shocks should lead to increases in the price level and positive aggregate supply shocks repercussions are declines in the price level are generally fulfilled.*

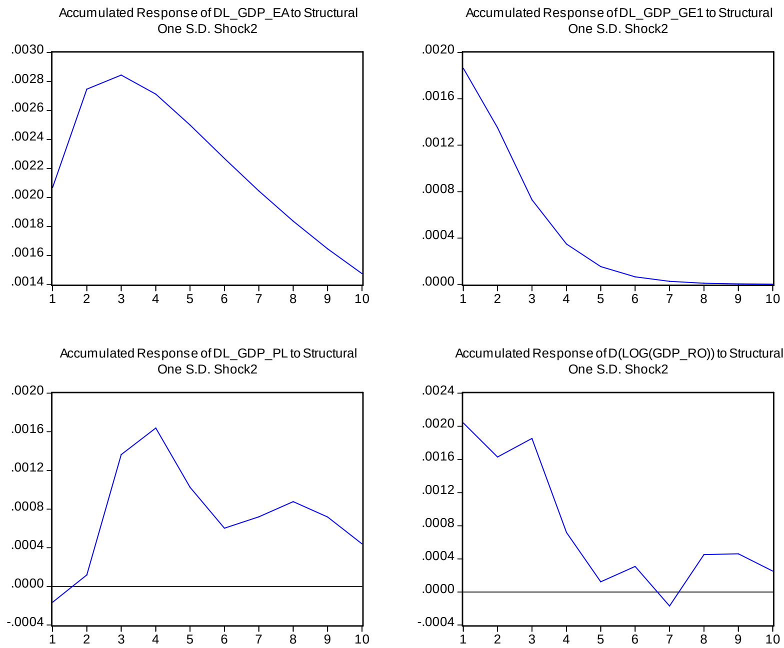
The exception comes from Hungary (in Appendix 4), were the response of prices to a supply shock is increasing instead of decreasing as it was expected. This result may decisively influence the correlation of shocks between Hungary and other countries and should be taken into consideration further on. In the same situation with an ambiguous response of prices to a supply shock is Slovakia. All the other countries show results perfectly consistent with our initial assumptions.

As it can be observed from the below graphs, possibly most important of all, at least for the beginning of the analysis, the result *that an aggregate demand shock has only temporary and positive influence on output* is confirmed in each and every case. This is an expected result as the restriction was posed in the same manner described in the previous sections. However, some differences in the corresponding accumulated impulse response functions can be seen between the two developed regions (Euro Area and Germany) and the two developing countries (Poland and Romania). Especially in the case of Romania output response to the demand shock is a bit confusing but its trend is correct. The next step is to analyze the effect of a supply shock to the real GDP growth. As expected and as assumed we find positive, strong and permanent response of GDP to a supply shock in all the countries analyzed. Especially in the case of Euro Area countries we find similarity in response of GDP to supply shocks.

Further on, a positive demand shock should have a permanent effect on prices (measured as the difference in GDP deflator) and should determine an increase in inflation.

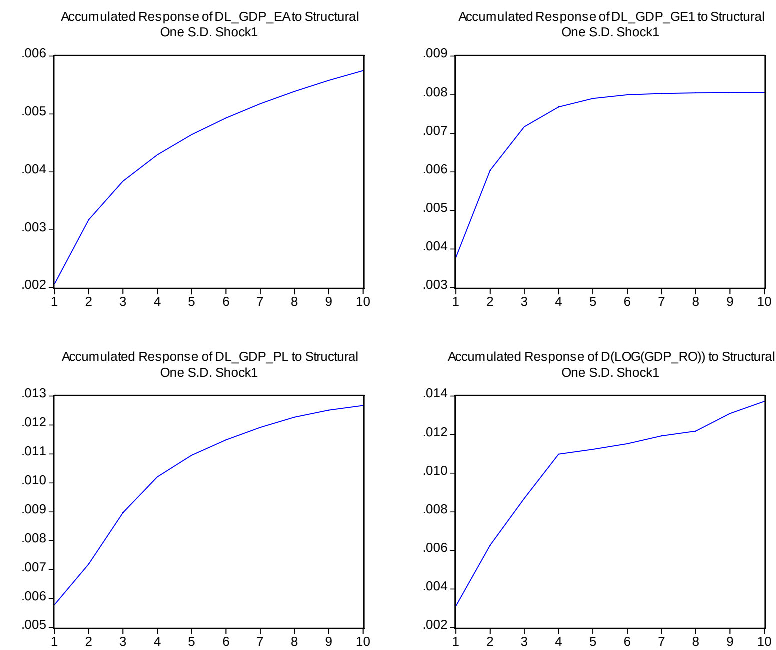
Figure

Accumulated responses of real GDP growth in *Euro Area, Germany, Poland and Romania* to a positive demand shock

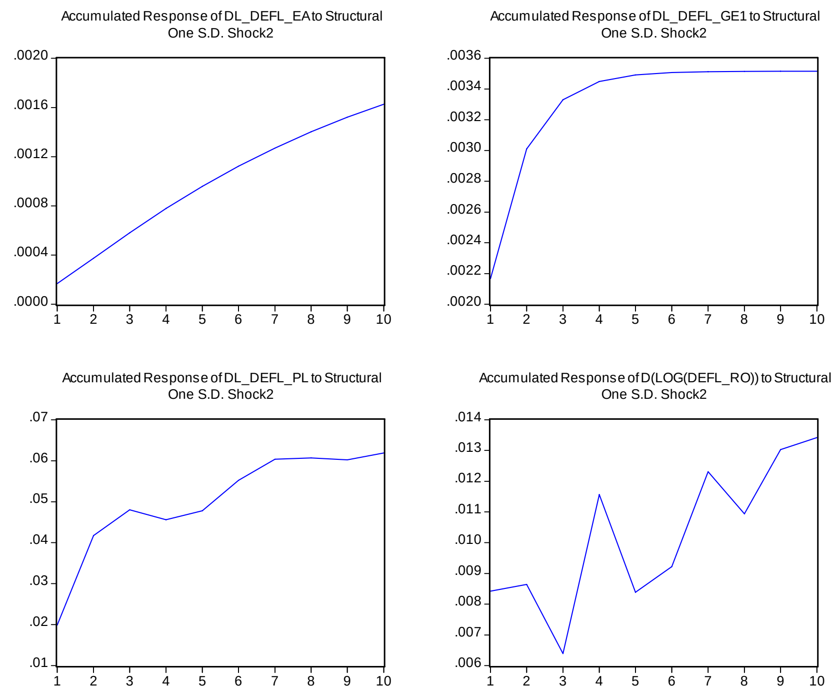


Figure

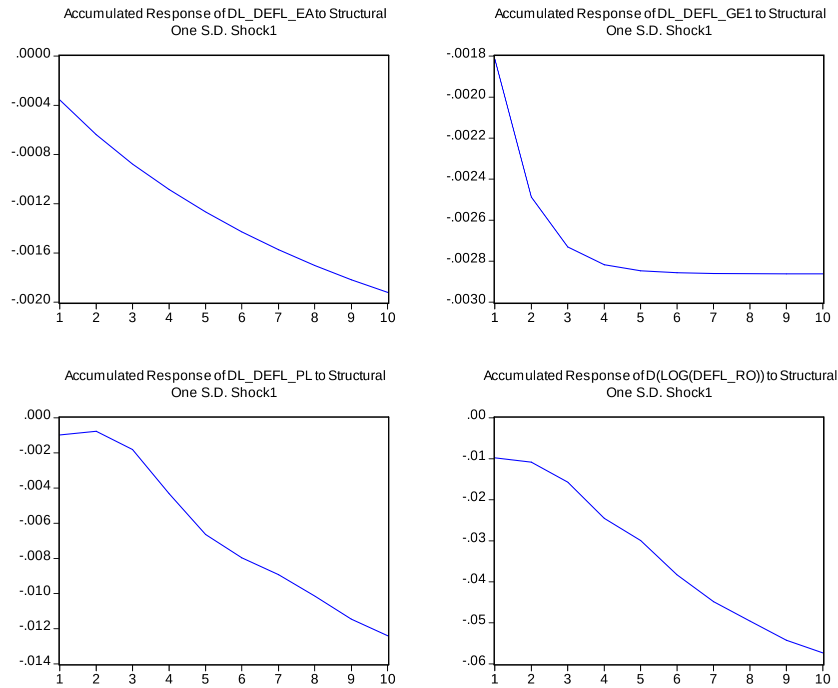
Accumulated responses of real GDP growth in *Euro Area, Germany, Poland and Romania* to a positive supply shock



Accumulated responses of GDP deflator growth in *Euro Area, Germany, Poland and Romania* to a positive demand shock



Accumulated responses of GDP deflator growth in *Euro Area, Germany, Poland and Romania* to a positive supply shock



This intuition is confirmed in all cases with visible differences between the responses of developed countries and the developing ones. A supply shock should affect prices in the opposite sense. A positive supply shock should determine a decline in prices as these shocks are usually associated with gains in productivity or improved technique that favourably influences the level of prices. All countries respond in the expected manner.
These immediate observation basically helps us trust the model we used to identify the structural shocks and the economic background in the AD-AS model.

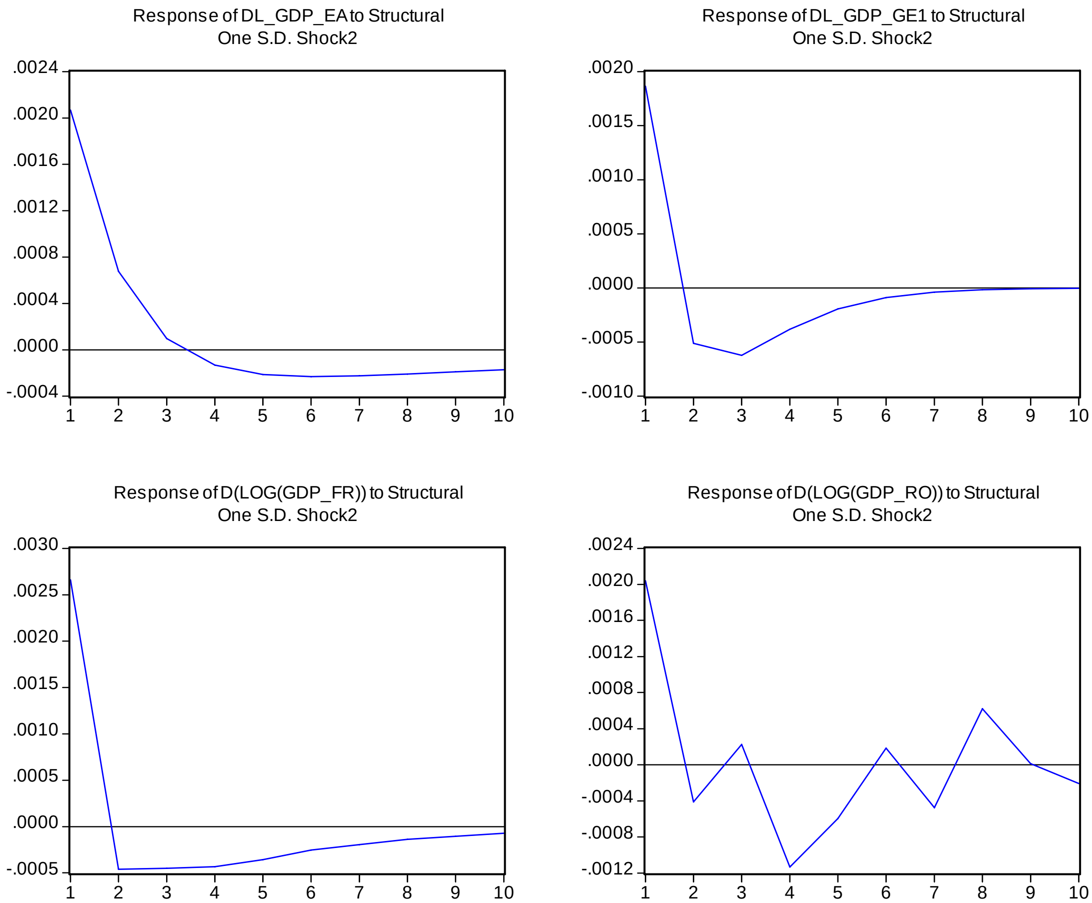
In terms of impulse responses as well, (as observable above and in Appendix 4) there is an interesting observation that arises from studying the graphs for all the analyzed countries.
The supply shocks seem to be more important then the demand shocks for output response even in the short run (by the construction of the structural model they are definitely more important in the long run since the aggregate demand shocks are constrained to die out with the time). There is no such statement that can be inferred for the prices since the effects of supply as opposed to demand shocks are of different sign.

Speed of adjustment means the number of time units (quarters) after which the shock of any type is relatively absorbed by the economy. When considering the supply shocks to output, the general pattern is that, within two years, with an average around 7-8 quarters, the shocks are almost fully absorbed. From the group of the core economies in the Euro Area, it is only Italy that has a quicker absorption of the supply shock on the output. In this case the effect vanishes in one year time. The situation is slightly different in the eastern economies where similar shocks are absorbed marginally quicker after around 5-7 quarters.

In Romania's case the horizon is around 6 quarters. It is only the case of Slovak economy with a different kind of evolution of output as a response to a supply shock. The effect turns null after only 2 quarters.

The effects of the supply shock on prices stabilizes after around 8-9 quarters in Euro Area and Italy and after only 4-5 quarters in Germany and France. In Romania the effect of a demand shock over prices is the most ample of the Eastern economies included in the analysis and it stabilizes only after 8-10 quarters. This may be a strong argument in favour of the fact that the Romanian economy responds more aggressively and stabilizes only after a longer period of time than the developed economies.

In terms of GDP response to a demand shock, it is notable that the demand shock seems to die out extremely fast in the case of EMU countries being generally accommodated within half of year. In the case of Euro Area it accommodates within two quarters while in Germany and France it takes only one quarter to accommodate the shock. In the CEECs the accommodation of a demand shock takes longer - within 3-4 quarters.



Although *the magnitude of responses* is pretty similar within the two groups of countries (developed economies and developing economies) the differences between the two groups remain high in term of the magnitude of the responses. The response of output to a supply shock in EA is almost half of the magnitude of the similar reaction at the same type of shock for the Romanian economy.

After analyzing the impulse response functions which state the reaction of the economy (through its two considered variables: real GDP and GDP deflator) I can proceed to the most important part of the paper, i.e. shock correlation. The structural shocks were identified from the VAR's estimated residuals according to the procedure presented in the previous chapters. I further calculate the simultaneous correlations among shocks for all the eight included economies. The figures I obtained are presented in the tables below.

Correlations for aggregate supply shocks

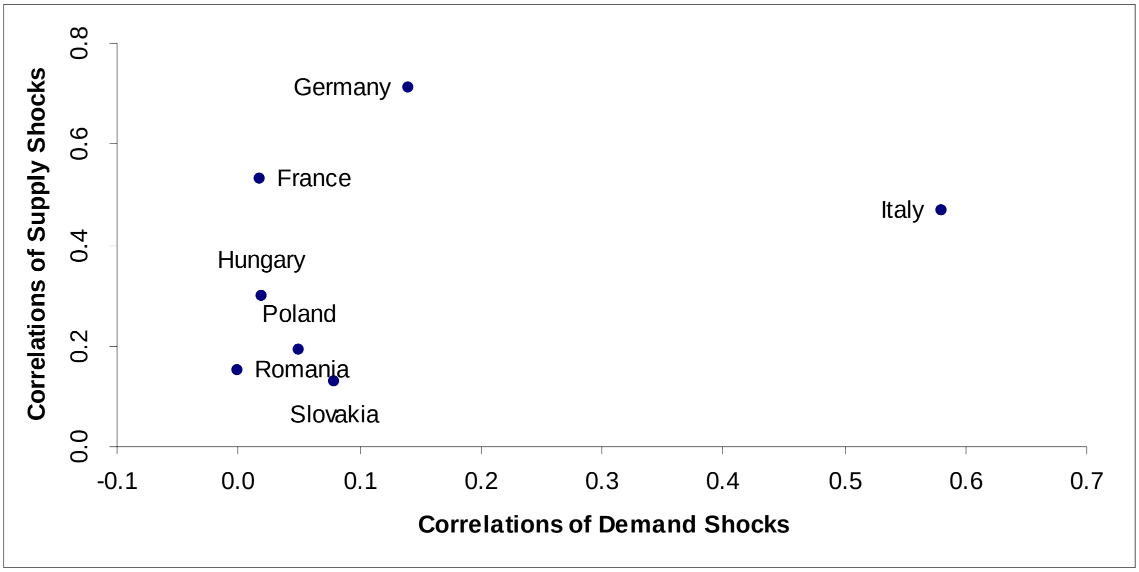
	EA	Germany	France	Italy	Romania	Poland	Slovakia	Hungary
EA	1							
Germany	**0.71**	1						
France	**0.53**	**0.36**	1					
Italy	**0.47**	**0.28**	**0.25**	1				
Romania	0.15	0	0.27	0.08	1			
Poland	0.19	0.27	0.15	0.14	0.13	1		
Slovakia	0.13	0.07	-0.10	0.13	-0.06	-0.05	1	
Hungary	0.30	0.12	0.14	0.31	0.17	0.19	-0.30	1

Correlations for aggregate demand shocks

	EA	Germany	France	Italy	Romania	Poland	Slovakia	Hungary
EA	1							
Germany	**0.14**	1						
France	**0.02**	**0.07**	1					
Italy	**0.58**	**0.34**	**0.16**	1				
Romania	0.00	-0.06	-0.14	0.01	1			
Poland	0.05	-0.05	0.19	-0.11	-0.01	1		
Slovakia	0.08	0.41	0.00	0.28	-0.08	0.25	1	
Hungary	0.02	0.00	0.19	-0.04	-0.05	-0.26	-0.39	1

We look first at the EMU members which are also the "old" EU members and which we expect to exhibit significant and positively correlated shocks, since the EU Commission (1990:11) asserted that "*EMU will reduce the incidence of country specific shocks*". Still, the data seem to offer a different view, meaning that it may be unclear how to interpret the results. We find strong correlation among the core economies especially in terms of aggregate supply shocks correlation. The results are a little disappointing in what concerns the aggregate demand shock correlation as the coefficients are much lower with a very weak correlation between France and the other two economies. Although this particular result is rather new, in all the other studies the correlation do not remain perfect for all the core European economies.

The fact that the correlation of demand shocks is clearly lower than the correlation of the supply shocks for most countries was also the result of Firmuc and Korhonen (2003). There are some natural explanations for lower correlations in demand shocks for some countries if we bear in mind that usually, the demand shocks are associated with changes in economic and monetary policy or changes in exchange rate regimes. *Most acceding countries have grown much faster than the Euro Area. This partly reflects differing economic policies* (e.g. Fiscal deficits have been higher in the acceding counties, on average) *that allowed them to realize the necessary investment plans*. This resulted in a divergence in term of demand shocks. However, as joining the Euro Area presumes following one singe policy (at leas monetary policy) and convergent economic and fiscal policies the differences in terms of demand shocks should diminish in time.
Thus, as it is stated also in the previous studies, *the correlation of supply shocks is seen to be more important for assessing the degree of business cycle integration*. The difference in demand shocks mostly emanate from different economic policies. As economic policies should be considerably more similar within a monetary union, the correlation of demand shocks should also increase. Moreover with the disappearance of the effects of individual exchange rates, monetary policy is essentially similar across countries. Therefore, the correlation of supply shocks reveals more about the underlying similarity of economies.



Romania has positive but small correlation in terms of supply shocks and null correlation in terms of demand shocks. Although this is a rather weak result it is not unexpected as Romanian economy has passed a long and tiresome transition period with delays in the structural reforms and enough economic slippages. The good side of the story is that the strongest correlation (although doubts can be raised about the significance of the coefficient) is in the case of supply shocks as it is proven that these shocks are the most difficult to accommodate and reflect in a better way the correlation among the business cycles.

As the results of the contemporaneous correlation confirm out expectations, it is interesting enough to study the evolution of the correlation coefficients over time. First, I calculate the correlation in the structural shocks I obtain from the previous estimation on different time samples. I obtain the results in the below table.

Time Correlations between shocks in Euro Area and Romania						
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
Supply Shocks	0.24	0.21	0.25	0.28	0.23	0.14
Demand Shocks	-0.27	-0.16	-0.04	-0.06	-0.06	-0.02

As this method could be placed under some doubts as it does not reflect the pure evolution in shock correlation I follow another way and re-estimate the two VARs (for EA and for Romania) for samples ending in 2004 and in 2006. This should better reflect the correlation in shocks at that particular time. However I cannot go further than 2004 with the estimation due to insufficient data sample.

	2004	**2006**	**2008**
Supply Shocks	0.54	0.52	0.15
Demand Shocks	-0.37	-0.37	0.00

Both ways of calculating the time evolution of the correlation in shocks return similar results. It is interesting enough to observe strong supply correlation over time and its decrease in the last year (2007). In terms of the figure of around 50% this should be regarded with care as the sample is rather small. However, the results can be interpreted as indicative for the sign and relative weight rather that for their intrinsic value.

Strong supply shock in 2007 caused by very poor agriculture year mainly due to floods affected the Romanian economy more than it affected the Euro Area. This proves that the structure of the economies is rather different even if we look at it only in terms of response to supply shocks.

The negative correlation in demand shocks should be regarded taking into consideration the fact that Romania has passed through several exchange rate regimes during this period with the capital account being completely liberalized only in April 2005. This issue has possibly affected the demand shocks.

The results and the methodology for identifying the structural shocks allow not only for a survey and interpretation of the shocks, but also an estimation of their relative size. The larger the size of the shocks, the more difficult will it be for the countries to maintain a fixed exchange rate, especially in the case of negative correlations and the more attractive the idea of pursuing an independent monetary policy.

The table below reports the standard deviations and the means of the aggregate demand and supply disturbances for all the 14 countries.

Standard deviations of the aggregate supply disturbances								
	Euro Area	**Fance**	**Germany**	**Italy**	**Hungary**	**Poland**	**Romania**	**Slovakia**
Std. Dev.	0.003	0.003	0.004	0.004	0.002	0.005	0.003	0.002
Standard deviations of the aggregate demand disturbances								
	Euro Area	**Fance**	**Germany**	**Italy**	**Hungary**	**Poland**	**Romania**	**Slovakia**
Std. Dev.	0.0004	0.0020	0.0027	0.0004	0.0115	0.0182	0.0113	0.0195

In terms of supply shocks the variation is quite close for all the included countries. However, in the case of the demand shocks significant differences occur with notable higher variance in the developing economies compared with the developed ones.

After analyzing the correlation in shocks between the countries included in this study and the relative size of the shocks I turn again towards the response of the economy to the shocks. As the differences between countries do not appear extreme I examine the similarity between the dynamic responses following a symmetric shock in more detail. The table below reveals the correlation coefficients of the impulse response functions between the output response of different economies.

Correlation coefficients of Impulse response functions to demand shocks								
	Impulse response of output				**Impulse response of prices**			
	EA	Germany	France	Italy	EA	Germany	France	Italy
EA	1				1			
Germany	0.78	1			0.30	1		
France	0.88	0.98	1		0.40	0.97	1	
Italy	0.96	0.58	0.71	1	0.92	0.50	0.64	1
Romania	0.73	0.82	0.85	0.60	-0.04	0.62	0.58	0.10
Poland	0.04	-0.37	-0.21	0.23	0.42	0.81	0.72	0.45
Slovakia	-0.88	-0.69	-0.78	-0.84	0.07	0.89	0.77	0.17
Hungary	-0.69	-0.87	-0.90	-0.54	0.46	0.95	0.92	0.57

The calculations confirm the impression conveyed by the diagrams, i.e. the greater similarity among the Euro Area group countries but, at the same time that there are some CEEC's that have values similar to those of countries in the Euro Area.

Correlation coefficients of Impulse response functions to supply shocks								
	Impulse response of output				**Impulse response of prices**			
	EA	Germany	France	Italy	EA	Germany	France	Italy
EA	1				1			
Germany	0.99	1			0.88	1		
France	0.95	0.92	1		0.72	0.81	1	
Italy	0.97	0.96	0.92	1	0.26	-0.16	0.06	1
Romania	0.80	0.85	0.66	0.70	0.26	0.31	0.50	0.33
Poland	0.96	0.92	1.00	0.91	-0.26	-0.34	-0.02	0.47
Slovakia	0.43	0.36	0.63	0.35	-0.50	-0.74	-0.84	0.22
Hungary	0.97	0.96	0.91	0.94	-0.76	-0.88	-0.96	0.02

The table above shows the correlation coefficients of impulse response functions to supply shocks. The response functions again confirm the impression that the correlation in responses is much higher for both groups of countries in terms of supply shocks. At the same time, it is reaffirmed that in the case of most of the CEECs the speed of adjustment is somewhat lower than in the other Euro Area group countries.

The overall picture that emerges from the analysis of the response dynamics is that the four CEECs included in the study adjust more slowly to the same shocks than EU countries.

Last but not least, there remains one more issue to analyze before concluding this study. That is the importance of structural shocks and I will use for this the variance decomposition for the SVAR model. This way I will obtain information about the role played by the two structural shocks in explaining the variability of the two series included in the model (real GDP growth and GDP deflator inflation) at different time horizons. Due to space limitation I chose to present the results for only a few economies but I will elaborate comments on the results for all the eight included economies. The entire set of results are available upon request.

		Romania		Italy	
Variable	Period	**Supply shock**	**Demand Shock**	**Supply shock**	**Demand Shock**
Real GDP growth	1	70.0	30.0	94.8	5.2
	2	81.9	18.1	94.7	5.3
	3	85.3	14.7	94.6	5.4
	4	84.5	15.5	94.5	5.5
	5	83.7	16.3	94.4	5.6
	6	83.6	16.4	94.1	5.9
	7	83.2	16.8	93.9	6.1
	8	82.4	17.6	93.7	6.3
	9	82.8	17.2	93.5	6.5
	10	82.8	17.2	93.5	6.5
GDP deflator inflation	1	57.5	42.5	42.8	57.2
	2	57.8	42.2	52.9	47.1
	3	61.3	38.7	58.0	42.0
	4	65.9	34.1	63.1	36.9
	5	66.9	33.1	66.1	33.9
	6	72.4	27.6	68.4	31.6
	7	73.4	26.6	69.8	30.2
	8	74.4	25.6	70.8	29.2
	9	74.8	25.2	71.3	28.7
	10	75.3	24.7	71.5	28.5

		Germany		Hungary	
Variable	Period	**Supply shock**	**Demand Shock**	**Supply shock**	**Demand Shock**
Real GDP growth	1	80.5	19.5	60.3	39.7
	2	83.9	16.1	59.2	40.8
	3	83.4	16.6	59.2	40.8
	4	83.1	16.9	60.7	39.3
	5	83.0	17.0	60.5	39.5
	6	83.0	17.0	60.7	39.3
	7	83.0	17.0	60.6	39.4
	8	83.0	17.0	60.6	39.4
	9	83.0	17.0	60.6	39.4
	10	83.0	17.0	60.6	39.4
GDP deflator inflation	1	41.2	58.8	54.4	45.6
	2	40.9	59.1	47.3	52.7
	3	40.8	59.2	49.5	50.5
	4	40.8	59.2	47.4	52.6
	5	40.8	59.2	47.4	52.6
	6	40.8	59.2	47.3	52.7

	7	40.8	59.2	47.2	52.8
	8	40.8	59.2	47.2	52.8
	9	40.8	59.2	47.2	52.8
	10	40.8	59.2	47.2	52.8

Looking at the two tables above supply shocks have are the most important in explaining the output growth variability. In the countries that are part of Euro Area, the supply shocks account for 80-95% of the variation in GDP while the importance of supply shocks in explaining real GDP growth variance is around 70% for Romania and 60% for Hungary. By contrast, almost none of the variation in GDP growth is explained by demand shocks. Technology shocks therefore, not only dominate variations of GDP in the long run but they are also important for short-term output movements. This comes back to stress the conclusion that I have already drawn and that states that the supply shocks are the most important for GDP growth even in the short-run. The forecast error variance decomposition for GDP deflator inflation shows for countries in Euro Area comparable importance of the two shocks. Romania has the same behaviour with close importance of demand and supply shocks in explaining the GDP deflator inflation.

V. Conclusions

In this paper, my intention was to assess the correlation of supply and demand shocks between the Euro Area and Romania. Romania has joined the EU in January 2007 and the prospect of the country joining the single currency area has already been mentioned in public speeches. The only thing that is sure about this is that Romania will join the EMU sometime in the future as it can no longer opt out of the EMU. In order to be able to make a more robust comparison between the behaviour of shocks in Romania and in Euro Area I also included in my analysis three countries that are considered to be the core of the Euro Area (Germany, France and Italy) and three other CEECs that joined the EU in May 2004 and for which the perspective of joining EMU is not that far (Poland, Hungary and Slovakia). Out of these, Slovakia is the closest to EMU as it will join it in January 2009.

Supply and demand shocks were recovered using structural VAR methodology within the setting of the general Aggregate Supply – Aggregate Demand model. I analyze the manner in which the two types of shocks may affect the candidate economies (Romania and the other CEECs) within the framework of the optimal currency theory and I interpret the results in order to assess the EU but non-EMU countries' suitability to join the EMU. I look at the magnitude of shocks in connection with the speed of the economy's adjustment, and finally at the correlation between these shocks.

First of all, assuming that the theory of optimal currency area is a good approach in dealing with the problem stated above, and that the structural form disturbances yield indeed the true demand and supply shocks (as proved by the satisfied overidentifying restrictions), the results seem to agree with the existing literature by supporting the view that EMU is not an optimal currency area. Generally, the figures show that the asymmetry prevails not only between candidate countries but also among the EA members.

Second, as intuitively expected Romania does not register very strong shock correlation with the Euro Area countries. However, the finding that the correlation of supply shocks is positive even in the last years proves that we can at least discuss the issue of business cycle correlation. No correlation between demand shocks is registered. Despite previous findings as in Frenkel et al. (1999), Boone and Maurel (1999), Fidrmuc (2001a), Frenkel and Nickel (2002) and Korhonen (2003) that found in Hungary the performer of the region in term of correlation, I find poor results including the data until first quarter of 2008. This may be explained by Hungary's poor economic performance in the latest years which may have lead to a de-synchronization of business cycles. Poland and Slovakia gave satisfactory results even though Slovakia could have proved better given its imminent EMU entrance.

The synchronization of supply and demand shocks is likely to increase for Romania as times goes by since the 2007 EU accession brought in increased trade intensity (higher shares of intra-industry trade and industrial production). However, unlike in recent years fiscal policy constrained by the Maastricht Treaty is likely to become less available for the management of the cyclical development of the acceding EMU countries.

The fact that the EU but non-EMU members exhibit significant correlation with several EMU members, while idiosyncratic shocks appear among many of the Maastricht signatories, allows us to conclude that accepting some of these countries in the monetary union will not severely disturb its functioning. It is rather a question for the individual aspiring countries to ensure that they have the mechanisms in place to implement adequate fiscal policies, lest they find themselves without appropriate demand management.

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Appendix 1
Data sources

Country	Real GDP	Nominal GDP	Period
Romania	NIS (National Institute of Statistics)	NIS	1998Q1:2007:Q1
Euro Area	Eurostat	Eurostat	1998Q1:2008Q1
Germany	International Financial Statistics (IMF)	IFS (IMF)	1998Q1:2008Q1
France	International Financial Statistics (IMF)	IFS (IMF)	1998Q1:2008Q1
Italy	Eurostat	Eurostat	1998Q1:2008Q1
Slovakia	Eurostat	Eurostat	2000Q1:2008Q1
Hungary	International Financial Statistics (IMF)	IFS (IMF)	1998Q1:2008Q1
Poland	Eurostat	Eurostat	1998Q1:2008Q1

Appendix 2
Unit root tests for Romania

a) Log of GDP level (Augmented Dickey Fuller)

Null Hypothesis: LGDP_RO has a unit root
Exogenous: None
Lag Length: 5 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.478743	0.9997
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP_RO)
Method: Least Squares
Date: 06/29/08 Time: 13:51
Sample (adjusted): 1999Q3 2007Q4
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP_RO(-1)	0.000440	0.000126	3.478743	0.0017
D(LGDP_RO(-1))	0.567183	0.123442	4.594726	0.0001
D(LGDP_RO(-2))	0.279768	0.137180	2.039424	0.0509
D(LGDP_RO(-3))	-0.271661	0.133394	-2.036526	0.0513
D(LGDP_RO(-4))	-0.461320	0.125793	-3.667292	0.0010
D(LGDP_RO(-5))	0.600451	0.107691	5.575702	0.0000

R-squared	0.741890	Mean dependent var	0.013065
Adjusted R-squared	0.695799	S.D. dependent var	0.005686
S.E. of regression	0.003136	Akaike info criterion	-8.533076
Sum squared resid	0.000275	Schwarz criterion	-8.263718
Log likelihood	151.0623	Durbin-Watson stat	1.405737

b) First difference of log real GDP (Augmented Dickey Fuller)

Null Hypothesis: DL_GDP_RO has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.958702	0.0492
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DL_GDP_RO)
Method: Least Squares
Date: 07/08/08 Time: 00:28
Sample (adjusted): 1999Q3 2007Q4
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DL_GDP_RO(-1)	-0.278717	0.094203	-2.958702	0.0062
D(DL_GDP_RO(-1))	-0.152311	0.116836	-1.303624	0.2030
D(DL_GDP_RO(-2))	0.127985	0.114140	1.121299	0.2717
D(DL_GDP_RO(-3))	-0.143914	0.114239	-1.259764	0.2182
D(DL_GDP_RO(-4))	-0.603936	0.107286	-5.629213	0.0000
C	0.004359	0.001247	3.496855	0.0016

R-squared	0.685374	Mean dependent var	0.000632
Adjusted R-squared	0.629191	S.D. dependent var	0.005142
S.E. of regression	0.003131	Akaike info criterion	-8.536222
Sum squared resid	0.000274	Schwarz criterion	-8.266864
Log likelihood	151.1158	F-statistic	12.19894
Durbin-Watson stat	1.409275	Prob(F-statistic)	0.000002

c) Log of GDP Deflator level (Augmented Dickey Fuller)

Null Hypothesis: LDEFL_RO has a unit root
Exogenous: None
Lag Length: 3 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.019818	0.6826
Test critical values:	1% level	-2.630762	
	5% level	-1.950394	
	10% level	-1.611202	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LDEFL_RO)
Method: Least Squares
Date: 07/08/08 Time: 00:32
Sample (adjusted): 1999Q1 2007Q4
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LDEFL_RO(-1)	2.04E-05	0.001029	0.019818	0.9843
D(LDEFL_RO(-1))	0.142327	0.148206	0.960336	0.3441
D(LDEFL_RO(-2))	0.259530	0.142851	1.816787	0.0786
D(LDEFL_RO(-3))	0.543957	0.147597	3.685412	0.0008

R-squared	0.726680	Mean dependent var	0.053184
Adjusted R-squared	0.701057	S.D. dependent var	0.031353
S.E. of regression	0.017142	Akaike info criterion	-5.190078
Sum squared resid	0.009404	Schwarz criterion	-5.014132
Log likelihood	97.42141	Durbin-Watson stat	1.461623

d) First difference of log GDP Deflator (Augmented Dickey Fuller)

Null Hypothesis: DL_DEFL_RO has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.958702	0.0492
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DL_DEFL_RO)
Method: Least Squares
Date: 07/08/08 Time: 00:30
Sample (adjusted): 1999Q3 2007Q4
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DL_DEFL_RO(-1)	-0.278717	0.094203	-2.958702	0.0062
D(DL_DEFL_RO(-1))	-0.152311	0.116836	-1.303624	0.2030
D(DL_DEFL_RO(-2))	0.127985	0.114140	1.121299	0.2717
D(DL_DEFL_RO(-3))	-0.143914	0.114239	-1.259764	0.2182
D(DL_DEFL_RO(-4))	-0.603936	0.107286	-5.629213	0.0000
C	0.004359	0.001247	3.496855	0.0016

R-squared	0.685374	Mean dependent var	0.000632
Adjusted R-squared	0.629191	S.D. dependent var	0.005142
S.E. of regression	0.003131	Akaike info criterion	-8.536222
Sum squared resid	0.000274	Schwarz criterion	-8.266864
Log likelihood	151.1158	F-statistic	12.19894
Durbin-Watson stat	1.409275	Prob(F-statistic)	0.000002

Appendix 3
Residual tests in the VAR estimated for Romanian data

1) Autocorrelation LM test

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 07/05/08 Time: 15:24
Sample: 1998Q1 2008Q1
Included observations: 35

Lags	LM-Stat	Prob
1	12.68185	0.0129
2	2.232379	0.6931
3	5.859644	0.2099
4	0.544745	0.9690
5	6.550526	0.1616
6	7.830231	0.0980
7	3.145139	0.5338
8	6.392800	0.1717
9	6.714363	0.1518
10	2.882695	0.5776
11	6.900461	0.1412
12	5.641710	0.2276

Probs from chi-square with 4 df.

2) Cholesky (Lutkepohl) Normality test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Date: 07/05/08 Time: 15:27
Sample: 1998Q1 2008Q1
Included observations: 35

Component	Skewness	Chi-sq	df	Prob.
1	0.063843	0.023776	1	0.8775
2	0.204510	0.243975	1	0.6214

Joint		0.267751	2	0.8747

Component	Kurtosis	Chi-sq	df	Prob.
1	2.235153	0.853111	1	0.3557
2	1.338940	4.023718	1	0.0449
Joint		4.876829	2	0.0873

Component	Jarque-Bera	df	Prob.
1	0.876887	2	0.6450
2	4.267692	2	0.1184
Joint	5.144579	4	0.2728

3) White Heteroskedasticity test

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 07/05/08 Time: 15:35
Sample: 1998Q1 2008Q1
Included observations: 35

Joint test:

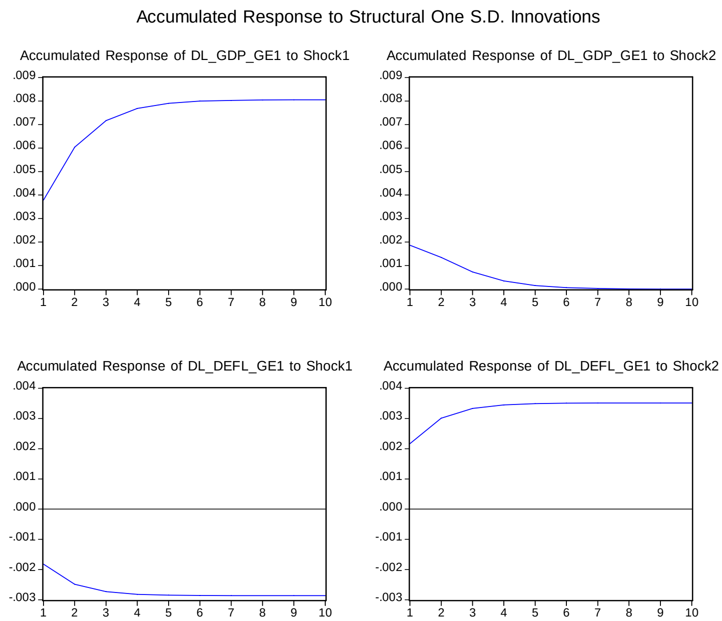
Chi-sq	df	Prob.
57.44497	48	0.1650

Individual components:

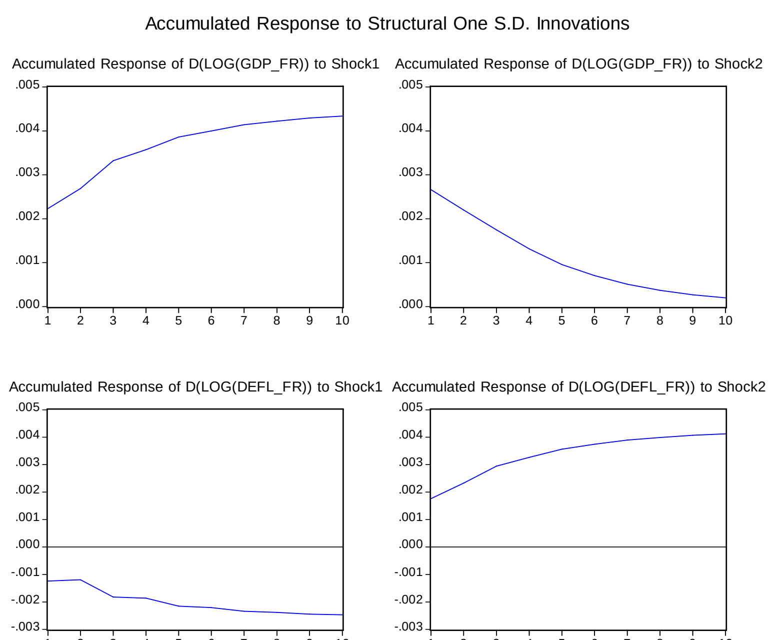
Dependent	R-squared	F(16,18)	Prob.	Chi-sq(16)	Prob.
res1*res1	0.746190	3.307448	0.0083	26.11665	0.0524
res2*res2	0.542379	1.333368	0.2764	18.98328	0.2695
res2*res1	0.397253	0.741456	0.7238	13.90387	0.6059

Appendix 4

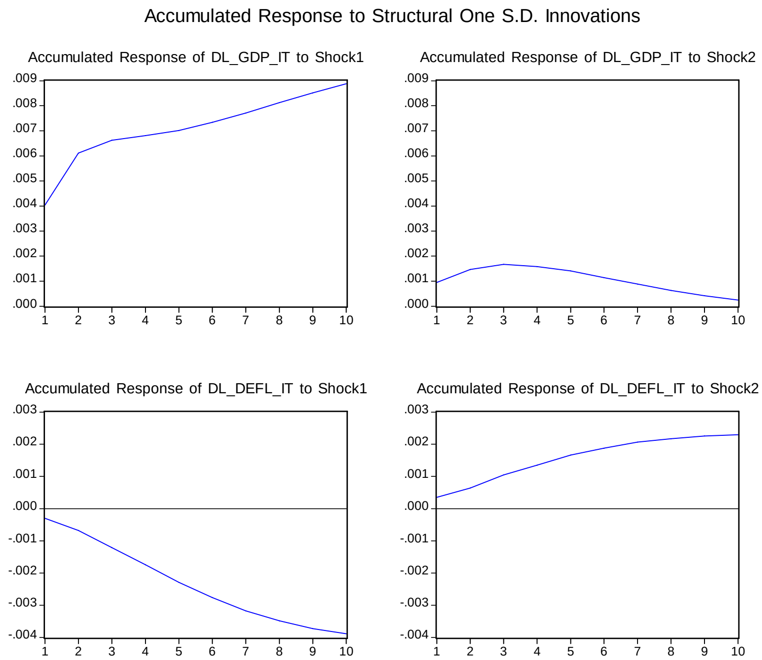
Accumulated responses of real GDP growth and Prices growth in *Germany* to supply (Shock 1) and demand (Shock 2) shocks.



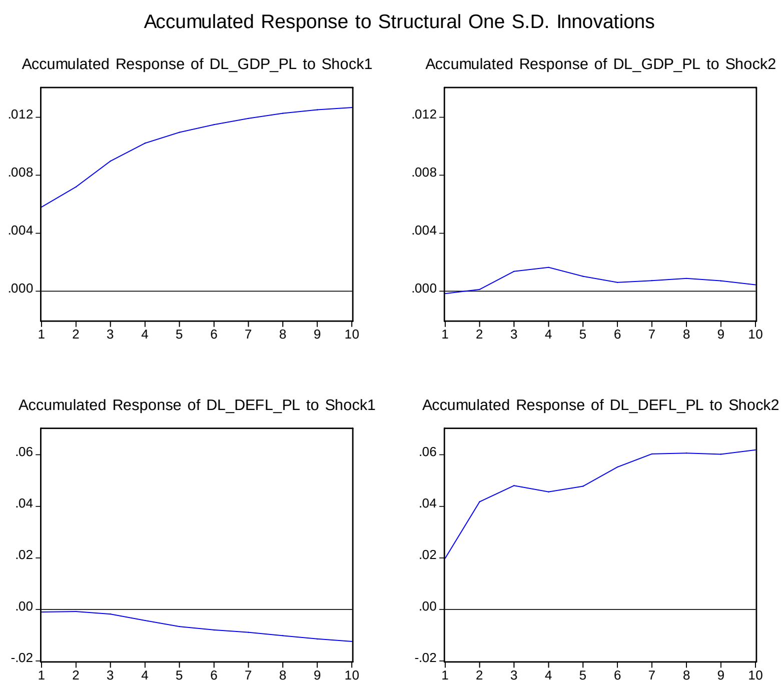
Accumulated responses of real GDP growth and Prices growth in *France* to supply (Shock 1) and demand (Shock 2) shocks.



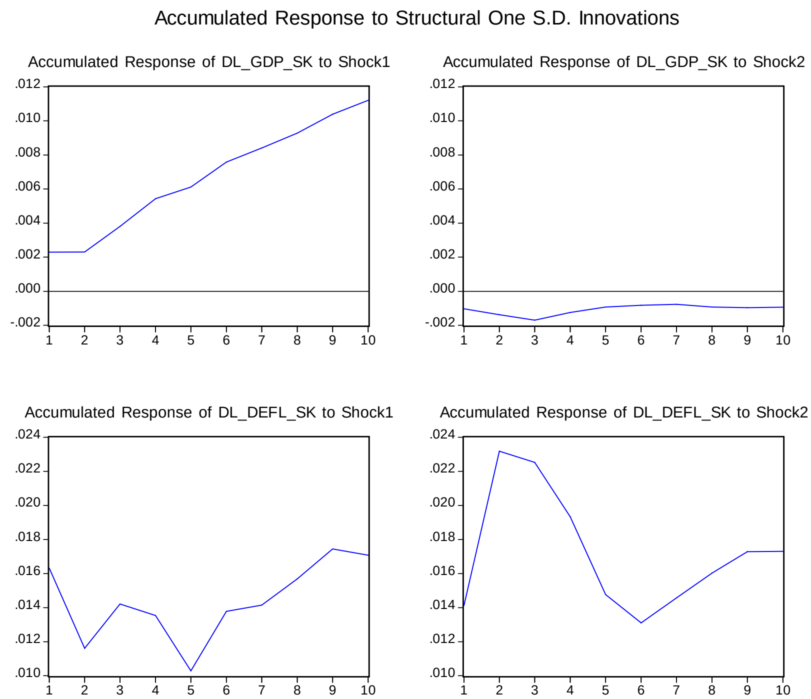
Accumulated responses of real GDP growth and Prices growth in *Italy* to supply (Shock 1) and demand (Shock 2) shocks.



Accumulated responses of real GDP growth and Prices growth in *Poland* to supply (Shock 1) and demand (Shock 2) shocks.



Accumulated responses of real GDP growth and Prices growth in *Slovakia* to supply (Shock 1) and demand (Shock 2) shocks.



Accumulated responses of real GDP growth and Prices growth in *Hungary* to supply (Shock 1) and demand (Shock 2) shocks.