Academy of Economic Studies – ASE Bucharest
Doctoral School of Finance and Banking

Analysis of business cycle synchronization and shock similarities between Euro area and CEECs

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Topics of the paper

I. Motivation, Objectives & Literature review

II. Methodology and theoretical considerations

III. Data analysis

IV. Demand and supply shocks symmetry- a SVAR approach

V. Synchronization of business cycles- filters technique

VI. Results & Conclusions

I. Motivation

A. **Main objective:**
   1. evaluate the correlation of business cycles between the Euro area and the acceding countries

B. **OCA (optimum currency area) theory (Mundell-1961):**
   1. economic business cycle not synchronized whith the states form a monetary union => giving up to its monetary policy autonomy can bring some significant economic costs
   2. economic cycles of the countries participating in a monetary union not synchronized => a common monetary policy cannot stabilize all economies simultaneously.

C. **Purpose**:
   1. assess whether the acceding countries belong to the same optimum currency area as the current members of the monetary union.
   2. if benefits for each country wishing integration are positive and higher than costs, monetary area is called as optimal.
   3. Real convergence criteria to be met:
      1. correlation of demand and supply shocks
      2. business cycles synchronization

I. Objectives

1. Identify aggregate supply and demand shocks and study the response of the economies to these shocks;

2. Evaluate the correlation between agregate and demand shocks affecting all the countries included in the study;

3. Study the degree of business cycle syncronization between Euro area and CEECs using some filtering methods;

4. Analyse how synchronization of business cycles evolved in time.

I. Literature review

- The optimum currency area theory originates with **Mundell** (1961), who proposed that a country would find it advantageous to peg the external value of its currency to a another country's currency when the business cycles of the two countries were highly correlated. If business cycles are not synchronized, a common monetary policy may create conflicts across countries about the preferred conduct of monetary policy and an early enlargement of a monetary union may be very costly.

- Especially influential is the contribution by **Bayoumi and Eichengreen** (1992). They recovered the underlying supply and demand shocks in the prospective members of the monetary union using the technique developed by **Blanchard and Quah** (1989). In the end they conclude that the EU is divided into two groups, and that the "core" countries may represent an optimum currency union.

- **Horvath** (2002), **Frenkel** and **Nickel** (2002), **Babetski, Boone** and **Maurel** (2002) follow the SVAR identification methodology pioneered by Blanchard and Quah (1989) and developed by Bayoumi and Eichengreen (1996).

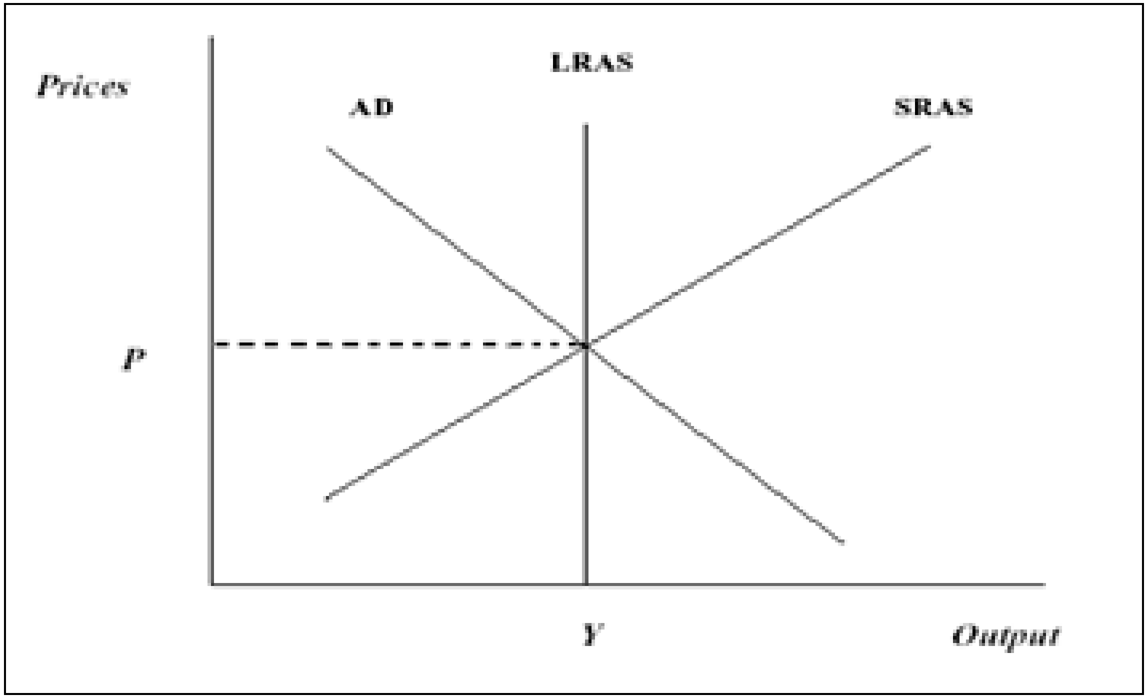
- **Artis** and **Al** (2004) and **Darvas** and **Szapary** (2004) describe business cycles of acceding countries by using Band-Pass filter.

- More recently studies: **Arfa** (2009), **Crespo-Cuaresma** (2013), **Dumitru** (2009), **Bojesteanu** and **Manu** (2011).

II. Methodology and theoretical considerations

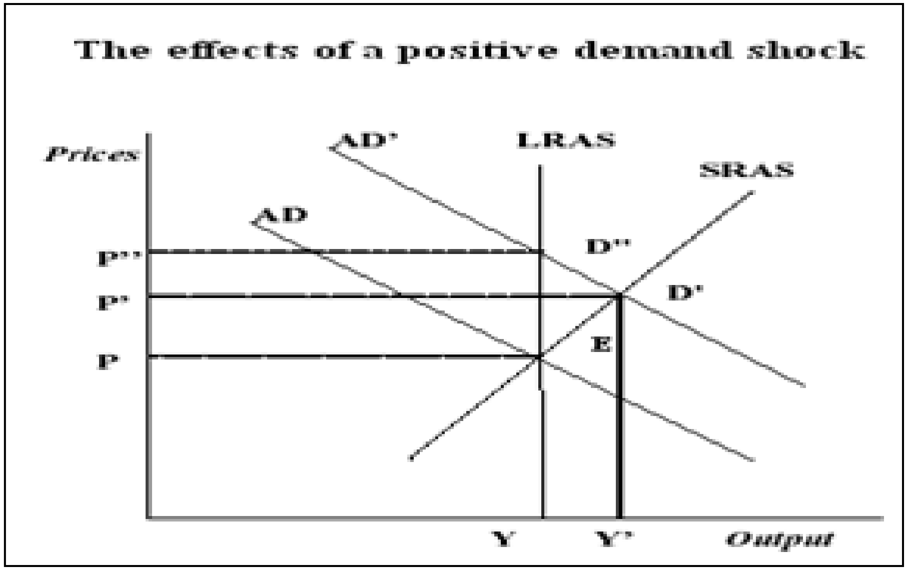
- Optimum currency are theory concentrated on the similarity of business cycles among countries supposed to participate in a monetary union. However, the business cycle includes all the shocks affecting the economy. It is therefore important to identify the original shocks affecting members of a monetary union.

- The aggregate demand and supply model allows supply and demand shocks to be identified :



Source: Korhonen and Fidrmuc (2002)- "Similarity of Supply and Demand Shocks Between the Euro Area and the CEEECs"

II.Methodology and theoretical considerations



Source: Korhonen and Fidrmuc (2002)- "Similarity of Supply and Demand Shocks Between the Euro Area and the CEEECs"

- AD → AD'

Short run equilibrium E → D'

Temporary increase in Output (Y')

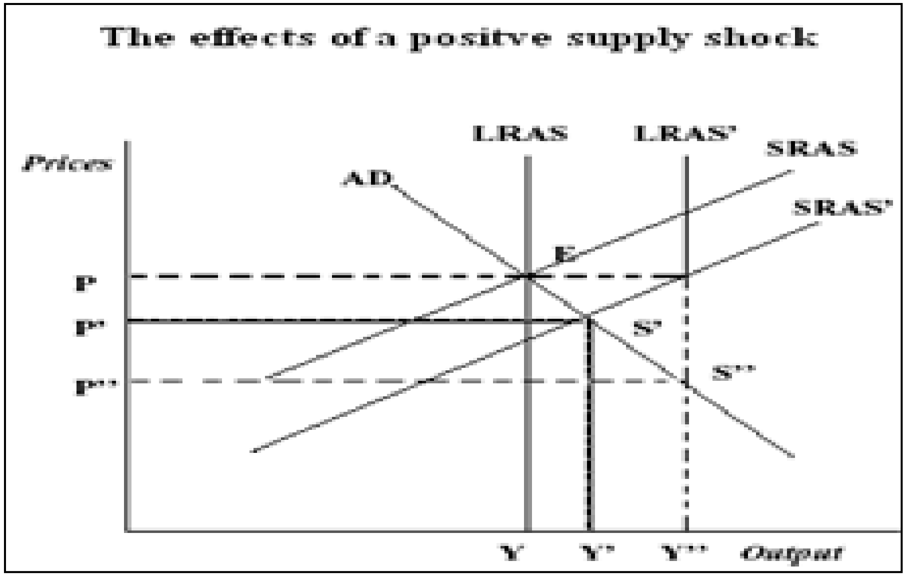
Increase in Prices (P')

- Supply curve becomes vertical LRAS
- Equilibrium D' → D"
- Output returns to its initial level (Y)
- Permanent increase in Prices (P")

Results:

➢ Temporary positive effect on Output; Long run zero effect;

➢ Permanent positive effect on Prices.



Source: Korhonen and Fidrmuc (2002)- "Similarity of Supply and Demand Shocks Between the Euro Area and the CEEECs"

- both SRAS and LRAS move rightwards to SRAS' and LRAS'

Short-run equilibrium E → S'

- Increase in Output (Y')
- Decrease in Prices (P')

- Supply curve becomes vertical LRAS'
- Equilibrium S' → S"
- Output increases further (Y")
- Prices decline further (P")

- **Results:**

➢ Permanent positive effect on Output;

➢ Permanent decline in Prices.

II. Methodology and theoretical considerations - SVAR approach

- In order to indentify demand and supply shocks we use Blanchard and Quah's methodology (1989) based on **structural VAR models (SVAR).**
- For each country/region a vector autoregressive with **two variables** (GDP growth and inflation) is estimated.
- Fluctuations in GDP and in inflation are caused by supply and demand shocks.
- As mentioned before **supply shocks** have a **permanent effect on GDP**, while **demand shocks** have only a **transitory effect on GDP**. In addition, both supply shocks and demand shocks have a permanent effect on the level of prices. A supply shock lowers prices, while a demand shock increases prices.

The two variables that compose the VAR:

$$X_t = \begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} \qquad BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \ldots + \Gamma_p X_{t-p} + \varepsilon_t$$

II. Methodology and theoretical considerations - SVAR approach

ε_t - is a vector of the two structural (demand and supply) errors.

Assuming that B is invertible, that is $(1 - b_{12} b_{21} \neq 0)$

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

$$\boxed{X_t = A(L)LX_t + e_t} \quad \boxed{(1)}$$

The bivariate moving average representation of VAR:

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

Using (1) we can say that e_{1t} is the one-step forecast error of $\Delta y_{t.}$ From the BMA representation in (2) we can further obtain that:

II. Methodology and theoretical considerations - SVAR approach

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

or

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} b_{11(0)} & b_{12(0)} \\ b_{21(0)} & b_{22(0)} \end{bmatrix} \begin{bmatrix} \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix}$$

If the *b* coefficients were known, it would be possible to recover and from the residuals e_1 and e_2. We need four additional restrictions. We can use the residuals e_1 and e_2 to construct the covariance matrix so we would know $var(e_1)$, $var(e_2)$ and $cov(e_1,e_2)$.

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

Knowing that $E(\varepsilon_{dt}, \varepsilon_{st}) = 0$ since the two disturbances are uncorrelated and assuming at the same time that the two disturbances have unit variance, we obtain restriction no 1:

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

Restriction 2 :

In the same manner we obtain restriction no 2: $\mathrm{var}(e_2) = b_{21(0)}^2 + b_{22(0)}^2$

II. Methodology and theoretical considerations-SVAR approach

Restriction 3: $$e_{1t}e_{2t} = [b_{11(0)}\varepsilon_{dt} + b_{12(0)}\varepsilon_{st}][b_{21(0)}\varepsilon_{dt} + b_{22(0)}\varepsilon_{st}]$$

Assuming once more that the structural disturbances are not correlated and that they have unit variance we obtain restriction no 3:

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

Restriction 4:

For all possible realizations of the sequence, demand shocks will have only temporary effects on the sequence if:

$$\sum_{i=0}^{\infty} b_{11i} = 0$$

III. Data description

Period: 2000 Q1-2013 Q4

Quarterly data

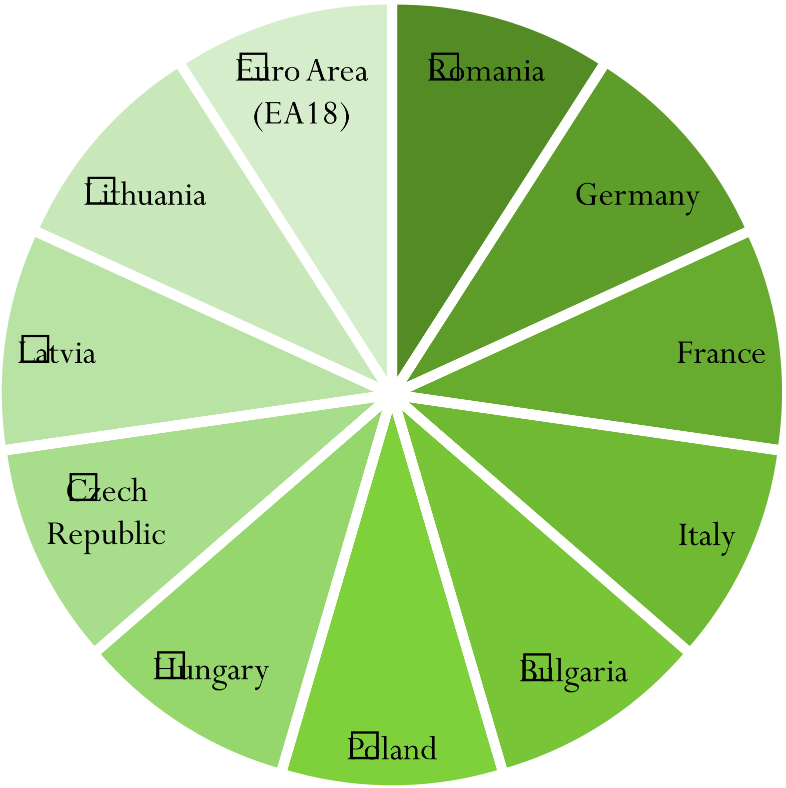
Variables: 1. Real GDP Growth

2. Inflation

Source: Eurostat

- Variables calculated as the first differences of the natural logarithms of the real GDP and GDP deflator.

- All variables used in the analysis are **seasonally adjusted**.



IV. Empirical estimation *SVAR*

1. Testing stationarity using Augmented Dickey Fuller and Phillips-Perron tests.

The probabilities associated with ADF Test		
Country	GDP growth	Inflation
H0: the series has a unit root		
Euro area (18 countries)	0,0000	0,0003
Bulgaria	0,0000	0,0000
Czech Republic	0,0000	0,0000
Germany (until 1990 former territory of the FRG)	0,0004	0,0000
France	0,0021	0,0026
Italy	0,0043	0,0000
Latvia	0,0000	0,0000
Lithuania	0,0000	0,0000
Hungary	0,0000	0,0000
Poland	0,0000	0,0000
Romania	0,0059	0,0001

The probabilities associated with PP Test		
Country	GDP growth	Inflation
H0: the series has a unit root		
Euro area (18 countries)	0,0000	0,0001
Bulgaria	0,0001	0,0000
Czech Republic	0,0000	0,0000
Germany (until 1990 former territory of the FRG	0,0003	0,0000
France	0,0017	0,0032
Italy	0,0037	0,0000
Latvia	0,0000	0,0000
Lithuania	0,0000	0,0000
Hungary	0,0000	0,0000
Poland	0,0004	0,0000
Romania	0,0000	0,0000

IV. Empirical estimation SVAR

2. Choosing the optimal lag length for each VAR according to the four criteria provided by LR Sequential tests, Akaike Criterion, Schwarz and Hanna-Quinn Criterion tests.

Country	Sequential LR	FPE	AIC	SC	HQ	Chosen
Euro area (18 countries)	0	1	1	0	0	1
Bulgaria	2	2	2	2	2	2
Czech Republic	1	1	1	1	1	1
Germany (until 1990 former territory of the FRG)	0	1	1	0	0	1
France	1	1	1	1	1	1
Italy	4	4	4	0	4	4
Latvia	3	3	3	3	3	3
Lithuania	4	4	4	0	4	4
Hungary	4	4	4	0	0	4
Poland	2	2	2	2	2	2
Romania	4	4	4	0	4	4

3. Verifying stability condition. The VAR is stable only if the absolute values of all eigenvalues of the system matrix lie inside the unit circle. All the VARs verify the stability condition.

IV. Empirical estimation *SVAR*

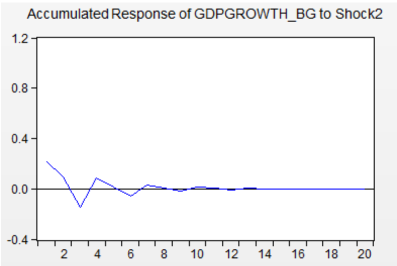
4. Testing the residuals of the VARs. One of the fundamental hypotheses of VAR methodology is that the residuals represent "white noise". More specifically, they have to be normally distributed, uncorrelated and homoskedastic.

    - Autocorrelation (LM Autocorrelation test)
    - Normality (Jarque-Berra test)
    - White Heteroskedasticity test

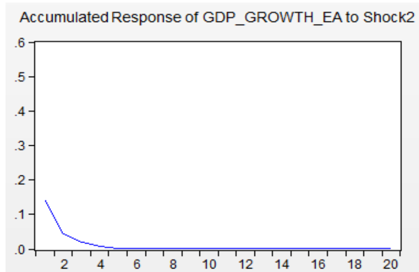
Finally, we impose the structural restriction that the **aggregate demand shock does not have a permanent effect on output .**

→ Structural aggregate demand and supply shocks.

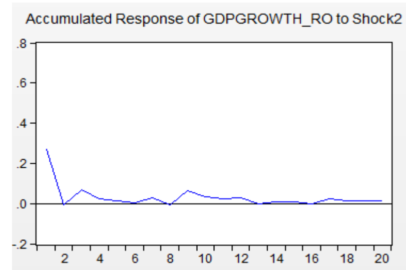
IV.Response of GDP Growth to Demand Shock



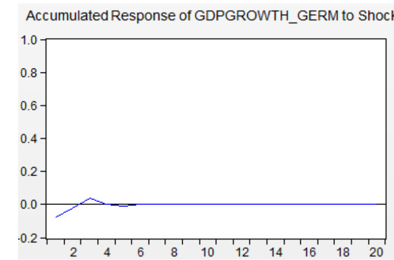
Bulgaria



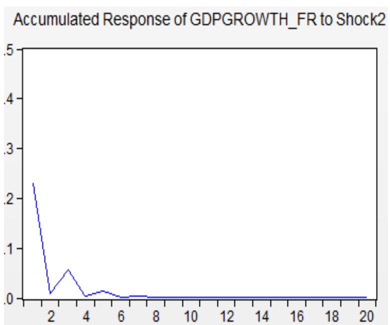
Euro area



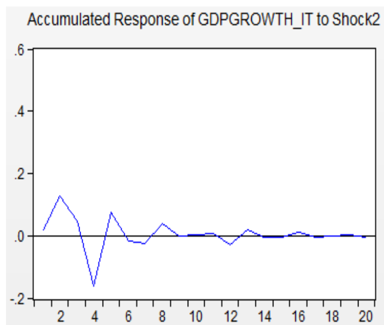
Romania



Germany



France



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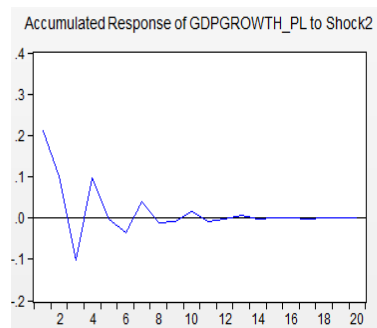

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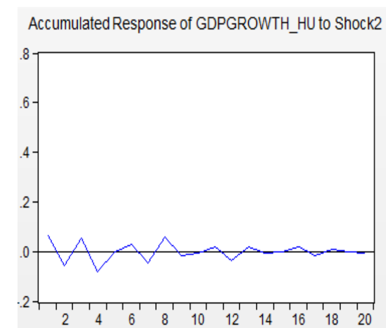
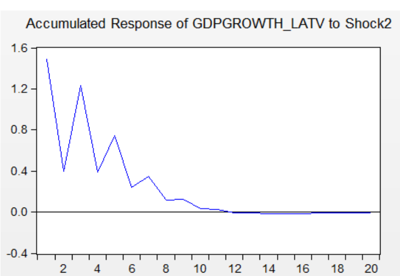
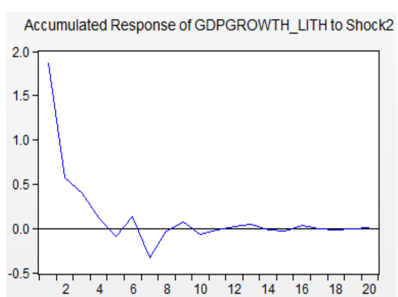


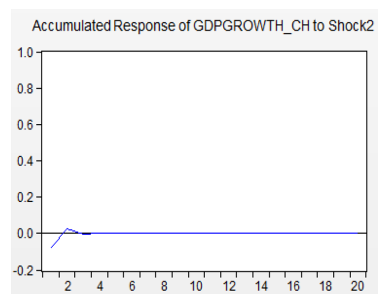
Hungary



Latvia

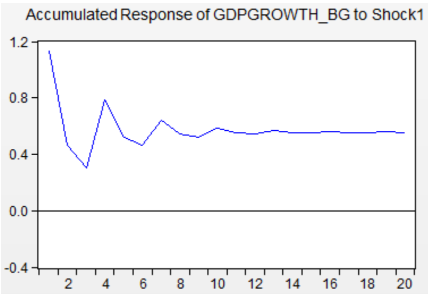


Lithuania

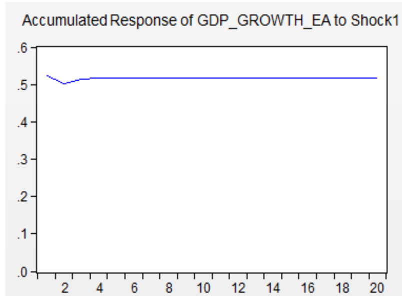


Czech Republic

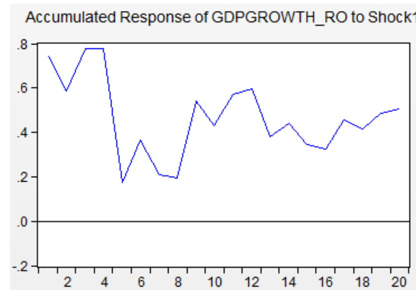
IV. Response of GDP Growth to Supply Shock



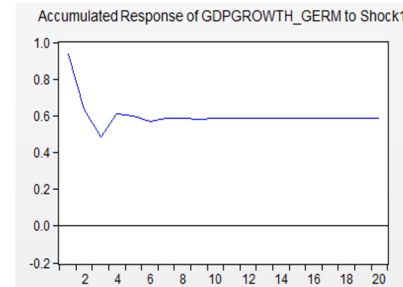
Bulgaria



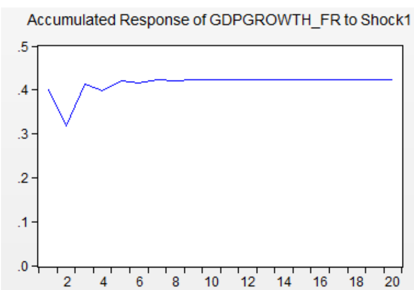
Euro area



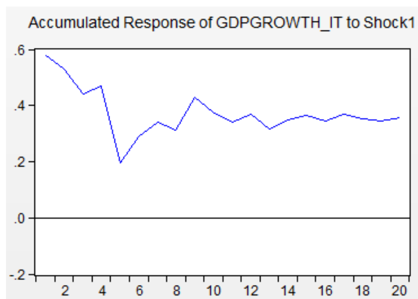
Romania



Germany



France



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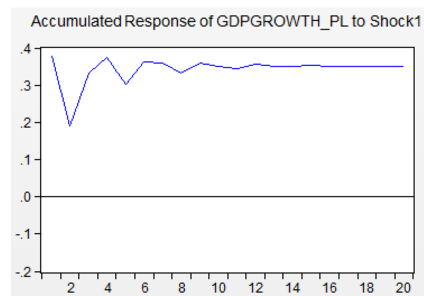
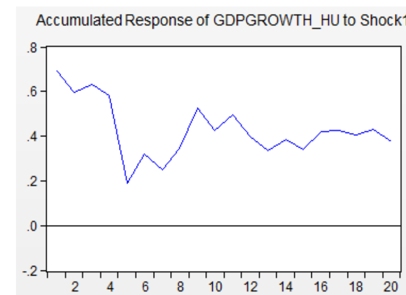
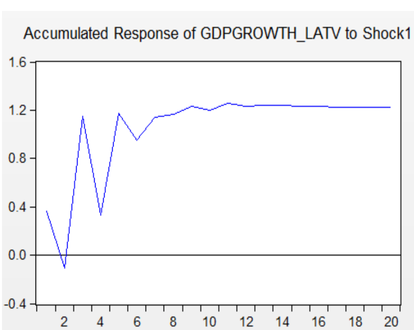


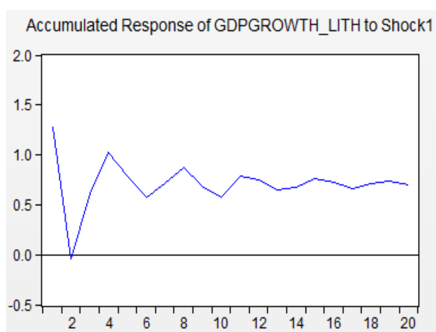
Poland



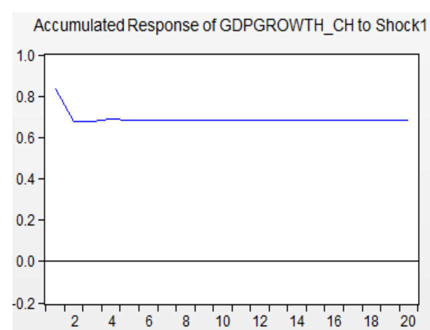
Hungary



Latvia

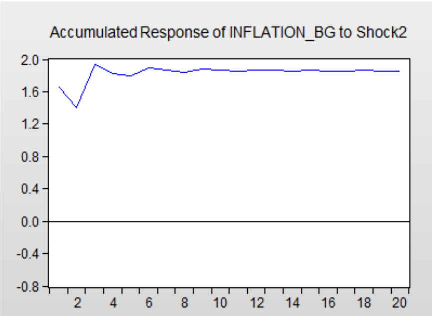


Lithuania

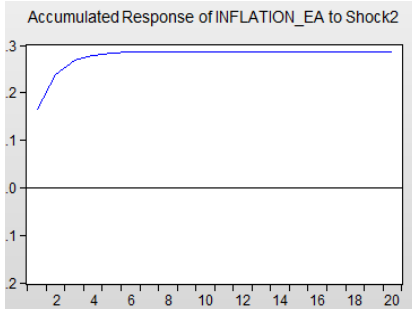


Czech Republic

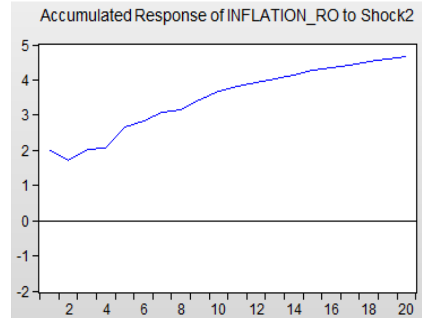
IV. Response of Inflation to Demand Shock



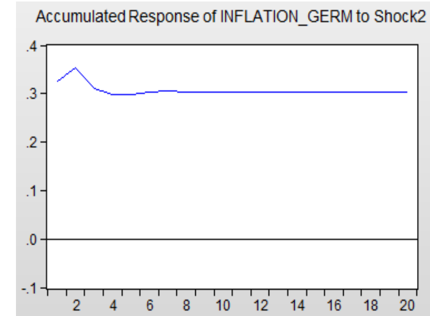
Bulgaria



Euro area



Romania



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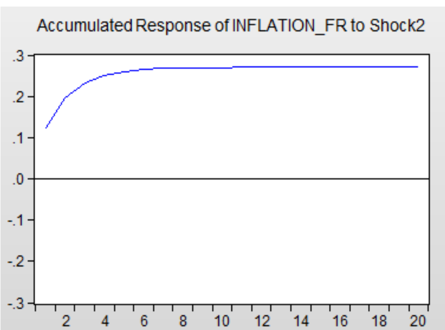
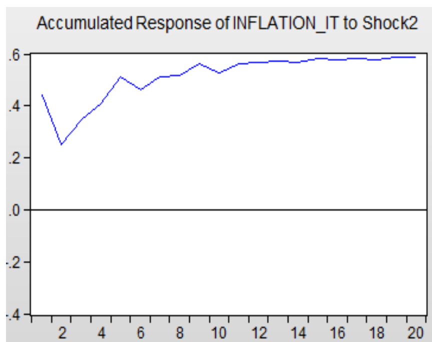


France



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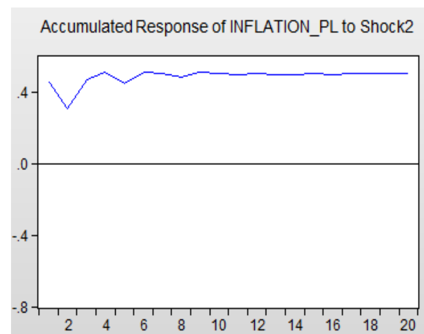

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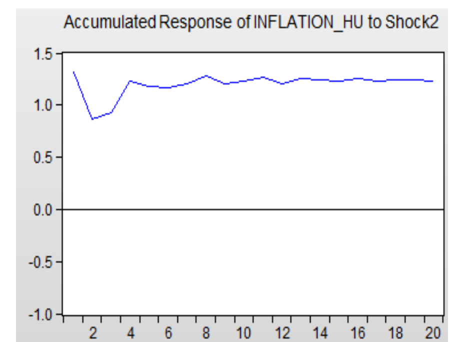
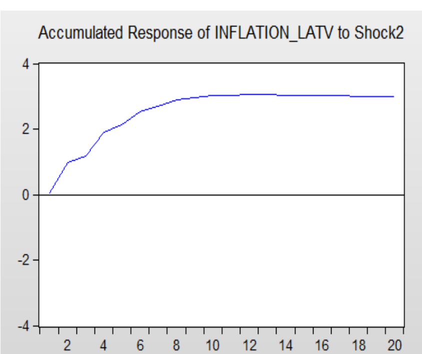
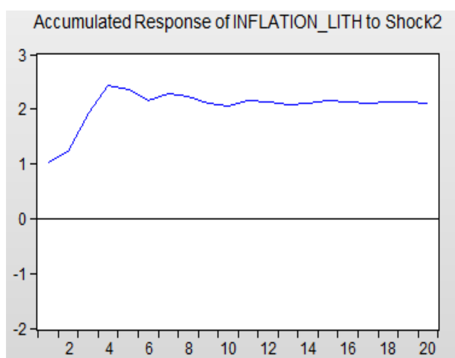


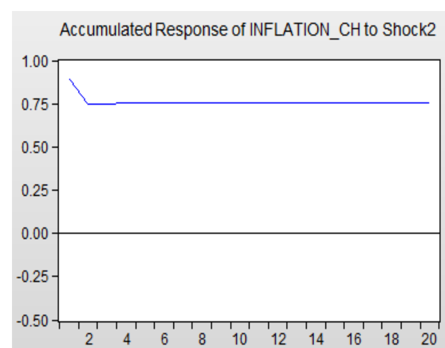
Hungary



Latvia

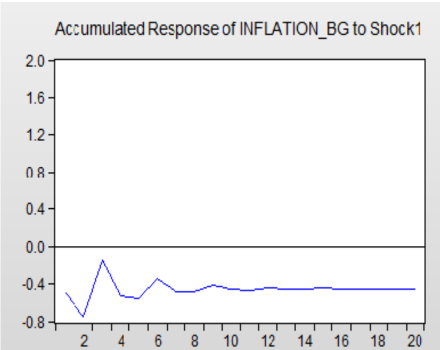


Lithuania

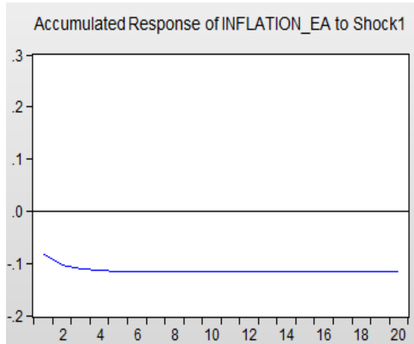


Czech Republic

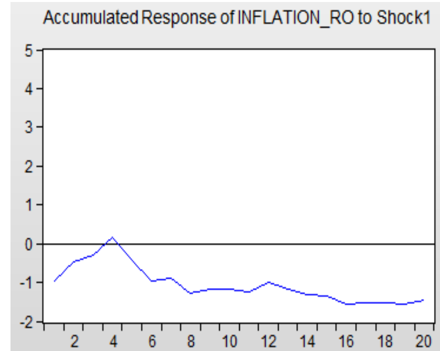
IV. Response of Inflation to Supply Shock



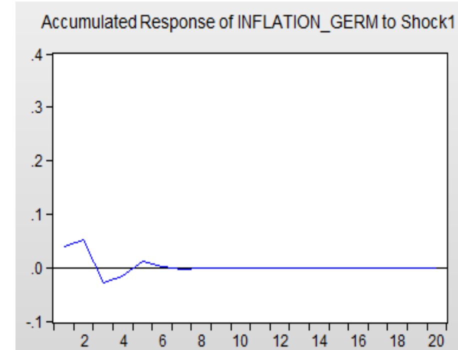
Bulgaria



Euro area



Romania



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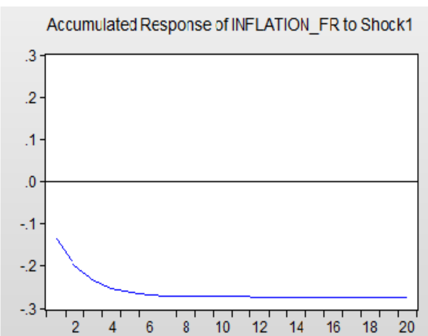

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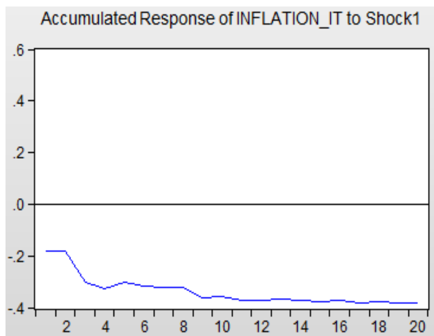
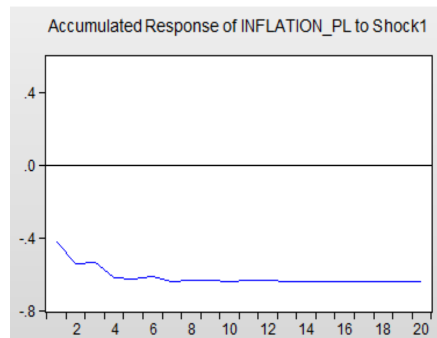
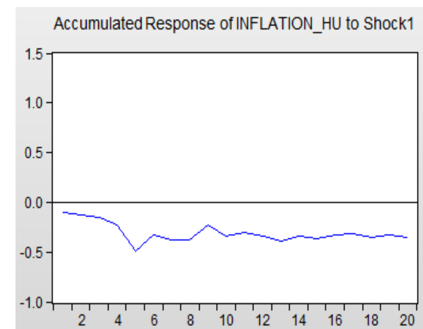


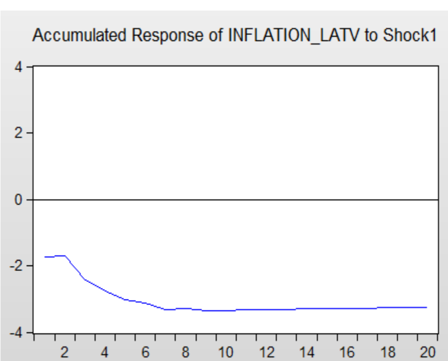
Italy



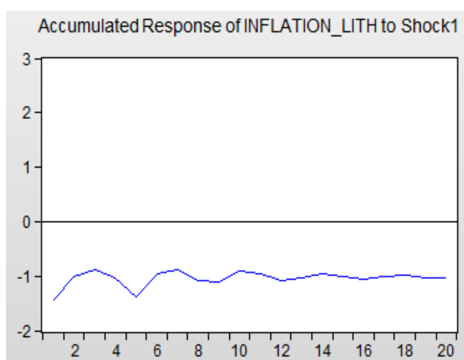
Poland



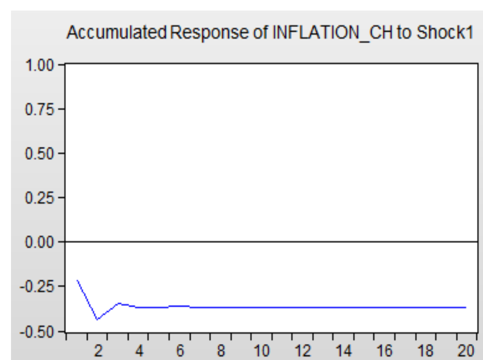
Hungary



Latvia



Lithuania



Czech Republic

IV. Correlation of demand and supply shocks

Supply shocks correlations

`	Bulgaria	Czeck Republ	Euro Area	France	Germany	Hungary	Italy	Latvia	Lithuania	Poland	Romania
Bulgaria	1										
Czeck Republic	0.423242	1									
Euro Area	0.427212	0.585446	1								
France	0.061623	0.502663	0.652345	1							
Germany	0.544303	0.561035	0.835804	0.489332	1						
Hungary	0.271712	0.293349	0.433269	0.278496	0.376813	1					
Italy	0.402866	0.461328	0.714461	0.401087	0.710799	0.413453	1				
Latvia	-0.132836	0.211778	0.018447	0.204513	0.004628	0.012464	-0.0205	1			
Lithuania	0.312503	0.084745	0.319816	0.191602	0.336424	0.113788	0.033196	-0.074899	1		
Poland	0.186671	0.244189	0.312565	0.236337	0.388753	0.112502	0.139531	0.228389	0.166806	1	
Romania	-0.156107	-0.130702	0.058823	0.010327	0.06326	0.388981	0.175992	0.049046	0.061033	0.04817	1

Demand shock correlations

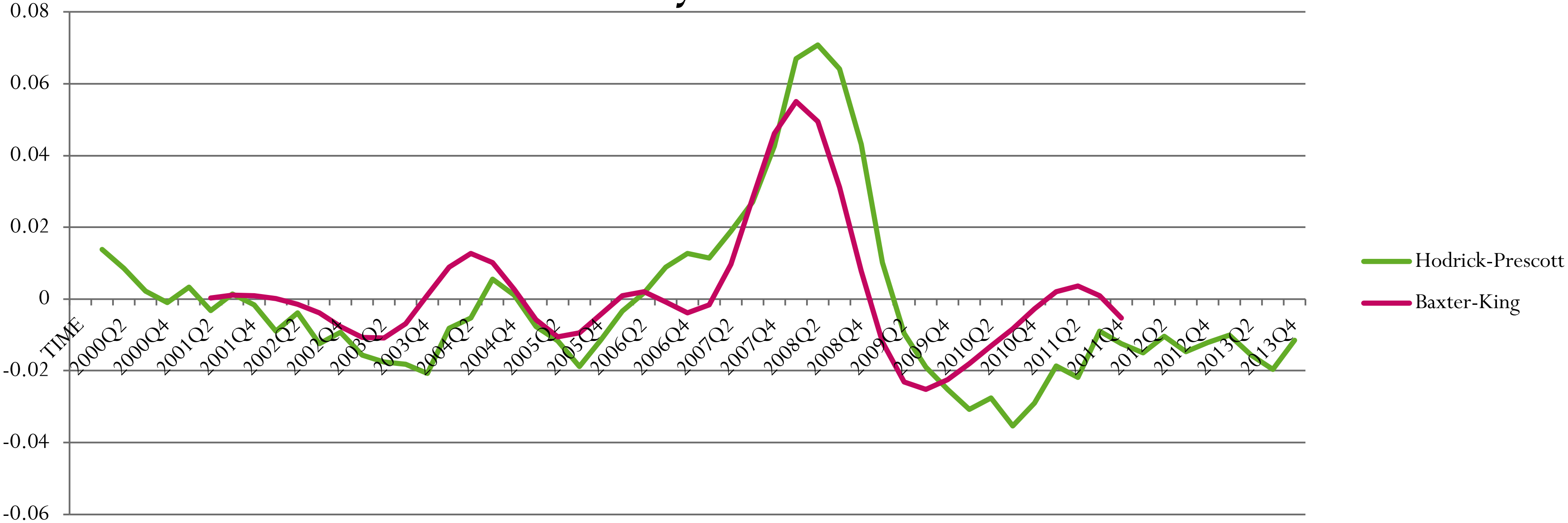
	Bulgaria	Czeck Republ	Euro Area	France	Germany	Hungary	Italy	Latvia	Lithuania	Poland	Romania
Bulgaria	1										
Czeck Republic	-0.14917	1									
Euro Area	0.303637	-0.000146	1								
France	0.187027	-0.029513	0.484893	1							
Germany	-0.087872	0.300575	0.341982	0.119631	1						
Hungary	0.121105	-0.006531	0.200106	0.298104	-0.023892	1					
Italy	0.002084	0.055961	0.595236	0.233559	0.108433	0.098814	1				
Latvia	-0.01133	-0.251258	0.163606	0.195969	-0.059597	-0.041436	0.054113	1			
Lithuania	0.229926	-0.245769	0.314537	0.297785	0.063723	-0.142501	0.067646	0.260768	1		
Poland	0.102886	0.348453	0.209403	0.05902	0.132071	0.057649	0.090505	-0.193896	-0.025599	1	
Romania	0.369382	-0.174647	0.325627	0.53651	-0.003789	-0.038982	-0.007392	0.184836	0.416381	-0.045871	1

V. Synchronization of business cycles

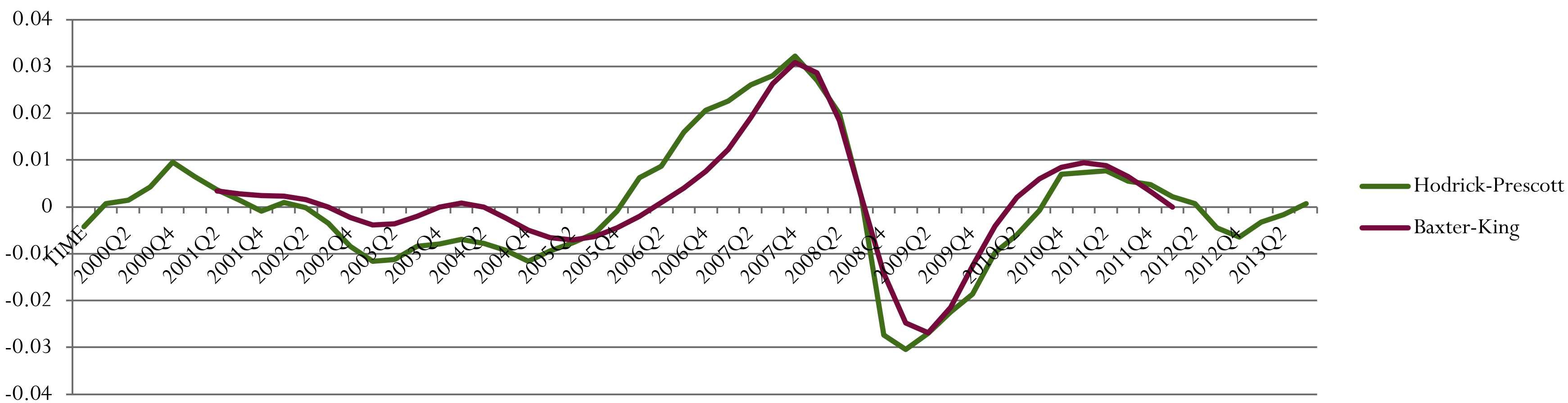
- Economies tend to fluctuate around a long term trend. Fluctuations around this trend correspond to cyclical fluctuations.
- The most common methods to assess business cycles are filters techniques like: the Hodrick-Prescott technique of decomposition (1980) and Band Pass: Baxter King filter.
- This analysis enables assessment of the optimality (or otherwise) of a monetary union extended to CEECs.
- The basic idea is to decompose the economic series of interest into the sum of a slowly-evolving secular trend and a transitory deviation from it which is classified as "cycle".
- We use quarterly GDP data as a measure of economic activity, ranging from Q1 2000 to Q4 2013 for Romania, Euro Area and all the other countries included in the study.
- A logarithm was applied on the initial series, in order to obtain the percentage deviation from trend.

V. Synchronization of business cycles

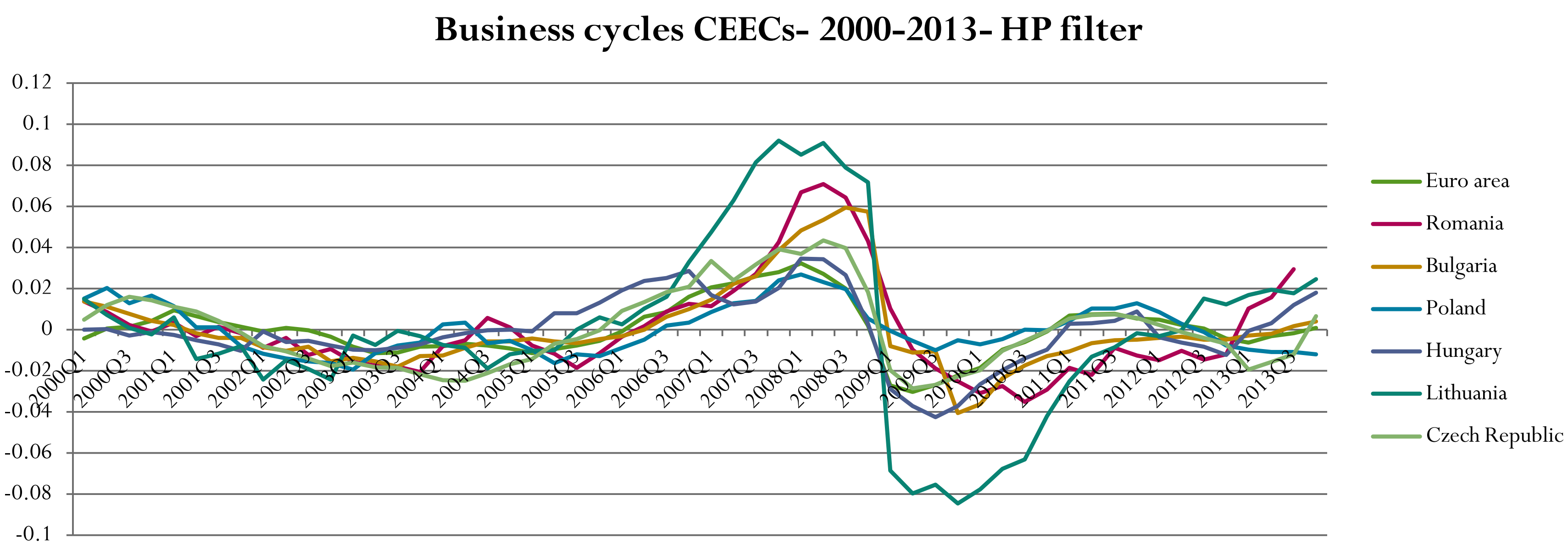
Romanian business cycle 2000-2013

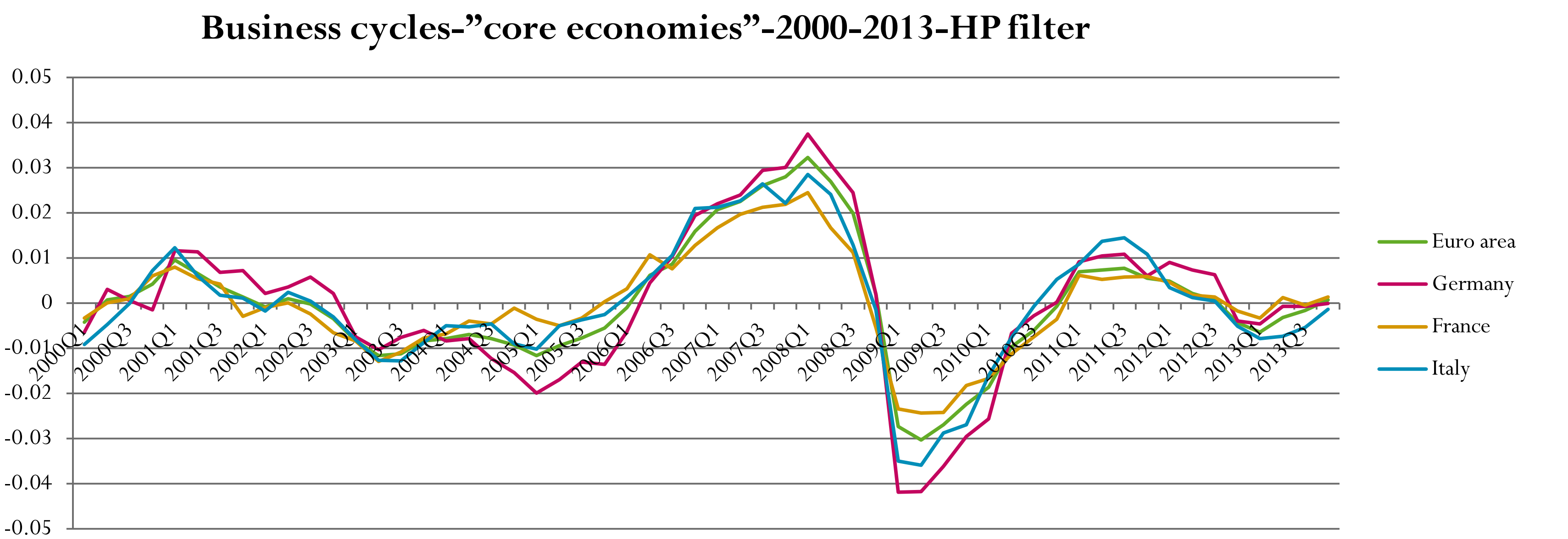


Euro area business cycle 2000-2013



V. Synchronization of business cycles





V. Synchronization of business cycles

BP filter correlations

	Bulgaria	Czeck Rep	Euro Area	France	Germany	Hungary	Italy	Latvia	Lithuania	Poland	Romania
Bulgaria	1										
Czeck Rep	0.716523	1									
Euro Area	0.667539	0.79617	1								
France	0.527957	0.728398	0.961334	1							
Germany	0.515227	0.708382	0.967797	0.947036	1						
Hungary	0.665083	0.591211	0.853373	0.845476	0.787067	1					
Italy	0.51981	0.67247	0.955258	0.983272	0.962999	0.848359	1				
Latvia	0.774922	0.704704	0.756368	0.640853	0.633589	0.727896	0.585664	1			
Lithuania	0.72867	0.736699	0.917669	0.839316	0.830878	0.861345	0.809993	0.885423	1		
Poland	0.546816	0.693009	0.769269	0.741615	0.699679	0.603153	0.720981	0.533117	0.719328	1	
Romania	0.83525	0.856521	0.756311	0.63923	0.616666	0.736839	0.579755	0.861907	0.832351	0.670978	1

HP filter correlations

	Bulgaria	Czeck Rep	Euro Area	France	Germany	Hungary	Italy	Latvia	Lithuania	Poland	Romania
Bulgaria	1										
Czeck Republ	0.811402	1									
Euro Area	0.73429	0.901075	1								
France	0.669381	0.860196	0.968841	1							
Germany	0.65985	0.824363	0.974847	0.921208	1						
Hungary	0.691993	0.754521	0.817733	0.855566	0.754737	1					
Italy	0.610978	0.844077	0.968905	0.951925	0.947247	0.808572	1				
Latvia	0.66194	0.485744	0.497777	0.496163	0.430588	0.601097	0.36783	1			
Lithuania	0.870747	0.77149	0.834377	0.818638	0.790133	0.829384	0.746452	0.676969	1		
Poland	0.672946	0.766752	0.677994	0.625793	0.612961	0.440352	0.602792	0.277006	0.5462	1	
Romania	0.915222	0.679462	0.646823	0.59711	0.569979	0.65703	0.490521	0.788692	0.8105	0.579818	1

V. Synchronization of business cycles

Pearson correlation coefficient is used in order to evaluate the business cycles synchronization

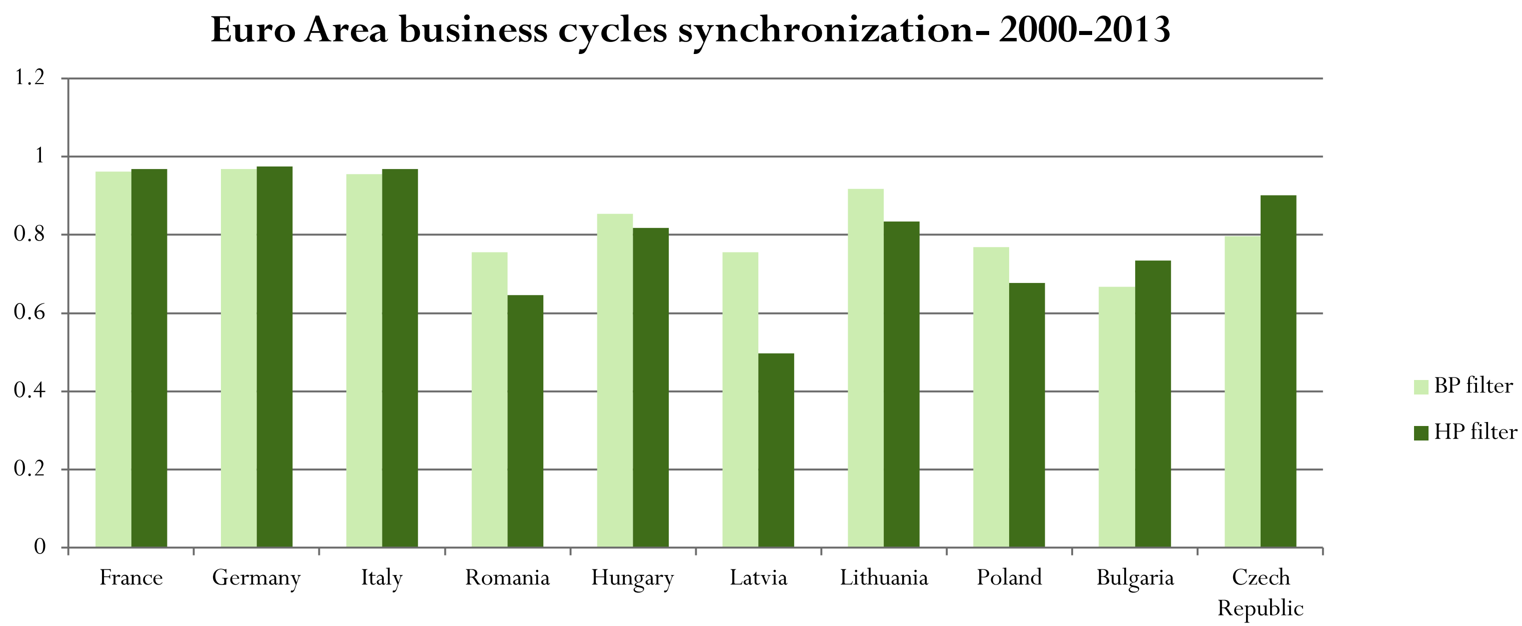
Euro Area correlations of business cycles based on BP

	Euro Area
France	0.96
Germany	0.97
Italy	0.96
Romania	0.76
Hungary	0.85
Latvia	0.76
Lithuania	0.92
Poland	0.77
Bulgaria	0.67
Czech Republic	0.80

Euro Area correlations of business cycles based on HP

	Euro Area
France	0.97
Germany	0.97
Italy	0.97
Romania	0.65
Hungary	0.82
Latvia	0.50
Lithuania	0.83
Poland	0.68
Bulgaria	0.73
Czech Republic	0.90

V. Synchronization of business cycles

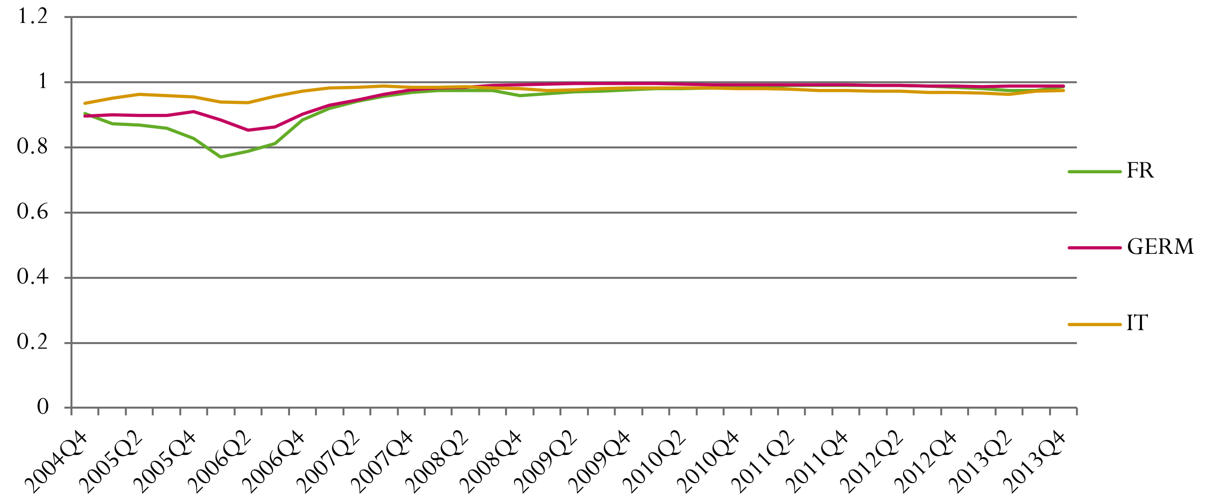


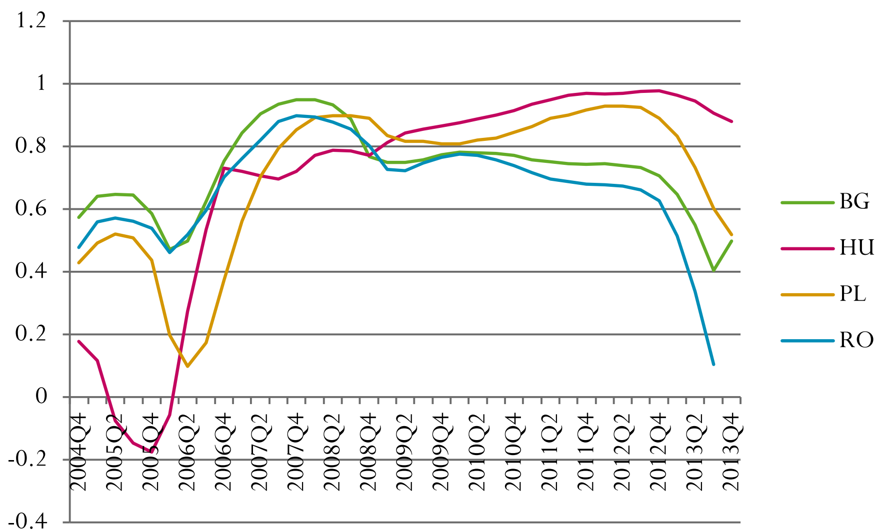
Sub-periods analysis for business cycle syncronization of Romania and Euro area

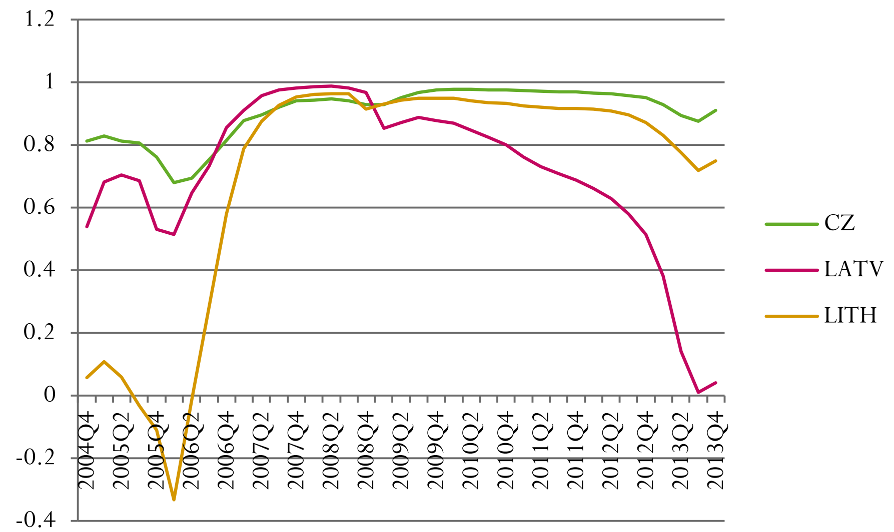
Periods	Business cycle correlation between Romania and Euro Area
2001Q3-2004Q4	0.48
2005Q1-2008Q4	0.80
2009Q1-2013Q4	0.18

V. Synchronization of business cycles

Rolling window for business cycle correlation







VI. Conclusions

- Considering the GDP cumulative reaction to supply, the macroeconomic correlations are acording to the economic theory for all 11 considered economies. The supply shocks are rather permanent, while demand shocks are in most cases insignificant (according to the imposed restiction).
- As for the inflation reaction to aggregate demand and supply shocks, theoretical correlations were observed in all cases. A supply shock has a negative impact on prices, while a demand shock has a positive impact on prices.
- Core EMU countries are strongly correlated on supply side with both entire euro area and the CEECs.
- For the most economies, shocks correlation on the demand side is lower than the correlation on the supply side.

VI. Conclusions

- In term of supply shocks Romania and Latvia occupy the last two places, while in term of demand shocks the last ones are Czeck Republic and Latvia.

- The degrees of business cycle syncronization are quite high for all CEECs countries, on the last positions being Romania, Poland and Latvia.

- In the period 2000-2004, Romania business cycle correlation degree with the Euro Area was lower than in the next period when Romania recorded a rapid increase (influenced by the EU accession in 2007 and by the higher economic integration with the EU starting from the pre-accession years). And starting 2008 droped down again because of the financial crisis.

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