2. BUSINESS CYCLE CORRELATION OF THE NEW MEBER STATES WITH EUROZONE - THE CASE OF ROMANIA[1]

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Abstract

This paper assesses the degree of readiness of New Member States (NMS) of the EU, including Romania, to adopt euro, mainly based on an optimal currency area (OCA) criterium. Using three consensus measures of output gap based on revisions of the estimated output gaps computed by 5 filtering techniques and a benchmark method based on Principal Component Analysis (PCA) we estimated the business cycle correlation between NMS and eurozone. Our findings suggest that the correlation of the business cycle in the case of Romania is one of the lowest among NMS, although it increased tremendously in the last years. The main conclusion of our paper is the fact that Romania, as well as some other NMS countries still need time to progress on the real convergence criteria in order to adopt euro without major costs.

Keywords: OCA; output gap; business cycle synchronization; euro adoption; convergence

JEL Classification: E32, F41

1. Introduction

Ten countries joined the European Union on 1st May 2004 and another two (Romania and Bulgaria) on 1st January 2007. None of these countries has been allowed to opt out from the third Stage of Economic and Monetary Union (EMU) like Denmark and

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the United Kingdom. This implies that they are expected to adopt the euro at a time sooner or later after their EU accession[4]. The accession of the NMS to the European Union has stimulated a growing academic and policy debate about when should the Eurozone be extended to the new EU members based on the achievements in the convergence process.

The current international financial and economic crisis triggered by the subprime mortgage market in the United States led to a re-thinking in the euro adoption strategies of some New Member States (NMS) in order to speed-up the process. The benefits and costs of the euro adoption are quite clear, but the current international crisis emphasized especially the advantages of the euro as a strong currency and its international reserve currency status.

Nevertheless, the euro adoption is still constrained by the fulfillment of the convergence criteria. The only formal conditions regarding the Eurozone entry are related to the fulfillment of the nominal convergence indicators. In the case of Romania, only the public debt criterion is currently fulfilled. Romania still has problems with inflation and will continue probably to experience higher inflation than in the Eurozone in the next years, as the price level convergence is expected to continue (which includes also the Balassa-Samuelson effect, which is important, see Dumitru and Jianu, 2009) and the general price level in Romania is still much lower than in the Eurozone. Moreover, the budget deficit has exploded in 2008 and is expected to remain very high in the next years.

From the real convergence point of view, there is no formal condition in the euro adoption process. Just in the Maastricht treaty there is a general provision mentioning the necessity of social and economic cohesion in order to reduce the development gap between countries. In a broader sense, the real convergence means the adjustment process of the social, political and economic structures towards the ones from the Eurozone. In a narrow sense, real convergence means a reduction in the level of economic development gap, the reference being indicators like GDP per capita, productivity, and living standard. From an economic point of view, Romania is still in a marginal position if compared with the European developed countries (Iancu, 2007).

A special approach in terms of real convergence assessment is related to the Optimal Currency Area (OCA) theory, introduced in the seminal papers of Mundell (1961, 1973). From the OCA theory point of view, when a country wants to join a monetary union there should be taken into consideration criteria like the convergence of economic structures, business cycle synchronization, demand and supply shocks correlation, labor market and market flexibility, in general, degree of financial intermediation, level of economic openness, etc.

In this paper we investigate business cycles of the New Member States economy and their symmetry to the Eurozone economy using the *correlation of business cycle approach*, based on three consensus estimations for the output gap.

[4] Four of the New Member States (NMS) adopted euro already: Slovenia in 2007, Cyprus and Malta in 2008 and Slovakia in 2009.

The paper is organized as follows. The next session briefly reviews the literature of optimum currency area (OCA) theory, especially in relation to the New Member States (NMS) from Central and Eastern Europe. The third section of the paper includes the estimation methodology based on the data, which are presented in Section 4. In the fifth section of the paper we present our results, and in the last section we have some concluding remarks.

2. Optimal currency area – Literature review

The **Optimal Currency Area** (OCA) theory is based on the idea that the advantages of being a member of a monetary union depends on the degree of optimality of this union, meaning that it would maximize economic efficiency to have the entire area sharing a single currency. The theory of OCA was pioneered by Mundell (1961), with important contributions and extensions of McKinnon (1963) and Kenen (1969).

After many amendments, the OCA has become a complex theory associating and mixing various aspects of international macroeconomic processes. Within OCA theory various authors emphasize various criteria:

a) ***Production factors mobility***, especially labor force (Mundell, 1961). High factor market integration and sufficient factor mobility within a group of partner countries can reduce the need to adjust real factor prices, and the nominal exchange rate, between countries in response to disturbances. If one country faces depression due to a negative shock, factors of production may move from this country to another which is hit by a positive shock. Hence, prices of these factors do not need to fall so sharply in the depressed country and rise in the booming country. The factor mobility is then able to compensate for the exchange rate changes.

b) ***Level of economic openness*** (McKinnon, 1963; Alesina and Barro, 2002). The higher the degree of openness is, the more changes in international prices of tradable are likely to be transmitted to the domestic cost of living. Also devaluation would be more rapidly transmitted to the price of tradables and the cost of living, denying its intended effects. Hence, the nominal exchange rate would be less useful as an adjustment instrument for small and open economies.

c) ***Production and consumption diversification*** (Kenen, 1969; Tavlas, 1994). A high diversification in production and consumption diminishes the possible impact of shocks specific to any particular sector. Therefore diversification reduces the need for changes in terms of trade via the nominal exchange rate and provides "insulation" against a variety of disturbances. More diversified partner countries are more likely to face small costs from forsaking nominal exchange rate changes amongst them and find a common currency beneficial.

d) ***Wage and price flexibility*** (Friedman, 1953). When nominal prices and wages are flexible between and within countries contemplating a common currency, the transition towards adjustment following a shock is less likely to be associated with sustained unemployment in one country and/or inflation in another.

e) ***Business cycle synchronization and demand and supply shocks symmetry*** (Cohen and Wyplosz, 1989; Weber, 1990; European Commission, 1990). A very important criterion is the similarity of supply and demand shocks and business cycles in countries using a common currency (or having their exchange rates fixed). Monetary and exchange rate policy cannot be used as a stabilization tool if a member country is, for example, hit by an asymmetric shock. Hence, business cycles of countries considering creation of a currency area must be correlated to a maximum extent.

f) ***Fiscal policy integration*** (Kenen, 1969) and ***political integration*** (Mintz, 1970). Fiscal transfers are a part of a non-market based adjustment process. The aim is the redistribution of financial transfers from relatively richer to relatively poorer countries or from countries hit by a positive shock to countries hit by a negative shock. However, these two aims could be inconsistent: a country hit by a positive shock could be at the same time a relatively poorer country. Moreover, the system of fiscal transfers requires a certain degree of political integration.

g) ***Financial markets integration*** (Ingram, 1962). Financial market integration can reduce the need for exchange rate adjustment. It permits, amongst others, to cushion temporary adverse disturbances through capital inflows (by borrowing from surplus areas or decumulating net foreign assets that can be reverted when the shock is over).

h) ***Inflation differential*** (Fleming, 1971). Similarities of inflation rates are also needed to create an OCA. External imbalances can arise from persistent differences in national inflation rates resulting, inter alia, from: disparities in structural developments, diversities in labour market institutions, differences in economic policies, and diverse social preferences. When inflation rates between countries are similar over time, terms of trade will also remain fairly stable. This will foster more balanced current account transactions and trade, and reduce the need for nominal exchange rate adjustment.

The degree of fulfillment of the OCA criteria is an essential factor when judging the advantages and disadvantages of the euro adoption.

3. Estimation methodology

We used in our estimation a methodology similar to Darvas and Vadas (2005). In order to compute the correlation of business cycles we used for extracting the output gap five univariate methods: Quadratic trend (QT), Hodrick-Prescott filter (HP), Band-Pass filter (BP), Beveridge-Nelson decomposition (BN), and Wavelet transformation (WT). All of them have in common the idea that the seasonally-adjusted GDP can be decomposed into two components: potential output and output gap.

Using different methods to compute the output gap is quite common in literature. For instance, Canova (1998) uses seven univariate methods: Hodrick Prescott filter, Beveridge-Nelson decomposition, linear trend, segmented trend, first order differencing, unobservable component model, frequency domain masking and three multivariate cointegration, common linear trend and multivariate frequency domain. He concludes that properties of business cycles depend on the detrending method.

In this paper we used the following univariate methods to obtain the trend and the cycle from the GDP series:

I. Quadratic trend (QT): the cycle is the residual of a regression on a deterministic trend and its square. The potential output has the following polynomial form: $\ln(Y_t) = a + bt + ct^2$.

II. Hodrick-Prescott filter (HP) is a two-sided linear filter that computes the smoothed series *s* of *y* by minimizing the variance of *y* around *s*, subject to a penalty that constrains the second difference of *s*. That is, the HP filter chooses *s* to minimize:

$$\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda\sum_{t=2}^{T-2}((s_{t+1} - s_t) - (s_t - s_{t-1}))^2$$

where: y_t =GDP; s_t =trend;

The smoothness parameter *λ* takes the values of 100 for annual data, 1,600 for quarterly data and 14,400 for monthly data. The HP filter has two main drawbacks: arbitrary chose of the parameter λ and becomes unstable at the end and at the beginning of the sample.

III. Band-Pass filter (BP) - intends to remove both high frequency and low frequency of a series, keeping the business cycle frequencies. We define the lower and upper frequencies of the two low pass filters as six and thirty two quarters, respectively, for the cycle range to be passed through. The major weakness is that in finite samples only various approximations could be used: Baxter-King (1999) and Christiano-Fitzgerald (2003). We used in our paper the approximation of Christiano-Fitzgerald.

IV. Beveridge-Nelson (BN) decomposition. Any time series can be viewed as the sum of a random walk, a stationary process and an initial condition. The cycle (the output gap) is the stationary process which can be derived from the decomposition (Beveridge and Nelson, 1981). We used in the decomposition an ARIMA representation. We selected the best ARIMA representation using the Akaike criterion.

V. Wavelet transformation (WT) eliminates certain frequencies, but contrary to the BP filter it does not assume that frequency components are stationary. The GDP is regarded as a signal. The output decomposition structure contains the wavelet decomposition vector *C* and the bookkeeping vector *L*. The first step starts from *s* and produces two sets of coefficients: approximation coefficients *CA1*, and detail coefficients *CD1*. The cycle is reconstructed from the coefficients of details. The families of wavelet transformation are: Haar, Mexican Hat, Morlet, Daubechies, etc. In the literature the most frequently used wavelets are the Daubechies wavelet family, with different number of filter elements starting at four and have also a parameter scale. We performed more types of Daubechies wavelet filters (with 2, 3, 4 scales) and we choose the 3-scale ones. We used the 3-scale Daubechies wavelet filters based on a higher correlation of the results with the other detrending methods.

As each filtering techniques has advantages and some weaknesses, we adopted a method similar to Darvas and Vadas (2005) in order to obtain a consensus measure of the output gap, based on some weights derived upon the stability of each filter. Basically, a method is “better” and contains more information about the output gap if it leads to smaller revisions of past inference as new observation is added.

We used, similar to Darvas and Vadas (2005), three measures of consensus output gap. We gave weights to the output gaps estimated by the five filters proportional to the inverse of revisions of the output gap for all data estimate for recursive samples. First we filtered the series ending at a time k, smaller than the full sample. We added an observation and we applied again filters and we had the first revision for the sample [1,k]. Adding observations one by one we obtain a number of estimates (*l+1*) and revisions (*l*).

The size of revision at time t is:

$$k_t^{(m)} = \frac{1}{l_t}\sum_{s=k+1}^{T}\left|(\bar{q}_{t,s}^{(m)} - \bar{q}_{t,s-1}^{(m)})\right| = \frac{1}{l_t}\sum_{s=k+1}^{T}\left|(q_t - \bar{q}_{t,s}^{(m)}) - (q_t - \bar{q}_{t,s-1}^{(m)})\right| \quad (1)$$

$l_t = T - k$ for $t \le k$ and $l_t = T - t$ for k<$t \le T$

where:

$k_t^{(m)}$ =the revision of the m^{th} method for observation t; m$\in$[1,2,3,4,5];

$\bar{q}_{t,s}^{(m)}$ - the logarithm of potential output revealed by the m^{th} method for observation t in the sample [1,s];

q_t - the logarithm of actual GDP and l_t = the number of revisions.

The average revision for the m^{th} method is:

$$k^{(m)} = \frac{1}{T-1}\sum_{t=1}^{T-1} k_t^{(m)} \quad (2)$$

The weights that will be used are: $\omega_m = \frac{1/k^{(m)}}{\sum_{j=1}^{p} 1/k^{(j)}}$ (3)

where: ω_m is the weight of the m^{th} method, *p* is the number of methods.

Using (3) we obtained the "Consensus A" output gap as: $\bar{c}_t = \sum_{j=1}^{p} \omega_j \bar{c}_{t,T}^{(m)}$ (4)

where: $\bar{c}_t$ is the consensus output gap measure and $\bar{c}_{t,T}^{(m)} = q_t - \bar{q}_{t,s}^{(m)}$ is the output gap extracted by the m^{th} method.

As Darvas and Vadas (2005) pointed out, the main disadvantage of the above methodology was related to the variance dependence. The absolute value of revisions is most likely smaller for methods which lead to smaller variance of estimated output gap. So, the methods leading to smaller variance output gaps will have higher weights. In order to avoid this, a standardization of the output gaps when calculating the revisions could be better. We replace (1) with (1'):

$$k(\sigma)_t^{(m)} = \frac{1}{l_t} \sum_{s=k+1}^{T} \left| \frac{(q_t - \bar{q}^{(m)}_{t,s}) - (q_t - \bar{q}^{(m)}_{t,s-1})}{\sigma_{\left(q_t - \bar{q}^{(m)}_{t,s}\right)}} \right|$$

Replacing (1') in (2) and (3) we obtain new weights, and using these new weights in (4) we have a new combined output gap – "Consensus B".

Darvas and Vadas (2005) proposed an additional method to compute the consensus output gap in order to prevent the use of methods which contains almost the same information about the output gap, namely methods that are highly correlated and contains redundant information. They suggested correcting the weights with the correlation matrix of the output gaps, namely, to reduce the weight for methods that are highly correlated. So, they modified relation (1) to:

$k(\sigma,\rho)_t^{(m)} = \left[\sum_{j=1}^{m} \rho\left(\bar{c}^{(m)}{}_{t,T}, \bar{c}^{(j)}{}_{t,T}\right) \right] k(\sigma)_t^{(m)}$, where $\rho\left(\bar{c}^{(m)}{}_{t,T}, \bar{c}^{(j)}{}_{t,T}\right)$ is the correlation coefficient between the output gaps of methods m and j estimated on the full sample.

We obtain a new weight to be used in a new consensus measure – "Consensus C". In order to avoid the negative weights for methods that are highly negatively correlated we exclude the methods which are assigned a negative weight.

Finally, we used also the *Principal Components Analysis (PCA)* in order to have a benchmark to compare with our "Consensus" measures of output gaps.

4. Data

Our data cover the period 1997Q1-2009Q2 for eleven countries that joined the EU in 2004 and 2007, and for Eurozone. We excluded Malta from the group of NMS and the rest of the countries from the European Union because of the lack of data for the entire sample.

We used the GDP series in constant prices (2000=100) available from EUROSTAT and we seasonally adjusted the data using the Tramo/Seats procedure. For Romania, we used data from National Institute of Statistics for 2007. Data for quarterly GDP is not available for Romania, as there are a lot of data reliability problems for the period before 1998 (Dobrescu, 2007).

5. Empirical results

We used in our estimations the econometric packages Matlab 7.1 for deriving the output gap for the wavelet transformation (WT) and Eviews 6.0 for the other 4 filters.

For the quadratic trend (QT) we estimated a regression where the cycle is the residual of the regression. For Hodrick Prescott filter we used the λ parameter equal to 1,600. We started our recursive estimation in 2002Q1, i.e filtered the series in the sample 1997q1-2002q1 and stored the resulting cycles. Next, we extended the sample by one quarter ahead and we reestimated and stored again the cycles and so on. In total we have 30 estimations for each filter. Figures 1 and 2 show the revisions made in the case of Romania and Eurozone.

Figure 1

Revisions of business cycles of Romania

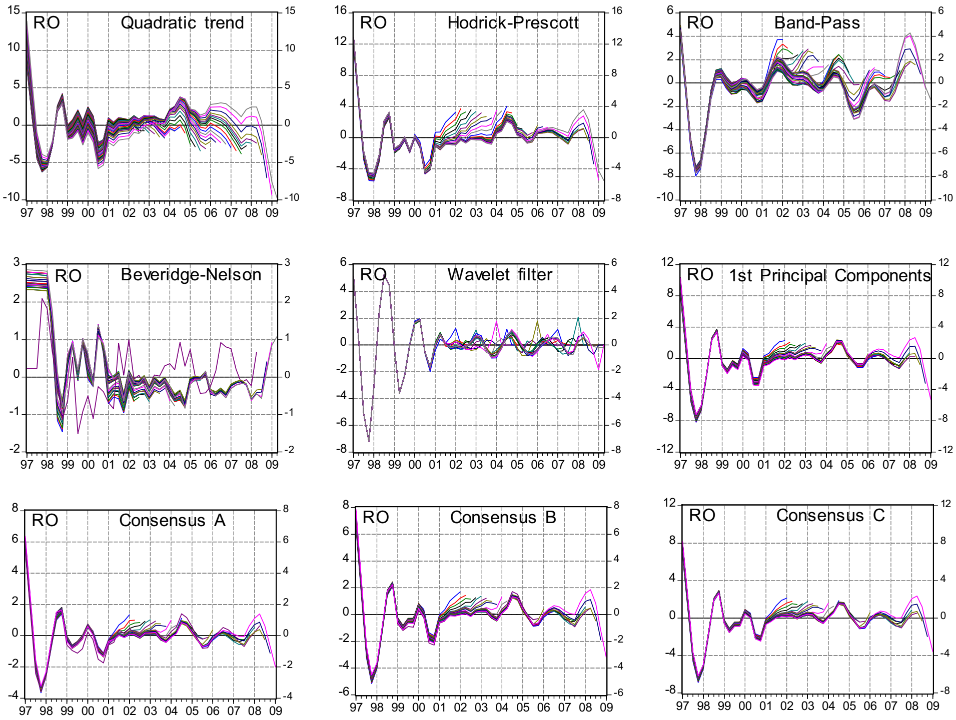

Figure 2

Revisions of business cycles of eurozone

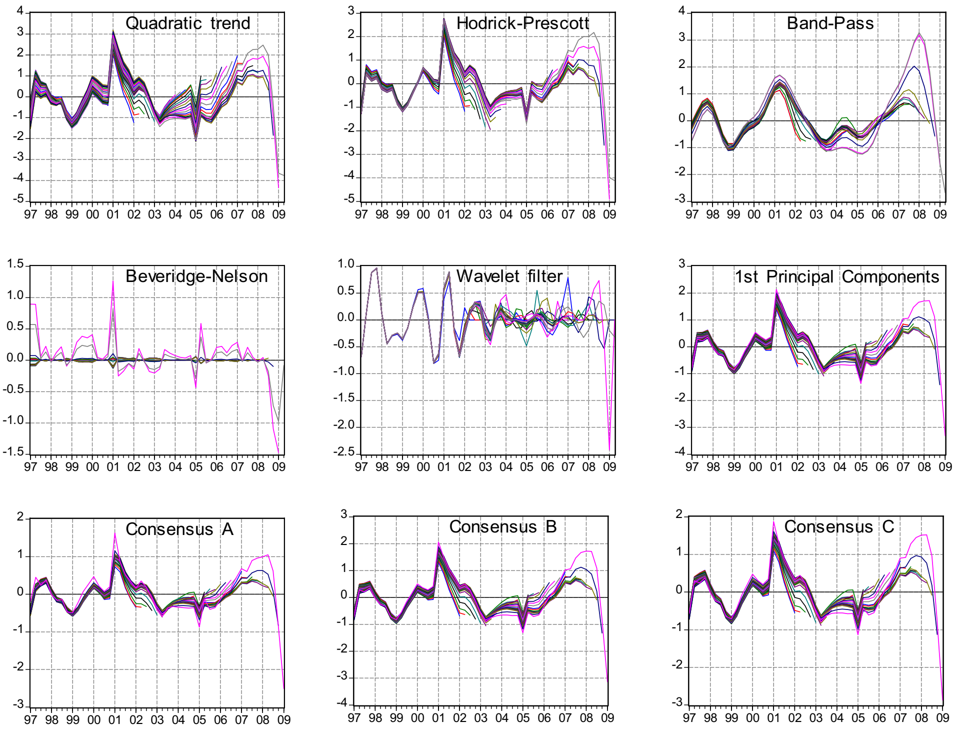

Table 1

Weights for the consensus measures

	Euro zone	BG	CZ	EE	LV	LT	HU	PL	RO	SI	SK	CY	NMS average
Weights based on principal components													
QT	0.27	0.33	0.26	0.28	0.30	0.25	0.25	0.28	0.29	0.28	0.26	0.29	0.28
HP	0.27	0.34	0.27	0.30	0.32	0.27	0.27	0.29	0.32	0.28	0.26	0.29	0.29
BP	0.25	0.34	0.21	0.26	0.29	0.20	0.21	0.27	0.27	0.25	0.22	0.27	0.25
BN	0.11	-0.19	0.17	0.04	-0.06	0.19	0.16	0.08	-0.16	0.14	0.15	0.07	0.06
WT	0.09	0.18	0.09	0.12	0.16	0.09	0.12	0.08	0.28	0.06	0.11	0.07	0.12
Weights based on revisions of percentage point output gaps - Consensus A													
QT	0.12	0.13	0.16	0.15	0.16	0.17	0.18	0.04	0.09	0.17	0.04	0.12	0.13
HP	0.15	0.17	0.22	0.20	0.20	0.22	0.20	0.05	0.18	0.20	0.05	0.18	0.17
BP	0.17	0.17	0.26	0.25	0.26	0.22	0.22	0.07	0.18	0.24	0.05	0.17	0.19
BN	0.40	0.33	0.00	0.05	0.02	0.13	0.07	0.77	0.33	0.22	0.80	0.35	0.29
WT	0.16	0.19	0.36	0.35	0.36	0.26	0.33	0.07	0.22	0.17	0.05	0.18	0.23

	Euro zone	BG	CZ	EE	LV	LT	HU	PL	RO	SI	SK	CY	NMS average
Weights based on revisions of standardized output gaps - Consensus B													
QT	0.23	0.18	0.30	0.29	0.31	0.26	0.26	0.17	0.16	0.27	0.28	0.19	0.24
HP	0.26	0.18	0.30	0.28	0.28	0.27	0.22	0.20	0.25	0.30	0.27	0.24	0.25
BP	0.29	0.16	0.32	0.29	0.31	0.22	0.22	0.21	0.21	0.32	0.26	0.24	0.26
BN	0.14	0.37	0.02	0.06	0.03	0.18	0.24	0.35	0.16	0.06	0.10	0.26	0.16
WT	0.08	0.11	0.05	0.07	0.07	0.08	0.05	0.07	0.22	0.05	0.08	0.07	0.08
Weights based on revisions of standardized output gaps adjusted by correlation - Consensus C													
QT	0.18	0.26	0.26	0.26	0.26	0.22	0.23	0.13	0.18	0.23	0.25	0.14	0.22
HP	0.21	0.25	0.26	0.23	0.22	0.21	0.18	0.14	0.23	0.25	0.23	0.17	0.22
BP	0.27	0.27	0.36	0.29	0.30	0.24	0.23	0.17	0.31	0.32	0.27	0.22	0.27
BN	0.21	0.00	0.03	0.13	0.13	0.20	0.29	0.46	0.00	0.09	0.13	0.38	0.17
WT	0.13	0.22	0.09	0.10	0.08	0.12	0.07	0.10	0.28	0.11	0.13	0.10	0.13

Notes: QT: quadratic trend, HP: Hodrick-Prescott filter, BP: band-pass filter, BN: Beveridge-Nelson, WT: wavelet filter. Consensus: combined output gap measure using equations (1), (2), (3), and (4).

In Table 1 we present the weights based on revisions of percentage point output gaps for the New Member States. The combined business cycles are presented in Figure 3.

Our results in terms of potential output and output gap for Romania are quite similar to Altăr *et al.* (2008).

Using the combined measures of the business cycles, we can compute now the business cycle synchronization first by looking at the correlation coefficients between New Member States and Eurozone. Table 2 shows the correlation coefficients for two sub-periods 1997q1-2002q4 and 2003q1-2009q2 to see the evolution of correlation in time.

For the entire sample, the correlation of the business cycle is by far the lowest in Romania, followed by Poland, Bulgaria, Slovakia and Lithuania. The correlation increased substantially in the recent period for all the NMS countries. For the period before 2003, the correlation was even negative in the case of Romania, Slovakia, Hungary and Lithuania. Even for the period 2003-2009, the correlation in the case of Romania was one of the lowest, after Hungary, being significanthly below the average correlation for the NMS.

Figure 3

Combined business cycle, 1997-2009

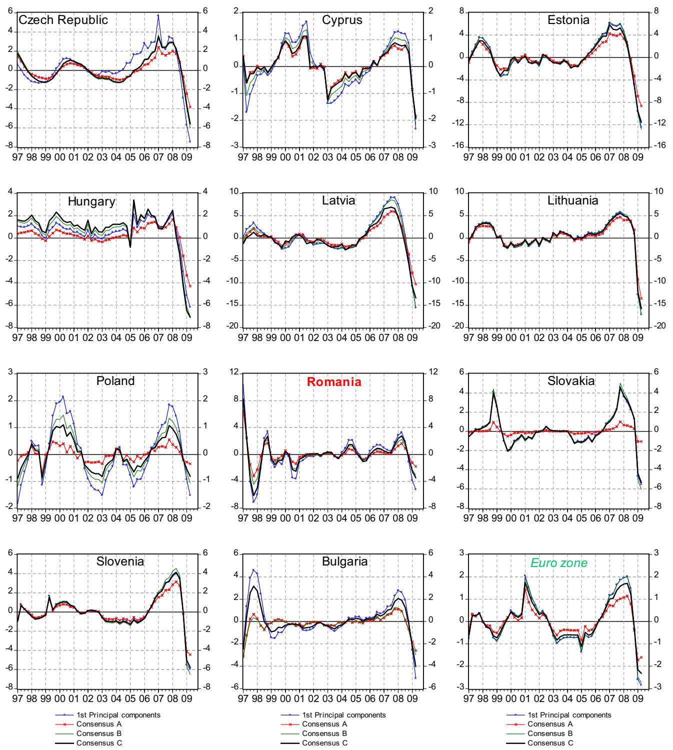

Table 2

Correlation of business cycles with Eurozone based on GDP

Correlation of business cycles between the Eurozone and NMS										
1997:1-2009:2	**BG**	**CZ**	**EE**	**LV**	**LT**	**HU**	**PL**	**RO**	**SI**	**SK**	**NMS avg**
Quadratic trend	0.51	0.66	0.50	0.57	0.46	0.48	0.58	0.17	0.85	0.57	0.58
Hodrick-Prescott	0.63	0.77	0.72	0.76	0.63	0.72	0.57	0.23	0.86	0.58	0.68
Band-Pass	0.62	0.93	0.86	0.92	0.73	0.86	0.65	0.34	0.91	0.62	0.77
Beveridge-Nelson	-0.06	0.30	0.48	0.26	0.57	0.63	0.33	0.23	0.76	0.29	0.43
Wavelet filter	0.66	-0.06	0.71	0.46	0.39	0.74	0.53	-0.40	0.58	-0.18	0.40
PCA	0.55	0.66	0.68	0.76	0.61	0.55	0.61	0.19	0.87	0.59	0.64
Consensus A	0.60	0.83	0.73	0.78	0.62	0.69	0.52	0.16	0.87	0.55	0.67
Consensus B	0.61	0.82	0.68	0.75	0.61	0.49	0.61	0.17	0.88	0.60	0.66
Consensus C	0.59	0.83	0.69	0.73	0.62	0.46	0.61	0.18	0.88	0.59	0.65
1997:1-2002:4	**BG**	**CZ**	**EE**	**LV**	**LT**	**HU**	**PL**	**RO**	**SI**	**SK**	**NMS avg**
Quadratic trend	-0.04	0.13	-0.15	-0.24	-0.45	-0.27	0.24	-0.30	0.10	-0.55	-0.05
Hodrick-Prescott	0.10	0.18	0.12	0.04	-0.37	0.14	0.20	-0.29	0.21	-0.51	0.07
Band-Pass	0.07	0.81	0.43	0.77	-0.24	0.44	0.39	0.04	0.51	-0.35	0.35

Correlation of business cycles between the Eurozone and NMS											
Beveridge-Nelson	-0.24	-0.21	0.13	-0.15	0.30	0.11	0.31	0.37	0.43	-0.25	0.17
Wavelet filter	0.68	-0.71	0.73	0.55	0.46	0.81	0.60	-0.45	0.58	-0.29	0.36
PCA	0.05	0.58	0.07	0.01	-0.33	-0.05	0.28	-0.27	0.24	-0.53	0.09
Consensus A	0.19	0.50	0.19	0.19	-0.29	0.16	0.14	-0.23	0.30	-0.52	0.15
Consensus B	0.21	0.49	0.07	0.03	-0.35	-0.08	0.26	-0.29	0.28	-0.54	0.10
Consensus C	0.11	0.54	0.15	0.09	-0.31	-0.03	0.26	-0.25	0.30	-0.54	0.12
2003:1-2009:2	**BG**	**CZ**	**EE**	**LV**	**LT**	**HU**	**PL**	**RO**	**SI**	**SK**	**NMS avg**
Quadratic trend	0.77	0.76	0.67	0.72	0.80	0.64	0.89	0.45	0.97	0.89	0.78
Hodrick-Prescott	0.92	0.90	0.84	0.86	0.94	0.80	0.83	0.82	0.98	0.90	0.89
Band-Pass	0.91	0.98	0.94	0.95	0.90	0.94	0.86	0.66	0.98	0.84	0.91
Beveridge-Nelson	0.66	0.84	0.69	0.52	0.80	0.84	0.53	-0.63	0.95	0.70	0.63
Wavelet filter	0.56	0.73	0.50	-0.12	0.64	0.75	-0.16	0.07	0.83	0.24	0.46
PCA	0.92	0.68	0.81	0.88	0.83	0.51	0.88	0.70	0.98	0.92	0.83
Consensus A	0.89	0.93	0.86	0.89	0.89	0.75	0.81	0.72	0.98	0.89	0.87
Consensus B	0.84	0.90	0.80	0.85	0.84	0.40	0.88	0.72	0.99	0.92	0.83
Consensus C	0.92	0.90	0.77	0.80	0.84	0.35	0.88	0.72	0.98	0.91	0.83

PCA – 1st Principal Components.

We investigated also what sector of the economy is the most correlated with Eurozone. We find out that the most correlated sector with Eurozone is industry. The correlation of the Romanian industry with Eurozone is quite high, being above the average correlation for NMS (Table 3).

Table 3

Correlation of business cycles with Eurozone based on industrial output

Correlation of business cycles between the Eurozone and NMS – industrial output											
1997:1-2009:2	**BG**	**CZ**	**EE**	**LV**	**LT**	**HU**	**PL**	**RO**	**SI**	**SK**	**NMS avg**
Quadratic trend	0.52	0.81	0.78	0.62	0.65	0.92	0.82	0.54	0.89	0.62	0.74
Hodrick-Prescott	0.50	0.74	0.84	0.68	0.68	0.92	0.77	0.47	0.92	0.56	0.73
Band-Pass	0.45	0.77	0.90	0.63	0.76	0.95	0.76	0.50	0.95	0.57	0.75
Beveridge-Nelson	-0.28	0.41	0.73	0.24	0.46	0.77	-0.12	-0.14	0.81	0.17	0.37
Wavelet filter	0.07	0.49	0.81	0.66	0.15	0.61	0.45	-0.17	0.80	-0.55	0.39
PCA	0.48	0.78	0.67	0.60	0.67	0.67	0.77	0.48	0.81	0.57	0.68
Consensus A	0.45	0.75	0.82	0.66	0.67	0.91	0.78	0.50	0.91	0.48	0.72
Consensus B	0.47	0.77	0.60	0.65	0.66	0.58	0.79	0.51	0.86	0.55	0.68
Consensus C	0.47	0.76	0.57	0.46	0.67	0.52	0.79	0.49	0.84	0.54	0.65
1997:1-2002:4	**BG**	**CZ**	**EE**	**LV**	**LT**	**HU**	**PL**	**RO**	**SI**	**SK**	**NMS avg**
Quadratic trend	0.19	0.43	0.40	0.20	0.09	0.78	0.83	-0.16	0.57	0.08	0.40
Hodrick-Prescott	0.14	0.36	0.35	0.03	-0.22	0.83	0.76	-0.30	0.59	-0.30	0.29
Band-Pass	-0.09	0.64	0.55	-0.12	-0.03	0.91	0.82	-0.41	0.83	-0.29	0.35
Beveridge-Nelson	-0.17	0.00	0.44	-0.06	-0.19	0.57	-0.21	0.13	0.61	-0.16	0.18
Wavelet filter	0.45	0.46	0.84	0.84	-0.83	0.89	0.73	-0.03	0.93	-0.25	0.46
PCA	0.08	0.49	0.45	-0.02	-0.21	0.44	0.84	-0.35	0.54	-0.23	0.28

Correlation of business cycles between the Eurozone and NMS – industrial output											
Consensus A	0.09	0.42	0.46	0.18	-0.17	0.84	0.84	-0.37	0.65	-0.26	0.33
Consensus B	0.07	0.44	0.39	0.03	-0.19	0.30	0.85	-0.37	0.55	-0.26	0.26
Consensus C	0.08	0.42	0.39	0.22	-0.18	0.22	0.85	-0.36	0.54	-0.27	0.27
2003:1-2009:2	**BG**	**CZ**	**EE**	**LV**	**LT**	**HU**	**PL**	**RO**	**SI**	**SK**	**NMS avg**
Quadratic trend	0.78	0.90	0.91	0.82	0.84	0.96	0.90	0.85	0.95	0.75	0.88
Hodrick-Prescott	0.77	0.87	0.94	0.89	0.88	0.95	0.87	0.84	0.95	0.74	0.88
Band-Pass	0.78	0.92	0.97	0.92	0.95	0.98	0.84	0.87	0.97	0.73	0.90
Beveridge-Nelson	-0.46	0.56	0.79	0.66	0.61	0.80	-0.21	-0.47	0.84	0.34	0.41
Wavelet filter	-0.68	0.53	0.83	0.63	0.65	0.27	-0.02	-0.41	0.69	-0.73	0.25
PCA	0.79	0.89	0.73	0.90	0.87	0.72	0.87	0.84	0.84	0.74	0.83
Consensus A	0.69	0.87	0.90	0.87	0.83	0.93	0.87	0.84	0.94	0.61	0.85
Consensus B	0.74	0.89	0.66	0.85	0.85	0.64	0.88	0.86	0.89	0.71	0.81
Consensus C	0.76	0.87	0.62	0.59	0.84	0.59	0.88	0.84	0.87	0.70	0.78

PCA – 1st Principal Components.

The second approach we used to assess the synchronization is a non-parametric statistic proposed by Harding and Pagan (2000, 2001, 2003, 2005, 2006) known as the Concordance Index. Let S_{xt} be a series which takes the value 1 when the economy is in expansion and the value 0 when the economy is in recession (S_{xt} take the value 1 when the cycle in country x is positive and take the value 0 when the cycle is negative). The index has the following formula:

$$C_{xy} = \frac{1}{T}\left\{\sum_{t=1}^{T} S_{xt}S_{yt} + \sum_{t=1}^{T}(1-S_{xt})(1-S_{yt})\right\}$$

The Concordance Index is equal to 1 if x and y are always in the same phase and to 0 if x and y are always in opposite phases. A value of 0.5 indicates the lack of any systematic relationship in the dynamics of the two variables. The data for Concordance Index are presented in Table 4. As we can see in the table, in the recent period the Concordance Index is 1 only in the case of Slovenia, meaning that only Slovenia was always in the same phase of the business cycle with Eurozone.

Table 4

Concordance Index

	Principal Components		Consensus A		Consensus B		Consensus C	
	I	II	I	II	I	II	I	II
Bulgaria	0.54	0.69	0.64	0.85	0.60	0.85	0.58	0.73
Czech Republic	0.72	0.69	0.84	0.92	0.80	0.85	0.84	0.88
Estonia	0.68	0.85	0.68	0.85	0.68	0.85	0.70	0.85
Hungary	0.60	0.54	0.66	0.65	0.56	0.50	0.56	0.50
Lithuania	0.40	0.50	0.40	0.58	0.40	0.54	0.42	0.54
Latvia	0.64	0.88	0.66	0.88	0.64	0.85	0.66	0.85
Poland	0.70	0.88	0.74	0.92	0.70	0.88	0.70	0.88
Romania	0.50	0.69	0.60	0.77	0.50	0.69	0.60	0.77
Slovenia	0.90	1.00	0.92	1.00	0.90	1.00	0.88	0.96
Slovakia	0.58	0.92	0.48	0.73	0.54	0.81	0.52	0.77

I – Period 1997-2009; II – Period 2003-2009.

How much the business cycle of a NMS should be correlated with Eurozone in order to have net benefits from euro adoption? Artis (2004) argues that the literature doesn't help us too much but probably the best criterion will be that the NMS country which wants to adopt euro should not have smaller synchronization with Eurozone than the existing members of Eurozone do. Fidrmuc and Korhonen (2006) said that if business cycle correlation in a new EU member state is higher than the correlation of a peripheral Eurozone economy (e.g. Ireland or Portugal) we have confidence that the NMS has progressed far enough in fulfilling this OCA criterion.

Acording with our results, among the EU members, the business cycles of Romania and Hungary have the lowest correlation with the business cycle of Eurozone. Slovenia, Slovakia, Poland and the Czech Republic have the highest correlation of busniness cycles with Eurozone among New Member Countries.

Conclusions

The current international financial and economic crisis led to re-thinking the euro adoption strategies for some New Member States (NMS) in order to speed-up the process. Romania maintains the previous plan to adopt euro in 2014, which could be a good decision in the light of the results in our paper, as Romania still needs more time to obtain more progress on the real convergence process and to become more correlated with the Eurozone business cycle.

The euro adoption decision is a matter of fulfillment of convergence criteria, namely nominal and real convergence indicators. Our results are relevant for the euro adoption decision in NMS, as the optimal currency area criteria are important for the assessment of the real convergence process. The synchronization of the business cycle is a critical criterion when assessing the costs and advantages of euro adoption.

This paper assesses the degree of readiness of New Member States (NMS) of European Union, including Romania, to adopt euro, mainly based on optimal currency area (OCA) criteria. Using a consensus measure of output gap computed by 5 filtering techniques plus a benchmark method based on Principal Component Analysis (PCA), we estimated the business cycle correlation between NMS and eurozone. Our findings suggest that the correlation of the business cycle in the case of Romania is one of the lowest among NMS, although it increased tremendously in the last years. The correlation increased substantially in the last years for all the NMS. As shown in the paper, even for the period 2003-2009, the correlation in the case of Romania was the lowest, after Hungary. Also, the correlation increased in time, the most in the case of Slovakia and Romania.

Our results suggest also that the financial and economic crisis which hit the world economy recently led to an increase in the business cycle correlation between NMS and Eurozone, as the countries are simultaneously faced with a sharp GDP contraction.

The main conclusion of our paper is the fact that Romania, as well as some other NMS still need time to progress on the real convergence criteria in order to adopt euro without major costs.

References

Alesina, A., R. J. Barro, and S. Tenreyro (2002), "Optimal Currency Areas", National Bureau of Economic Research Working Papers, 9072

Altar, M., Necula, C., Bobeica, G. (2008), “Modeling the economic growth in Romania. The influence of fiscal regimes”, *Romanian Journal of Economic Forecasting,* Volume 9(4): .

Artis, M., M. Marcellino and T. Proietti (2004), “Characterising the Business Cycle for the Accession Countries”, Innocenzo Gasparini Institute for Economic Research (IGIER), working paper no. 261

Beveridge, S. Nelson, C. R., (1981), “A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the Business Cycle”, *Journal of Monetary Economics,* 7: 151-174.

Canova, Fabio, (1998), “Detrending and Business Cycle Facts”. *Journal of Monetary Economics,* 41: 475-512.

Cohen, D. and C. Wyplosz (1989), "European Monetary Union: An Agnostic Evaluation", *CEPR Discussion Paper Series*, No. 306.

Darvas, Z. and G. Vadas. (2005), ”A New Method for Combining Detrending Techniques with Application to Business Cycle Syncronization of the New EU Members”, Magyar Nemzeti Bank.

Dobrescu, E. (2007), “Modelling the Romanian Economy: Some Data Problems”, *Romanian Journal of Economic Forecasting*, 8(1): 7-25.

Don Harding & Adrian Pagan, 2006. "Measurement of Business Cycles," Department of Economics - Working Papers Series 966, The University of Melbourne.

Dumitru, I., Jianu, I. (2009), “The Balassa–Samuelson effect in Romania – The role of regulated prices”, *European Journal of Operational Research,* Volume 194, Issue 3, 1 May 2009, Pages 873-887.

European Commission (1990), “One Market, One Money. An Evaluation of the Potential Benefits and Costs of Forming an Economic and Monetary Union”, *European Economy*, No. 44.

Fidrmuc, J. and I. Korhonen (2006), ”Meta-Analysis of the Business Cycle Correlation between the Euro Area and the CEECs”, *CESifo Working Paper* No. 1693.

Fleming, M. J. (1971), "On Exchange Rate Unification", *Economic Journal*, 81(323): 467-88.

Friedman, M. (1953), *The Case for Flexible Exchange Rates. Essays in Positive Economics*, Chicago: University of Chicago Press.

Harding, D., Pagan, A., (2000), "Disecting the Cycle: A Methodological Investigation," Econometric Society World Congress 2000 Contributed Papers 1164, Econometric Society.

Harding, D., Pagan, A., (2001). "Extracting, Using and Analysing Cyclical Information," *MPRA Paper* 15, University Library of Munich, Germany.

Harding, D., Pagan, A., (2005), "A suggested framework for classifying the modes of cycle research," *Journal of Applied Econometrics*, John Wiley & Sons, Ltd., vol. 20(2), pages 151-159.

Iancu, A., (2007), "Economic Convergence. Applications - Second Part", *Romanian Journal of Economic Forecasting*, Volume 8 Issue 4 /2007.

Ingram, J. C. (1962), *Regional Payment Mechanisms: The Case of Puerto Rico*, Chapel Hill: University of North Carolina Press.

Kenen, P. (1969) "The Theory of optimum Currency Areas: An Eclectic View", in Mundell, R. and A. K. Swoboda (eds.) *Monetary Problems of the International Economy*, University of Chicago Press, 41-60

McKinnon, R. (1963) "Optimum Currency Areas", *American Economic Review*, 52: 717-725

Mintz, N. N. (1970), "Monetary Union and Economic Integration", *The Bulletin of New York University Graduate School of Business Administration* (Institute of Finance), No. 64.

Mundell, R. A. (1961), "A Theory of Optimum Currency Areas," *American Economic Review* 51.

Mundell, R. A. (1973), "Uncommon Arguments for Common Currencies," in H.G. Johnson and A. K. Swoboda (eds), *The Economics of Common Currencies*, London: Allen & Unwin.

Tavlas, G., (1994), "The theory of monetary integration", *Open Economies Review*, 5(2): 211-230

Weber, A. (1990), "EMU and Asymmetries and Adjustment Problems in the EMS: Some Empirical Evidence", *CEPR Discussion Paper Series*, No. 448.