Economics Bulletin

Volume 33, Issue 3

# Testing cyclical convergence with the factor model in the Euro Area

Maria Jesús Delgado-Rodriguez
*Universidad Rey Juan Carlos*

Sonia De lucas-Santos
*Universidad Autónoma de Madrid*

## Abstract

In this paper we use the factor model and propose a parametric approach to investigate the process of cyclical convergence in the Euro Area (EA) over the period 1989-2011. Our results show that despite the fact that EA countries share a common business cycle, further convergence after the run-up period to the euro is found not to have been reached.

**Citation:** Maria Jesús Delgado-Rodriguez and Sonia De lucas-Santos, (2013) "Testing cyclical convergence with the factor model in the Euro Area", *Economics Bulletin*, Vol. 33 No. 3 pp. 2245-2250.
**Contact:** Maria Jesús Delgado-Rodriguez - mariajesus.delgado@urjc.es, Sonia De lucas-Santos - sonia.delucas@uam.es.
**Submitted:** August 16, 2013. **Published:** September 03, 2013.

## 1. Introduction

The existence of a common business cycle in the Euro Area is a widely discussed topic in the economic debate. The current financial crisis and the adoption of the Euro by some Eastern European countries maintain interest in this topic. To understand the EA business cycle it is important to have a clear perspective of the cyclical process of convergence for each of these countries with the EA´s common fluctuations. There are no doubts that business cycle convergence is a key indicator of the optimality of a common currency area. If business cycles in countries forming a monetary union diverge considerably, the common monetary policy will not be optimal for the countries concerned.

Despite its importance, the literature has not yet reached consensus on whether business cycles of countries in the Euro area are converging and on how cyclical convergence should be tested[1]. Most of the existing empirical literature examining cyclical convergence is based on the study of bilateral correlations between cycles, either from the time domain (see Gonçalves, *et al.*, 2009), the frequency domain (in this case, see Weyerstrass *et al.*, 2011, Papageorgiou, *et al.*, 2010) or alternative methodologies based on spectral and wavelet analysis to approach this research question (Aguiar-Conraria and Soares, 2011 and Crespo-Cuaresma and Fernández-Amador, 2013).

Unlike these works, we employ factor models with principal components, which allows us not only to identify countries sharing common cycles (as is shown in de Lucas *et al.*,2011), but also to test parametrically the degree of cyclical convergence of individual member countries with respect to that common factor. This is possible because the factor obtained summarizes all information of bilateral correlations or cyclical convergence. This paper contributes to the literature of European integration by exploiting the entire distribution of factor loadings across all current EA economies (starting and new EA countries) to analyze cyclical convergence over the period 1989-2011. Furthermore, this parametric approach offers the significant test of correlations alongside the sample, something that is not usually conducted. This extends previous works that only report average correlations, a partial result of the correlations established by *ad hoc* sub-samples, or analyze only a certain group of EA countries.

The rest of the paper is organized as follows: section 2 discusses the methodology employed, section 3 presents data and empirical application and section 4 briefly concludes.

## 2. Methodology

Our proposal is based in estimating a common cycle for the EA following the methodology employed in de Lucas *et al.* (2011) for the factor analysis of business cycles. This allows the identification of EA countries that share the common fluctuations using the factor loadings or correlations and the study of this relationship alongside the period, through the structural stability of parameters as in Cendejas *et al.* (2011).

Formally, in the model it is assumed that a set of variables $X_t$ can be represented by the common latent factors, such as:

$$X_t = \Lambda_t F_t + e_t; \qquad (1)$$

where the idiosyncratic disturbances, $e_t = (e_{1,t}, e_{2,t}, \mathrm{K}, e_{N,t})'$, contained in a $N \times 1$ vector, capturing dynamics specific to country *i*, such as country-specific shocks and measurement errors, and are serially correlated and slightly cross-sectionally correlated with other variables in the model.

[1] See Haan *et al*, 2008 for a useful suvey of the literature on euro area business cycle convergence.

To analyze the cycle itself it is important to assess the cyclical convergence, an additional question to the estimation of the cycle, which is the primary motivation of our work. To this objective, we propose a parametric approach based on a linear relation between each of the observed series (countries) and the factor. With this purpose we recursively estimate:

$$x_{j,t} = \beta_{1j}(\tau)\hat{f}_t + v_{j,t}(\tau) \qquad (2)$$

where $\tau = \tau_0, \tau_0 + 1, \mathrm{K}, \tau_1$, is a possible moving break date, where $\tau_0 = \pi T$ and $\tau_1 = T - \pi T$ (both the integer parts), and $\pi$, a symmetric trimming, is a minimum sample percentage excluded both at the beginning and at the end of the sample. $\hat{f}_t$ is the common factor estimated in (1). $\beta_j(\tau)$ are the recursive parameters in (2) and $\beta_j$ are the whole sample parameters .

Note that if the series are standardized, then the parameters in (2) are correlations. This procedure allows us to extract information about the recursive correlations in order to obtain results on the evolution of the cyclical convergence of each country with respect to the common factor. Therefore, we can offer graphic information on the evolution of recursive correlation of each country with respect to the common factor as a continuum of results and their t-statistics.

## 3. Data and empirical application.

In this section we apply the common factor approach we proposed in section 2 to the data set of the 17 EA member countries over the period 1989-2011. The time dimension of our data set includes the first stage of the Economic and Monetary Union (EMU) of the European Union, when the project of the EMU moved to its decisive phase to the introduction of the Euro in the last country until now (Estonia in 2011)[1]. The estimate is carried out in terms of the economic cycle (growth rate) of GDP per capita on annual basis at market prices based on 1990 purchasing power parities (PPP) US dollars. The data used in this study is taken from *The Conference Board and Groningen Growth and Development Center (GGDC), Total Economy Database, January 2012,* available at http://www.conference-board.org/economics.

The series have been log-transformed and differenced to obtain stationarity, and stardardized, so the factor loadings in Eq. (1) can be interpreted as correlations between the series and the common factor. Our results (table 1) confirm that all countries (excluding Malta) share the common EA fluctuations, with France as the reference economy[2]. Furthermore, the results of the test for structural breaks allow not rejecting the null hypothesis of parameter stability according to the simulated critical values for the period 1989-2011[3] (the simulated critical values of the $F_{SupWald}$ test are shown also in table I)[4].

We then proceed to investigate the existence of a process of ongoing cyclical convergence. We implement equation (2) to estimate the recursive correlations that measure the degree of convergence for each of these countries with the EA common factor and their t-statistics. The results obtained are presented in graphical form (Figures 1 and 2). From the analysis of the results several interesting findings emerge. In general, we see statistically significant increases in the degrees of convergence of most of the

[1] The introduction of the euro for 11 of the 17 EA countries was in 1999, for Greece in 2001 (these are considered the starting countries), Slovenia in 2007, Malta and Cyprus in 2008, the Slovak Republic in 2009 and Estonia in 2011 (the former 5 recently joined are named the new EA countries).

[2] Although it may seem surprising that France is the reference country in the EA business cycle, similar results have also been obtained in works such as Aguiar-Conraria and Soares (2011).

[3] The database employed contains information for most countries since 1950 but preliminary estimations for the entire period (albeit with a smaller number of countries) showed the existence of structural breaks that made the use of the full sample from 1989 more convenient.

countries with the EA common factor over the period studied. Nonetheless, some differences still remain in the business cycles of EA countries.

**Table I: Estimates of Factor model and the $F_{SupWald}$ statistic and simulated critical values in Euro Zone (1989-2011)**

| Countries^ | Factor loadings | communalities | Critical value at 10% | Critical value at 5% | Critical value at 1% | $F_{SupWald}$ |
|---|---|---|---|---|---|---|
| Austria | 0.9259 | 0.8573 | 12.20 | 18.80 | 48.80 | 1.40 |
| Belgium | 0.9033 | 0.8159 | 24.10 | 42.60 | 113.40 | 2.50 |
| Cyprus | 0.6443 | 0.4151 | 9.40 | 16.10 | 36.90 | 2.80 |
| Estonia' | 0.6935 | 0.481 | 9.00 | 14.20 | 39.30 | 4.70 |
| Finland | 0.8192 | 0.6711 | 8.20 | 13.20 | 27.50 | 3.90 |
| France | 0.9491 | 0.9009 | 8.90 | 12.30 | 25.60 | 1.50 |
| Germany | 0.7279 | 0.5298 | 10.10 | 14.20 | 41.60 | 1.10 |
| Greece | 0.5918 | 0.3502 | 9.40 | 14.10 | 30.80 | 1.40 |
| Ireland | 0.8011 | 0.6417 | 11.50 | 15.80 | 35.50 | 0.50 |
| Italy | 0.8998 | 0.8097 | 8.60 | 15.00 | 42.70 | 0.70 |
| Luxembourg | 0.749 | 0.561 | 29.80 | 43.90 | 87.30 | 21.30 |
| Netherlands | 0.9149 | 0.8371 | 9.00 | 14.00 | 32.10 | 1.50 |
| Portugal | 0.7212 | 0.5201 | 8.60 | 13.00 | 41.00 | 2.10 |
| Spain | 0.9042 | 0.8175 | 27.10 | 43.90 | 119.30 | 1.20 |
| Slovak Republic | 0.4028 | 0.1622 | 8.40 | 12.20 | 36.50 | 2.40 |
| Slovenia | 0.5533 | 0.3061 | 8.80 | 14.40 | 38.40 | 1.40 |

^ Malta has been excluded because it does not have a factor loading with a sufficient weight in the common factor. Explained variance by the model is 61%. If Eastern European countries are excluded the explained variance by the model is 68.51%
1000 simulations are performed. The contrast is applied to a common factor which would have a single constraint. The trimming at the beginning is 30% and at the end of the sample is 10%. * The date of break is significant at 90%, ** significant at 95% and *** significant at 99%.

Estimation results also show that most starting EA economies have converged during the 1990s in the run-up period to the euro and, since then, correlations have levelled out at a statistically relevant higher level. Instead, the NEA and some peripheral countries like Finland are more heterogeneous and unstable than the starting members with respect to cyclical correlations and exhibit significantly lower correlations. These differences in levels among groups of countries maybe an indication of a core/periphery divide in terms of cyclical convergence in EA, as is discussed in works like Aguiar-Conraria and Soares, 2011. Our results are also in line with recent literature (see Weyerstrass *el al*, 2011, Lee, 2012 and Crespo-Cuaresma and Fernández-Amador, 2013 are examples) that shows that the introduction of the euro does not seem to have generated a very strong impact on EA business cycle convergence.

**Figure 1: Recursive parameters associated with the common factor in Euro Area (1989-2011)**

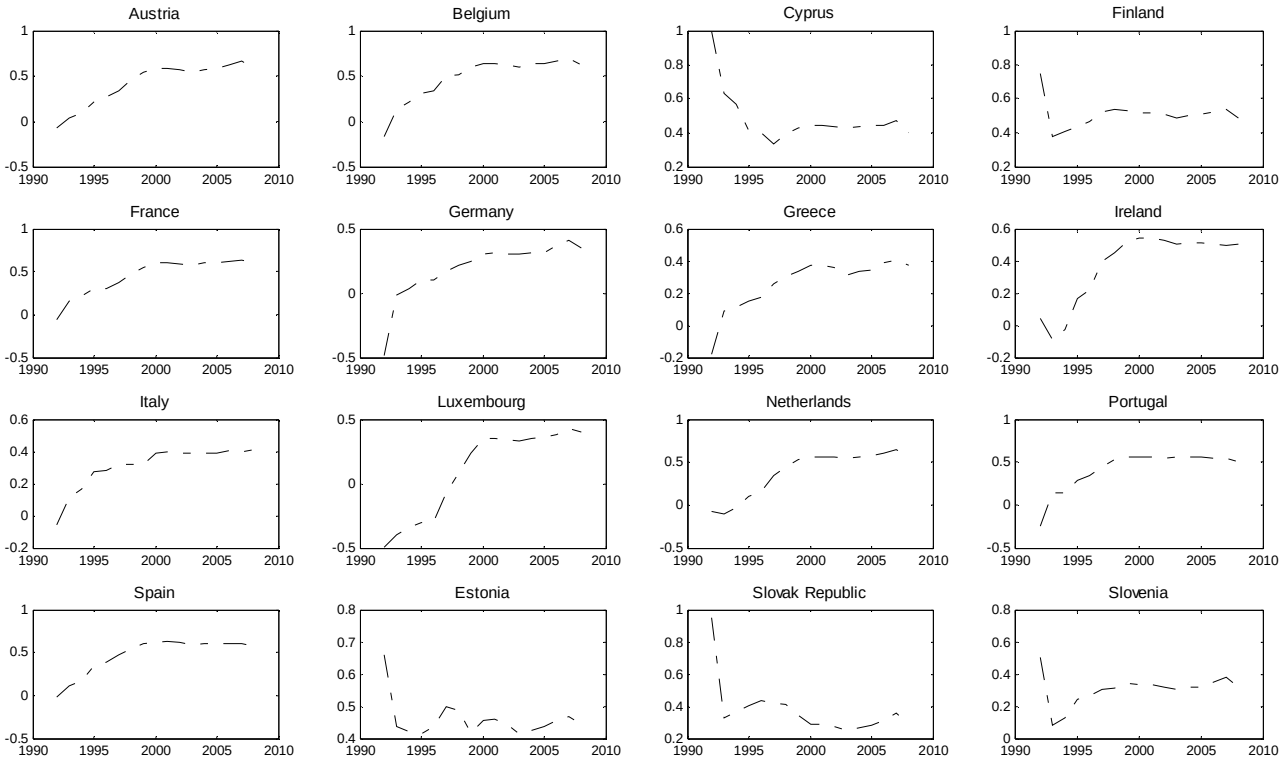
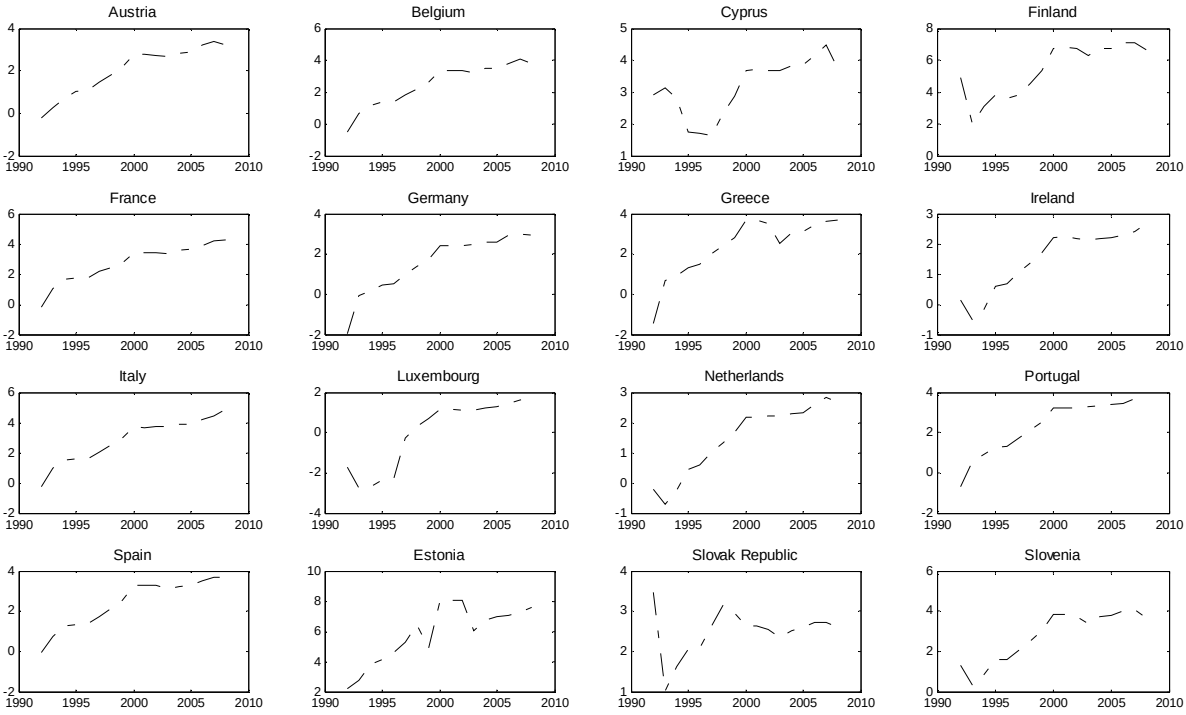



**Figure 2: t-statistics of recursive correlations associated with the common factor in Euro Zone (1989-2011)**



## 4. Concluding remarks

In this paper, we highlight the usefulness of the factor analysis of business cycles to offer a parametric approach that allows the measurement of the extent to which individual economies are converged with respect to the common cycle. Estimation results in the EA for the period 1989-2011, reaffirm previous findings obtained using alternative methodologies and show greater EA business cycle convergence during the 1990s in the run-up to the third stage of EMU. Despite which, the differences between the NEA and periphery countries and the starting (core) economies have not been reduced, which raises concern about the implementation of a common monetary policy in the EA.

## References

Aguiar-Conraria, L. and M.J. Soares (2011) "Business cycle synchronization and the Euro: A wavelet analysis", *Journal of Macroeconomics*, 33, 477-489.

Cendejas, J. L., de Lucas, S., Delgado, M. J. and I. Álvarez (2011) "Testing for structural breaks in factor loadings: An application to international business cycles", *Economic Modelling*, 28(1-2): 259-263.

Crespo-Cuaresma, J. and O. Fernández-Amador (2013) "Business cycle convergence in EMU: A second look at the second moment", *Journal of Macroeconomics*, article in press.

De Hann, J., Inklaar, R. and R. Jong-A-Pin (2008) "Will Business Cycles in the Euro Area Convergende? A Critical Survey of Empirical Research", *Journal of Economic Surveys*, 22(2), 234–273

De Lucas, S., Delgado, M. J. and I. Alvarez (2011) "Application of factor models for the identification of countries sharing international reference-cycles", *Economic Modelling*, 28, 2424-2431.

Gonçalves, C.E.S., Rodrigues, M. and T. Soares (2009) "Correlation of business cycles in the Euro zone", *Economics Letters*, 102, 56-58.

Lee, J., (2012) "Measuring business cycle comovements in Europe: evidence from a dynamic factor model with time-varying parameter", *Economics Letters*, 115, 438-440.

Papageorgiu, T., Michaelides, G. and J.G. Milios (2010) "Business cycles synchronization and clustering in Europe (1960-2009), *Journal of Economics and Business*, 62, 419-470.

Weyerstrass, K., van Aarle, B., Kapper, M. and A. Seymen (2011) "Business cycle synchronization with (in) the Euro Area: in search of a "euro effect", *Open Economies Review*, 22, 427-446.