Are European Business Cycles Close Enough to be just One?*

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Abstract

We propose a comprehensive methodology to characterize the business cycle comovements across European economies and some industrialized countries, without impossing any given model but trying to "leave the data speak". We develop a novel method to show that there is no evidence of a "European economy" that acts as an attractor to the other economies of the area. We show that the establishment of the Monetary Union has not significantly increased the level of comovements across Euro-area economies. Finally, we are able to explain an important proportion of the distances across their business cycles using macro-variables related to the structure of the economy, to the directions of trade, and to the size of the public sector.

Keywords: Business Cycle Synchronization, Economic Integration, European Union Enlargement, Cluster analysis, Multidimensional Scaling.

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1 Introduction

The academic literature and the press are full of references to the importance of globalization and links across the economies' business cycles. Several economists write about the "world business cycle" and, assuming from the beginning that this cycle exists, estimate it and calculate its importance in explaining country specific movements. Some examples are Gregory, Head and Raynauld (1997), Lumsdaine and Prasad (2003), and Canova, Ciccarelli and Ortega (2004). At the same time, many other economists talk about the "European business cycle", also assuming that there are either European-specific business cycle driving factors, or a leading economy or an artificial weighted average economy that are taken as reference of the European cycle. Supporting this view, significant examples are Artis, Kontolemis, and Osborn (1997), Forni, Hallin, Lippi and Reichlin (2000), del Negro and Ottrok (2003), Mansour (2003), and Artis, Krozlig and Toro (2004).

The recent accession of Central and Eastern European countries to the European Union (EU) has revived the interest in the study of business cycle synchronization across EU countries. The standard paradigm used in the literature to describe the European business cycles is the so called core and periphery scheme. Some countries, which exhibit higher synchronization are typically situated in the business cycle core, whose cycle recognized as the representation of the European business cycle. The peripheric countries are situated around this core and represent economies with more particular business cycles. Darvas and Szapary (2004) is a significant example of this core-periphery story. In this context, the relative situation of each country in relation to the central core of countries is key to evaluate the potential gains and losses of supranational interventions in controlling business cycles. The theoretical argument supporting this reasoning is that decisions made at supranational levels might be based on the evolution of a hypothetical European business cycle. Consequently, these decisions could be optimal only for the subset of countries with strong linkages with the European cycle, in terms of business cycle correlations and concordances. However, they could also be just suboptimal for those countries with relatively less synchronized cycles.

The purpose of our paper is to go behind the assumptions of this literature. As in the independent recent work of Artis (2004), we want to answer the leading question about the existence of an European attractor: Do the European economies move according to a common driving force? In this attempt, we always try to "leave the data speak" without imposing any kind of *a priori* restrictions of assuming that they should or should not move together. To that extend, we present different contributions to the literature. First, we propose a pairwise comparison across economies without taking any of them or any combination of them as reference for the European business cycle. Due to the interest stimulated by the recent European Union enlargement, we include in the analysis the newly acceded countries. Second, in order to check for the robustness of our results and not to condition our findings to any given framework, we calculate different measures of comovements across economies. Third, in contrast to other studies in the literature that develop just descriptive analyses, we propose a novel methodology to test if European business cycles are close enough to validate the assumption that there exists one European reference cycle. Finally, we analyze the role of macroeconomic and policy variables in explaining business cycle distances across economies.

With respect to the results, in line with Artis, Marcellino and Proietti (2004), we obtain that the degree of business cycle synchronization within the group of old EU members is higher than across the recently acceded countries. However, we find that the synchronization across old members has not significantly increased since the establishment of the common currency. By contrast, it seems that the existing synchronization among old members is prior to the implementation of the euro. In this respect, the degree of synchronization obtained through the euro is not higher than in some periods of the recent history. More importantly, although some countries present closer business cycles than others, we cannot find evidence supporting the view of some distinct Euro-economy attractor. This result reinforces the idea that those papers that take as given that the European cycle exists and that it coincides either with the cycle of a leading European economy, or the cycle of a weighted average of several European economies, or the cycle of a common factor, should be interpreted with caution. Consequently, we do not find empirical evidence supporting the core and periphery distinction. Finally we find that, apart from trade, there is a significant role for other structural variables and some economic policy variables to explain these business cycle comovements.

The paper is structured as follows. Section 2 describes the data used in this study. Section 3 discusses several measures of business cycle synchronization. Section 4 analyzes the existence of a common attractor among European economies. Section 5 relates the business cycle distances across economies with macroeconomic variables. Section 6 concludes.

2 Data

In our business cycle analysis, we have used the logarithm of the (seasonally adjusted) Industrial Production (IP) index extracted from the OECD Main Economic Indicators and the IMF international Financial Statistics Databases. We understand that using industrial production indexes as a measure of aggregate activity could be controversial since this is a measure of only one sector and only the supply side of the economy. However, we choose these series against other alternatives for several reasons. First, we tried to create a diffusion index for each economy, following the diffusion index approach of Stock and Watson (2002). However, the results were disappointing when we analyzed the calculated series, probably due to the small number of series available for the newly acceded economies. Second, we constructed a composite index for each country by using a Kalman filter specification of the type proposed by Stock and Watson (1991), with the series of industrial production, total sales, employment and measures of income for the different economies. However, this specification leads in many cases to weights close to one for the IP series and almost zero to the other series. Finally, we evaluate the usefulness of more comprehensive measures of activity using aggregates such as Gross Domestic Product (GDP) series. However, in line with the discussion of Artis, Marcellino and Proietti (2004), we consider that GDP series present several disadvantages. The frequency of these series are quarterly, the available samples are shorter and, for most of the European countries, GDP series are not calculated from national accounts on a quarterly basis but constructed from annual series that are converted to quarterly using indicators.

The sample of countries includes the old EU members, and all the countries recently acceded but Malta. In order to gain insights in comparison, we include two negotiating countries, Romania and Turkey, and four industrialized economies, Canada, US, Norway and Japan. Broadly speaking, in the analysis of European and industrialized countries we use data from 1962.01 to 2003.01. However, due to data constraints, the exercises including the newly acceded and negotiating countries only use data from 1990.01.[1] See Appendix A for a detailed description of data sources, missing data, and the nomenclature used for the different countries.

3 Evaluating distances

In the literature of business cycle synchronization it is well known that correlations between log levels of industrial productions are dominated by long-term components and that correlations between the first differences of the logs are dominated by short-term noises.[2] Thus, we need some kind of filtering (more sophisticated that just taking the differences) in order to extract from these series the information about business cycle movements. Obviously, the chosen filter will affect the shape of the cycle, and, of course, the comovements across the series. In order to give robustness to our results, we consider three different measures of comovements that have been proposed in the recent literature. The first one is based on VAR estimations, following den Haan (2000). The second one is based on spectral analysis, following Croux, Forni, and Reichlin (2001). The third one is based on business cycle dummy variables, following Harding and Pagan (2002). To facilitate comparisons and the interpretation of some results, we consider in this paper distances (one minus correlations) instead of correlations.

As mentioned in the introduction, the recent enlargement of the EU has increased the interest in the study of business cycle synchronization given that the newcomers are potential candidates to be members of the Euro area. Therefore, before going to the careful analysis of pairwise correlations across countries, it is relevant to study the comovements

[1] Following Blanchard (2003), we elude atypical downturns by not using the first two years of observations of Latvia, Czech Republic, Hungary, Poland and Slovenia.

[2] For example, for Italy and Spain the correlation between the log levels is 0.94 and the correlation between their growth rates is 0.09.

between two groups of countries, the Euro area members in comparison with the correlation of the newly acceded economies. Given that we do not take any series as the business cycle reference for any of these groups, we have to aggregate their pairwise correlation coefficients. We follow David (1949) to compute the combined correlation of several correlation coefficients. For simplicity in the exposition, let us assume that we try to combine two correlation coefficients, r_1 and r_2, that are computed over two samples of sizes T_1 and T_2, respectively. Let r be the coefficient that summarizes the information about these two correlation coefficients. We first need the Fisher's transformations of these correlations, called ζ_1 and ζ_2, respectively. This transformation is defined by

$$\zeta_i = \tanh^{-1}(r_i) = \frac{1}{2}\left(\ln(1+r_i) - \ln(1-r_i)\right), \tag{1}$$

where $\tanh^{-1}(\bullet)$ is known as the inverse hyperbolic tangent function, and $i = 1, 2$. Using these transformations, the coefficient that summarizes the correlations may be calculated as

$$\zeta = \tanh^{-1}(r) = \frac{1}{T_1 + T_2}(T_1 \tanh^{-1}(r_1) + T_2 \tanh^{-1}(r_2). \tag{2}$$

This expression is approximately normally distributed with variance $1/(T_1 + T_2)$. Once ζ is computed, we can undo the transformation to get the correlation coefficient as $r = \tanh(\zeta')$.

3.1 VAR-based approach

Den Haan (2000) argues that unconditional correlation coefficients lose important information about the dynamic aspects of the comovements across variables and that they may produce spurious estimates in the case of non-stationary variables. In order to overcome these problems, he proposes to use the correlations of the VAR forecast errors at different horizons as the measure of comovements of the series. He starts with the following identification scheme:

$$Z_t = \mu + \sum_{j=1}^{N} A_j Z_{t-j} + \varepsilon_t, \tag{3}$$

where Z_t represents in our case, the logs differences of the industrial production indexes for each pair of countries at time t, A_j is a (2×2) matrix of regression coefficients, μ is a vector of constants, N is the number of necessary lags, and ε_t are serially uncorrelated errors with zero mean and covariance matrix Ω. Out of this specification, the k-period ahead forecast error is

$$\widetilde{Z}_{t+k/t} = Z_{t+k} - Z_{t+k/t} = \sum_{j=0}^{k-1} \Theta_j \varepsilon_{t+k-j}, \tag{4}$$

where $Z_{t+k/t}$ is the k-period ahead forecast, and Θ_j may be obtained recursively from $\Theta_j = \sum_{i=1}^{N} A_i \Theta'_{j-i}$, with $\Theta_0 = I$, and $\Theta_\tau = 0$ for any $\tau < 0$. Therefore, the covariance matrix of the k-period ahead forecast error becomes

$$E\left(\widetilde{Z}_{t+k/t}\widetilde{Z}'_{t+k/t}\right) = \sum_{j=0}^{k-1} \Theta_j \Omega \Theta'_j. \tag{5}$$

The correlation of the k-period ahead forecast error between the two variables that form Z_t can be computed from (5) as the off diagonal element (forecast error covariance) divided by the product of the square roots of the main diagonal elements (forecast error standard deviations). Finally, den Haan (2000) shows that standard deviations of correlations to be used for significance tests may be calculated by bootstrapping the VAR forecast errors.

The empirical results obtained from this measure appear in the first panel of Table 1. This table shows aggregated distances that are computed from correlations of 48 months ahead forecasting errors following equation(2).[3] Using the sample 1990.01 − 2003.01, the table reveals that the Euro economies are more interlinked within them than the recently acceded economies within them (distances of 0.61 versus 0.82). In fact, if we test the null hypothesis of no correlation with respect to the alternative of positive correlation, we reject the null in more than 50% of the occasions in the case of Euro countries with themselves, but only in 27% in the case of the new members with themselves. However, according to this measure, the business cycle synchronization among the Euro economies is previous to the creation of the Eurozone since the distance computed with data from the sixties to the eighties is 0.56, and the null of no correlation is rejected in 73% of cases.

[3] We obtained qualitatively the same results by using 36 and 60 months ahead forecast errors.

3.2 Spectral-based approach

Using spectral analysis we can extract the comovements of the log of industrial production series at periodicities that correspond to business cycle frequencies. For this attempt, the spectral density assigns the variance of the log of industrial production of some country, x, to different intervals of frequencies, ω. This function has the form:

$$S_x(\omega) = \frac{1}{2\pi} \sum_{h=-\infty}^{\infty} e^{-ih\omega} \gamma_x(h) = \frac{\gamma_x\left(e^{i\omega}\right)}{2\pi}, \tag{6}$$

where $\gamma_x(h)$ is the autocovariance function, ω holds $-\pi \leq \omega \leq \pi$, and $\gamma_x\left(e^{i\omega}\right)$ is the autocovariance generating function. In the bivariate case, the cross-spectral density function assigns the covariance between two logs of industrial productions, x and y, to different frequencies,

$$S_{x,y}(\omega) = \frac{1}{2\pi} \sum_{h=-\infty}^{\infty} e^{-ih\omega} \gamma_{x,y}(h) = \frac{\gamma_{x,y}\left(e^{i\omega}\right)}{2\pi}, \tag{7}$$

where $\gamma_{x,y}(h)$ is the cross-covariance function, ω again holds $-\pi \leq \omega \leq \pi$, and $\gamma_{x,y}\left(e^{i\omega}\right)$ is the cross-covariance generating function.

Using these decompositions, calculated at intervals of frequencies that correspond to the business cycle, we are able to compute the business cycle correlation in frequency domain. In particular, we choose the measure of correlation defined by Croux et al (2001) that is called *dynamic correlation*:

$$\rho_{x,y}(\omega) = \frac{\text{Real}\left(S_{x,y}(\omega)\right)}{\sqrt{S_x(\omega)\, S_y(\omega)}}. \tag{8}$$

The main advantages of this measure of correlation are that it is a real number, that it takes values between -1 and 1, that it incorporates the sign of the relation, and that it allows us to compute the correlation for each band of frequencies.

We need some remarks concerning the estimation of the spectrum. First, before estimating the spectrum, we use the well-known filter proposed by Hodrick and Prescott (1997) to reduce the power of the lower frequencies of the series.[4] Second, to overcome the asymptotic inconsistency of the estimates, we use the standard Barlett's lag spectral window that weights the sample covariance in the spectral estimator and reduces the

[4] For our monthly series, we follow the standard literature to propose a so-called lambda parameter of $14,400$.

variance. Third, as it is not possible to calculate the sum of infinite terms, we follow Andrews (1991) to truncate the sum with a truncation parameter equals to the sample size to the power of one third. Finally, hypotheses about the value of $\rho_{x,y}$, the correlation coefficient between variables x and y of the underlying population, can be tested by using the Fisher's transformation of the correlation coefficients defined in (1). This expression is approximately normally distributed with variance $1/T$, where T is the sample size.

The second panel of Table 1 shows the results of the business cycle distances that are based on dynamic correlations on the components with periodicities ranging from 18 to 48 months (frequencies from 0.13 to 0.35 radians).[5] This panel confirms the results of the previous section. The Euro area countries are closer than the newly acceded countries (distances of 0.55 versus 0.66). Besides we reject the null of no correlation in more than 65% of the occasions in the case of Euro countries with themselves, but only in about 45% of occasions in the case of newly acceded countries with themselves. In the case of the Euro economies, this link is also previous to the creation of the common currency. In particular, the business cycle distance computed from the sixties to the eighties is 0.44, with 83% of rejections of the null of no correlation.

3.3 Dummy approach

The third approach to assess the degree of synchronicity among the countries' business cycles is proposed by Harding and Pagan (2002). They consider the pairwise correlation coefficient between the countries' reference cycles, that are binary variables having value one when the country is in recession and zero otherwise. Unfortunately, with the exception of the US economy, for which the NBER dates its official peaks and troughs, no generally accepted reference cycles appear to be available for the other countries. In this paper, we follow the well-known procedure of Bry and Boschan (1971) to identify the countries' business cycle turning points.[6] These authors develop an algorithm that isolates the local minima and maxima in a series, subject to reasonable constraints on both the length and

[5] We obtained qualitatively the same results by using periodicities from 18 to 36 and from 18 to 60 months.

[6] Several authors propose slightly different versions of the Bry-Boschan dating rule. In this respect, Garnier (2003) finds that they lead to similar turning points for most of the industrialized countries.

amplitude of expansions and contractions.

According to Harding and Pagan (2002), a simple way to obtain the sample correlation between the reference cycles of country i and country j can be computed from the regression

$$\sigma_i^{-1} D_{it} = a_{ij} + \rho_{ij} \sigma_j^{-1} D_{jt} + u_t, \tag{9}$$

where D_i is the reference cycle of country i, σ_i is its standard deviation. In this case, the estimate of ρ_{ij} is the sample correlation between the reference cycle of countries i and j.

One can employ simple tests of the null of no business cycle synchronization by using the t-ratios of the null that the correlation coefficient is zero, allowing for heteroskedasticity and serial correlation. However, these tests may be biased to reject the null of no correlation simply because there are more zeroes than ones in the countries' reference cycles since expansions are typically longer than recessions. In this respect, we propose to develop the test of no business cycle synchronization between countries i and j based on the bootstrap approximation of the t-ratio's true distribution. First, we compute the countries' reference cycles D_{it} using the Bry-Boschan dating procedure. Second, for each country we estimate the probability of being in recession, the probability of being in expansion, and the probability of switching the business cycles phase. Third, given these estimates, we generate $10,000$ reference cycle variables sharing the same business cycles characteristics than these two countries. Finally, we compute the p-value associated to the null of zero correlation coefficient.

The third panel of Table 1 shows the empirical results. Again, the business cycle distance within Euro economies has not decreased with the implementation of the common currency. Instead, the distance increased from 0.65 with the sample from the sixties to the eighties to 0.70 with the sample from the nineties. In addition, the percentage of rejections of the null of no correlation is 52% with the first sample, becoming 46% with the second sample. At the same time, as in the other previous measures, distances within Euro economies are smaller than distances within new members (0.70 versus 0.73) although in this case, it is remarkable the big distances from the newly acceded to the Euro economies (0.93). In this case, the percentage of rejections is 46% for Euro countries and 27% for new members.

3.4 Comprehensive approach

The result from the previous sections is a collection of distances among countries, applying three different methodologies, which measure the degree of business cycle synchronization among several countries. Despite the heterogeneity of these approaches, they come to the same two conclusions: synchronization between Eurozone countries with themselves is higher than synchronization between the new members with themselves, and there are no appreciable gains in synchronization among the Eurozone countries in the last decade. Thus, although we develop all the analysis for each of the individual measures, we now consider a combined distance in order to facilitate the exposition of our results. Given that we do not have any *a priori* about which is the most accurate individual measure, we again follow the Fisher's transformation to combine them into a comprehensive measure of distance as described in (1).

As stated in the last panel of Table 1, the conclusion is that Eurozone economies seem to be more homogeneous and closer together than the new members (distances of 0.62 versus 0.73). In fact, simple tests of equal means and variances of the distribution of distances within Euro economies and new members are rejected, with p-values of 0.00 and 0.02, respectively. Again, the distance is higher during the nineties (distances of 0.55 versus 0.62).

Finally, to check the robustness of our results, we divided the first part of the sample into two shorter subsamples of similar lengths: $1962.01 - 1975.12$ and $1976.01 - 1989.12$. Last two columns of Table 1 reveal that the comovements across European economies decreased in the eighties and increased in the nineties but not reaching the strong correlation of the sixties and early seventies. Actually, the distances across Euro economies are basically the same for the highly idiosyncratic period of the eighties (0.68) and the period of convergence and establishment of the Euro in the nineties (0.62) and one cannot reject the null of equal distances. In this respect, we can conclude that the monetary integration may have helped to create some links across its members. However, this effect is too weak to produce statistically significant increases in the level of business cycle synchronization.

4 Is there a European attractor?

In this section we try to answer the question that forms the title of the paper. We ask whether there is a cycle that we could identify as the "European cycle", and if so which European countries belong to it. As suggested, among others, by Timm (2002), clustering techniques and classical multidimensional scaling may help us to identify these possible cyclical affiliations.

The goal of cluster analysis is to develop a classification scheme of our set of countries in several distinct group of countries. First, the analysis begins with 30 clusters, each containing only a single country. Second, starting from the $(n \times n)$ matrix of business cycle distances, $D = [d_{ij}]$, the algorithm searches for the "most similar" pairs of countries, so that country r and s are selected. In this respect, we follow the most similar criterion that is based upon the minimum increase in the within-group variance of distances. Third, countries r and s are combined into a new cluster, called p, which reduces the total number of clusters by one. Then, dissimilarities between the new cluster and the remaining clusters are computed again following the most similar criterion. For instance, the distance from the new cluster p to, say, country q, is computed according to

$$d_{p,q} = \frac{n_r + n_q}{n_p + n_q} d_{r,q} + \frac{n_s + n_q}{n_p + n_q} d_{s,q} - \frac{n_q}{n_p + n_q} d_{r,s}, \tag{10}$$

where n_r, n_s, n_p and n_q are the number of countries included in the respective clusters, and $d_{r,s}$, $d_{r,q}$, and $d_{s,q}$ are the business cycle distances. Finally, steps two and three are repeated until all countries form a single cluster.

This process leads to the dendogram that is depicted in Figure 1. The tree starts with the leaves at the bottom, which are the original countries. Then, clusters are successively combined, forming the tree's branches until the top of the graph. The height of the tree represents the level of dissimilarity at which observations or clusters are merged. Hence, big jumps to join two groups occur when there are high intergroup dissimilarities so a reasonable number of groups is often situated at those junctures. Looking at the figure, we can observe a group formed by most of the EU countries, another group formed by around the US economy, a third group with most of the accession countries, and a fourth group with three "atypicals", Cyprus, Greece and Portugal. Even though we consider different sets of countries and different measures economic activity, these clusters broadly agree with those obtained by Artis (2004).

On the other hand, we use multidimensional scaling to project the business cycle distances among the n countries in a map in such a way that the Euclidean distances among the countries plotted in the plane approximate the business cycle dissimilarities. In the resulting map, countries which present high business cycle dissimilarities have representations in the plane that are far away from each other. Hence, the goal of this technique is, given the $(n \times n)$ matrix of business cycle distances, D, to compute the so-called $(n \times 2)$ configuration matrix X, that contains the position in two orthogonal axes to which each country is placed in the map. Following Timm (2002), define

$$B = \frac{1}{2}\left(I - n^{-1}O\right) D^2 \left(I - n^{-1}O\right), \tag{11}$$

where I is the identity matrix and O is a $(n \times n)$ of ones. Now, compute the (2×2) diagonal matrix Λ with the two largest eigenvalues of B on the main diagonal, and P, the $(n \times 2)$ matrix of its corresponding eigenvectors. The classical metric scaling coordinates correspond to

$$X = P\Lambda^{1/2}. \tag{12}$$

Figure 2 represents the map of the average distances using multidimensional scaling. This representation gives us a glimpse of the proximity among the business cycles of our countries. According to our previous results, the Euro economies are closer to each other than to any other group of countries. The new EU members countries are far away from each other and with respect to the Euro economies. Among the European countries, Greece and Portugal exhibit the less "European" cycles. In addition, Finland and UK cycles are closer to the cycles of Canada and US than to the cycles of the Euro area countries.

These results may be erroneously interpreted as in favor of those papers that consider the existence of a core among the European business cycles. These papers, when dealing with the problem of the European business cycle comovements, consider a business cycle attractor that is usually either a leading economy or a weighted average of all the economies of the area that represent this core. In this section, we want to check if this attractor matches with what we find in the map previously showed in the paper. In practical terms and looking at Figure 2, the question to ask is: Are those points (countries) in the map randomly distributed or is there any kind of attractor that keep them together? In order to check if a common attractor could explain the comovements across economies, we propose a new methodology that, to our knowledge, has not been used in the previous literature. It is based on the view that, if an attractor exists, most of the distances between the leading country and the rest of countries would be small, and we would observe a great amount of small distances and very few large ones.

We develop the analysis by using the following exercise. First, we normalize the distances to include them in a square of dimensions one by one. Second, we generate 27 observations (30 countries minus Japan, US and Canada) from a bivariate uniform distribution and we calculate the distances between each pair of points.[7] We repeat this exercise $10,000$ times and we generate the density function of those distances between each pair of countries (top left panel of Figure 3). The plotted distribution represents the distances across economies when there is no attractor across them since they have been generated from a uniform distribution. Third, we generate 27 observations with the same support space but coming from a bivariate normal distribution, where an attractor is clear. We repeat the exercise $10,000$ times and show the distribution of the distances (top right panel of Figure 3). As we can see, in the case of one attractor, there is a concentration of small distances across the points, implying a higher value for the skewness than in the case of the uniform distribution.

Additionally, we consider the possibility of the existence of two attractors. In order to simulate economies with two attractors we consider a mixture of bivariate normals, with mixing probability of 0.5. If this is the data generating process of the data and the distances between the two attractors are big enough, we will expect a bimodal distribution as the one plotted in bottom left panel of Figure 3. We have generated the plot by extracting $10,000$ times observations from the mixture of normals. The bimodality comes from the fact that there is a set of short distances associated with observations that are generated by the same normal and a set of long distances associated with observations that has been

[7] For this first exercise, we consider all the European economies in order to maximize the number of observations used for the kernel density estimation.

extracted from different normals.

In the bottom right panel of Figure 3 we represent the estimated distribution of the distances of the actual data plotted in Figure 2. There are few basic statistics that could help us to distinguish which is the distribution that describe the data generating process of the observations the best. High values of the skewness will imply evidence of the existence of one attractor whereas bimodality will be evidence of two attractors. Table 2 presents skewness, kurtosis, and bimodality index of the different distributions of the simulated and observed data. Let us concentrate first on the results obtained with the combined measure of business cycle distances. We can observe that the estimated skewness of the observed data is -0.08, which is statistically different from the estimated value for one attractor, 0.65 (the p-value of equal skewness coefficients is 0.00) but not different from the estimated value for the uniform distribution, 0.20 (p-value of 0.15). On the other hand, the bimodality index of the actual data is 0.41, that is below the critical value of 0.55, which may be interpreted as evidence on contrast to the existence of two attractors.

Finally, we evaluate the robustness of this result in two different ways. First, we search for one or two attractors in reasonable subsets of European countries, the old fifteen EU members and the Euro economies. Their estimated skewness coefficients are -0.05 and -0.15, that are clearly lower than the skewness of one attractor. Moreover, the p-values associated to the nulls of equal coefficients are 0.00 in both cases. In addition, these skewness coefficients are not statistically different from the skewness of the case of no attractor (p-values of 0.18 and 0.14, respectively). The bimodality index of the data are 0.41 and 0.43, clearly below the critical value of 0.55. Hence, we find evidence in contrast to the assumption of either one or two attractors among the economies included in these two subsets of European countries. Second, even though we concentrate our explanation on the combined measure of distance, the results are extremely robust to any of the three other measures. As shown in Table 2, observed data seems to be generated by a distribution with no attractor. Out of this experiment, we do not obtain evidence of the existence either one or two attractors within the European economies' business cycle comovements. However, the null of no attractor cannot be rejected.

5 Can distances been explained?

We have shown that, in terms of business cycle comovements, some economies are closer than others. However, we would like to understand what is behind those distances. Are there any macroeconomic variables that could help us to explain these distances? The attempt to answer these questions is not new in the literature. Some papers have tried to explain these facts but in different contexts. An influential paper in this literature is the one by Frankel and Rose (1998), where they introduce the importance of trade in explaining the correlations across economies. Clark and van Wincoop (2001), using basically rates of growth, compute correlations across regions in the US and Europe. Bordo and Helbling (2003) analyze annual data from 1880 to 2001, trying to measure the effect of the exchange rate regime on the correlations. Since they observe long series of annual data, they concentrate the analysis on static correlations rather than on the dynamics measures that we consider. The results are mixed but they all coincide that trade linkages are relevant in explaining comovements.

We want to explain comovements using our measures trying to incorporate in the analysis as much variables as we can with the only restriction that they should be available for all the countries in the sample. We carefully explain in the Appendix the data sources and the exact definition of each variable used in this section. After trying different specifications, the most successfully one is displayed in Table 3. Let us start with the first two columns of this table that refer to the combined measure of business cycle synchronization.

In this table, all the variables represent differences from country i to j. For example, the variable called percentage of industry means the differences in percentage of industry output divided by total output in country i and country j. As we can see, the distances can be explained, partially by the specialization of the economy, captured by differences in the percentage of industry production in total production and percentage of agriculture in total production. Other significant variables are differences in average saving ratio and average labor productivity. These variables are basically related to the structure of the economy, both, on the production side (the productivity) and on the consumer's side (the saving ratio).

Obviously, the trade variable is fundamental in explaining the relations across economies. We move slightly away from the standard measures of trade linkages in the literature.[8] We want to capture the transmission of the business cycle comovements through trade. We assume that a country i can export or import its cycle to another country j if the proportion of imports or exports coming in or going to the other country is high. In order to account for those relations, we create the trade variable as the maximum of two different averages over the sample: the proportion of exports of country i that go to country j and the proportion of exports of country j to country i.[9] The idea behind using the maximum is that, if business cycles are linked to trade, when a small economy has strong trade linkages with a big economy, we will observe that the business cycle of the small economy is linked to the business cycle of the big one. For example, in the case of Austria and Germany, the average proportion of exports of Austria going to Germany is 37%. The average proportion of exports of Germany going to Austria is 5%. Therefore, for this pair of countries we will use 37% as the trade linkages across them.

It is worth noting that trade presents a serious problem of endogeneity. We solve this problem by estimating the equation by instrumental variables. We use the standard instruments in the literature for explaining trade, border dummies, Euro dummies, European Union dummies, log of geographical distances, and absolute differences in log populations.[10] With the expected negative sign, the estimates of Table 3 show that trade is important in explaining the business cycle distances. These estimates suggest that the higher the trade, the closer the countries' business cycles. This implies that there are transmissions of cycles through trade.

However, it is important to remark the role of the policy variables. In all cases, the

[8] We also include the definition of trade linkage proposed by Frankel and Rose (1998) in terms of the summation of exports and imports from country i to country j, divided by the total amount of export and imports of country i plus country j, with very similar results.

[9] We tried the same measure with imports with extremely similar results. Actually, the correlation between both measures is 0.93.

[10] Sargan test for the correct specification of the orthogonality restrictions cannot reject the null of correct specification (p-value of 0.33).

macro variables used as explanatory variables are sample means for the longest period of information available. We pretend to capture structure of the economy and avoid as much as possible all the cyclical variation in the variables so we think that the endogeneity problem is partially solved. Fiscal variables are significant (the size of the public balance on the GDP) but monetary policy related variables do not seem to explain any of the cyclical differences. We tried many possible combinations to include monetary policy variables (inflation differentials, inflation correlations, etc.), but the results were not very satisfactory.

Finally, in last columns of Table 3 we show that the results are robust to any of the individual measures of business cycle synchronization proposed in this paper. We consider that our results are fundamentally different from the previous results found in the literature where most of the variables but trade were non significant. We thus find a role for different macro-variables in explaining the comovements across economies.

6 Conclusions

We think that this paper has different lessons according to the interest of the reader. Most of the papers that analyze international links among economies usually assume that there is a "European business cycle". In most cases, this cycle is associated to some economies with a leading role in the area or to a weighted average of different European economies. This paper tries to go further by testing if such business cycle attractor actually exists. For this attempt, we present a comprehensive methodology to characterize the comovements across these economies. In addition, we propose a new method to test for statistical support of the supposed attractor. Using this test, we show that there is not evidence of the existence of either one or two attractors in the comovements across European economies. By contrast, it seems that the distribution of business cycle distances across EU (and just Euro) economies has been generated under the assumption of no attractor. Obviously, this result puts a question mark in those papers that either implicitly or explicitly assume that a European business cycle exists. In addition, it may be interpreted as empirical support against the extended view of the core and periphery distinction.

In addition, we consider two features of the international business cycles. The first one, is related to the evolution of the business cycle synchronization. As Stock and Watson (2003) have recently documented, we show that there are no appreciable gains in the international business cycle synchronization in the last fifteen years. The second one, is related to the role of trade in explaining international business cycle transmissions. In contrast to other results in the literature, we find that, apart from trade, there is a significant role for other macroeconomic variables to explain business cycle comovements, basically structural variables and some economic policy aggregates.

Finally, due to the recent incorporation of ten new members to the European Union, we think that the analysis of similitudes and differences among the old members and the newly acceded economies is going to be a source of many studies. We show that the business cycles of Euro economies are more closely linked than the business cycles of the new members. On average, these last countries are further away from the Euro economies than across themselves. Finally, we detect that the linkages across Euro economies are prior to the establishment of the union, and we show that the smooth transition of these economies towards a more integrated economic area could be due to previous strong business cycles correlations, fundamentally through trade. This is not the case of the current enlargement because the differences among the new members and the old members seem to be much more important than the differences that the old members exhibited prior to the establishment of the European Union.

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Table 1. Summary of distances across economies

	90.01-03.01		62.01-89.12	62.01-75.12	75.12-89.12
	Euro	Acceded	Euro	Euro	Euro
			VAR-based approach		
Euro	0.61 (0.06)	0.83 (0.05)	0.56 (0.04)	0.53 (0.06)	0.77 (0.05)
Acceded	-	0.82 (0.04)	-	-	-
			Spectral-based approach		
Euro	0.55 (0.06)	0.70 (0.06)	0.44 (0.05)	0.25 (0.11)	0.66 (0.05)
Acceded	-	0.66 (0.05)	-	-	-
			Dummy approach		
Euro	0.70 (0.05)	0.93 (0.05)	0.65 (0.04)	0.57 (0.06)	0.67 (0.05)
Acceded	-	0.73 (0.04)	-	-	-
			Comprehensive approach		
Euro	0.62 (0.06)	0.82 (0.05)	0.55 (0.05)	0.42 (0.08)	0.68 (0.05)
Acceded	-	0.73 (0.04)	-	-	-

Notes. Entries refer to combined business cycle distances across economies. The Appendix contains a detailed description of data sources, missing data, and countries used in the different approaches. Standard errors are in parentheses (see Section 3).

Table 2. Summary of distances across economies

	Skewness	Kurtosis	Bimodality index
	27 countries		
Simulated: no attractor	0.20	-0.68	0.44
Simulated: one attractor	0.65	0.26	0.42
Simulated: two attractors	0.19	-1.19	0.59
Observed: Comprehensive approach	-0.08	-0.56	0.41
Observed: VAR-based approach	-0.15	-0.44	0.40
Observed: Spectral-based approach	0.24	-0.41	0.40
Observed: Dummy-based approach	-0.16	-0.45	0.40
	EU-15 countries		
Observed: Comprehensive approach	-0.05	-0.64	0.41
	Euro countries		
Observed: Comprehensive approach	-0.15	-0.75	0.43

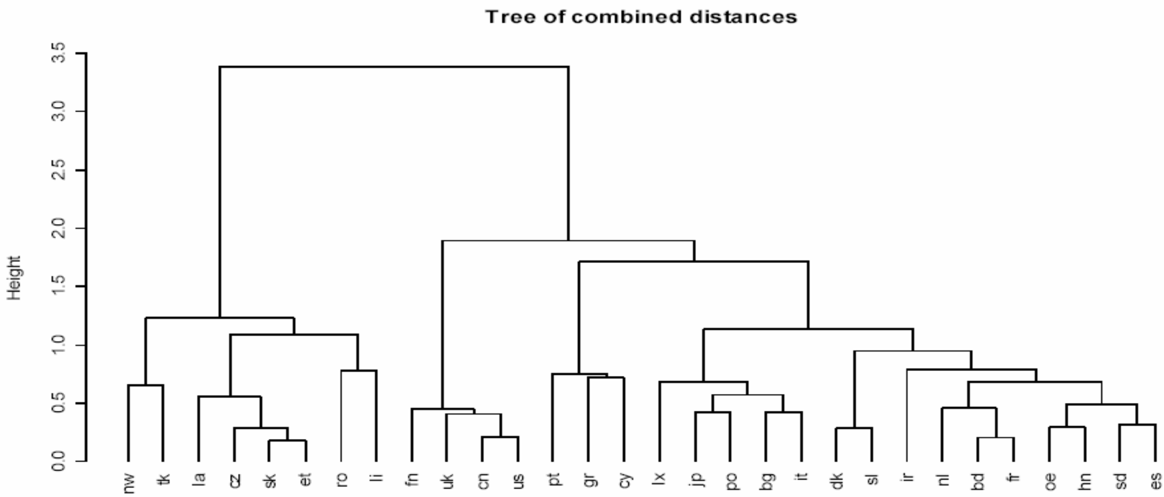
Notes. Entries refer to skewness, kurtosis, and bimodality index of the distribution of distances in a one-to-one map. First three lines refer to simulated points as Section 4 describes. Other lines refer to the multidimensional scaling projection of countries according to their business cycle distances using the sample 90.01-03.01. See the Appendix for a detailed description of data sources, missing data, and countries used in the different approaches.

Table 3. Business cycle distances and macroeconomic variables

	Combined approach		VAR-based approach		Spectral-based approach		Dummy-based approach	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Constant	0.58	0.58	0.56	0.56	0.50	0.52	0.71	0.70
	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)
% Industry	0.84	0.83	1.21	1.22	0.70	0.66	0.54	0.54
	(0.18)	(0.19)	(0.21)	(0.22)	(0.22)	(0.22)	(0.23)	(0.24)
%Agriculture	1.55	1.54	1.70	1.70	2.04	2.05	0.78	0.78
	(0.26)	(0.26)	(0.30)	(0.30)	(0.31)	(0.31)	(0.33)	(0.33)
Saving ratio	0.36	0.36	0.37	0.37	0.42	0.39	0.35	0.35
	(0.17)	(0.17)	(0.19)	(0.19)	(0.20)	(0.20)	(0.21)	(0.21)
Labor productivity	0.08	0.08	0.05	0.05	0.001	-0.006	0.18	0.18
	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.06)	(0.06)
Public Balance	0.56	0.55	0.62	0.63	0.95	0.90	-0.02	-0.01
	(0.23)	(0.24)	(0.28)	(0.28)	(0.28)	(0.29)	(0.30)	(0.30)
Trade	-0.86	-0.64	-0.48	-0.46	-0.69	-0.93	-0.46	-0.41
	(0.14)	(0.27)	(0.16)	(0.30)	(0.16)	(0.31)	(0.17)	(0.33)
R-squared	30%		28%		28%		16%	

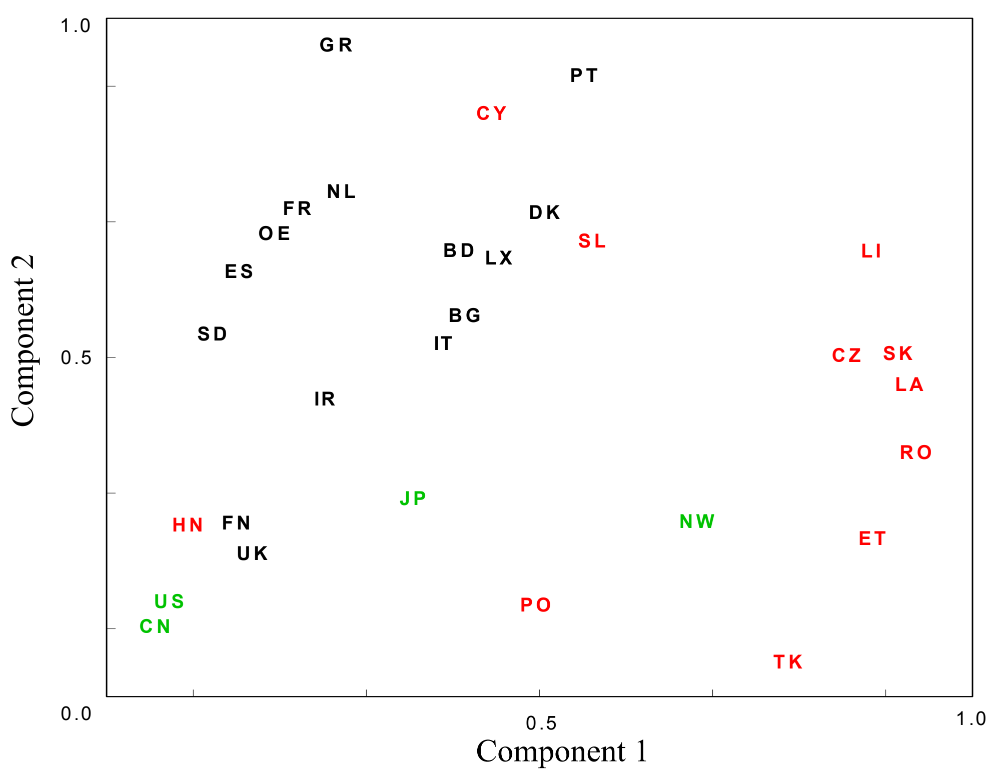
Notes. Entries refer to the estimated coefficients from OLS and instrumental variables regression of business cycle distances on different economic aggregates using the sample 90.01-03.01. Standard errors are in parentheses. See the Section 5 and the Appendix for a detailed description of data sources, missing data, and countries used in the different approaches.

Figure 1. Hierarchical clustering from averaged business cycle distances



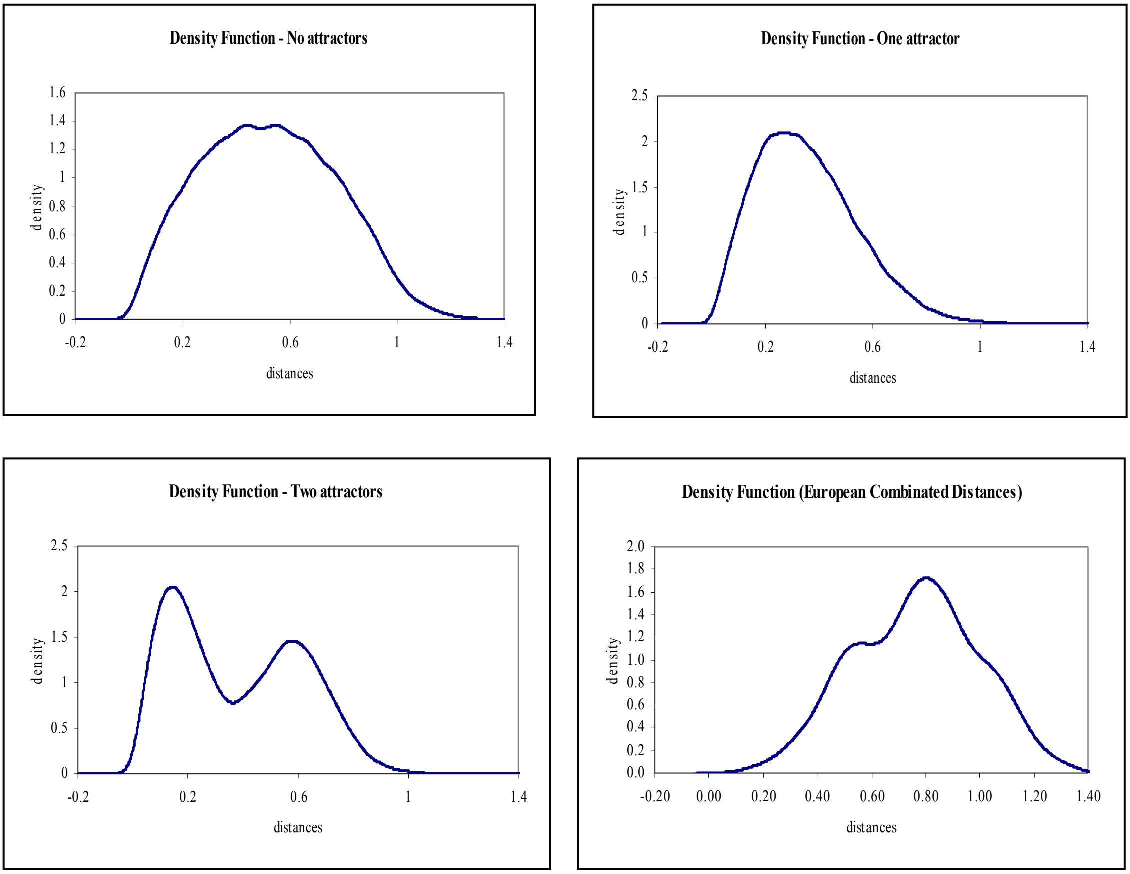
Note: The dendogram's heights represent the level of dissimilarity at which observations or clusters are merged. Symbols used to represent countries are explained in the Appendix.

Figure 2. Multidimensional scaling map from averaged business cycle distances



Note: The figure plots in a two dimensional scale the distances across the economies. Symbols used to represent countries are collected in the Appendix.

Figure 3. Density functions of distances across 27 points



Note: The density functions has been approximated using the Silverman's kernel estimation procedure.

Appendix

Countries and data availability

Industrial Production Index (s.a.)

Euro-area

Country		Sample	Source
Austria	OE	62.01-02.12	OECD -MEI
Belgium	BG	62.01-03.01	OECD -MEI
Germany	BD	62.01-03.01	OECD -MEI
Greece	BR	62.01-03.01	OECD -MEI
Finland	FN	62.01-03.01	OECD -MEI
France	FR	62.01-03.01	OECD -MEI
Italy	IT	62.01-03.01	OECD -MEI
Ireland	IR	75.07-03.01	OECD -MEI
Luxembourg	LX	62.01-03.01	OECD -MEI
Netherlands	NL	62.01-03.01	OECD -MEI
Portugal	PT	62.01-03.01	OECD -MEI
Spain	ES	65.01-03.01	OECD -MEI

European Union

Country		Sample	Source
Denmark	DK	74.01-03.01	OECD - MEI
Sweden	SD	62.01-03.01	OECD - MEI
United Kingdom	UK	62.01-03.01	OECD - MEI

Acceding (by 2007)

Country		Sample	Source
Bulgaria	--	--	--
Romania	RO	90.05-03.01*	OECD - MEI

Negotiating

Country		Sample	Source
Turkey	TK	90.01-03.01	OECD - MEI

Recently acceded (2004)

Country		Sample	Source
Cyprus	CY	90.01-03.01	IMF - IFS
Czech Republic	CZ	90.01-03.01*	OECD - MEI
Estonia	ET	95.01-03.01	OECD - MEI
Hungary	HN	90.01-03.01*	OECD - MEI
Latvia	LA	90.01-03.01*	OECD - MEI
Lithuania	LI	96.01-03.01	OECD - MEI
Malta	--	--	--
Poland	PO	90.01-03.01*	OECD - MEI
Slovak Republic	SK	93.01-03.01	IMF - IFS
Slovenia	SL	90.01-03.01*	OECD - MEI

Other countries

Country		Sample	Source
Canada	CN	62.01-03.01	OECD - MEI
Norway	NW	62.01-03.01	OECD - MEI
Japan	JP	62.01-03.01	OECD - MEI
USA	US	62.01-03.01	OECD - MEI

Macro variables

Variable	Smp Aver (1)	Source	Observation
Trade Variable	1989-1998	IMF, Dir Trade	Explained in text.
Saving Ratio	1995	Penn World Table	
%Public Sector	1998-2002	Eurostat	(2)
Inflation	1998-2002	Eurostat	(3)
Labor productiv.	1995-1999	Eurostat	(4)
%Industry	1996-2000	World Devel Report	
%Agriculture	1996-2000	World Devel Report	

(1) The sample average is, in all cases, the maximum allowed by the data

(2) Public balance - Net borrowing/lending of consolidated general government sector as a percentage of GDP

(3) Inflation rate - Annual average rate of change in Harmonized Indices of Consumer Prices (HICPs)

(4) Labour productivity - GDP in PPS per person employed relative to EU-15 (EU-15=100)

* The sample used in the estimation starts in 1992.01.