Do the Economic Cycles of the Eurozone Member States converge? Empirical Evidence.

Escañuela Romana, Ignacio

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Ignacio Escañuela Romana
Junta de Andalucía (Regional Government of Andalusia, Spain)
Calle Ramón de Paz 30,
41820 Carrión de los Céspedes, Seville.
Spain.
ignacioesro@gmail.com
Telephone Nos. (+34) 954755807, (+34) 674155783.

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ABSTRACT.
Scientific literature maintains by consensus that the Eurozone countries did not have the conditions required for an optimal currency area, at the time of acquiring the common currency. However, the endogeneity of such conditions is under debate. Can the conditions for optimal currency union contribute towards creating the elements necessary for this area? If the answer is negative, some member states have costs higher than the benefits produced through membership of the monetary area. As a result, the survival of this common currency will be at serious risk. This paper attempts to measure the variable considered essential by the literature: the convergence or synchronization between national economic cycles, from the adoption of the Euro in 1999. This synchronization would avoid the asymmetric shocks. Shocks that have different economic consequences on the member states of the Euro, making an optimal common monetary policy impossible for all states. I have employed three different methods in order to get a robust empirical measurement. My conclusion is that there is no robust empirical evidence about the synchronization of national economic cycles in the Eurozone. Moreover, there is no evidence of the growth of this convergence. Therefore, it must be impossible to set up a monetary policy capable of facing the movements that separate national cycles. They generate Euro membership costs that could be excessive.

KEYWORDS: Currency Areas, Economic Cycles.

JEL CODES: C10, E32, E42.

1. Introduction.

The purpose of this paper is to address the empirical data in the following questions. Is there convergence between the economic cycles of the Eurozone member states? And, secondly, what has been the impact of the creation of Eurozone monetary union in 1999 on this synchronisation of the cycles?

I have taken the definition of economic cycles provided by Burns et al. (1946): "Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion

phase of the next cycle (...)" (p.3). I take this definition without having to examine whether the cycles are periodic or not, as this bears no significance to this paper.

In order to discover the economic cycle, it is necessary to first remove the seasonal movements and the observed data trend. For example, Kaiser et al. (1999) compile this breakdown: "The second use of trends is in business cycle analysis, where the cycle is typically measured as what is left of the series, after detrending and seasonal adjustment. Short-term trends cannot be used in this context because they are contaminated with cyclical variation; longer-term trends are needed" (p.13).

Therefore we cannot observe the cycles without first carrying out a data analysis. The cycles are recurring movements, while the trend is not repeated and the seasonality has a constant annual quarterly factor. Only by removing the non-recurring or quarterly components can we gain access to the cycle.

Hereinafter, it is necessary to define the convergence between the cycles. The economic cycles of the member states synchronise or converge if, and only if, they comply with two conditions.

First, that the national cycles coincide: they share regularity, duration, direction and tipping points over time. According to this first condition, the German and French cycles are synchronised if they share expansions and contractions, with tipping points coinciding over time.

Second condition, that the phases of these cycles are of a similar depth. It is not enough that the tipping points and the direction coincide, it is also necessary that the cycles are of a similar amplitude. Assume that Germany and France share an upward cycle, but the rate of growth is very high in Germany and very low in France. The second country is interested in a much more lax monetary policy than the first. One of the two countries would end up losing if they belonged to a common monetary area.

It is important to know whether the cycles are synchronised, because, as I am going to demonstrate, it is one of the key conditions for an optimum monetary area.

The theory concerning the optimum monetary areas comes from Mundell (1961), with contribution from McKinnon (1963) and Kenen (1969), who analysed the costs and benefits of these areas for the countries who form them. The benefits come from reducing the costs and risks of economic transactions brought about by foreign exchange. The costs are derived from the loss of autonomy in exchange rate and monetary policies. The countries in the currency area cannot use these policies to address their specific problems. Faced with a prolonged situation of unbalanced foreign trade, or their own economic depression, they cannot even depreciate their currency, nor can they expand their monetary supply.

As Mundell (1961) pointed out: if the demand for a country's goods increases, and decreases in another country, the first country will experience increased inflation while the other will suffer unemployment. Consequently, a relative depreciation of the currency of a country in a recession would provoke a change in the terms of foreign exchange that would lessen the impact. If depreciation is not possible, the problem requires other solutions. Therefore, for Mundell an exchange rate regime is ideal if it

can ensure an equilibrium in the balance of payments, without causing unemployment or demand induced wage inflation (De Lombaerde, 1999). It is not ideal if it causes unemployment or inflation in one of the components of the area.

There are a series of debates within this theory of optimum currency areas. The effectiveness of the monetary and exchange policies (Mongelli, 2005, p.614) is discussed, which leads us to the macroeconomic debate around Keynesianism and the theory of rational expectations. But this discussion is not the object of this paper, and, furthermore, it is partly settled by the unanimous empirical evidence that prices and wages are on relatively downward and stable trend in the Eurozone (although there is variation between the states).

If the cycles do not converge, it can cause an asymmetric shock: one or various member states in the monetary area suffer economic depressions that are not experienced by the majority of countries. It can also surface as inflationary expansions, in which a State suffers a sharp economic expansion accompanied by differential inflation which will end up generating serious problems in the balance of payments. In the face of an unshared economic depression, the country in the monetary region may not use the relinquished policies, and will also have great difficulties developing a sustained expansive fiscal policy because it would create great mistrust in the external financial markets. Investors fear that the country in question would end up leaving the area to recover their autonomy by retrieving their own currency and carrying out a great depreciation and release from their debt. The rise in interest rate of loans will become prohibitive for the country.

If finally there is no convergence in the national economic cycles, there are some options that would reduce the costs of loss of autonomy in the economic policies. However, in the Eurozone there are no such conditions.

Firstly, the existence of relevant fiscal transactions with reference to the GDP of a country with problems (Kenen, 1969). Fiscal transfers that currently do not exist in the Eurozone.
Secondly, the mobility of the productive factors, especially work. In this way, the unemployed would cross borders, thus alleviating the unemployment situation. This perfect mobility of the work factor is not realistic and implies suffering. As Eichengreen (1991) points out: “direct evidence points to significantly lower labor mobility within Europe than within the United States” (p.2). To which he added that removing the legal restrictions from mobility does not mean that it increases, given that there are persistent cultural and social factors (p.16). There is a consensus in scientific literature regarding this.

Thirdly, the flexibility of prices and wages, which, by decreasing, cause an external expansion in a country in recession due to net exports. This flexibility requires a severe and prolonged depression and, consequently, is not a realistic option either. As I have already pointed out, the different studies indicate that prices and wages are firmly down in the Eurozone, as indicated by Mongelli (2005, p.615). An example can be found in Arpaia et al. (2007): “Our findings suggest the existence of a significant degree of nominal wage rigidity in the Euro area economy” (p.30). These authors point out that this downward rigidity is greater or less depending on the country, and that it implies sharp increases in unemployment in the face of asymmetric shocks (p.27). This rigidity

means an enormous sacrifice in terms of unemployment in the face of a differential shock. It could be ideally complemented by coordinated expansion of the internal demand of the rest of the countries in the monetary area, but there is no central authority in the Eurozone that could implement this kind of coordination.

In conclusion, belonging to the monetary area can offer benefits and costs, and the comparison between the two allied to experience, is the basis on which the member countries will ultimately decide on their membership.

The key element for analysing these benefits and costs is the synchronisation of national cycles, as it gathers the effects of the underlying economic factors and allows for the quantification of the monetary union's national costs. The condition is not sufficient in itself to form an optimum monetary union, although it is a necessary condition.

2. **Brief summary of scientific literature**.

Scientific literature maintains a clear consensus in reference to the thesis that, from the beginning, the Eurozone did not have the characteristics of an optimum monetary region, and was consequently subject to the possibility of rupture in the face of asymmetric shocks. Hein et al. (2005) effectively point out that the conditions of the optimum monetary region were not compliant with: “taking the OCA conditions seriously, would therefore have meant to postpone or even to abandon the EMU project”, (p.8), because there were already significant differences in GNP pc, labour productivity, unemployment rates, an insufficient level of labour integration and the rest of the factor markets. Bayoumi et al. (1992) present a very common thesis: there is a group that shares synchronised cycles within the countries that would form the Eurozone, with few asymmetric shocks, which are therefore comparable to existing ones within the United States. There is also a periphery of countries whose national cycles do not converge like those in the aforementioned group.

However, literature is indeed divided according to the question of whether the acquisition of a common currency could provoke the convergence of the economic cycles and therefore create the conditions required for an optimum monetary area.

Frankel et al. (1998) maintain, on a theoretical and empirical basis, the endogeneity of the conditions of the optimum monetary area: having a common currency will increase the commercial ties, which will be intensified especially in the intraindustrial part and this will modify the structure of the national economic cycles, causing their convergence. They state that: “Entry into a currency union may raise international trade linkages (…). More importantly, tighter international trade ties can be expected to affect the nature of national business cycles. Countries that enter a currency union are likely to experience dramatically different business cycles than before” (p.2). This position has been supported by studies like that of Agresti et al. (2001).

There does not seem to be any doubt that intraindustrial commerce strengthens the convergence between the national economic cycles, although it may not be a significant factor in itself (Kenen, 2000). Among other investigations it is worth mentioning that of Fidrmuc (2001), who notes that it all depends on commercial specialisation. According to Krugman (1993), if monetary union causes a commercial deepening based on

interindustrial rather than intraindustrial commerce, this will generate a greater divergence between the cycles. This prediction is based on the Ricardian theory of comparative advantage: each country will specialise in what makes them comparatively better, and any international disturbance that increases the demand of some products and reduces that of others will end up benefiting some countries and damaging others, causing asymmetric shocks. De Haan et al. (2002) support this view.

Empirically, no conclusion has been drawn. For example:

- Darvas et al. (2004) and Böwer et al. (2006) detect great convergence from the beginning of the Eurozone. Gayer (2007) found evidence in favour of seasonality around a high synchronisation.
- Studies like that of Artis (2003) and Aguiar-Conraria et al. (2010) notice the convergence of one group in the Eurozone, while other countries do not synchronise. After considering a total of seven quantification attempts, Horvath (2003) concludes that the convergence between the cycles only occurs for one group of European countries, and that the asymmetry between cycles is predominant in the most peripheral countries of the Eurozone (p.26).
- Giannone et al. (2009) and Weyerstraβ et al. (2011) do not detect greater synchronisation in the cycles. Furthermore, Gächter et al. (2012) notice an increase in the desynchronization as of the 2008 economic-financial crisis, But this desynchronisation is principally centred around Spain, Cyprus and Greece. Cancelo (2012) notices a reduction in the synchronisation of the national cycles within the Eurozone, which is in contrast to greater global convergence, and of the Eurozone with other countries such as the United States or Japan. However this divergence is explained by three countries' data: Principally Greece, Portugal and Spain. Ireland is also an anomalous case.

Thus, there is no consensus regarding the evolution of the possible convergence between the national cycles of the Eurozone member countries. The reason is possibly based on the variety of methods used: the use of different data, the use of different methods of cycle identification and their convergence, different synchronisation quantification (Massmann et al., 2004). Cancelo (2012): “A variety of approaches have been suggested: dispersion statistics, correlation coefficients, concordance indices, factor analysis, spectral analysis, etc. The most popular procedure consists of computing bivariate correlations to quantify pairwise relationships, and calculating their mean to get a summary measure” (pp.89-90).

In any case, the inflation differentials do not stop being a source of concern. Despite their reduction in the Eurozone, these differentials between states persist, and they cannot be explained by the evolution of national productivity or the Balassa-Samuelson effect (Mongelli, 2005, p.619).

The empirical studies should make a series of choices:

- Different data: different countries and periods.
- The variables to select. The most common is the real, quarterly or annual GNP. Quarterly GNP provides more data, annual GNP is used on the basis that it will eliminate irregular movements and measurement errors. However, this leaves us practically without any data and it is preferable to use seasonally adjusted quarterly data. Monthly industrial production is the other variable that is also used . Similarly, breakdowns have been used in GNP

components (Gayer, 2007) or in industrial sectors. The GDP/GNP option is the most natural, given that we want to measure the economic cycle and the industrial component is no longer predominant.

- The cycle as raw data (absolute evolution of the value) or as a deviation with respect to a trend that must be removed. This second option is the most commonly chosen and seems logical bearing in mind the concept of the economic cycle.
- The process for extracting the trend. The most common is:

  * to use mobile averages to calculate the trend, in one way or another, which are present in filters like that of Hodrick-Prescott, Baxter-King, etc.

  * Or apply the first differences in order to achieve a stationary series. Even though this option has been criticised for adding volatility (De Haan et al., 2005).

  * However, there are other methods such as subtracting a linear trend.
- The analysis of the empirical cycle: the harmonic analysis consists of breaking it down into various underlying theoretical cycles. Other studies simply believe that the empirical cycle is the cycle, once trend and seasonality have been disregarded.
- The measurement of the relationship between the cycles: the quantification of synchronisation. Two measurements are usually used: bilateral correlation coefficients between the cycles and the typical deviation of the cycles. The correlation coefficients disregard the amplitude of the cycles, which is very important data. In any case, the increase in the average of the correlation coefficient demonstrates a high level of synchronisation, as long as the variance of this coefficient does not increase (Gayer, 2007, p.4). Likewise, the typical deviation provides a quantification of the cycles' dispersion, which reduces the convergence between cycles as it increases. Therefore, the greater it is the less synchronisation there can be. Even though the typical deviation has the drawback of being dependent on the scale or measurement of the cycles. Additionally, some studies use a dynamic correlation coefficient for use in non-stationary series.

3. Data.

The variables used refer to the five principle countries in the Eurozone in terms of national income: Germany, Spain, France, Italy, the Netherlands. Similarly, data from three countries that do not belong to the Eurozone is used, although one does belong to the European Union: The United Kingdom, United States and Japan. They have been selected as a result of their relevance in terms of global income. In this way, it is possible to compare internal evolution of the Eurozone, with external evolution.

The variable used is the most common in the studies on convergence of national cycles: GDP in national currency at constant prices (2005). I have eliminated the seasonality by annualising this data: adding together the three previous quarters and the present one. Source: The Bank of Spain, who takes the original data from Eurostat and the OECD. GDP is therefore chosen for being the flow directly related to the economic cycle, and the series is estimated in constant prices in order to eliminate the nominal influence of prices.

The time frame is: Jan 1999 to Feb 2012, 54 items of data. That is to say the observations began at the beginning of the Eurozone. I am going to analyse the evolution throughout this period, but I am also going to compare the development of the second part with the first part (27 items of data for each sub-period). In this way, conclusions can be reached concerning the synchronisation of the cycles and also in reference to the evolution that it has experienced: whether convergence has increased or not.

4. Methodology.

In this paper there are two fundamental methodological problems. Firstly, calculating the economic cycles from the data available, which I refer to as empirical or observable cycles. Secondly, quantifying the synchronisation that these empirical cycles maintain.

The calculation of the empirical cycles allows for different methodologies, each one having a different theoretic base. The key is to decide how to work out the trend in order to subtract it. I understand that trend is simply a movement whose recurrence or repetition is not observable in the period in which we have related data.

Certainly, as the objective is to calculate the convergence and its evolution, whether one method or another is chosen to arrive at the empirical cycle is of relatively little importance. Applying the same method would result in similar outcomes. However, it is not possible to disregard that the chosen method of subtracting the trend determines the conclusions. For example, we may remove, together with the trend, precisely those cycles that point towards a greater or lesser convergence.

Therefore, in order to strengthen the results obtained, I have used three different methods of calculating and subtracting trend. Consequently, I have applied three different methods of calculating the empirical cycle:

A. The first method is calculating the series in first differences. That is to say, the series is transformed by subtracting the value taken in the previous quarter from each item of data. In this way a stationary series is obtained, which would be the empirical cycle. It is accepted that this process is adequate for the purposes of removing trends, without prejudging which ones they are (for example, Giannone et al., 2009). It is criticised however, because, in the medium and long term, it would eliminate cyclical movements, thus increasing the significance of short term cycles and, as a consequence, volatility.

   Series in first differences: IPIBALE, IPIBESP, IPIBFRA, IPIBITA, IPIBHOL, IPIBRUN, IPIBUSA, IPIBJAP.

   I have also calculated the series of differences between the empirical cycles. For example, DALEESP = IPIBALE – IPIBESP. The differences between the empirical cycles allow me to calculate the distance between the amplitude of the sequences.

B. The second method is to pass all the data through one of the most common filters, the Hodrick-Prescott (HP) filter. It is basically subtracting a mobile

average, thus forcing the trend to pass through the temporal centre of the data series. HpPIBALE is the German empirical cycle, formed by subtracting a trend from the data series via the HP filter. This process has a series of advantages: the longest cycles would be preserved, and we follow a method regularly employed by scientific literature. A disadvantage would be the criticism suggesting that an average that passes through the centre of a series generates amplified movements on the edges of the series and, therefore, explosive cycles on the edge.

I have again calculated the series of differences: DHPALEESP = HpPIBALE – HpPIBESP.

C. The third method is to subtract the linear trend using the string method and to apply the harmonic analysis in order to determine the theoretical cycles that make up the empirical cycle. The string method involves not having any particular hypothesis regarding the shape of the trend and calculating it as the straight line which connects the first and the last observation over time. Thus, an empirical cycle is obtained to which I apply the breakdown by the Fourier series, supposing therefore, that the observed movements are the product of recurrent movements of exact periodicity. The entire method is based on a double hypothesis: a strictly deterministic hypothesis which affirms that there are no random movements, and it is postulated that the cycles are exactly recurring and whose periods are fixed.

   This method is criticised as being arbitrary for assuming fixed and indemonstrable movements. Without going into the criticism in depth, the harmonic analysis allows us to carry out a different analysis, with other assumptions, which strengthen the general conclusions.

The second methodological choice refers to the measurement of the synchronisation.

A. The first method I have used is the most common in scientific literature that studies economic cycles of monetary regions: the linear correlation coefficient between the empirical cycles. It is an index that measures the linear relationship between the two quantitative random variables, being independent of the variable measurement scale. Its value can oscillate between –1 (perfect negative correlation) and +1 (perfect positive correlation). It allows us to determine whether the economic cycles evolve in the same direction and if they share tipping points between a positive and negative evolution.
B. Estimation of the mean and the typical deviation of the series of differences between the national cycles. If the average increases, in absolute values, the amplitude of the difference between cycles becomes greater and they distance themselves. Likewise, a greater typical deviation indicates that the differences become more erratic around this mean, thus making it more difficult to determine common monetary policy for the area.
C. The coincidence in the periodogram of different member countries: that the theoretical cycles of each of the frequencies contribute in a similar quantity to the 100% of the observed variance, and that the ascending and descending movements, and changes in the cycle, coincide between the countries (correlation coefficient between the theoretical cycles).

5. Results.

5.1. First method: series in first differences.

I have already stated that for first differences we arrive at stationary series, with the inconvenience that we amplify the series' short term volatility, thus blurring the information regarding medium and long-term movements.

The correlation coefficients between the series in first differences, for the different periods, have the following values.

N=54	IPIBALE	IPIBESP	IPIBFRA	IPIBITA	IPIBHOL	IPIBRUN	IPIBEEUU	IPIBJAP
IPIBALE	1.00							
IPIBESP	0.55	1.00						
IPIBFRA	0.82	0.85	1.00					
IPIBITA	0.85	0.82	0.94	1.00				
IPIBHOL	0.80	0.83	0.90	0.85	1.00			
IPIBRUN	0.66	0.85	0.86	0.85	0.74	1.00		
IPIBEEUU	0.67	0.76	0.90	0.80	0.76	0.86	1.00	
IPIBJAP	0.75	0.49	0.71	0.74	0.57	0.75	0.74	1.00

n=27, Jan 1999 to Mar 2005	IPIBALE	IPIBESP	IPIBFRA	IPIBITA	IPIBHOL	IPIBRUN	IPIBEEUU	IPIBJAP
IPIBALE	1.00							
IPIBESP	0.81	1.00						
IPIBFRA	0.80	0.88	1.00					
IPIBITA	0.87	0.69	0.74	1.00				
IPIBHOL	0.81	0.91	0.93	0.66	1.00			
IPIBRUN	0.56	0.48	0.38	0.42	0.35	1.00		
IPIBEEUU	0.47	0.62	0.75	0.33	0.72	0.47	1.00	
IPIBJAP	0.01	-0.15	-0.12	0.28	-0.23	0.28	-0.03	1.00

n=27, Apr 2005 to Feb 2012	IPIBALE	IPIBESP	IPIBFRA	IPIBITA	IPIBHOL	IPIBRUN	IPIBEEUU	IPIBJAP
IPIBALE	1.00							
IPIBESP	0.76	1.00						
IPIBFRA	0.97	0.84	1.00					
IPIBITA	0.97	0.83	0.96	1.00				
IPIBHOL	0.87	0.94	0.90	0.89	1.00			
IPIBRUN	0.87	0.83	0.94	0.90	0.88	1.00		
IPIBEEUU	0.91	0.72	0.94	0.88	0.78	0.91	1.00	
IPIBJAP	0.85	0.56	0.82	0.81	0.69	0.83	0.89	1.00

n=54	IPIBEURO	IPIBRUN	IPIBEEUU	IPIBJAP
IPIBEURO	1.00			
IPIBRUN	0.84	1.00		
IPIBEEUU	0.82	0.86	1.00	

IPIBJAP	0.74	0.75	0.74	1.00

n=27, Jan 1999 to Mar 2005	IPIBEURO	IPIBRUN	IPIBEEUU	IPIBJAP
IPIBEURO	1.00			
IPIBRUN	0.47	1.00		
IPIBEEUU	0.58	0.47	1.00	
IPIBJAP	0.24	0.54	0.30	1.00

n=27, Apr 2005 to Feb 2012	IPIBEURO	IPIBRUN	IPIBEEUU	IPIBJAP
IPIBEURO	1.00			
IPIBRUN	0.92	1.00		
IPIBEEUU	0.91	0.91	1.00	
IPIBJAP	0.82	0.83	0.89	1.00

The following facts have been observed:

A. There is a high level of convergence between the countries in the Eurozone for the entire period considered. There is one clear exception: the lesser correlation between the Spanish and the German cycles.
B. There is a general improvement in the synchronisation of the economic cycles for the Eurozone. This convergence also occurs internationally, outside of the Eurozone. The only exceptions are the relationship between the economic cycles of Spain and of Germany and France, as well as between the Netherlands and France. Likewise, if we quantify the correlation by analysing its values according to the weight of the respective GDPs in terms of percentage (the sum of all the countries would be 100), in the middle of each period, this clear increase in synchronisation, both within and outside of the Eurozone can again be observed.

Can this great correlation disguise persistent, and maybe growing, differences in the amplitude of the cycles? With reference to the series in differences between the cycles and with the objective of understanding the evolution of the differences in amplitude, I have obtained the following results. Mean refers to the average difference between the national cycles for the period considered, typical deviation is calculated for the series of differences and it can therefore be explained if the difference between the cycles becomes more (greater typical deviation) or less erratic. I have taken into account, in order to simplify matters, only the differences with regard to Germany and France.

n=54	DALEESP	DALEFRA	DALEITA	DALEHOL	DESPFRA	DFRAITA	DFRAHOL
Typical deviation	0.59	0.36	0.33	0.38	0.34	0.22	0.25
mean	-0.22	-0.03	0.18	-0.08	0.19	0.21	-0.05

n=27, Jan 1999 to Mar 2005	DALEESP	DALEFRA	DALEITA	DALEHOL	DESPFRA	DFRAITA	DFRAHOL
Typical deviation	0.19	0.18	0.16	0.24	0.14	0.18	0.19
mean	-0.65	-0.26	-0.09	-0.26	0.39	0.17	0.00

n=27, Apr 2005 to Feb 2012	DALEESP	DALEFRA	DALEITA	DALEHOL	DESPFRA	DFRAITA	DFRAHOL

Typical deviation	0.54	0.36	0.23	0.41	0.37	0.25	0.30
mean	0.21	0.20	0.45	0.09	-0.01	0.25	-0.11

diff. between 2 periods (absolute value)	DALEESP	DALEFRA	DALEITA	DALEHOL	DESPFRA	DFRAITA	DFRAHOL
Typical deviation	0.35	0.18	0.08	0.18	0.23	0.07	0.11
mean	-0.44	-0.06	0.36	-0.17	-0.38	0.08	0.10

Unequal behaviour can be observed:

A. In four cases there is a reduction in the difference between the cycles and an increase in three.
B. To which the increase in typical deviation of the difference is added, which shows the general increment in the volatility of the difference. The variations regarding the average increase, thus making the evolution of the amplitudes more unpredictable. This would prevent the designing of a common monetary policy for the region.

As a consequence, the correlation coefficient indicates a greater synchronisation of the cycles in the Eurozone, with reference to their negative and positive evolution and the changing points of the cycle. An evolution shared by the principal countries outside the Eurozone However the difference in amplitude stagnates or deteriorates, especially with reference to the volatility of this difference, thus distancing the cycles.

5.2. Second method: estimating the economic cycles using a Hodrick-Prescott filter.

By applying a HP filter, and calculating the correlation coefficients between those empirical cycles estimated, the following data is obtained.

n=54	hpPIBALE	hpPIBESP	hpPIBFRA	hpPIBITA	hpPIBHOL	hpPIBEURO	hpPIBRUN	hpPIBEEUU	hpPIBJAP
hpPIBALE	1.00								
hpPIBESP	0.83	1.00							
hpPIBFRA	0.94	0.87	1.00						
hpPIBITA	0.96	0.84	0.96	1.00					
hpPIBHOL	0.88	0.91	0.88	0.84	1.00				
hpPIBEURO	0.98	0.90	0.98	0.98	0.92	1.00			
hpPIBRUN	0.84	0.83	0.89	0.88	0.73	0.88	1.00		
hpPIBEEUU	0.76	0.73	0.91	0.82	0.68	0.82	0.88	1.00	
hpPIBJAP	0.79	0.66	0.83	0.86	0.59	0.81	0.92	0.87	1.00

n=27, Jan 1999 to Mar 2005	hpPIBALE	hpPIBESP	hpPIBFRA	hpPIBITA	hpPIBHOL	hpPIBEURO	hpPIBRUN	hpPIBEEUU	hpPIBJAP
hpPIBALE	1.00								
hpPIBESP	0.88	1.00							
hpPIBFRA	0.82	0.95	1.00						
hpPIBITA	0.91	0.81	0.87	1.00					
hpPIBHOL	0.91	0.99	0.96	0.85	1.00				
hpPIBEURO	0.97	0.95	0.94	0.95	0.97	1.00			
hpPIBRUN	0.35	0.51	0.52	0.35	0.46	0.43	1.00		
hpPIBEEUU	0.31	0.66	0.75	0.39	0.63	0.51	0.71	1.00	

hpPIBJAP	0.17	0.25	0.44	0.42	0.24	0.30	0.76	0.59	1.00

n=27, Apr 2005 to Feb 2012	hpPIBALE	hpPIBESP	hpPIBFRA	hpPIBITA	hpPIBHOL	hpPIBEURO	hpPIBRUN	hpPIBEEUU	hpPIBJAP
hpPIBALE	1.00								
hpPIBESP	0.83	1.00							
hpPIBFRA	0.97	0.87	1.00						
hpPIBITA	0.97	0.84	0.99	1.00					
hpPIBHOL	0.89	0.95	0.86	0.85	1.00				
hpPIBEURO	0.99	0.90	0.99	0.99	0.92	1.00			
hpPIBRUN	0.93	0.86	0.97	0.96	0.86	0.96	1.00		
hpPIBEEUU	0.89	0.75	0.96	0.94	0.71	0.91	0.94	1.00	
hpPIBJAP	0.89	0.69	0.92	0.93	0.72	0.89	0.93	0.94	1.00

Therefore:

A. The data shows a high synchronisation of the cycles in the Eurozone.
B. This convergence within the Eurozone has not increased from the beginning of monetary union. While internationally, an improvement in the synchronisation in the second half of the period in question can again be perceived.

Returning to the issue of the relationship between the amplitudes, the evolution of the series of bilateral differences between cycles is as follows.

n=54	DHPALEESP	DHPALEFRA	DHPALEITA	DHPALEHOL	DHPESPFRA	DHPFRAITA	DHPFRAHOL
Typical deviation	28.22	20.77	19.52	30.70	10.02	5.11	12.33
mean	0.39	-0.24	0.56	0.10	-0.62	0.80	0.33

n=27, Jan 1999 to Mar 2005	DHPALEESP	DHPALEFRA	DHPALEITA	DHPALEHOL	DHPESPFRA	DHPFRAITA	DHPFRAHOL
Typical deviation	18.56	14.84	13.43	17.69	7.37	6.25	6.64
mean	-0.30	-1.36	0.19	-2.53	-1.06	1.54	-1.17

n=27, Apr 2005 to Feb 2012	DHPALEESP	DHPALEFRA	DHPALEITA	DHPALEHOL	DHPESPFRA	DHPFRAITA	DHPFRAHOL
Typical deviation	35.76	25.62	24.41	39.92	12.24	3.61	16.15
average	1.07	0.88	0.94	2.72	-0.19	0.06	1.84

Once again we find that:

A. A reduction in the differences between the amplitudes of the cycles, which continue to be significant, cannot be perceived.
B. Moreover, the typical deviation of these series of differences increases, thus suggesting an increase in the volatility of the cycles.

This deterioration in the relative evolution of the amplitudes also occurs to an equal degree in the international sphere, as can be observed in the relative data in the Eurozone, United States, Japan and the United Kingdom.

n=27, Jan 1999 to Mar 2005	DHPEURORUN	DHPEUROEEUU	DHPEUROJAP	DHPRUNEEUU	DHPRUNJAP	DHPEEUUJAP
Typical deviation	54.40	91.90	55.54	103.35	3.22	105.13
mean	-7.47	2.15	-8.94	9.62	-1.47	-11.10

n=27, Apr 2005 to Feb 2012	DHPEURORUN	DHPEUROEEUU	DHPEUROJAP	DHPRUNEEUU	DHPRUNJAP	DHPEEUUJAP
Typical deviation	92.22	97.35	104.35	167.13	13.18	178.42
mean	11.24	-13.30	13.07	-24.55	1.82	26.37

Therefore, with the first two methods of estimation I have drawn the same conclusions:

A. The evolution of the synchronisation between the national cycles in the Eurozone has the same characteristics as the international sphere as a whole, at least as far as the countries with the greatest GDP per capita and the greatest global significance are concerned. Therefore, it is not possible to conclude that the Euro has had no positive or negative global impact.
B. The Eurozone has a high level of synchronisation between cycles in terms of positive or negative cyclical evolution and tipping points. This convergence has not suffered changes since the beginning of the common currency, or they have been positive changes, while an increase in the overall international sphere can be perceived.
C. Important differences in the Eurozone between the region's national cycles persist because the amplitude of these cycles is increasingly different and this difference between them evolves ever more erratically, thus making it more difficult to design a common monetary policy. This is also a common characteristic in the international sphere, meaning that it should not be related to the establishment of the Euro. It is indeed an increase in the cost of a common monetary policy.

5.3. Third method: subtracting a linear trend and applying harmonic analysis.

This third method is based on different assumptions and applies a different breakdown. I have applied harmonic analysis, based on an approach supported by Álvarez et al. (2005) among others. It is based on the hypothesis that there are regular movements (theoretical cycles or hidden periodicities) that comprise the changes observed (empirical cycles). Therefore, the series can be broken down into sinusoid functions, and a reduced number of these functions should explain and predict its evolution, with correct approximation. The breakdown into Fourier's trigonometric series is used, which is a method based on a discrete number or a discontinuation of functions. The results are presented in a periodogram, where each frequential component makes a contribution to the variance of the series.

Prior to this, the harmonic analysis specifies that the trend of the original series is removed. The trend is understood here as a movement whose recurrence is not observable, due to having a period greater than or equal to the temporal longitude of the series. I have chosen to apply the string method: I connect the first item of data observed to the last via a straight line, and I subtract this linear trend from the observed series. In this instance I prefer this method to the method of estimation using a polynomial as this could eliminate cycles. Likewise, I have decided not to estimate through a straight line calculated using ordinary squared minimums, in order to newly avoid using an average, which, by passing through the centre of the distribution, amplifies the movements on the edge of the series (Álvarez Vázquez, N.J., 1985).

As a consequence, I have subtracted a trend, calculated using the string method, and I have subsequently subtracted the average of the empirical cycles obtained in this way.

For the complete period of Jan 1999 to Feb 2012, the periodogram, or contribution of each period to the complete variance observed in the respective empirical cycles, is as follows.

Percentage contribution of the period to the total variance observed.						
Periods	54	27	18	13.5	10.8	9
Germany	7.14	**53.87**	18.47	15.04	2.84	1.10
Spain	**81.14**	16.54	0.44	1.11	0.54	0.17
France	**53.06**	36.74	1.72	6.47	1.47	0.14
Italy	**63.65**	23.14	3.69	7.46	1.34	0.18
The Netherlands	18.42	**67.22**	0.81	7.98	3.85	1.25
Eurozone	36.62	**44.92**	5.57	9.54	2.19	0.54

The period of 54 quarters predominates in Spain, Italy and France. While it is hardly 7.14% in Germany. Compared with the predominance of 27 quarters (frequency 2) in Germany and the Netherlands. Other differences have also been observed such as the importance of the 18 quarter period for Germany. Globally, the Eurozone periodogram reflects an analysed average of the countries it comprises.

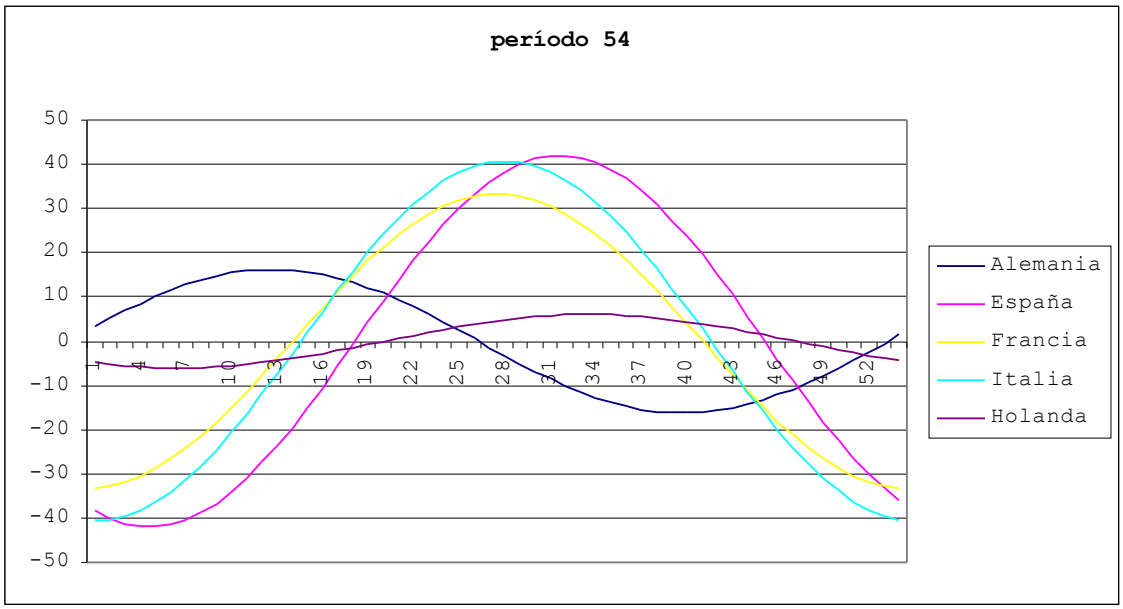
The linear correlation coefficients of the theoretical cycles of the different periods are as follows.

Periods	54.00	Frequency	1.00			
	Germany	Spain	France	Italy	The Netherlands	Eurozone
Germany	1.00					
Spain	-0.59	1.00				
France	-0.15	0.89	1.00			
Italy	-0.21	0.91	1.00	1.00		
The Netherlands	-0.76	0.97	0.75	0.79	1.00	
Eurozone	-0.23	0.92	1.00	1.00	0.81	1.00
Periods	27.00	Frequency	2.00			
	Germany	Spain	France	Italy	The Netherlands	Eurozone
Germany	1.00					
Spain	0.93	1.00				
France	1.00	0.91	1.00			
Italy	0.99	0.96	0.99	1.00		
The Netherlands	0.95	1.00	0.93	0.97	1.00	
Eurozone	1.00	0.96	0.99	1.00	0.97	1.00
Periods	18.00	Frequency	3.00			
	Germany	Spain	France	Italy	The Netherlands	Eurozone
Germany	1.00					
Spain		1.00				
France	0.98		1.00			
Italy	0.86		0.94	1.00		
The Netherlands					1.00	
Eurozone	1.00		0.99	0.90		1.00
Periods	13.50	Frequency	4.00			
	Germany	Spain	France	Italy	The Netherlands	Eurozone
Germany	1.00					
Spain	1.00	1.00				
France	1.00	1.00	1.00			
Italy	1.00	1.00	1.00	1.00		

The Netherlands	1.00	1.00	0.99	0.99	1.00	
Eurozone	1.00	1.00	1.00	1.00	1.00	1.00
Periods	10.80	Frequency	5.00			
	Germany	Spain	France	Italy	The Netherlands	Eurozone
Germany	1.00					
Spain		1.00				
France	0.99		1.00			
Italy	1.00		0.99	1.00		
The Netherlands	1.00		0.99	1.00	1.00	
Eurozone	1.00		0.99	1.00	1.00	1.00
Periods	9.00	Frequency	6.00			
	Germany	Spain	France	Italy	The Netherlands	Eurozone
Germany	1.00					
Spain		1.00				
France			1.00			
Italy				1.00		
The Netherlands	1.00				1.00	
Eurozone						1.00

Various points can be observed which, on the basis of this methodology, lead to a series of conclusions:

A. The periodogram gathers substantial differences between the Eurozone countries, with reference to the contribution of the different frequencies to the variance observed in the empirical cycle. The German and Dutch theoretical cycles are, on the whole, different: the movement of 54 quarters is secondary compared that of other countries. These two countries have a primary movement in 27 quarters. Likewise, in Germany cyclical movements in 18 quarters (frequency 3) and in 13.5 quarters (frequency 4) stand out, which do not occur or are more diminished in the rest of the countries. The differences are so substantial that the compulsory conclusion is that there is no convergence between the cycles.
B. Furthermore, the longest cycle of 54 quarters in Germany is desynchronised with the rest of the Eurozone. This fact can be observed graphically:



C. For the quarter periods of 27, 13.50 and 10.80, a good convergence can be observed between the national cycles of the Eurozone, apart from between Germany and Spain in the last case. However the overall percentage significance of this convergence is less.

Overall, this method therefore shows us a significant desynchronisation between Germany and the other Eurozone countries in question. In some frequencies there is a convergence, but it is secondary in significance to the final evolution of real GDP. This would seriously compromise the possibility of a joint monetary policy that could solve the problems considered.

With reference to the evolution of synchronisation, I have not employed this method because the data series would be too short to reach minimally reliable conclusions using harmonic analysis.

6. Overall conclusions.

I have employed three possible methods of empirical data analysis in order to reach a firm conclusion. The three methods do not coincide, thus preventing the results from being reliable. Therefore, the first conclusion is that the choice of method does indeed decidedly influence the conclusions we can reach regarding the convergence of the cycles.

Consequently, the following conclusions contain an amount of unquantifiable uncertainty.

In answer to the question of whether there is a high level of synchronisation between the national cycles in the Eurozone, overall there is not. The three methods produce different results, but two of them indicate that substantial differences exist between the amplitudes of the cycles, and that these differences are erratic. The third method indicates that there is no convergence between Germany and the rest of the Eurozone.

With reference to the possibility of an increase in the convergence of the national cycles, the overall answer is negative. The two methods used indicate an increase in the differences between the amplitude of the cycles, and a greater volatility in this variable.

In general, the empirical evidence implies high national costs for membership of the Eurozone, as there is not sufficient synchronisation.

7. **Bibliography.**

Agresti, A.M. and Mojon, B. (2001), "Some Stylised Facts on the Euro Area Business Cycle", Banco Central Europeo, Working Paper No. 95.

Artis, M. (2003): Is there a European Business Cycle?, CESifo Working Paper No. 1053,July.

Altavilla, C. (2004), "Do EMU Members Share the Same Business Cycle?", JMCS, Vol. 42, 5, pp. 869-896.

Álvarez Vázquez, N. J. (1985), "EI Análisis armónico en Economía", Estadística Española, No. 108, pp. 65-96.

Álvarez Vázquez, N. J., Rodríguez Ruíz, J. and González Salgueiro, C. (2005), "El Papel de la Inferencia Estocástica en Economía Cuantitativa", Rect@, Minutes 13-1, pp. 1-13.

Anguiar-Conraria, L. and Soares, M.J. (2010), "Business Cycle Synchronization and the Euro: A Wavelet Análisis", NIP MP 36/2010.

Arpaia, A. and Pichelmann, K. (2007), "Nominal and real wage flexibility in EMU", Directorate General for Economic and Financial Affairs, European Commission, Economic Papers No. 281.

Baxter, M. and King, R.G. (1999), "Measuring Business Cycles: Approximate Bandpass Filters for Economic Time Series", Review of Economics and Statistics, 81(4), pp. 575-593.

Baxter, M. and Kouparitsas, M. (2004), "Determinants of Business Cycle Comovement: A Robust Analysis", NBER Working Paper, No. 10725.

Bayoumi, T. and Eichengreen, B. (1992), "Shocking Aspects of European Monetary Unification", NBER Working Papers No. 3949.

Björksten, N., and Syrjänen, M. (2000). "How problematic are internal Euro area differences?", Bank of Finland.

Bjorksten, N. (2000), "Real Convergence in the Enlarged Euro Area: a Coming Challenge for Monetary Policy", Bank of Finland, Working Paper 1/2000.

Böwer, U. and Guillemineau, C. (2006), "Determinants of Business Cycle Synchronisation across Euro Area Countries", European Central Bank, Working Paper No. 587.

Burns, A.F. and Wesley C. M. (1946), Measuring Business Cycles, New York: National Bureau of Economic Research, 1946.

Cancelo, J. R. (2012), "Cyclical synchronization in the EMU along the financial crisis: An interpretation of the conflicting signals", European Journal of Government and Economics, Vol. 1, No. 1.

Darvas, Z. and Szapáry, G. (2004), "Business Cycle Synchronization in the Enlarged EU: Comovements in the New and Old Members", Central Bank of Hungary Working Paper, No. 2004/1

De Grauwe, P. and Mongelli, F.P. (2005), "Endogeneities of Optimum Currency Areas: What brings Countries Sharing a Single Currency Closer together?", Department of Economics, Gestão e Engenharia Industrial, Universidade de Aveiro, Working Papers de Economia No. 29.

De Haan, J. and Inklaar, R. (2001), "Is There Really an European Business Cycle?. A Comment", Oxford Economic Papers 53, pp. 215-220.

De Haan, J., Inklaar, R. and Sleijpen, O. (2002), "Have Business Cycles Become More Synchronized?", Journal of Common Market Studies, Vol. 40 (1), pp. 23-42

De Haan, J., Inklaar, R. and Jong-A-Pin, R. (2005), "Trade and Business Cycle Synchronization in OECD Countries a Re-Examination", CCSO Centre for Economic Research, Working paper 2005/08.

De Haan, J., Mink and M. Jacobs (2007), "Measuring Synchronicity and Co-movement of Business Cycles with an Application to the Euro Area", CESIFO Working Paper 2112.

De Haan, J., Inklaar, R. and Jong-A-Pin, R. (2008), "Will Business Cycles in the Euro Area Converge?. A critical Survey of Empirical Research", Journal of Economic Surveys, Vol. 22, 2, pp. 234-273.

De Lombaerde, P. (1999), "Robert A. Mundell and la Teoría de las Áreas Monetarias Óptimas", Cuadernos de Economía, v. XVIII, No. 31, pp. 39-64.

Eichengreen, B. (1991). "Is Europe an Optimum Currency Area?", National Bureau of Economic Research, Working Paper No. 3579.

Fidrmuc, J. (2001), "The Endogeneity of Optimum Currency Area Criteria, Intraindustry Trade and EMU Enlargement", Bank of Finland, Institute for Economies in Transition BOFIT, Discussion Papers No.8.

Frankel, J. A. and Rose, A. K. (1998), "The Endogeneity of the Optimum Currency Area Criteria", Economic Journal, Royal Economic Society, Vol. 108, No, 449, pp. 1009-1025.

Gächter, M., Riedl, A. and Riczberger-Grünwald, D. (2012), "Business Cycle Synchronization in the Euro Area and the Impact of the Financial Crisis", Monetary Policy and the Economy Q2/12.

Gayer, C. (2007), "A fresh Look al Business Cycle Synchronisation in the Euro Area", European Commission Directorate-General for Economic and Financial Affairs Publications, No. 287.

Giannone, D., Lenza, M. and Reichlin, L. (2009), "Business Cycles in the Euro Area", NBER Working Paper Series, Working Paper No. 1010/ Feb. 2009.

Gruben, W. C., Koo, J. and Millis, E. (2002), "How Much Does International Trade Affect Business Cycle Synchronization?", Federal Reserve Bank of Dallas, Research Department Working Paper 0203.

Hein, E. and Truger, A. (2005), "European Monetary Union: Nominal Convergence, Real Divergence and Slow Growth?", Structural Change and Economic Dynamics 16, pp. 7 – 33.

Horvath, J. (2003), "Optimum currency area theory: A selective review", Bank of Finland, Institute for Economies in Transition, BOFIT, Discussion Papers No. 15.

Kaiser, R. and Maravall, A. (1999), "Short-Term and Long-Term Trends, Seasonal Adjustment, and the Business Cycle", Research body, The Bank of Spain. Working Paper No. 9918.

Kenen, P. B. (1969), "The Theory of Optimum Currency Areas: An Eclectic View", in Mundell, R. A. and Swoboda, A. K. (Eds.), Monetary Problems of the International Economy, Chicago: University of Chicago Press.

Kenen, P. B. (2000), "Currency Areas, Policy Domains and the Institutionalization of Fixed Exchange Rates", London School of Economics, Centre for Economic Performance Discussion, Paper 467.

Kopits, G. (1999), Implications of EMU for Exchange Rate Policy in Central and Eastern Europe, Working Paper 99/9, FMI, Washington.

Krugman, P. (1993), "Lessons of Massachusetts for EMU", in Torres, F. and Giavazzi, F. (Eds.), Adjustment and Growth in the European Monetary Union, Cambridge: Cambridge University Press and CEPR. pp. 241-261

Martín, R. (2000), "EMU Versus the Regions?. Regional Convergence and Divergence in Euroland", ESRC Centre for Business Research, Working Paper No. 179.

Martirena- Mantel, A.M. (2003), "Sobre la Creación de Áreas Monetarias Óptimas. El Aporte de Robert Mundell", Economica, Vol. IL, No. 1-2, pp. 97-115.

Massmann, M. and Mitchell, J. (2004), "Reconsidering the Evidence: Are Euro Area Business Cycles Converging?", Journal of Business Cycle Measurement and Analysis Vol. 1:3, pp. 275-306.

McKinnon, R. (1963), "Optimum Currency Areas", American Economic Review, Vol. 52, pp. 717-25.

Mongelli, F. P. (2005), "What is European Economic and Monetary Union Telling us About the Properties of Optimum Currency Areas?", European Central Bank, JCMS, Vol. 43. No. 3, pp. 607–635.

Mundell, R. A. (1961), "A Theory of Optimum Currency Areas", The American Economic Review, Vol. 51, No. 4., pp. 509-517.

Toribio Dávila, J.J. (2011), "Áreas Monetarias Óptimas y la Experiencia Europea: Algunas Reflexiones", ICE No. 863, pp. 13-19.