# A COMPARISON OF THE CYCLICAL EVOLUTION OF VARIOUS GEOGRAPHIC AREAS OF REFERENCE WITH PORTUGAL*

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ABSTRACT

This article evaluates the existing relative degree of association among several developed economies, including Portugal. Using the Kalman filter the cyclical evolution of GDP in Portugal is compared with the cyclical evolution of GDP from several other economies of reference, such as the euro area, France, Germany, Greece, Ireland, Italy, Japan, Spain, the UK and the US.

## 1. Introduction

The perspectives about the enlargement of the European Union (EU) and the consequent increase of the geographical and population dimensions of the euro area have motivated researchers to analyze the main characteristics of the business cycles in the new member states and the synchrony of cycles between these countries and the euro area as a whole. On the other hand, the determinants of cyclical co-movement and the possibility of the existence of a "common European cycle" have motivated a growing literature.

An exhaustive analysis of the literature, with relevant contributions to the topic, resorting to different theoretical and methodological approaches, can be found among others, in Artis (2003), Artis, Krolzig and Toro (2004), Woźniak and Paczyński (2007) and Guerreiro (2010). In general terms, the measure of joint evolution of cycles frequently used has been the coefficient of correlation between national cycles. In line with this research, the conclusions point towards an evident homogeneity of economic cycles in the EU (Agresti and Mojon, 2001, Christodoulakis *et al.*, 1995, Wynne and Koo, 2000), with some studies supporting the existence of a common cycle in the EU[1] (e.g. Agresti and Mojon, 2001, and Wynne and Koo, 2000). However, there is a general consensus that cycles have become more similar since the process of monetary integration, *i.e.*, from the 90s onwards (e.g. Ambler *et al*. 2004; Artis and Zhang, 1997, 1999; and Artis, Kontolemis and Osborn, 1997, among others).

A large number of studies focus on a particular country. For example, studies that focused on the UK have concluded that the country presented a stronger correlation with the US than with any other European country, in particular when data from the 60s and 80s are considered. A larger correlation with European countries has been observed in the period after the German unification in the 90s (see for example, Massmann and Mitchell, 2002, and Hall and Yhap, 2003, among others). Another set of studies are regionally focused and aim to investigate the existence of a regional economic cycle. However, the

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* The opinions expressed in the article are those of the authors and do not necessarily coincide with those of the Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors.

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1 These studies, in general, refer to the period from 1980 to 1999.

exclusion of some regions of the euro area has made it difficult to obtain consensual conclusions (see, for example, Belke and Heine, 2006, Barrios and de Lucio, 2003, and Barrios *et al*., 2002).

There are only a few studies about the specific situation of Portugal and the position of the respective cycle relatively to other member states. Cavalcanti (2007), for example, uses growth accounting to analyze the Portuguese economic cycle relatively to the US; Almeida, Castro and Felix (2009, pp.74-79) analyze the cyclical characteristics of the Portuguese economy and compare them with the euro area; and Valle e Azevedo (1999) presents a descriptive analysis of the economic cycles of the EU countries including Portugal. The contribution of this paper is twofold. On the one hand, it attempts to analyze the relation between the cyclical evolution in the EMU countries, relatively to the euro area, Portugal and the US, with the objective of analysing the existing relative degree and nature of association. On the other hand, in methodological terms, we chose to use the Kalman[2] filter and the development of specific tools to conduct simulations.

To compare the cycles of the euro area (limited to 15 countries)[3] and a group of ten countries (France, Germany, Greece, Ireland, Italy, Japan, Portugal, Spain, the UK, and the US), quarterly GDP data was used (in PPP terms) for the period from the first quarter of 1961 to the first quarter of 2011, obtained from www.oecd.org.

The structure of the paper is as follows: Section 2 presents briefly the main aspects related to the methodology of analysis of the cycle and the comparative analysis between the economic cycles of several countries relatively to Portugal and the euro area; Section 3 reports the main conclusions.

## 2. Cyclical co-movement in the GDP of several economies

This section presents the general aspects of the methodology adopted to analyze the joint evolution of the economic cycles, followed by an analysis of results, first of the cycles of the several economies considered relatively to the Portuguese and the euro area cycles, for the period between 1961-Q1 and 2011-Q1, and at a disaggregated level of the countries of the euro area, for the period before and after the introduction of the euro.

### 2.1. Methodological framework

In this analysis an additive structural model is considered, where the dependent variable, $\{y_t\}$, represents the values of the observed time series of interest[4], so that,

$$y_t = \Gamma_t + C_t + \varepsilon_t \qquad (1)$$

The representation in (1) decomposes $\{y_t\}$ into a nonstationary component (trend) and a stationary component (cycle), considered as unobserved variables (Clark, 1987). Therefore, in equation (1), $\Gamma_t$ represents the trend function, $C_t$ the cyclical component and $\varepsilon_t$ the noise component (Maybeck, 1979).

The modeling of the trend and cycle in the structural model in (1) can be carried out in different ways and with different representative models. However, according to Clark (1987) and Wada and Perron (2006), the structural model most frequently used, among the class of models found in studies that involve the economic cycle, is (1) with the following specification:

2 In this analysis we will refer to the term "economy" to mention the evolution of the deviation of the cyclical component of GDP.

3 The euro area (15 countries) will be referred to hereafter as the euro area.

4 It is considered that the time series are seasonally adjusted.

$$\begin{cases} \Gamma_t = \Gamma_{t-1} + \beta_{t-1} + \delta_t \\ \beta_t = \beta_{t-1} + \theta_t \\ \phi(L) C_t = \omega_t \end{cases}$$

where the trend, $\beta_t$, uses the known formulation of Theil and Wega (Crato, 1990), in which the variable follows an expected linear growth; both the trend ($\beta_t$) and level ($\Gamma_t$) evolve according to a "random walk" (Gilchrist, 1976) and $\phi(L)$ is a finite order polynomial in the lag operator, $L$, which, in this case, adopting the proposal of Clark (1987) and Wada and Perron (2006), is autoregressive of second order, AR(2), *i.e.*, $\phi(L) = 1 - \phi_1 L - \phi_2 L^2$ and consequently, the cyclical component, $C_t$, , follows a second order autoregressive process. The complete representation of the structural model is,

$$\begin{cases} y_t = \Gamma_t + C_t + \varepsilon_t \\ \Gamma_t = \Gamma_{t-1} + \beta_{t-1} + \delta_t \\ \beta_t = \beta_{t-1} + \theta_t \\ C_t = \phi_1 C_{t-1} + \phi_2 C_{t-2} + \omega_t \end{cases} \quad (2)$$

The structural model in (2) is therefore the basis of this investigation, which is used for the representation of the observed data, $y_t$, and its unobserved components (trend, cycle and error).[5]

In this way, using the Kalman filter and GDP data for the euro area, France, Germany, Greece, Ireland, Italy, Japan, Portugal, Spain, the UK, and the US a study to isolate the cyclical component was carried out, based on (2) and its respective state space representation.

## 2.2. Aggregate analysis of the GDP cycle of several economies relatively to Portugal

Table 1 presents a set of summary results that compare the cyclical components of GDP relatively to the whole sample, *i.e.*, from the first quarter of 1961 to the first quarter of 2011, for the euro area, France, Germany, Greece, Ireland, Italy, Japan, Spain, the UK, and the US in relation to Portugal, sustained through statistical measures of the average characteristics of the economic cycles.

The analysis of table 1 allows for the identification of several stylized facts that need to be highlighted. **First**, all cycles have a positive correlation with the Portuguese cycle in the period under analysis, with values between 0,24 and 0,74. **Second**, there is an apparent moderate high (≥70%) contemporaneous correlation between Portugal and France and also with the euro area, and a moderate (>50%) correlation with Spain, Germany and Italy. The lowest contemporaneous correlation values are observed with respect to the countries which are not members of the Economic and Monetary Union, namely the US, Japan and the UK, but also Greece. **Third**, the different values of correlation indicate larger or smaller lagged periods between cycles. The lags (or leads) indicate the average number of quarters that the cycle of each country is lagged (or leading) in relation to Portugal, and their values vary between -4 and 4 quarters, during which a maximum correlation is observed. The tuning between the strength of contemporaneous correlation and the degree of lagging of the cycles of the countries is observed. In general, a small lag is related to strong contemporaneous correlation of the GDP cycles of the different countries. Hence, no lags are observed relatively to the euro area, France and Germany, a lag of one quarter is observed in relation to the Spanish cycle, which anticipates the Portuguese cycle, and a large lag in relation to the US and Greek cycles, which anticipate the Portuguese cycle by 12 months (4 quarters), respectively. This

5 The model in (2) will later be transformed into state-space formulation (see Guerreiro, Rodrigues and Andraz, 2010 for details), to make the subsequent application of the Kalman filter possible (Guerreiro, 2010), for the extraction of the signals (values) of each of the components (variables of interest).

**Table 1**

**GDP CYCLE STATISTICS OF SEVERAL REFERENCE ECONOMIES | 1961-Q1 TO 2011-Q1**

| | G | EA | S | US | F | G | Ire | I | J | P | UK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation (Pearson) | 0,55 | 0,70 | 0,56 | 0,26 | 0,74 | 0,24 | 0,42 | 0,54 | 0,39 | | 0,35 |
| Lead (+) Lag (-) | 0 | 0 | 1 | 4 | 0 | 4 | 0 | 0 | -2 | | -2 |
| Synchrony (%) | 65,50 | 65,50 | 63,00 | 59,00 | 68,00 | 54,50 | 53,50 | 62,50 | 58,00 | | 59,50 |
| Standard deviation | 0,46 | 0,43 | 0,44 | 0,43 | 0,47 | 0,29 | 0,40 | 0,47 | 0,37 | 0,36 | 0,39 |
| Ratio of the standard deviation with GDP | 1,28 | 1,19 | 1,22 | 1,19 | 1,31 | 0,81 | 1,11 | 1,31 | 1,03 | 1,00 | 1,08 |
| Autocorrelation $x(t)-x(t-1)$ | 0,95 | 0,94 | 0,95 | 0,96 | 0,96 | 0,90 | 0,94 | 0,91 | 0,91 | 0,97 | 0,93 |
| Autocorrelation $x(t)-x(t-2)$ | 0,82 | 0,82 | 0,81 | 0,87 | 0,87 | 0,70 | 0,80 | 0,72 | 0,70 | 0,88 | 0,78 |
| Autocorrelation $x(t)-x(t-3)$ | 0,65 | 0,66 | 0,63 | 0,75 | 0,73 | 0,52 | 0,61 | 0,50 | 0,45 | 0,75 | 0,59 |

**Source:** Authors' calculations.

**Note:** Countries are represented as follows: G-Germany, EA - the euro area, S-Spain, US-United States, F-France, G-Greece, IRE-Ireland, I-Italy, J-Japan, P-Portugal and UK - the United Kingdom.

lag is quite long relatively to the average duration of the cycle, making it difficult, with these data and these statistical measures to associate the cyclical evolution of one variable with another, in the case of these countries. For Japan and the UK, the existence of a moderate/low (>30%) correlation is followed by a lag of the Portuguese cycle anticipating the cycles of these countries in about 6 months (2 quarters). **Fourth**, the synchronization[6] of the cycles presents a low amplitude of variation, between 53,5% and 68%. The largest level of synchronization occurs with the French cycle, 68%, and with the German and euro area cycles, 65,5%. The lowest value, of 53,5%, corresponds to the level of synchronization with the Irish cycle. **Fifth**, the degree of volatility, measured by the standard deviation, presents a small interval of variation, between 0,29 and 0,47. The less volatile series are the Greek (0,29), the Portuguese (0,36), the Japanese (0,37) and that from the UK (0,39), so that an impact of a shock in these economies, taking into consideration these values, will eventually have smaller impacts than on the other countries under analysis, which present volatility values between 0,40 and 0,47. It is also observed that, in general, the cyclical fluctuations in the economies considered are greater than the fluctuations of the Portuguese cycle, except for Greece, where the fluctuations correspond on average to about 81% of the cyclical fluctuations in Portugal. **Sixth**, strong persistence is observed in all economies, when evaluated through the values of the autocorrelation, with values that vary between 0,90 and 0,97, 0,70 and 0,88, and 0,45 and 0,75, when one, two and three lags are considered, respectively.

The existence of historical relationships between economies such as, for instance, between the US and the UK, the geographical proximity, such as, for example, between Portugal and Spain, as well as the effects associated with the integration in the euro area of some economies under analysis and the dimension of the individual economies, among others, are important factors that need to be taken into consideration, in the analysis of the cyclical influences in the different economic areas.

Using only summary average values, such as those in table 1, can in certain circumstances be less useful than the immediate contemporaneous information about the cyclical evolution of the different economies, thus leading us to complement the previous analysis with a graphical analysis. For the graphical comparison of the cyclical evolution of the different economies under analysis, the values of the series have been normalized using the following formula:

6 The values of "synchronization" define the percentage points of positive and negative growth in common (in time) in the series under analysis, *i.e.*, define the points where the cyclical components increase and decrease simultaneously.

$$Norx_t = \frac{\left(x_t - x_{Minimum}\right)\left(Norx_{Maximum} - Norx_{Minimum}\right)}{x_{Maximum} - x_{Minimum}} + Norx_{Minimum},\ t = 1,\ldots,n$$



where $Norx_t$ is the normalized value of the series, $x_t$ is the value of the series at time $t$, and $Norx_{Maximum}$ and $Norx_{Minimum}$ are the maximum and minimum normalized values, respectively. In the present study, the normalized values, $Norx_t$, are defined in the closed interval [-1, 1], *i.e.*, $Norx_{Maximum} = 1$ and $Norx_{Minimum} = -1$, so that the previous expression can be simplified as,

$$Norx_t = \frac{2\left(x_t - x_{Minimum}\right)}{x_{Maximum} - x_{Minimum}} - 1,\ t = 1,\ldots,n$$

From the analysis of the normalized cyclical evolution over the complete sample, from 1961-Q1 to 2011-Q1, it is observed that there is cyclical synchronization (*i.e.* common periods of positive and negative growth) between Portugal and the euro area, as well as with the largest economies, such as France, Germany, Italy and the UK. However, contrary to these economies, Portugal did not register, at the end of the sample, a change in the recessive trend of the last years. Portugal also presents a high cyclical coincidence with Spain, in particular since the adhesion of these two countries to the European Community in 1986, however, registering contrary movements from 2009 onwards. It is also possible to establish an almost perfect synchrony between Portugal and the US from 1995 onwards. The situation in relation to Greece presents some non-synchrony between 1960 and 2000, but since 2002 there seem to exist similarities in their evolutionary paths, with the Greek cycle slightly anticipating that of the Portuguese economy. Also Ireland and Portugal present many non-synchronies. However in recent years, in particular since 2004, the Irish economy seems to evolve in synchrony with the euro area and, therefore, with Portugal. Finally, comparing the cyclical evolution of Japan and Portugal, common periods of evolution and nonsynchronous phases of positive and negative growth are observed.

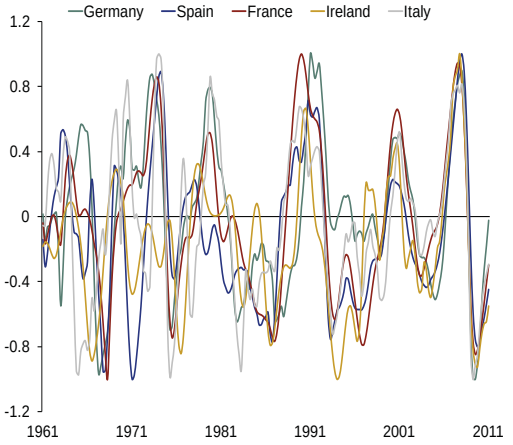
These facts suggest some uniformity between the different economies of the euro area countries under analysis, where we highlight in some more recent periods the non-synchrony behavior of the Portuguese and Greek cycles in relation to the other euro area economies, the US and Japan.

From chart 1 a strong cyclical uniformity in the evolution of some euro area countries can be observed, namely for France, Germany, Ireland, Italy and Spain, in the period from 1961-Q1 to 2011-Q1, highlighting the extreme affinity over the last decade, *i.e.*, in the period after 2001.

Chart 2 presents the joint evolution of the two largest economies of the euro area (France and Germany) relatively to Greece and Portugal, where the existing synchrony/ nonsynchrony in these four economies over the last decade is highlighted.

**Chart 1**

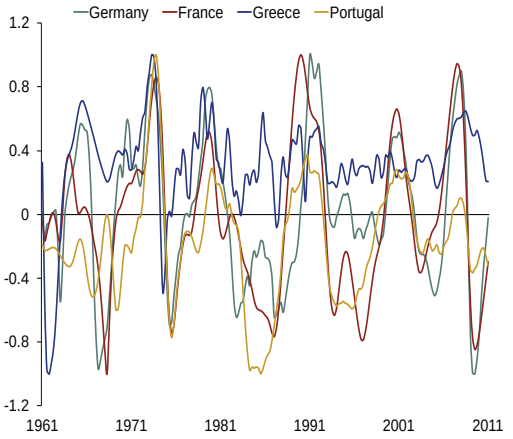
**CYCLICAL EVOLUTION | FRANCE, GERMANY, IRELAND, ITALY AND SPAIN**




**Source:** Authors' calculations.

**Chart 2**

**CYCLICAL EVOLUTION | FRANCE, GERMANY, GREECE AND PORTUGAL**




**Source:** Authors' calculations.

## 2.3. Analysis of the GDP cycle of various economies relatively to Portugal over the last 10 years

Following the previous analysis of identification of the main stylized facts in the sample period under analysis, it becomes relevant to investigate the cycles of these economies in the periods before and after the introduction of the euro. Consequently, the values obtained with the Kalman filter for the variables observed over the period from 1961-Q1 to 2011-Q1, normalized between -1 and 1, were compared in the time periods 1961-Q1 to 2001-Q4 and 2002-Q1 to 2011-Q1.[7] Tables 2 and 3 present the same set of statistical measures of table 1, thus facilitating the comparison with the cyclical components of GDP for the two sub-periods under analysis.

Table 3 indicates that there is an apparent high contemporaneous correlation between Portugal on the one hand, and the euro area, France, Germany, Ireland and Italy, on the other, with values ranging between 0.70 and 0.82 . Between Portugal and Spain and the UK, the contemporaneous correlation is moderate/high, 0.69 and 0.67, respectively. Finally, it should be noted that the gap between the cycles in Portugal and Greece is large, and that contemporaneous correlation is very low. The comparison with the levels of correlation observed in the period before the introduction of the euro, given in table 2, allows us to conclude that with the exception of Greece, correlation between Portugal and other economies, inside and outside the European area, increased significantly over the last decade.

The degree of synchrony of the Portuguese economy with all the other economies increased after 2001, and the maximum value was observed with the euro area, 80.56%, followed by Ireland, Japan, France and Germany, which denotes an increase in synchronization with the Irish and Japanese economies in the post-euro period.

Volatility, measured by the standard deviation increased over the last period considered, with values ranging between 0.49 and 0.68, when compared with the range between 0.31 and 0.50 obtained for

7 Given the specific characteristics of the Kalman Filter, the results for the period from 2002-Q1 to 2011-Q1 are less sensitive to the choice of the starting values of the filter (for more details see Guerreiro, Rodrigues and Andraz, 2010).

**Table 2**

**GDP CYCLE STATISTICS FOR SEVERAL REFERENCE ECONOMIES | 1961-Q1 TO 2011-Q1**

| | G | EA | S | US | F | G | Ire | I | J | P | UK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation (Pearson) | 0,57 | 0,76 | 0,59 | 0,24 | 0,78 | 0,23 | 0,43 | 0,54 | 0,41 | | 0,34 |
| Lead (+) Lag (-) | 0 | 0 | 2 | 4 | 0 | 4 | -1 | 0 | -2 | | -2 |
| Synchrony (%) | 64,42 | 61,69 | 60,74 | 58,28 | 66,26 | 51,53 | 51,53 | 58,90 | 53,37 | | 56,44 |
| Standard deviation | 0,45 | 0,50 | 0,44 | 0,42 | 0,46 | 0,31 | 0,43 | 0,47 | 0,41 | 0,39 | 0,39 |
| Ratio of the standard deviation with GDP | 1,15 | 1,28 | 1,13 | 1,08 | 1,18 | 0,79 | 1,10 | 1,21 | 1,05 | 1,00 | 1,00 |
| Autocorrelation $x(t)-x(t-1)$ | 0,95 | 0,95 | 0,95 | 0,96 | 0,97 | 0,89 | 0,94 | 0,90 | 0,91 | 0,96 | 0,93 |
| Autocorrelation $x(t)-x(t-2)$ | 0,83 | 0,83 | 0,81 | 0,86 | 0,87 | 0,69 | 0,79 | 0,71 | 0,73 | 0,88 | 0,78 |
| Autocorrelation $x(t)-x(t-3)$ | 0,68 | 0,69 | 0,62 | 0,75 | 0,75 | 0,51 | 0,59 | 0,48 | 0,50 | 0,75 | 0,60 |

**Source:** Authors' calculations.

**Note:** Countries are represented as follows: G-Germany, EA - the euro area, S-Spain, US-United States, F-France, G-Greece, IRE-Ireland, I-Italy, J-Japan, P-Portugal and UK - the United Kingdom.

**Table 3**

**GDP CYCLE STATISTICS FOR SEVERAL REFERENCE ECONOMIES | 2002-Q1 TO 2011-Q1**

| | G | EA | S | US | F | G | Ire | I | J | P | UK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Correlation (Pearson) | 0,82 | 0,75 | 0,69 | 0,54 | 0,72 | 0,19 | 0,70 | 0,76 | 0,52 | | 0,67 |
| Lead (+) Lag (-) | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | -1 | | 0 |
| Synchrony (%) | 75,00 | 80,56 | 72,22 | 61,11 | 75,00 | 66,67 | 63,89 | 77,78 | 77,78 | | 72,22 |
| Standard deviation | 0,55 | 0,57 | 0,58 | 0,68 | 0,58 | 0,62 | 0,57 | 0,56 | 0,49 | 0,50 | 0,50 |
| Ratio of the standard deviation with GDP | 1,10 | 1,14 | 1,16 | 1,36 | 1,16 | 1,24 | 1,14 | 1,12 | 0,98 | 1,00 | 1,00 |
| Autocorrelation $x(t)-x(t-1)$ | 0,93 | 0,94 | 0,95 | 0,94 | 0,95 | 0,91 | 0,95 | 0,93 | 0,88 | 0,81 | 0,93 |
| Autocorrelation $x(t)-x(t-2)$ | 0,74 | 0,79 | 0,82 | 0,84 | 0,83 | 0,75 | 0,82 | 0,77 | 0,62 | 0,53 | 0,75 |
| Autocorrelation $x(t)-x(t-3)$ | 0,49 | 0,58 | 0,64 | 0,71 | 0,65 | 0,58 | 0,65 | 0,56 | 0,30 | 0,28 | 0,50 |

**Source:** Authors' calculations.

**Note:** Countries are represented as follows: G-Germany, EA - the euro area, S-Spain, US-United States, F-France, G-Greece, IRE-Ireland, I-Italy, J-Japan, P-Portugal and UK - the United Kingdom.

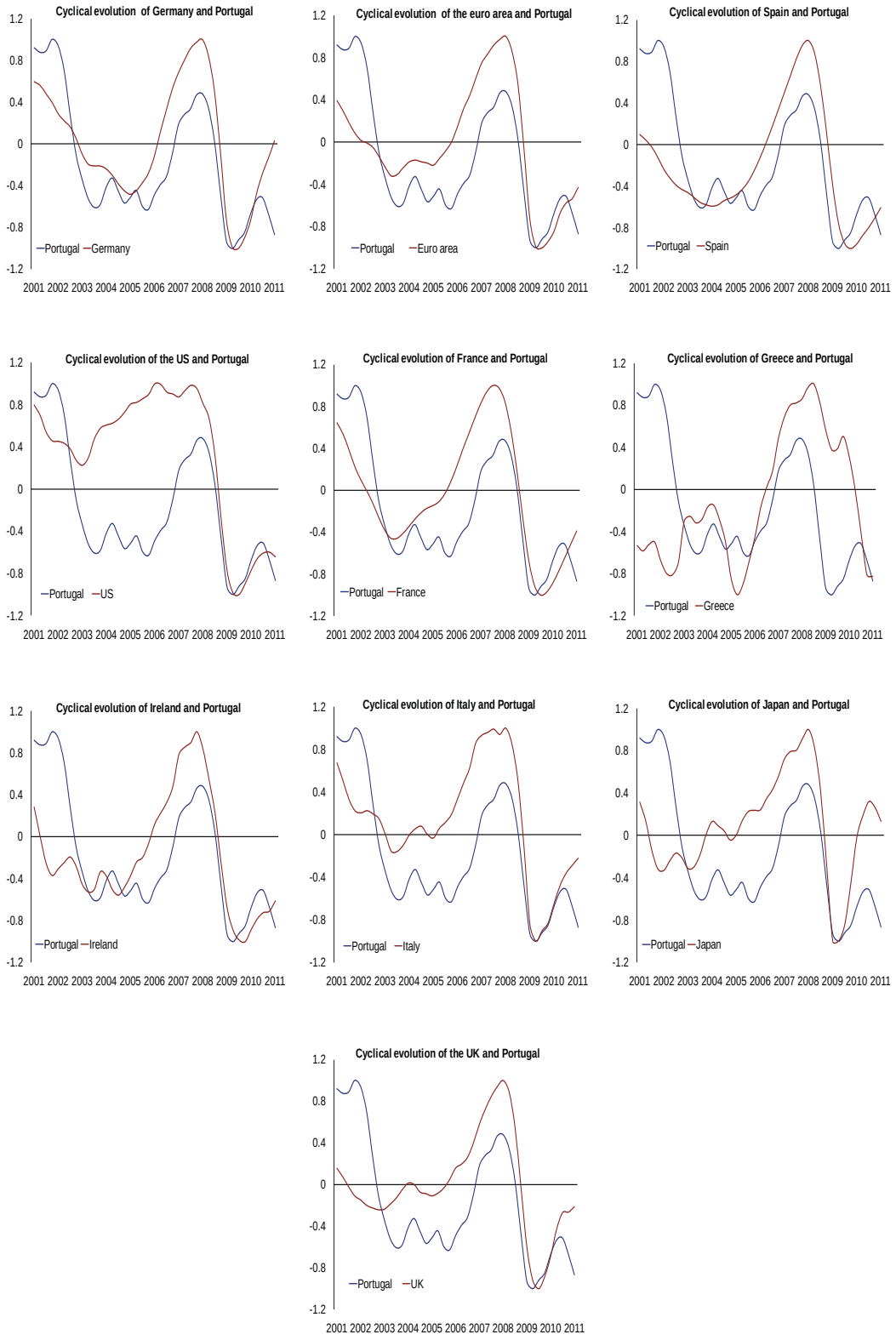
the previous period. The lowest values are recorded for Japan (0.49), Portugal (0.50) and the UK (0.50), and higher values are observed for the US (0.68) and Greece (0.62). In terms of the Portuguese cyclical fluctuation, it appears that the other economies report higher oscillations, having, however, registered a decrease in almost all cases, except for Greece, Ireland, Spain and the US.

The autocorrelations in the various countries under study continue to suggest the continuity of strong persistence. However, there is a reduction in the values of correlation after 2001, particularly in the higher-order correlations, which is certainly not independent from the effects of adopting the single currency by the EMU member states. However, there are exceptions, such as Greece, Ireland and Italy, where persistence was accentuated over the last decade.

The standard cyclical evolution of the euro area, France, Germany, Greece, Ireland, Italy, Portugal, Spain, the UK and the US, over the last decade, is presented in chart 3.

## Chart 3

### CYCLICAL EVOLUTION OF THE COUNTRIES UNDER ANALYSIS AND PORTUGAL | 2001-Q1 TO 2011-Q1



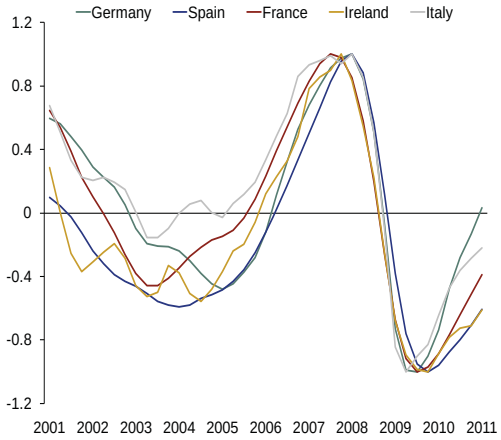

**Source:** Authors' calculations.

The observed facts suggest that the great uniformity observed over the whole sample period between the different economies of the euro area, namely France, Germany, Ireland, Italy and Spain, continues to hold over the last decade. This is clear from chart 4.

It appears that, in most recent years, in particular from the mid-2009 onwards, Greece differs from the group of other euro area member countries, by evolving in descending order, contrary to the general tendency. For Portugal a similar behavior is observed from mid-2010 onwards. Chart 5 highlights this aspect by comparing the cyclical evolution of the euro area, Portugal and Greece.

**Chart 4**

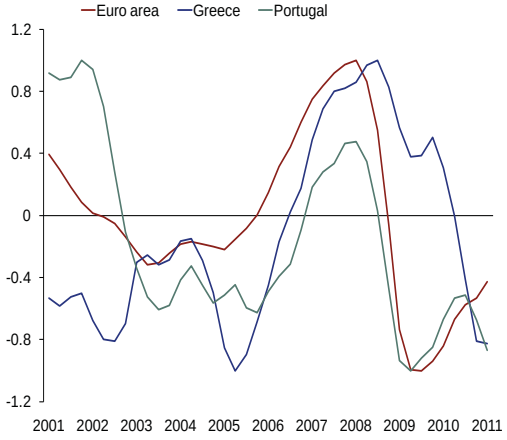
**CYCLICAL EVOLUTION OF FRANCE, GERMANY, IRELAND, ITALY AND SPAIN | 2001-Q1 TO 2011-Q1**




**Source:** Authors' calculations.

**Chart 5**

**CYCLICAL EVOLUTION OF THE EURO AREA, GREECE AND PORTUGAL | 2001-Q1 TO 2011-Q1**




**Source:** Authors' calculations.

## 2.4. Analysis of the GDP cycle of several advanced economies in relation to the euro area

Taking into account the differences in monetary units in circulation in the countries under analysis, it was also decided to investigate the cyclical coincidences between the US, Japan and the UK with the euro area during the period from 1961-Q1 to 2011-Q1 and the sub-periods before and after the introduction of the euro.

Tables 4, 5 and 6 and chart 6 present the main results. Japan, the US and the UK report a moderate and moderate/high contemporaneous correlation with the euro area, and it is observed that this correlation has increased significantly over the past 10 years, denoting an increased level of economic integration. However, it appears that the US cycle anticipates the average cyclical phenomenon in the euro area by two quarters. Instead, the cycles of Japan and the UK anticipate, on average, the cycle of the euro area by a quarter. The degree of synchronization is also high throughout the period, but again, over the last period economies have become more synchronized, registering values of 91.7% for the US. Volatility registered an increasing trend in all economies in the sample period under analysis, recording the highest figures over the last 10 years, suggesting higher volatility in the US and lower volatility in Japan, the UK, and the euro area.

Given the existing similarities between the Portuguese cyclical evolution and that of the euro area, the conclusions can, therefore, be extrapolated from those made for Portugal with the cycles of the US, Japan and the UK.

**Table 4**

**STATISTICS OF THE GDP CYCLE IN THE EURO AREA, US, JAPAN AND THE UK**

| | EA | US | J | UK |
|---|---|---|---|---|
| Correlation (Pearson) | | 0,51 | 0,63 | 0,65 |
| Lead (+) Lag (-) | | -2 | -1 | -1 |
| Synchrony (%) | | 63,50 | 61,50 | 71,00 |
| Standard Deviation | 0,43 | 0,43 | 0,37 | 0,39 |
| Ratio of the standard deviation with GDP | 1,00 | 1,00 | 0,86 | 0,91 |

**Source:** Authors' calculations.

**Table 5**

**STATISTICS OF THE GDP CYCLE IN THE EURO AREA, US, JAPAN AND THE UK | 1961-Q1 TO 2001-Q4**

| | EA | US | J | UK |
|---|---|---|---|---|
| Correlation (Pearson) | | 0,41 | 0,54 | 0,56 |
| Lead (+) Lag (-) | | -2 | -1 | -2 |
| Synchrony (%) | | 61,69 | 58,28 | 66,26 |
| Standard Deviation | 0,50 | 0,42 | 0,41 | 0,39 |
| Ratio of the standard deviation with GDP | 1,00 | 0,84 | 0,82 | 0,78 |

**Source:** Authors' calculations.

**Table 6**

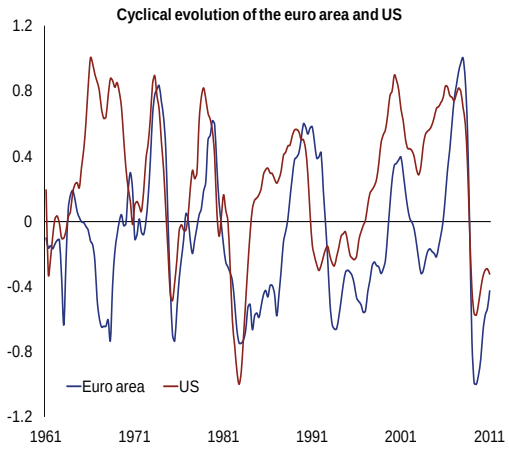
**STATISTICS OF THE GDP CYCLE IN THE EURO AREA, US, JAPAN AND THE UK | 2002-Q1 TO 2011-Q1**

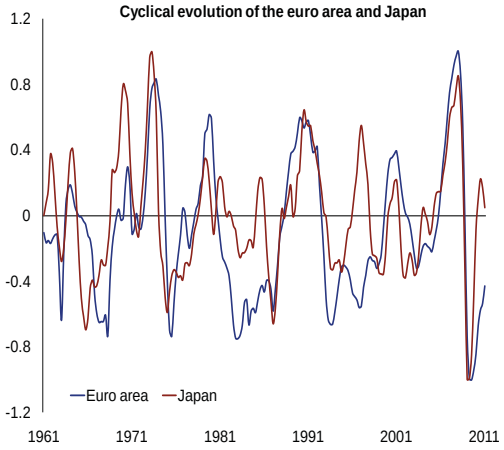
| | EA | US | J | UK |
|---|---|---|---|---|
| Correlation (Pearson) | | 0,79 | 0,83 | 0,97 |
| Lead (+) Lag (-) | | -1 | -1 | 0 |
| Synchrony (%) | | 69,44 | 75,00 | 91,67 |
| Standard Deviation | 0,57 | 0,68 | 0,49 | 0,50 |
| Ratio of the standard deviation with GDP | 1,00 | 1,19 | 0,86 | 0,88 |

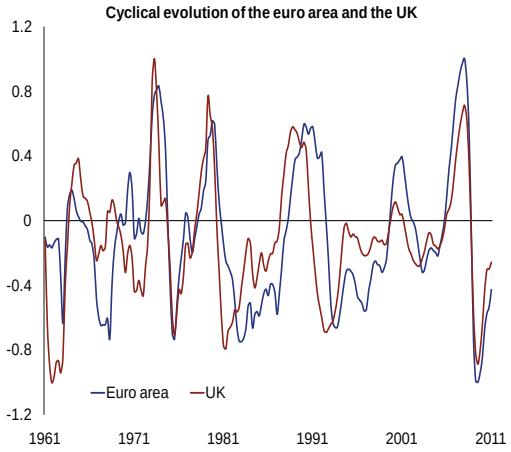
**Source:** Authors' calculations.

## Chart 6

### CYCLICAL EVOLUTION OF THE COUNTRIES UNDER STUDY AND THE US




**Source:** Authors' calculations.

## 3. Conclusion

This study analyses the evolution of the Portuguese GDP cycle and that of several reference economies, in particular the euro area, France, Germany, Greece, Ireland, Italy, Japan, Spain, the UK and the US. The results underpin several ideas referenced in the literature regarding the cyclical association of the economies investigated.

The medium and high contemporaneous correlation between Portugal and some countries of the euro area and the fact that the Portuguese cycle decreases from mid-2010 onwards seem to be relevant factors. On the other hand, it appears that cyclical synchronization of Portugal in the period 2001-Q1 to 2011-Q1 is mostly with the euro area. When we consider the period 1961-Q1 to 2011-Q1, the synchronization is greater with France. In the period 2001-Q1 to 2011-Q1, the Portuguese economy was the least volatile (after Greece), among all economies of the euro area, suggesting that the impact of a shock in the Portuguese and Greek economies, have a lower amplification. In this same period, the US emerged as the more volatile economy.

The US cycle also anticipates the cycle of the euro area member states and displays great synchronization with those economies. In late 2010, the US cycle seems to start a process of descent that is not accompanied by most countries in the euro area.

It is natural that the evolution of the Portuguese business cycle, as well as other economies' cycles, undergoes changes resulting from the process of economic and financial adjustment. The future evolution of the Portuguese trend and cycle will be determined largely by the balance of the results of the profound changes that the economy is undergoing.

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