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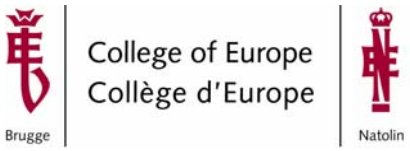

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Regional Business Cycle Synchronization in Europe?

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BEER paper n ° 11

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Abstract

We analyse regional business cycle synchronization in the Euro Area, using Gross Value Added in 53 NUTS 1 regions for a period of thirty years (1975-2005), detrended by Hodrick-Prescott and the Christiano-Fitzgerald filters. We conclude that, on average, synchronization has increased for the period considered with exceptions during the eighties and the beginning of the nineties. Still, the correlation of the business cycle in some regions with the benchmark remained low or even decreased. Our findings also support the hypothesis of the existence of a 'national border' effect.

Key words: business cycles, synchronization of business cycles, regions.

JEL codes: E32, F42.

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1. Introduction

Many studies have examined to what extent business cycles of the countries in the Euro Area have become similar. Other studies have examined the driving forces of the co-movement of output (see De Haan *et al*. 2007 for a survey). These studies are highly relevant from a policy perspective. If the synchronization of business cycles in the Euro Area has increased and will further increase due to economic and monetary integration, the well-known critique that a common monetary policy may not be equally good for all countries or regions in the union ("one size does not fit all") can be dismissed. This 'optimistic view' is popular among European policy makers. For instance, according to the president of the European Central Bank (ECB):

> "We can be reasonably confident in the increasing integration of European countries, and in the fact that economic developments are becoming more and more correlated in the area. This has been highlighted, in the academic field, by several empirical investigations: I would mention authors like Artis and Zhang (1999) who found evidence that business cycles are becoming more synchronous across Europe" (Trichet, 2001, pp. 5-6).

As economic policies in the euro area have become similar than before the start of the currency union and are likely to become even more similar, business cycle synchronization will increase (Inklaar *et al*., 2007).

Furthermore, economic and monetary integration will stimulate trade relations, which in turn, will lead to business cycle synchronization (Frankel and Rose, 1998). However, Krugman (1991, 1993) argues that integration will lead to regional concentration of industrial activities. In Europe a similar concentration of industries may take place as in the US mainly because of economies of scale and scope. Due to this concentration process, sector-specific shocks may become region-specific shocks, thereby increasing the likelihood of asymmetric shocks and diverging business cycles. So, the 'pessimistic view' holds that business cycles in the Euro Area, especially at the regional level, may become more divergent in the future.

In this paper, we focus on the synchronisation of regional business cycles in the Euro Area, using Gross Value Added covering a range of 53 NUTS 1 regions for a period of thirty years (1975-2005). The regional cycle is computed by using the Hodrick-Prescott and the Christiano-Fitzgerald filters. We measure the co-movement of the regional cycles and the Euro Area cycle in terms of their correlation coefficients. We conclude that, on average, synchronization has increased for the period considered with some exceptions during the eighties and the beginning of the nineties. Still, the correlation of the business cycle in some regions with the benchmark remained low or even decreased. Our findings also support the hypothesis of the existence of a 'national border' effect.

The remainder of the paper is organized as follows. Section 2 reviews previous studies on synchronization of business cycles of regions in Europe. Section 3 outlines our data and method, while section 4 examines the evolution of Euro Zone regional cyclical affiliations using various analytical tools. Section 5 considers the importance of the national border as a driver of regional synchronization. Finally, section 6 offers our conclusions.

2. Previous literature

Most of the existing literature on business cycle synchronization in Europe focuses at the national level. Those studies that examine regional cycles use different methodologies and datasets. There is not a common approach to analyse regional business cycles, while

datasets and methodologies vary considerably, making it difficult to compare the results of previous studies.

Those studies that we aware of, are summarized in Table 1. A quick glance at the table suffices to conclude that none of the studies employs a comprehensive database including all the Euro Area regions. It is therefore difficult to conclude whether there is a regional business cycle in the Euro Area on the basis of the existing literature.

Table 1. Review of the literature on regional business cycles

Authors	**Data Used**	**Measure of the cycle**	**Synchronization Measure**	**Conclusions**
De Grauwe and Vanhaverbeke (1993)	GDP, employment	Growth rates	Correlations between measures of dispersion in real exchange rate and output and employment growth rates	Exchange rate flexibility plays a role on regional adjustment to shocks. Asymmetric shocks occur frequently in regions.
Fatás (1997)	Employment, 38 European regions from FR, DE, IT and UK	Growth rates	Two sub-samples (pre- and post-ERM), contemporaneous correlation with the EU12 and the country aggregate	Cross-country regional correlation has increased whereas within country regional correlation has decreased.
Clark and van Wincoop (1999)	GDP, employment Control variables: Krugman index, trade measure and monetary and fiscal policies 9 U.S census regions and 38 European regions from FR, DE, IT and UK	Percentage changes, HP	Pairwise correlations using GMM	European national borders are stronger than in the US: Explained by lower level of trade and higher specialization. Single currency is not likely to soon increase business cycle synchronization.
Barrios *et al*. (2002)	GDP, Control variables: Krugman index, UK regions and Euro Zone countries	HP	Pairwise correlations using GMM	Cyclical divergence between UK and Euro Zone. Specialization does not explain dissimilarities between UK regions and Euro Zone.
Barrios and de Lucio (2003)	Employment, EU NUTS2 regions	HP	Pairwise correlation using GMM	Positive impact of economic integration on regional business cycles' correlation. Convergence nests may appear in Europe. Relative size and industrial structure are main determinants of business cycles affiliations.
Belke and Heine (2006)	Employment, 30 regions from BE, FR, DE, IE, NL, and ES Control variables: Index of conformity, Finger-Kreinin index, Specialization coefficient	HP	Pairwise bivariate correlations	Employment growth is more synchronized when there is similar sector structure. Degree of synchronicity has declined in last years.

3. Data and method

Research on the synchronization of business cycles of countries generally employs GDP and/or Industrial Production. However, these variables are not available at the regional level. Moreover, regional data on a quarterly or monthly basis are scarce. For our empirical analysis we therefore use annual data on Gross Value Added (GVA) per capita at 1995 prices for NUTS1 regions of the Euro Area.[1] Although this variable has not been used in previous studies on business cycle synchronization, we believe that it is an adequate variable for our purpose as GVA represents the added value of all sectors of the economy. The source of the data is Cambridge Econometrics, which itself retrieves the information from Eurostat and the national services of statistics. The series cover a period of thirty years, from 1975 to 2005, except for Portugal for which the data start in 1978.

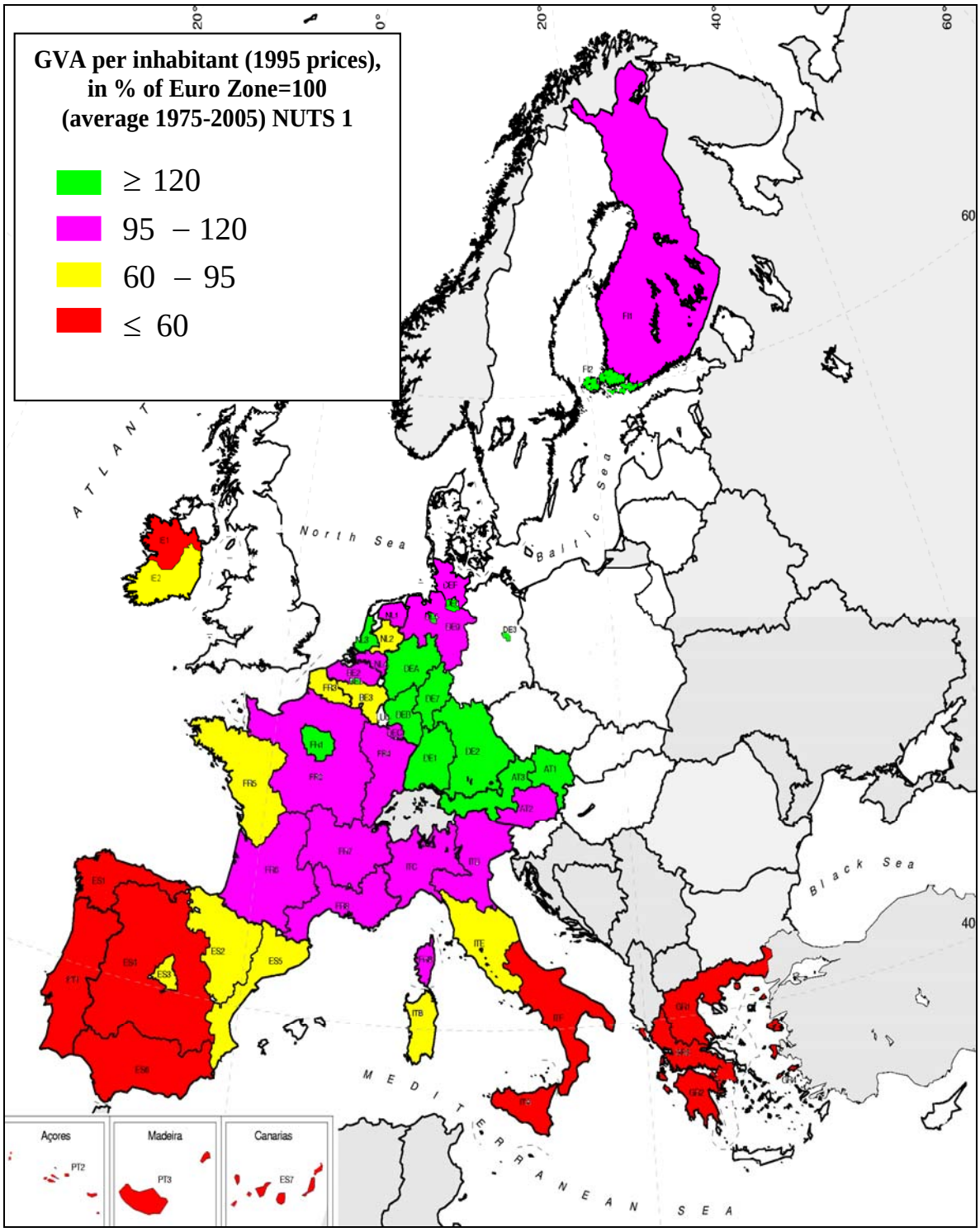
In choosing the sample, we faced a trade-off between geographical coverage and the length of the series. We sacrificed longer series in order to cover a wider range of regions. Still, a thirty years period should suffice to capture business cycles fluctuations. It also allows for comparison with previous studies that consider a similar time span.[2]

Figure 1 shows the average regional GVA as a percentage of the Euro Zone GVA for the period of reference. It is important to have a notion of the relative weight of every region in the Euro Zone in order to correctly interpret our results. Obviously, if we find that a region representing a huge percentage of the Euro Zone economy is not synchronized with the rest, the implications for the effectiveness of monetary policy and the viability of the currency union will be more important than if the region has a limited share in the Euro Zone economy.

We follow previous studies and focus on "deviation cycles", measuring the cycle as the deviation from a trend. For the purposes of signal extraction, we use two techniques: the Hodrick-Prescott (HP) filter and the Cristiano-Fitzgerald (CF) band-pass filter. The HP filter, developed by Hodrick and Prescott (1997), has been widely used in the business cycles literature.

[1] See Annex A for a detailed list of the regions and the codes assigned to them.
[2] Fatás (1997) and Barrios *et al*. (2002) have a sample running from 1966 to 1992, and 1966 to 1997, respectively.

Figure 1. Regional GVA (1975-2005)



The filter is obtained by minimizing the following function:

$$\sum_{t=1}^{N}\left(x_t - x_t^T\right)^2 + \lambda\left(\left(x_t^T - x_{t-1}^T\right) - \left(x_{t-1}^T - x_{t-2}^T\right)\right)^2$$

x_t represents the original data, x_t^T the trend and λ a smoothing parameter. In other words, it minimizes the variance of the cycle subject to a penalty for variation in the second difference of the trend (Massmann *et al*., 2003). We set the smoothing parameter at 6.25 as proposed by Ravn and Uhlig (2002).

In addition, we use the band pass filter suggested by Christiano and Fitzgerald (2003). We filter GVA growth rates, since correlations of filtered series in levels or log levels reflect long-term relationship rather than business cycle affiliation (Camacho *et al*., 2006). As it turned out that – with one exception – both filtering methods yielded very similar results, we only report the outcomes using the HP filter (all other results are available on request).

The literature on business cycles accounts for several techniques for measuring co-movements of cycles. Even though it has been criticized, the Pearson correlation coefficient is the most widely used technique.[3] De Haan *et al*. (2007) show that the theoretical measure based on the potential loss of welfare due to asymmetric GDP fluctuations in the absence of risk sharing mechanisms as constructed by Kalemli-Ozcan *et al*. (2001) bears a strong resemblance with the correlation coefficient.

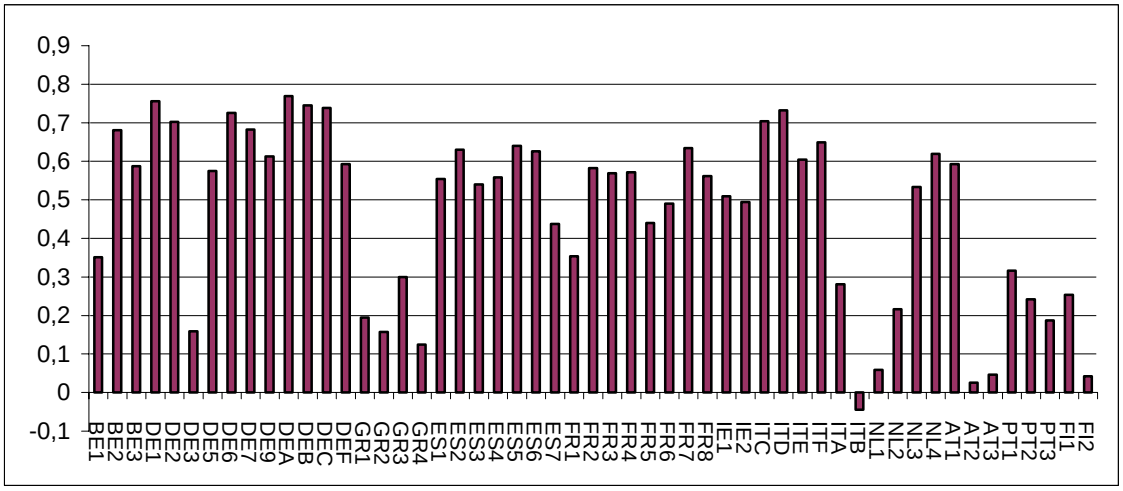
4. Synchronization of regional business cycle with the reference cycle

For our analysis, we compute the cross-correlation matrix for the full sample and time period considered (1978-2005) for the NUTS1 regions of the Euro Area. Given the size of the matrix, we focus on the correlations of the regional cycles with the Euro Zone cycle. The results are shown in Figure 2. It follows from the graph that the degree of synchronization with the Euro Zone cycle varies substantially among regions. This variation is much higher than the variation usually found in studies on business cycle synchronization in countries in the Euro Area. These results are in line with the findings of

[3] For a critique, we refer to Den Haan (2000).

De Grauwe and Vanhaverbeke (1993) and Fatás (1997), who also found larger divergences at the regional level.

Figure 2. Correlation of regional cycles with the Euro Area cycle (1978-2005)



Yet, the correlation coefficients as shown in Figure 2 do not tell us much about the effect of European integration on the synchronization of business cycles. For that end, we need to analyse the evolution of the correlation coefficient over time. Previous researchers examined the impact of integration by splitting the sample in various periods, like before and after the start of the European Exchange Rate Mechanism.[4] In more recent research rolling windows are used to observe the evolution of the correlation coefficient (see, for instance, Massmann and Mitchel, 2004). We opt for using a rolling window of 8 years; the results for the average correlation coefficient of all regions with the Euro Area reference cycle are shown in Figure 3.

As Figure 3 shows, the average correlation decreased during the eighties, recuperated in the nineties and remained high in successive years except for the very beginning of the nineties. The average correlation coefficient of the regional and the Euro Area business cycle may be influenced by outliers, i.e., observations that are far away from the rest of the data

[4] For instance, Artis and Zhang (1997, 1999) break their sample in two intervals corresponding with the period before and after the start of the ERM and conclude that business cycles have become more synchronized during the ERM phase. However, Inklaar and De Haan (2001) dispute this finding. See also Fatás (1997).

Figure 3. Average regional correlation with the Euro Area: 8-year rolling windows, (1978-2005)

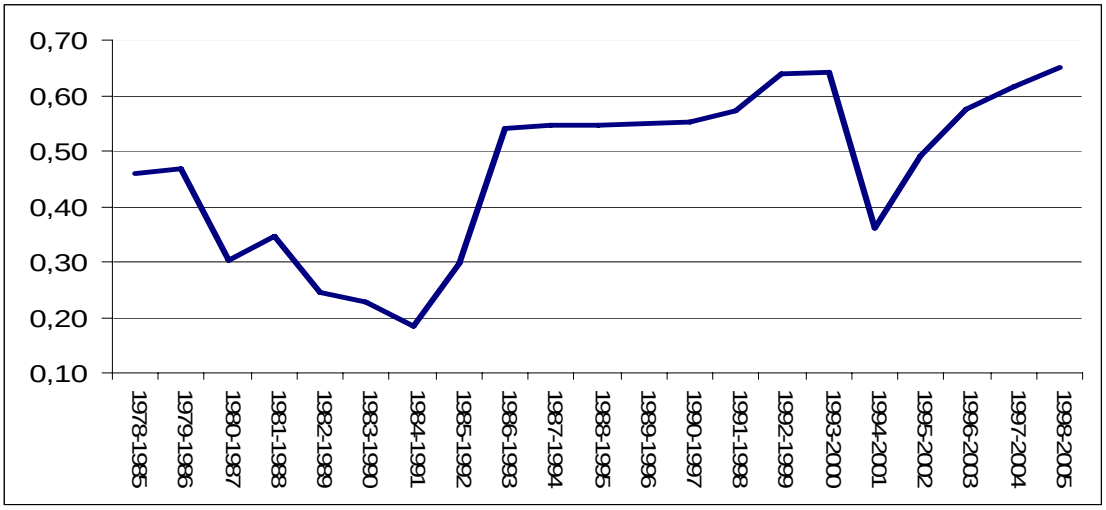
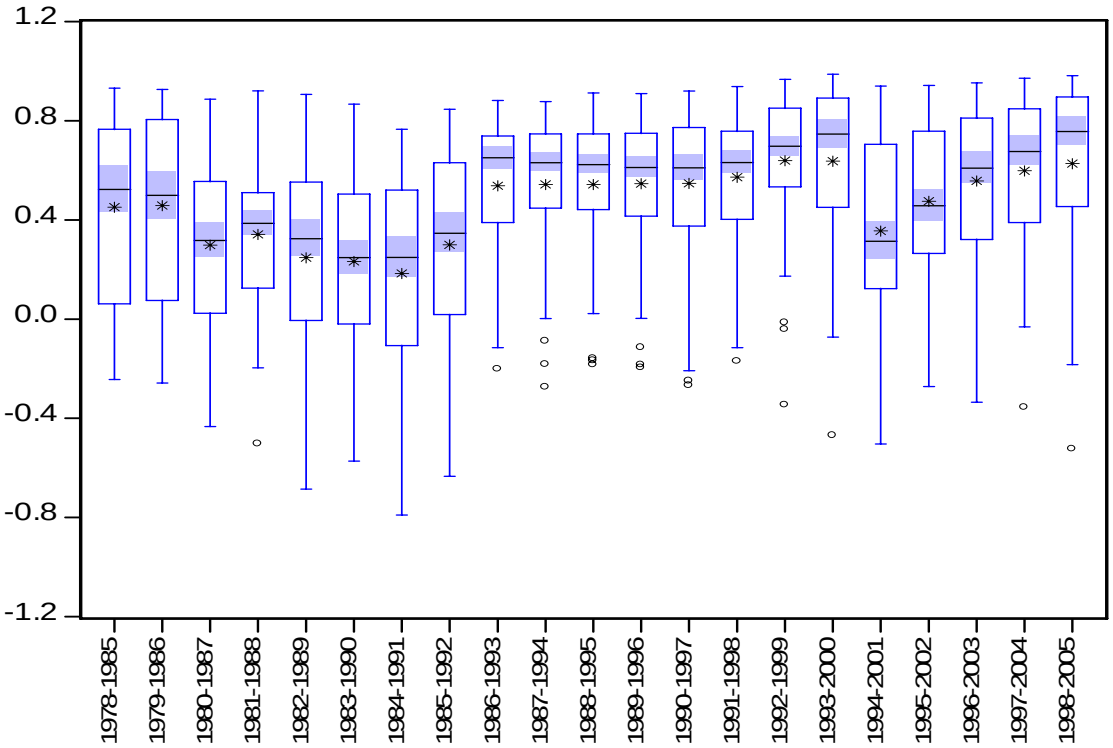


Figure 4. Box-plot: Average regional correlation with the Euro Area 8-year rolling window



To examine this issue is more detail, Figure 4 shows Box & Whisker diagrams that show the spread of the values. The plot provides the medians, quartiles (upper and lower), and ranges (minimum and maximum). The box is limited by the first and third quartile while the whiskers represent the minimum and the maximum value, respectively. The blue area in the box represents a confidence interval for the median, which is depicted by a black line. Outliers are defined as the observations that lie outside the staple, i.e., those observations with more than one and a half times the inter-quartile range.

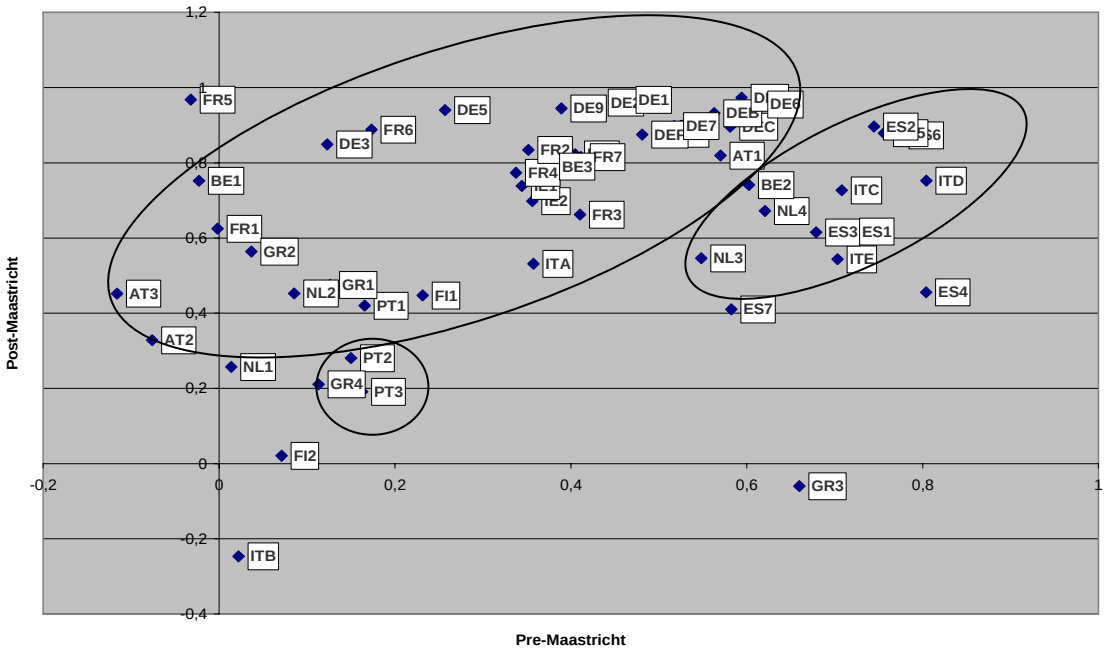
As Figure 4 shows, most of the irregular observations appear in the period following the Maastricht Treaty. The regions concerned are Sicilia, Manner-Suomi and Kentriki Ellada. By the end of the period, the Spanish region of Noroeste behaves as an outlier. Interestingly, all outliers have lower than average correlation with the Euro Zone cycle.

Even though Figure 3 suggests that there is no obvious way to split the sample in various sub-periods, we take the Maastricht Treaty as a watershed as various studies on national business cycle synchronization identify a "Maastricht effect".[5] Though the results must be interpreted with some caution, it appears that the synchronization of the business cycle of most regions with the Euro Area cycle has increased due to the Maastricht policy reforms. Some regions show a remarkable increase, like Portugal Continente, Ile de France, Brussels Capital, Westösterreich and Sudösterreich. However, there is also a group of regions without any change due to the Maastricht Treaty. Their cycle remained either at a fairly high level (e.g., Noreste and Madrid, Noreste and Noroeste (IT)) or at a low level (e.g., Madeira, Açores, and Nisia-Aigaiou-Kriti) of synchronization with the reference cycle. Still, the general conclusion that we draw is that, on average, regional cycles in the Euro Area are more in sync after 1992.

Massmann and Mitchell (2004) argue that full business cycle convergence implies that the mean of the business cycle correlation coefficients should tend towards 1, while the variance should approach to 0 over the period considered.[6]

Figure 5. Regional correlations with the Euro Zone: Before and after Maastricht

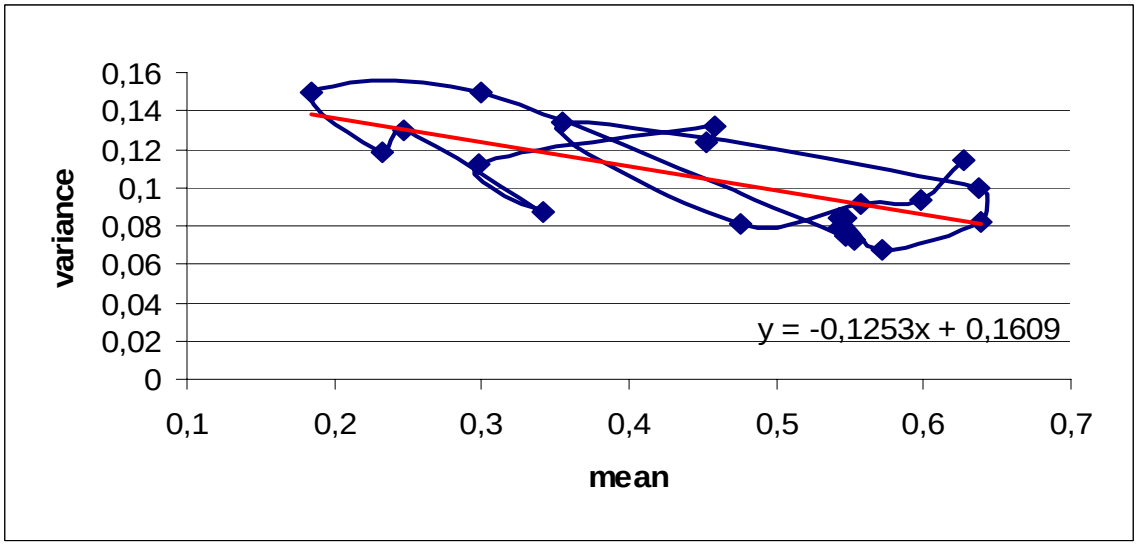
[5] See, for instance, Altavilla (2004) and Darvas *et al*. (2007).
[6] These conditions are similar to the "beta" and "sigma" convergence concepts used in the economic growth literature.



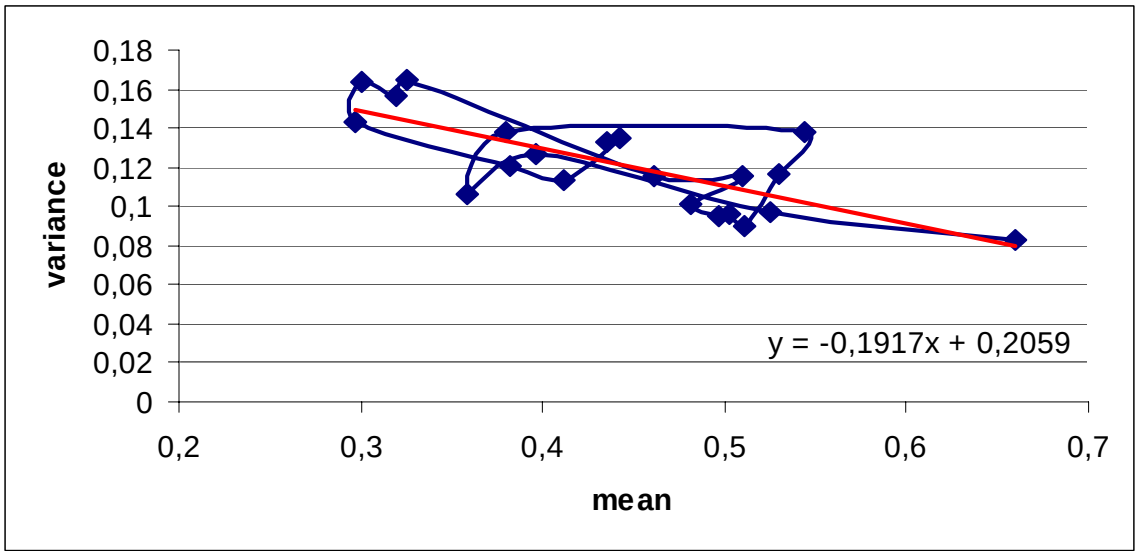
Following Massmann and Mitchell (2004), Figure 6 portrays the evolution of the mean and the variance of the regional correlation vis-à-vis the Euro Area, for an 8-year rolling window. It appears that both variables have moved in opposite directions suggesting regional cycle convergence.

Figure 6. Regional correlation respect to the Euro Zone cycle: Mean and Variance for 8-year rolling window

Data based on HP filter



Data based on CF filter



It appears that there have been three periods with different convergence patterns. In the first period, which ranges from 1978 till 1992, the average correlation coefficient with the Euro Zone business cycle decreases, while the variance remains high. These results contradict the findings of Fatás (1997). The most straightforward explanation for this different result is that Fatás' sample is limited to France, Germany, UK and Italy. During the first period, not only regions in Italy exhibit a low correlation coefficient but also regions in other countries, like the Netherlands, Austria and Finland, have a low correlation coefficient with the reference cycle.

The second period comprises the years after the signing of the Maastricht Treaty until the start of EMU. Corroborating the belief that further integration leads to higher synchronization, this period is characterized by low variance and high correlation with the Euro Zone. This finding supports our previous result concerning the "Maastricht effect".

Finally, for the period after EMU we are unable to draw a firm conclusion because the results differ according to the de-trending method used. Whilst the data constructed with the HP filter do not yield a clear pattern for the mean and the variance, the data constructed with the CF filter show an increase of the average, while the variance decreases.

5. Synchronization with the country or the Euro Area?

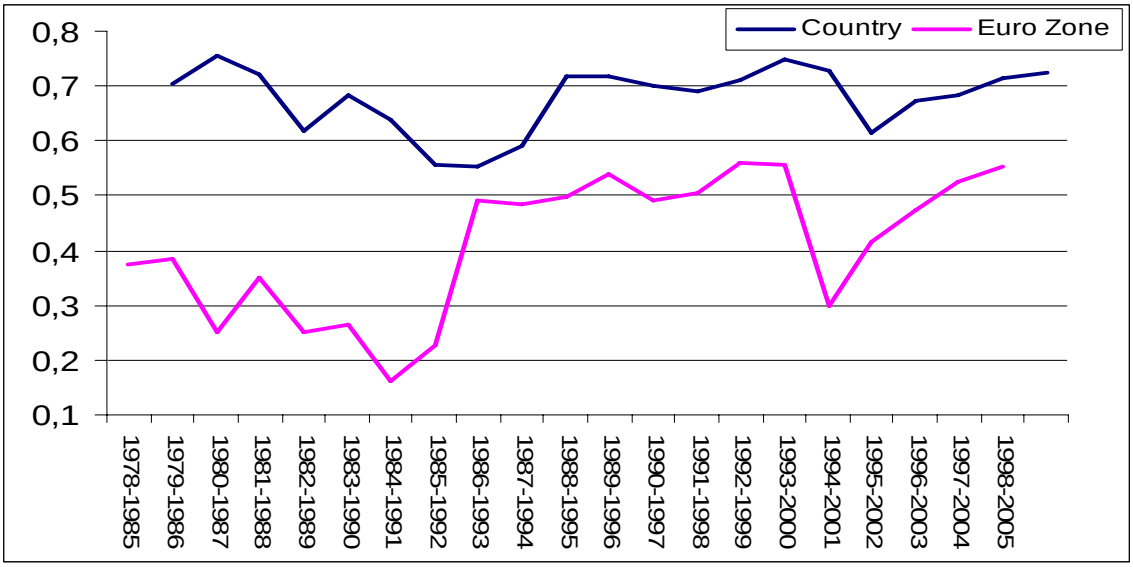
Various studies find that the correlation of regional business cycles with the national cycle remain high over time, despite European economic integration, i.e., there is a "border effect". For instance, Clark and Van Wincoop (1999) who compare the US and Europe, find a stronger "border effect" in Europe than in the US.

Following De Grauwe and Vanhaverbeke (1993) and Fatás (1997), we study the correlation of the regional cycle with the national cycle and with the Euro Area cycle over a thirty years period. However, instead of splitting the sample in arbitrary periods, we opt for building 8-year rolling windows. The results are shown in Figure 7. It appears that the correlation of the regional cycles with the national cycles is always higher than the correlation of the regional cycles with the Euro Area cycle. These findings contradict those of Fatás (1997) who reports that the correlation of the regional cycles with the national cycle decreased over time, whereas the correlation with the European cycle increased. This discrepancy can be explained by the difference of the sample (Fatás' sample only covers Germany, Italy, France and the UK) and the time period considered (Fatás' series stop in 1992).

Going deeper into the data, one notices different performances among countries. For instance, regions in Germany have always exhibited a high degree of correlation both with the country and with the Euro Zone cycles, whereas regions in Greece do not seem to follow neither their national cycle nor the Euro Zone's. Other regions, like those in Portugal, Spain, and France, saw their correlation with the Euro Zone cycle increase, while maintaining a high degree of synchronization with the country cycle. In contrast, the business cycle correlation of regions in Ireland with the Euro Area cycle decreased, while it remained incredibly high with the country cycle.

So far, we have analysed synchronization of regional cycles with the Euro Zone cycle. As an alternative, we follow Artis (2003) and Camacho *et al*. (2006) and perform a cluster analysis.

Figure 7. Regional correlation with national and Euro Zone business cycles. 8-year rolling window

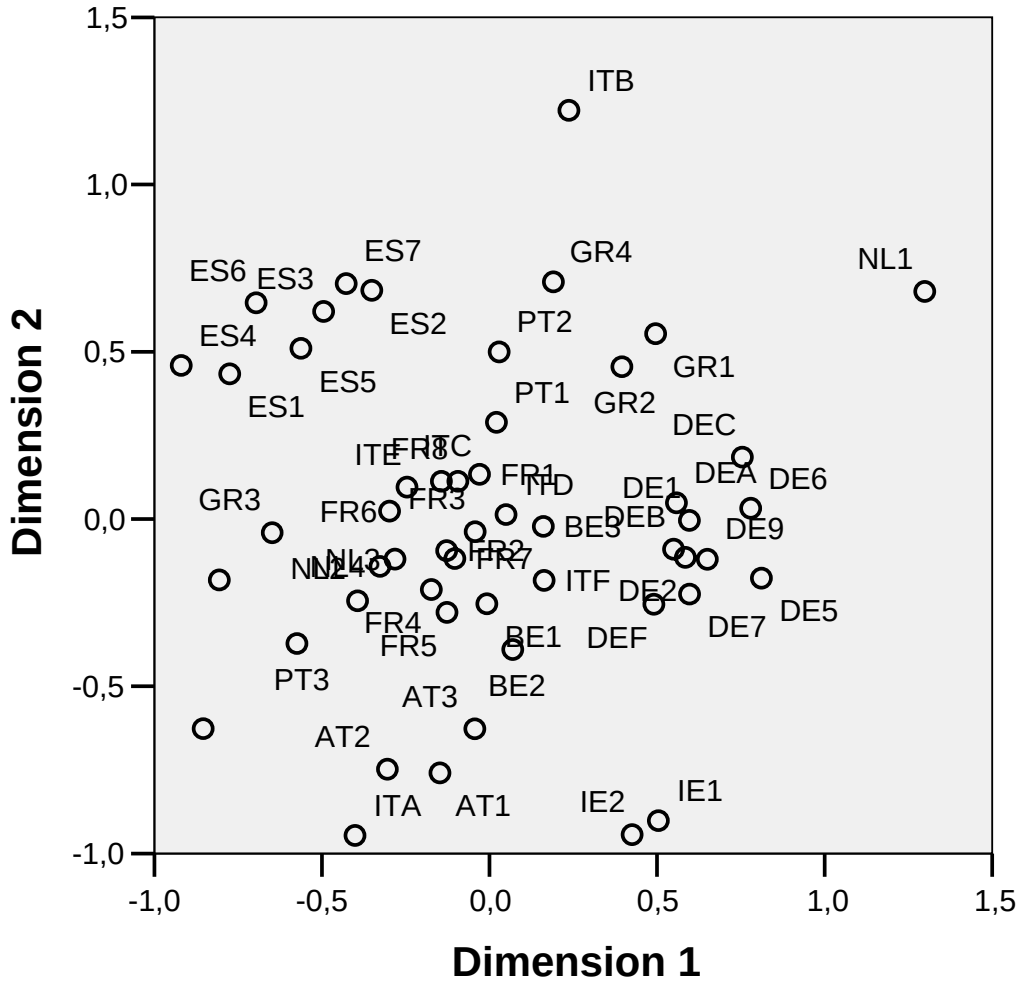


A pioneer study using this technique is Artis and Zhang (1998), who apply clustering to a set of 18 OECD countries and study their affiliations with Germany on the base of six criteria (correlation in business cycle, volatility in exchange rate, correlation in interest rate cycle, trade, inflation and labour market flexibility). Their findings reveal the existence of a "core" group, made up of France, Belgium, Austria and the Netherlands, and two "peripheral" groups comprising the northern and southern countries of the EU15. Artis (2003) reverses to some extent this earlier paper and concludes that there is not a European cycle on the basis of cluster analysis. Camacho *et al*. (2006) adopt a slightly different methodology. They apply sequentially two clustering procedures: first, they consider hierarchical clustering algorithms and use this information to apply non-hierarchical or partitioning clustering algorithms. Their findings reveal that there is no evidence of the existence of a "European attractor" that brings the European cycles together.

We apply Multidimensional Scaling techniques to the cyclical component of GVA of the 53 NUTS 1 regions in our sample. This technique converts a set of dissimilarity measures in several dimensions into two dimensions by minimizing the squared sum of the difference between the real and the estimated distance.[7]

[7] This measure is called STRESS (Standardized Residual Sum of Squares).

Figure 8. Multidimensional scaling NUTS 1 regions (1978-2005)



In our case, the distance among regions is measured as the Euclidean distance and we adopt a Simplex initial configuration. The results of our analysis, as shown on Figure 8[8], show that most of the regions belonging to the same country are closely located, confirming our prior results on national borders.

[8] The region of Berlin (DE3) has been excluded from the graph because it was very far away from the others (4 points)

6. Conclusions

In this paper we have analysed the question of whether regional business cycles in the Euro Area have become more synchronized. We have examined the correlation of detrended Gross Value Added (GVA) among 53 NUTS 1 regions over the 1975-2005 period. Our sample comprises nearly all the Euro Zone NUTS 1 regions. This is a major improvement compared to previous studies that only considered a group of selected regions. Using the correlation coefficient of the regional cycles with the Euro Zone benchmark, we find that synchronization has increased on average for the period considered with some exceptions during the eighties and the beginning of the nineties. Still, the correlation of the business cycle in some regions with the benchmark remained low or even decreased.

Our findings also support the hypothesis of the existence of a "national border" effect, which influences business cycles synchronization. Our findings do not support Krugman's (1991) view. We observe an increase in regional business cycle synchronization, although there are marked differences across regions. An interesting topic for future research is to determine the sources of these regional differences in business cycle synchronization.

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ANNEX A: List of regions and codes

The "Nomenclature of territorial Units for Statistics (NUTS)" subdivides the economic territory of the Member States into smaller units for statistical purposes, as defined in Decision 91/450/EEC. The classification is hierarchical and based on a population threshold. Therefore, NUTS do not necessarily coincide with existing administrative units[9].

Population threshold		
NUTS1	3M	7M
NUTS2	800000	3M
NUTS3	150000	800000

Thought statistical analysis have been substantially simplified, NUTS classification has changed over time which difficult obtaining long and homogeneous series.

List of regions and codes used for the empirical analysis (NUTS1)

BE	Belgium
BE1	Brussels-capital
BE2	Vlaams Gewest
BE3	Wallonie
DE	Germany
DE1	Baden-Württemberg
DE2	Bayern
DE3	Berlin
DE5	Bremen
DE6	Hamburg
DE7	Hessen
DE9	Niedersachsen
DEA	Nordrhein-Westfalia
DEB	Rheinland-Pfalz
DEC	Saarland
DEF	Schleswig-Holstein
GR	Greece
GR1	Voreia Ellada
GR2	Kentriki Ellada
GR3	Attiki
GR4	Nisia Aigaiou, Kriti
ES	Spain
ES1	Noroeste
ES2	Noreste
ES3	Comunidad Madrid
ES4	Centro
ES5	Este
ES6	Sur

ES7	Canarias
FR	France
FR1	Île de France
FR2	Bassin Parisien
FR3	Nord Pas de Calais
FR4	Est
FR5	Ouest
FR6	Sud-ouest
FR7	Centre-est
FR8	Méditerranée
IE	Ireland
IE1	Border
IE2	Southern and Eastern
IT	Italy
ITC	Nord-ouest
ITD	Nord-est
ITE	Centro
ITF	Sur
ITA	Sicilia
ITB	Sardegna
LU	Luxembourg
NL	Nederland
NL1	Noord-Nederland
NL2	Oost-Nederland
NL3	West-Nederland
NL4	Zuid-Nederland
AT	Austria
AT1	Ostösterreich

[9] Regulation 1059/2003 of the European Parliament and the Council, of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS).

AT2	Südösterreich
AT3	Westösterreich
PT	Portugal
PT1	Continente
PT2	Açores
PT3	Madeira
FI	Finland
FI1	Manner-Suomi
FI2	Aland

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