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What has changed after the Great Recession on the European cyclical patterns?

Alumna: Ana María Rodríguez Santiago
Tutor: Prof. Máximo Camacho (UMU)

Universidad de Huelva

Universidad Internacional de Andalucía

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Abstract

This article analyses the business cycle dynamics in the European Union (EU28), during the last decades. Following Saiz, Camacho & Perez-Quiros (2006), we extend the analysis of the European cycles to a broader range of countries, including the new entrants. In addition, we update their sample by including the Great Recession data with the aim of exploring whether the financial crisis led to changes in cyclical features across these countries. Our results point out that the Great Recession did not lead to any significant impact on the pre-existing European cyclical linkages. Notably, we failed to detect that the European economies move according to a common driving force or a "European cycle".

JEL classification: C5, E32; F02; C22

Keywords: Business cycle characteristics; Growth cycle; European Union enlargement; Turning points; Multidimensional scaling

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1. Introduction

The study of economic cycles is currently a hot policy issue in Europe, when some countries are rethinking the new role played in the European Union, and new member states are reconsidering the effects of the economic integration. In some sense, one could expect that economic integration should lead to have similar patterns in the macroeconomic dynamics.

In this context, this piece of research attempt to provide empirical evidence on the existence, or not, of a business and growth cycle pattern among members countries, and on the potential effect of the recent financial crisis on it.

In general, to identify and interpret the existence of patterns in graphs of data has been a challenge for different disciplines, especially in Economics. The finding of these patterns in economic time series and the provision of explanations for these stylized facts, have been the core of a body of theoretical and empirical literature devoted to the study of the business cycle. The inexistence of a European economic cycle would imply the adoption of different treatment for member countries of the European Union. It is important to know whether every country follows the same cyclical pattern or not, in order to adapt the economy and monetary politics that are developed by the European Union Commission looking for the common welfare.

In this context, and from an empirical perspective, the development of methods for capturing or identifying business and growth cycles, the study of the relationships among business cycles of different regions, sectors or variables, and the development of theories for explaining them, have been a common denominator in different fields of research in Economics. In other words, contributions –both theoretical and empirical– to the business cycle literature have been transverse, that is, this literature has had intersections with each and every topic in Economics.

The issues we deal with in this paper, are how to provide evidence on the business cycle similarities before and after the European Union enlargement. Moreover, another issue is to check if previous findings should be reconsidered after the financial crisis, thanks to the update of previous studies.

To this end, first, we check if the length, depth and shape of cycles across European Union countries are now following more close dynamics than before; second, and after more than a decade, we can try to extend the previous analysis to the new entrants; Lastly, we explore if the recent financial crisis has introduced some changes in the cyclical linkages across this set of European countries.

Our results point to the reconsideration of linkages across economic cycles of member countries of the European Union. The last great recession seems to have changed patterns in cyclical linkages, since the obtained results are showing closer cycle dynamics among countries once the great recession is included in the study.

The rest of the paper is structured as follows: Section 2, briefly outlines previous literature related to business and growth cycle. In section 3, we describe the methodology and data for analyzing business cycle and growth cycle

characteristics, in particular for dating turning points. Section 4 develops and applies a multidimensional scaling cluster analysis, as an approach for identifying groups of countries with similar patterns in cycles. Finally, in section 5, it finishes up with some general conclusions about the research and the study.

2. A selective review of previous literature

The study of business cycles is worldwide widespread, from the research about a global economic cycle to the study of groups such as the European Union. With respect to the study of a global business cycle, researchers seek if the integration of individual countries makes their economic cycles similar.

Lumsdaine and Prasad (2003), and Kose et al. (2008) have been working in the study of the existence of a global pattern on business cycle. Linkages among different formations of countries have also been studied, such as the group of developed economies forming the OECD, studied by Inklaar, Jong-A-Pin and de Haan (2008), or the MERCOSUR group, analyzed by Carrasco and Reis (2006), and Hurtado-Rendon and Builes-Vasquez (2011).

The most common practice for authors is pointed out on the study of continents. For example, in America, Mejia-Reyes (2004) analyzed the business cycles of some countries of the continent. Also Aiolfi, Timmermann and Catao (2006), and Camacho and Palmieri (2016) studied the features and sync between Latin America's business cycles. Regarding to Asia, there is also papers about business cycles, like the one by Fidrmun and Korhonen (2010) about the impact of the crisis in emerging economies.

In terms of Europe, there are publications about the whole continent and some of them about aggregations of countries. Gächter, Riedl and Ritzberger-Gruenwald (2012) studied the euro area's business cycle. But the main interest is in the business cycle across the components countries of the European Union, Krolzig and Toro (2005), and Camacho, Perez-Quiros and Saiz (2006) studied this case.

It is especially of a great interest the latest accessions of eastern countries of Europe around the mid-way of the last decade, some authors studied the business cycles of new members, such as Artis et al. (2005), and Darvas and Szapary (2004).

Our study provides a comprehensive analysis once the lately adhered economies have been established. We already hold more amount of data to analyze the evolution of the cycles of economies that entered the group of the European Union the last decade, allowing us to analyze the possible sync with those already belonging above, and check whether the last financial crisis has changed the way how relationships between countries were established before the crisis.

3. Business cycle and Growth cycle analysis

3.1. Previous descriptions to analyze cycles

In this study we analyze both business cycle and growth cycle across European Union countries, in order to provide a more complete analysis. Firstly, it is important to establish the base where we have started from. In this way, considerations about cycles descriptions are needed to understand the meaning of the study.

A business cycle is defined as a recurrent fluctuation in the aggregate economic activity of a country where recessions and expansions are happening successively. A recession is previously defined as the happening of two successive drops of the GDP indicator. The observance of this success does not imply the actually existence of a recession. In other words, it is possible that a country is experiencing a recession and nevertheless the GDP value is not decreasing. This situation is due to recessions are affected for more variables, not only the GDP as indicator of the economic activity; i.e. rates of interest, labor market variables and so forth. In this context, during a recession, a generalized and significant decreasing of the economic activity occurs, and it can last from a few months to some years. Analogy, expansions are defined symmetrically, but commonly they tend to be longer than recessions.

On the other hand, we investigate also the growth cycle, what is understood as an evolution of the economic activity where an intercalation of detrended GDP's position takes place above (expansion) and below (recessions) the potential GDP.

To clarify, a recession is the period between peak and trough, while expansion is the period between trough and peak. In this context, a peak is identified as the last moment of an expansion, and the trough is therefore the last moment of a recession.

Starting from these previous definitions, to established the cycles seems to be necessary the detection of the turning points, what are the moments when the cycle passes from an expansion to a recession (peak) and from a recession to an expansion (trough). For business cycle, the objective is to detect when the economic activity is increasing or decreasing. whilst for growth cycle, the importance resides on the identification of the potential GDP to check when the component cycle of the time series is evolving over or below this potential value.

3.2. Data

Our study is focused on the cycles of the countries members of the European Union group, because of the recent interest on the linkages between countries forming the group after the accessions on the last decades. The EU foundation occurred in 1957 with six member countries as founders, and from there successive incorporations have been taking place until the last and current composition of the EU28 group. Table 1 shows the chronological enlargement of the EU, including the date of accession of the different countries.

For the analysis of business and growth cycles of member countries of the European Union, we use the quarterly growth rate of GDP at market prices, seasonally adjusted. Although most of the time series were obtained from the Organization for Economic Co-operation and Development database (OECD), some of them were obtained from national statistics institutes or central banks of the countries. We used all the data available for each country. Table 2 shows the periods of each sample, the source of the data, the assigned country code for identification and the year of accession of each country to the European Union.

The aim of our work is to analyze the existence of cyclical patterns between members of the European Union. In particular, we focus on the differences in patterns for the whole period of data available and the cycles from the most recent financial crisis. However we are also interested in the reexamination of the business and growth cycles previous and after the accession to the European Union.

There was no data available previous to the formation of the group for the founding members of the European Union, except for France. But for the rest of incorporations, and in the way that the amount of data makes it possible, we have evaluated their cycles for the entire period of available data, as well as separate assessments for the period prior to entry in the group and from the date of accession to present. Furthermore, it has also been analyzed, as noted earlier, the cycles since the last expansion before the crisis until nowadays.

3.3. Methodologies for dating turning points

Respecting the turning points' identification, the dating of cycles, both business and growth cycle, have been made by the Economic Cycle Research Institute (ECRI) for seven of the countries (AT, FR, DE, IT, ES, SE and UK). This institute dates peaks -as the last data of an expansion- and troughs -as the last data of a recession- from the behavior of certain economic variables. As so for detecting business cycles, ECRI uses variables such as GDP, IPI, labor market, rent and sales. However, for our study, most of the dating have had to be obtained from algorithms.

The first step for analysing the business cycle is how we can recognize a cycle. We can find different approaches in the literature, which try to identify turning points as indication of the presence of a cycle. Although there are many methods for the dating of cycles, in the case of business cycle we have applied the methodology of Harding and Pagan (2002b)[1] to find maxima and minima from the series of rebuilt GDP. Harding and Pagan provided an algorithm to locate turning points and a measure of pro-cyclicality. Their approach allows to dissect cycles in terms of the contributions made by their different components; i.e. trend, volatility, serial correlation and non-linear effects. In particular, and for identifying and interpreting the existence of patterns in graphs of data, that it is an old challenge for different scientific fields, including Economics, scholars have provided different methods and approaches.

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[1] This methodology is a refinement of the dating algorithm suggested by Bry and Boschan (1979).

On the other hand, although we can find a lot of different ways of detrending series, the dating of growth cycle has been obtained by applying the band-pass filter proposed by Hodrick and Prescott (1997) to the rebuilt time series. This method decomposes each observation of the original time series into two unobservable components: the permanent component and the transitory one, by removing the transitory, only the permanent remains (cycle). This let us to get the component cycle series and then we can establish peaks and troughs of growth, where a recession occurs when the cycle takes a negative value, and expansions when the value of the cycle is positive.

Both algorithms give us a binary variable that takes value one on the date when a recession takes place. This variable is used to establish the peaks and troughs that a time series experimented, and then analyze the cycle characteristics, distinguishing between expansions and recessions.

3.4. Business cycle and growth cycle characteristics

To analyze groups formed between similar countries of the European Union, previously it is necessary to know the characteristics of each business or growth cycles. Business cycle refers to the sequence of expansions and recessions that have been registered and dated, while Growth cycle refers to the position of GDP above (expansion) or below (recession) respect the potential GDP.

Although there are a wide range of features identified across the empirical literature about business cycles, we have selected a set of necessary characteristics to describe the cycle from the GDP time series. The analyzed features about business cycle refers to the length, depth and shape of the cycles, that can be respectively measures by duration, amplitude and excess of the cycles, how Harding and Pagan (2002a) considered.

Concerning the length of the cycles, duration is the time spent between peak and trough in the case of a recession, or between trough and peak when an expansion takes place. In our case, as the format of the date is in quarters, duration is represented in number of quarters for each phase for each one of the countries, and the average refers to the mean duration that cycles last in the whole group of the European Union.

Regarding to the depth of the cycle, we measure the amplitude, what is referred to the total gain or loss between peak and trough, and vice versa, experienced in a phase. In order to measure the amplitude, a value of 100 is given to the first data of a phase (peak/tough) to recalculate the variation during the period by the GDP growth rates during the period. Then the variation value is obtained from the comparison between the last trough/peak of the phase and the initial value, depending if we are treating a recession or an expansion. This value is represented by rate of loss or gain, what is the mean percentage that the GDP has increased during expansions or decreased during recessions.

Finally, the last characteristic is the deepness, what is associated to the shape of the cycle. It can be measure by the so-called excess, that measures how the actual

time series behaves against a hypothetical linear path between two consecutive turning points. It is represented in percentage change versus a lineal evolution, and considering the way it is calculated, negative excess refers to a convex evolution against the linear path, and positive sign would indicate a concave evolution respect a linear growth/decrease. The excess has been calculated from a real GDP series and a supposed linear evolution series for each of the phase. First, a value of 100 is given to the first turning point (peak/trough) and the series is reconstructed by the real growth rates. On the other side, the hypothetical value during a linear path between the two turning points is calculated giving value 100 to the first turning point and constructing the series with the linear growth rate (it is obtained subtracting 100 to the last turning point and dividing that value by the number of periods of the phase). Then the actual GDP value for each moment is compared with the data that would be obtained in the event that the evolution occurred in a linear way (the lineal growth). So if the value is positive, the real series occurs over the linear way, and in the case of negative value, it happens below that linear path. In this way, a concave expansion and a convex recession evolve more sharply at the beginning of a phase, and at the end of it in a smoothly manner. By contrast, convex expansions and concave recessions present a moderate evolution at the start of the phase and it becomes more abrupt at the end. To illustrate these concepts, Figure 1 shows a representation of different kinds of expansions and recessions, depending on the sign of the excess, it is also represented the concepts of amplitude and duration.

Regarding to growth cycle, the analyzed features are length and depth, which are measured by the duration and amplitude, characteristics related to the same concepts analyzed for business cycle.

3.5. Results

The business cycle analysis is presented in tables 3, 5 and 8, while the tables dedicated to growth cycles analysis are 4, 6 and 9. Tables 3 and 4 present the results of the features for business and growth cycle, respectively, for the entire sample of data.

The first comments in this point are about characteristics of cycles, including in the analysis the entire sample that we have at our disposition. Then, we give a resume comments about differences in cycles between the period before the accession to the European Union and after it for each of the countries. All the data is collected on tables 5 and 6. Finally, cycles of the European Union group during the recent financial crisis have a place in this point, we present an analysis of the cycle's features from the previous expansion before the crisis until the last data. Results are displayed on tables 8 and 9.

At first, we start the analysis with the most complete sample, this means, including the whole period of data that we provide. In the tables of results, it is indicated the effective sample period per country. It is worth mentioning that for some of the countries who accessed the UE long time ago, the OECD has data from

1960, and for the last entries, the sample of GDP starts between 1994 and 2000.[2] First results of business cycle characteristics are analyzed, and then growth cycle features are explained.

Starting with the length of the cycles, how it is supposed, expansions last much longer than recessions. The average duration for the EU28 group takes a value of 22.2 quarters, that is, around five and a half years, while recessions have a mean duration of 6.1 quarters, or being the same, one and a half years. It is remarkable the cases of United Kingdom and Spain, whose expansions last in average 35.5 quarters, much longer than the mean on EU28. And, there are also countries whose expansions are much shorter than the average of the group, such as Greece, Malta and Poland, with expansions of 14.1, 11.6 and 13.2 quarters, respectively. Concerning to the recessions, it is extremely striking the case of Croatia, where recessions last in mean around 25 quarters, that means that it last more than 6 years[3]. Also Spain presents long recessions (15.7 quarters).

The amplitude analysis shows an average depth of 0.30 in expansions and -0.04 in recessions. It means that the average increase of the countries in the group is in a 30%, and the loss in recessions is around 4% of the GDP. Although most of the countries present similar results, some countries have a much higher increase of GDP during expansions, like Estonia, Latvia, Lithuania and Slovakia, whose gains rise between 45% and 49%. On other hand, there are countries like Czech Republic, Denmark, Hungary, Malta or Poland who present more modest growths (below 20%). With regards to recessions, some special cases are Croatia, Estonia and Lithuania, whose loss in recessions are between 10% and 14%.

Respecting the shape of the cycles, the mean of excess takes negative value for expansions and recessions (-0.98 and -0.21, respectively), what means that expansions tent to be smoother at the beginning and more abrupt at the end of the phase. Conversely, during recessions, the drop is more noticeable at the beginning and it evolves in a smoother way to the end of the recession. This reflects the presence of convex expansions and recessions on average across the EU28. For every country of the EU28 group, expansions present a negative excess, however, it is given a media situation for recessions, since around the half of the group has positive values of excess and the other half negative, but still the average is a negative excess.

Now with respect to growth cycles, the results of the analysis -that are presented on table 4- show that the average duration is 6.1 quarters in expansions and 7.9 in recessions, what is around one year and a half to almost two years, respectively. Although every country shows a similar behavior in terms of expansions, it does not happen in recessions. Countries like Bulgaria, Cyprus,

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[2] Except for Spain and Sweden, whose samples have had to be shorten, since the dating of this countries is made by ECRI and they only provide data from 1969 (Business cycle) and 1971 (Growth cycle) for this couple of countries.

[3] This can be cause of the availability of data, since the GDP's sample for Croatia starts in 2000, and the country has only experienced one complete cycle, so this 25 quarters recession in average refers to the only one recession that we have registered.

Hungary or Slovakia show longer recessions that the average (between 12 and 22 quarters).

About the depth of the phases, it is worth noting that, contrary to what happens in business cycle, in growth cycle, recessions has not necessarily have to represent a negative evolution in phases. That is to say that our way of calculating the amplitude, allows positive ascents during recessionary phases, since the dating of cycles is obtained from the component cycle of the GDP series, where recession means that the component cycle shows a negative value. So a positive amplitude during recessions means that the actual GDP shows a value below the potential GDP, but the rest of components of the GDP can be positive. After this explanation, the results of growth cycle characteristics show an average increase of 6% during expansions and a 5% of growth during recessions. That means, during recessionary phases, GDP still increases, but in a more modest way than the way it growths during expansions. It is remarkable the case of Bulgaria and Slovakia, who present higher increases during recessions than expansionary phases. But for the rest of countries, results are normal and they show similar results around the average amplitude.

As mentioned before, we have also studied the differences between the period before the EU accession and after this happened, for each of the countries[4]. We have also taken the opportunity in the study, to discriminate between cycle characteristics for the EU15 and EU28. Tables 5 and 6 of the annex show the average of the studied features for both business and growth cycle, distinguishing between pre and post accession to the European Union. Note that there is an average for the group of EU15 and another average for EU28. Because of this fact, the tables show the countries ordered by date of accession to the European Union.

At first, referring to the length of the business cycles, both expansions and recessions were longer previously to the accession, for both EU15 and EU28. For the countries that acceded to the group until 1995 (EU15), while expansionary phases last in average 31.3 and recessions last 6.1 quarters on the period before to enter in the group, results post-accession show an average duration of 23.6 and 5.7 quarters. Considering also the last accessing, in other words, the whole group of the actual European Union, the average duration of expansions and recessions before the countries acceded to the group were 30.7 and 6, respectively. However, regarding only period after every country's accession, average length of phases is 20.4 quarters during expansionary periods and 5.3 during recessions. Notice, that cycles have become shorter after the union for the group, but there are exceptions like Finland, Sweden, Estonia, Lithuania, Poland or Slovakia, whose expansions are on average longer now.

Amplitude does not show remarkable differences between average before and after being part of the formation, and neither between EU15 and EU28. Results for EU15 were increase in expansions past from 43% before EU to 25%, and loss in recessions pasts from 3% to 4%. Considering the average for all the countries, in

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[4] Due to the data availability, we do not have information for some of the countries about the period before the acceded to the European Union (these countries are Belgium, Germany, Italy, Luxembourg and Netherlands, founders of the group in 1957). Because of this, averages before the accession are calculated with the countries that we have information of.

expansions GDP increased on average 46% before EU and it does now in 23%, while loss in recessions were about 4% and the they are around 6%. In expansionary phases, this fact makes sense, due to the phases are shorter than during the period before countries add to the group, so it seems normal that GDP growth or decrease less that it did in longer phases. But it is remarkable how loss in recessions are bigger after the accession, in spite of recessions are shorter. This means that recessionary phases have become deeper after the entry to the EU[5], except for Poland that shows shallower recessions after the accession to the group.

To finish with business cycle, the shape of phases for the EU15 is similar before and after the accession (from -0.38 in expansions to -0.65, and from -0.05 to 0.09 in recessions), but if we consider the entire group, excess of both expansions and recessions have been reduced (from -1.94 to -0.60 and from -0.60 to -0.12, respectively), what means that phases are less convex and the increase/decrease is less abrupt, evolving closer to the lineal path between turning points.

On the other hand, the duration of growth cycles has not experienced much differences before and after the accession of the countries to the European Union, not only for EU15, but for EU28 too. In both cases, expansionary and recessionary phases are shorter until the adhesion to the group. Average duration on recessions shows an increase when we include the entire group, meaning that new enters have longer recessionary phases that the first components of the EU15. About the depth of the phases, for both expansions and recessions for EU15 and also EU268, amplitude has been reduced from the entry to the group. In other words, both expansionary and recessionary phases present more modest increase or decrease.

Finally, to resume the information commented, table 7 summarize the information about features on business and growth cycles, differencing between before and after being part of the EU, and also between EU15 and EU28 characteristics.

The last point in our analysis of cyclical characteristics, it is the one referred to the situation during last financial crisis. We analyze characteristics of the cycles for each of the countries only during the last sample of data, taking from the last expansion before the crisis started until the most recent date of GDP growth. For those countries that only had one recessionary phase, it is necessary to include the previous expansion in order to study a complete cycle.[6]

The last financial crisis had effects worldwide, with more or less repercussion depending on the country. But a generalized fact is that it started between the end of 2007 and the beginning of 2008. With regards to dating for business and growth cycle, a date for the start of the crisis period has been

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[5] Note that some information is missing for Cyprus, Slovenia and Bulgaria, due to there is no recessions registered before the EU accession. And also for Croatia, since they have not experienced any recession since they entered to the group on 2013.

[6] Although there are some countries that only experienced a long recession during last years, most of them present a double deep recession, this means that the economy started to decrease around 2007-2008, then it was recovered between 2009-2011, and suffered again a relapse between 2011-2013.

established. Tables 5 and 6 attached to the annex show the individual information for each country about cycle features for business cycle and growth cycle, respectively, and also the period of sample for the study.

To begin with, business cycle is commented. Comparing with the results obtained from the whole sample, we can check that the average duration does not suffer from too much change, for the entire sample is 22.2 quarters in expansions and 6.1 in recessions, while during the crisis the duration is 23.1 and 7. Theses averages are similar, only needed to point out that the phases are a little bit longer. However, the characteristics of the depth, show a relevant information, since expansions during the crisis present a smaller increase (from 30% to 24%), also during recessions the loss is more significant (from -4% to -7%). Finally, the measure of excess seems to be similar between the whole sample and the period of crisis (expansions from -0.98 to -1.08, and recessions from -0.21 to -0.11). Regarding to the individual results, a generalized fact that we can observe is that recessions are longer during the crisis and also the loss between recessionary phases has increased.

Finally, in terms of the growth cycle, the situation is similar than the one for business cycle. The average duration of phases has increased a little bit (from 6.1 quarters in expansions to 7.4 during the crisis, and recessions pass from 7.9 quarters to 8.3). The most important conclusion is about the depth of the phases, since during the crisis, the average increased during expansions has been reduced from 6% to 5%, and, what is more important, losses during recessionary phases has decreased 6 points, for the entire period the average amplitude was 5%, while in crisis it seems like economy suffers a bigger loss, in a generalized way. In fact, like we explained during the explanations about amplitude in growth cycle, although it can take a positive value because of the economy, not necessarily will decrease in recessionary phases of growth cycle, studying only the sample of the crisis, we can observe how every country present a negative amplitude or a low positive value.

4. Multidimensional scaling

4.1. Data and methodology

Once that we have obtained the cycle characteristics for the member countries of the European Union, the next step in our analysis is founding whether business and growth cycles are similar between these countries, and how is this relationship, in other words, if there are one or more groups of countries presenting similar cycles. Furthermore, we try to see whether there are some differences between relationships for the entire sample of GDP and the subsample of the crisis period.

To study the existence of patterns between the countries, we use a clustering method that finds similar behaviours on cycles' characteristics. We apply the method of Multi-Dimensional Scaling (MDS), a type of multivariate data analysis. Noted by Cox and Cox (2000), supposing a set of *n* objects where between each pair of objects there is a measurement of the dissimilarity, MDS application searches for

a low dimensional space, usually Euclidean, in which points in the space represent the objects and such that the distances between the points in the space match, as well as possible, the original dissimilarities. This analysis projects the pairwise cycle distances in a map in such way that the distances among the countries plotted in the layout approximate the economic cycle dissimilarities. In the resulting map, countries which present high economic cycle dissimilarities have representations in the layout that are far away from each other.

The MDS that we apply is the classical, whose aim is to find a configuration in a low number of dimensions that, in our case, this number is two. This method treats the distances as Euclidean distances, by going from a data matrix to a Euclidean distance matrix. The Euclidean distance between two points is the length of the line segment connecting them.

Firstly, and having access to the average features that we have obtained, we use the entire sample of data to build a MDS map, for both business and growth cycle. Then we do the same process with the results of the crisis analysis, to see if cyclical patterns are different or not during the crisis.

The aim is to represent in a map the different countries of the EU28 to find out relationships among groups of them. The maps allow us to understand visually which countries show similar patterns about business and growth cycles[7].

Finally, to prove the veracity of the results, we apply a non-parametric density estimation approach to examine the distribution of the pairwise distances that we have previously calculated. Once we have obtained the distances between each pair of countries, we apply this method to represent a density distribution. The kernel density estimator smooths out the contribution of each observed pairwise distance. We have represented the density distribution of the distances obtained from the entire sample and also for the period of crisis. In this way, we can check if there are any changes between cyclical patterns for the complete sample and for the crisis subsample.

4.3 Results of MDS

Figure 2 represent the map of dissimilarities in average business cycle features using multidimensional scaling. It is possible to identify two central cores that gather most of the countries. One of them is formed by Finland, Bulgaria, Portugal, Denmark, Ireland and Czech Republic. Close to this group but still noticeable a little separation, we can see Poland and Malta, and also Romania and Greece. These countries present shorter and more modest expansions. Then, close to this first core, there is another big core formed by Latvia, Hungary, Estonia, Slovenia, Lithuania, France, Netherlands, Italy, Sweden, Germany and Austria in the centre, and in its periphery we can see Cyprus, Slovakia and Belgium. United Kingdom, Spain and Croatia are located away from these groups. Based on the analysed features, UK and Spain present longer expansions than the average. The case of Croatia is understandable, this is because there is not too much information

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[7] Note that in this maps axes are meaningless, so they have been deleted. Every MDS map plots the country code, whose meanings are collected on table 2 - Data description.

since it is the most recent member who acceded the European Union, in 2013. Furthermore, unlike the rest, they experienced a longer recession during the crisis (25 quarters).

Based on the previous paragraphs, it is possible to see how there is not an approximation among countries in base of the date of accession to the European Union. However, it is true that with the exception of UK and Spain, the oldest members of the group are closer among themselves.

The MDS map which represents the dissimilarities on Growth cycle features is represented on Figure 3, where we can see the existence of a centre where the most of the countries are concentrated, and then there is a periphery. The core of the centre seems to group Spain, Belgium, Estonia, Latvia, Luxembourg, Germany, United Kingdom, Austria, Sweden, Italy and Ireland. To the right side of this group, from closest to furthest, we can see Poland, Lithuania, Slovenia, Finland, Netherlands, Denmark, Greece and Malta. From the left side, are represented Czech Republic, France, and Croatia, followed of Hungary, Slovakia and Bulgaria in a very faraway position. The separation of the three latest mentioned countries is due to their longer economic recession.

Again we face the same situation that we mentioned earlier for business cycle. It does not seem to be a relation between the moment of accession to the European Union and the characteristics of growth cycles. However, we can say that the old members of the group are closer to the centre of the core, while among every disperse country we can only found more recent members of the European Union. Concretely, the three countries that acceded later to the EU (Bulgaria, Hungary and Croatia), are among those that appear more disperse from the central group in the map. Aforementioned fact could make us think that it is because they still do not share a similar cyclical pattern with the rest of countries.

Finally, coming back to business cycle, the MDS analysis about business cycle features during the last financial crisis until now, is represented on Figure 4. There we can see that the average characteristics across European Union countries present more dissimilarities than those ones for the entire sample of data. Countries seem less close during the crisis than regarding the whole period. However, it is possible to detect a big central core formed by all the countries except Sweden, Belgium, Spain, Croatia, Ireland, Slovakia, Malta, Poland and Greece, which are located on the periphery of this central group. Saying from the left side of the core to the right side, in order to see which countries are closer among them, we find Portugal, Netherlands, France, Luxembourg, Denmark, Romania, Finland, Bulgaria, Cyprus, Czech Republic, Italy, Slovenia, Hungary, Germany, Austria, Latvia, United Kingdom, Estonia and Lithuania. Those countries located far away from the center, like Sweden, Belgium or Spain, present much longer expansions than the rest. The case of Croatia, like was commented before, happens because of the long recession that presents. Countries on the left side of the core share as peculiarity that they show lower gains during expansions.

Most of the old members of the European Union are within the central core, but there are others far away in the periphery, as well as some of the recent entrants

are close to these countries. So there is not a symptom that makes us think in a pattern across new or old members of the European Union, each of the countries shows a cyclical behavior which can be similar or not to those of other countries. What we can observe is that certain economies show different patterns, like the case of Croatia for the reasons that we presented earlier in this paper. Also, Spain and Greece are distant from the core, possibly because of the strength of the crisis on this economies, which was remarkably negative for these two countries.

The last point in our study, is that one about average features of growth cycle during the recent crisis across European Union countries. Figure 5 record the MDS map resulting from the analysis of the growth characteristics. Almost every country, except Bulgaria and Latvia, are concentrated in the right side of the map, forming a big group, which can be divided between the central core and the periphery. In the center, we can see Italy, Belgium, Czech Republic, Netherlands, Spain, Hungary, Luxembourg, Portugal, Greece and France. Around these countries are located Croatia, Slovakia, Romania, Sweden, Cyprus, Lithuania Ireland and Denmark. And still faraway are Finland, Poland, Estonia, UK, Austria, Denmark and Malta.

Analysing the map, we can check once again that there are not patterns in similarities of the countries. Some of them can appear far away from the rest and this could be produced because of singularities in their growth cycles. For example, Bulgaria present a longer economic recession in this last period of crisis, and that is why it is located on the other extreme of the map. In the case of Latvia, both expansions and recessions are longer than the average. But the fact is that it does not seem like there is a cyclical pattern between countries. Distances between them are changing based on individual characteristics and situations.

Comparing with the map resultant from the entire sample, many countries have changed position in the map. This can be caused by changes in the common growth cycles during this last period of crisis. Nevertheless, relationships based on date of accession to the group do not seem to be defined by a pattern.

What we can observe, regarding both business cycle features and MDS maps, it is that countries are showing more similar behaviours last decades, due to the experienced crisis. Their cyclical features seem similar during the crisis period, avoiding the commented exceptions.

To support this statement, we present the kernel density distribution of the pairwise distances on business and growth cycle features. And we also present a summary of descriptive statistics about skewness and kurtosis of the different variables of distances in features in Table 11.

Figure 6 represent the kernel density distribution of distances in business cycle features. The analysis of the entire sample shows a concentration on the left side of the distribution and a long right tail (left panel of figure 6). The mass of the distribution is formed by countries with more homogeneous business cycle features, while the tail refers to that countries with more heterogeneous characteristics. If we observe the density distribution of the distances for the crisis period (right panel of figure 6) we can see how the mass is bigger and the tail has

been reduced. It could mean that there are more similarities during the crisis period than before, but still there are countries with different business cycle features. If we observe the skewness and kurtosis, the values calculated from the distances on features for the entire sample are higher than the values obtained considering only the crisis period. Furthermore, the skewness of the density distributions show the existence of an attractor among cyclical features of countries.

The density distributions of distances in growth cycle features are recorded on Figure 7, both density distribution by kernel estimator show the same behaviour. There is no difference between distribution of the entire sample distances and the distances of the crisis subsample. Even skewness and kurtosis take similar values, but still higher in the case of the crisis period. It could mean that relationships between different economies have not changed after the great recession, nevertheless there could be more differences during the crisis. The density distributions of growth cycle features also present a deviation, what shows the possible existence on an attractor between economies.

These results point towards the reconsideration of the analysis about business cycle features made by Camacho, Perez-Quiros and Saiz (2006). They refused the existence of an attractor in cycles of member countries of the European Union, so it is reasonable to think that the great recession has introduced considerable changes in cyclical patterns. Their study only covered the sample until the last accessions in 2004, consequently, if our analysis shows the existence of that attractor in cycles, it is acceptable to think that the fact of studying the update sample has discovered the change on cyclical dynamics after the experienced financial crisis.

5. Conclusions

In this paper, it has been studied and analysed possible changes in cyclical linkages among countries of the European Union introduced after the Great Recession. By contrast, as shown in previous literature, see Camacho, Perez-Quiros and Saiz (2006), we provide empirical evidence on the existence of a clear pattern in economic cycles. Up to some extent, this paper is an update and an extended version of previous works done within the European Union. In particular, the consideration of a wide set of countries joint to an additional decade seems to be behind these new empirical findings, the change in the relationship.

To summarize, firstly we report the results obtained by applying different methodologies for detecting turning points in GDP time series for each country. These turning points help to date expansions and recessions of every country, that allows us to analyse the length, depth and shape for different cycles. Additionally, we check the differences among these cycles before and after the enlargement of the European Union, finding that cycles are shorter and shallower in average.

Maybe the most important contribution of our analysis emerges from the cyclical pattern observed after the recent financial crisis. In particular, cyclical characteristics after the crisis compared with the results obtained from the full

sample available. Basically, recessions become longer and deeper during the recent crisis than before.

On the other hand, focusing on the linkages between countries, and in order to check potential changes in the relationship after the crisis, we carried out an exhaustive analysis of distances on business and growth cycle features, for both, the whole sample and the most recent crisis period. In doing so, we apply a multidimensional scaling methodology to represent, in a map, every country by using their distances on features of business and growth cycle. No evidence of a definite linkage among countries is found. In other words, it is not possible to establish definite relationships depending on the date of the EU entry to the group. In order to check the robustness of these findings, we represent the density distribution by kernel estimator on each of the distances for growth and business cycle, from the whole sample and for the crisis period.

Finally, we check the existence of an attractor in these distributions, and verify the hypotheses that the recent crisis has probably powered linkages among countries, given that the recent crisis has had similar effects across the European Union. Although the oldest members should have deeper links than the new members, it is possible to check that, with some exceptions, countries are now following more closed dynamics.

All in all, these results are important to distinguish different groups of economies in terms of heterogeneous dynamics and groups with close linkages. To identify these groups is a key element for improving the effectiveness of European policies.

6. References

Aiolfi, M., Timmermann, A., and Catao, L. (2006). Common factors in Latin America's business cycles. *International Monetary Fund* Working Paper Series.

Artis, M., Marcellino, M., and Proietti, T. (2005). Business cycles in the new EU member countries and their conformity with the Euro area. *Journal of Business Cycle Measurement and Analysis* 2: 7-41

Bry, G., and Boschan, C. (1971). Cyclical analysis of time series: Selected procedures and computer programs. *National Bureau of Economic Research*.

Camacho, M. and Palmieri, G. (2016). Latin American Cycles: Has Anything Changed after the Great Recession? *Emerging Markers Finance and Trade*, forthcoming.

Camacho, M., Perez-Quiros, G., and Saiz, L. (2006). Are European business cycles close enough to be just like one? *Journal of Economic Dynamics & Control* 30: 1687-1706.

Camacho, M., Perez-Quiros, G., and Saiz, L. (2008). Do European business cycles look like one? *Journal of Economic Dynamics & Control* 32: 2165-2190.

Carrasco, C., and Reis, F. (2006). Evidence about Mercosur's business cycle. *Anais do XXXIV Encontro Nacional de Economia* 179.

Cox, Trevor F., and Michael A. A. Cox (2000) Multidimensional Scaling (Second Edition). *Chapman and Hall*.

Darvas, Z., and Szapary, G. (2005). Business cycle synchronization in the enlarged EU. *Open Economies Review* 19(1): 1-19.

Fidrmuc, J., and Korhonen, L. (2010). The impact of the global financial crisis on business cycles in Asian emerging economies. *Journal of Asian Economics* 21: 293-303.

Gächter, M., Riedl, A., and Ritzberger-Gruenwald, D. (2012). Business cycle synchronization in the euro area and the impact of the financial crisis. *Monetary Policy & the Economy* 2: 33-60.

Harding, D. and A. Pagan (2002). Dissecting the cycle: a methodological investigation. *Journal of Monetary Economics* 49: 365-381.

Harding, D. and A. Pagan (2002). A comparison of two business cycle dating methods. *Journal of Economic Dynamics & Control* 27:1681-1690.

Hodrick, R., and Prescott, E. (1997). Postwar U.S. Business Cycles: an Empirical Investigation. *Journal of Money, Credit and Banking* 29: 1-16.

Hurtado-Rendón, A., and Builes-Vásquez, F. (2011). Synchronization of business cycles in the Mercosur: 1960-2008. *Echoes of Economy* 1431: 7-35.

Inklaar, R., Jong-A-Pin, R. and De Haan, J. (2008). Trade and Business Cycle synchronization in OECD countries - A re-examination. *European Economic Review* 52: 646-666.

Kose, M. A., Otrok, C., and Prasad, E. S. (2008). Global business cycles: convergence or decoupling? (No. w14292). *National Bureau of Economic Research*.

Krolzig, H. and Toro, J. (2005). Classical and modern business cycle measurement: the European case. *Spanish Economic Review* 7: 1-22.

Mejia-Reyes, P. (2004). Classical business cycles in America: are national business cycles synchronized. *International Journal of Applied Econometrics and Quantitative Studies* 1-3: 75-102.

Appendix

Table 1. Chronological enlargement of the European Union.

Date	Countries	Date	Countries
1957 Founders	Belgium France Germany Italy Luxembourg Netherlands	**2004**	Cyprus Czech Republic Estonia Hungary Latvia Lithuania Malta
1973	Denmark Ireland United Kingdom		Poland Slovakia Slovenia
1981	Greece	**2007**	Bulgaria Romania
1986	Portugal Spain	**2013**	Croatia
1995	Austria Finland Sweden		

Table 2. Data description.

Country	Code	Period	Source	Accession
AUSTRIA	AT	1960/Q2 – 2016/Q2	OECD	01/01/1995
BELGIUM	BE	1960/Q2 – 2016/Q2	OECD	**25/03/1957**
BULGARIA	BG	2000/Q2 – 2016/Q1	Statistical Institute	01/01/2007
CROATIA	HR	2001/Q1 – 2016/Q1	Statistical Institute	01/07/2013
CYPRUS	CY	1995/Q2 – 2016/Q1	Statistical Institute	01/05/2004
CZECH REPUBLIC	CZ	1994/Q2 – 2016/Q1	OECD	01/05/2004
DENMARK	DK	1960/Q2 – 2016/Q1	OECD	01/01/1973
ESTONIA	EE	1995/Q2 – 2016/Q1	Statistical Institute	01/05/2004
FINLAND	FI	1960/Q2 – 2016/Q1	OECD	01/01/1995
FRANCE	FR	1949/Q2 – 2016/Q1	Statistical Institute	**25/03/1957**
GERMANY	DE	1960/Q2 – 2016/Q2	OECD	**25/03/1957**
GREECE	EL	1960/Q2 – 2016/Q1	OECD	01/01/1981
HUNGARY	HU	1995/Q2 – 2016/Q2	OECD	01/05/2004
IRELAND	IE	1960/Q2 – 2016/Q1	OECD	01/01/1973
ITALY	IT	1960/Q2 – 2016/Q2	OECD	**25/03/1957**
LATVIA	LV	1995/Q2 – 2016/Q1	OECD	01/05/2004
LITHUANIA	LT	1995/Q2 – 2016/Q1	Statistical Institute	01/05/2004
LUXEMBOURG	LU	1960/Q2 – 2016/Q1	OECD	**25/03/1957**
MALTA	MT	2000/Q2 – 2016/Q1	Central Bank	01/05/2004
NETHERLANDS	NL	1960/Q2 – 2016/Q2	OECD	**25/03/1957**
POLAND	PL	1995/Q2 – 2016/Q1	OECD	01/05/2004
PORTUGAL	PT	1960/Q2 – 2016/Q2	OECD	01/01/1986
ROMANIA	RO	1995/Q2 – 2016/Q1	Statistical Institute	01/01/2007
SLOVAKIA	SK	1993/Q2 – 2016/Q2	OECD	01/05/2004
SLOVENIA	SI	1995/Q2 – 2016/Q1	Statistical Institute	01/05/2004
SPAIN	ES	1960/Q2 – 2016/Q1	OECD	01/01/1986
SWEDEN	SE	1960/Q2 – 2016/Q2	OECD	01/01/1995
UNITED KINGDOM	UK	1955/Q2 – 2016/Q2	OECD	01/01/1973

Table 3. Business cycle features for the entire sample. Average for EU28.

		Duration (q)		Amplitude (%)		Excess (%)	
		Expansion	Recession	Expansion	Recession	Expansion	Recession
AUSTRIA	1960 – 2016	27,9	5	0,28	0,00	-1,24	-0,23
BELGIUM	1960 – 2016	29,6	3	0,30	-0,02	-1,07	0,04
BULGARIA	2000 – 2016	18,7	4	0,26	-0,02	-1,04	0,06
CROATIA	2001 – 2016	18	25	0,21	-0,14	-1,00	-2,86
CYPRUS	1995 – 2016	21,7	9,5	0,24	-0,07	-1,25	-0,34
CZECH REPUBLIC	1994 – 2016	18,8	4,3	0,19	-0,03	-1,27	-0,01
DENMARK	1960 – 2016	18,5	4,3	0,17	-0,03	-0,01	0,25
ESTONIA	1995 – 2016	24,3	5,5	0,46	-0,12	-1,41	0,50
FINLAND	1960 – 2016	16,5	4,3	0,20	-0,04	-0,36	-0,10
FRANCE	1949 – 2016	25,2	5,1	0,31	0,00	-1,01	0,04
GERMANY	1960 – 2016	25	8,3	0,23	-0,01	-0,62	0,26
GREECE	1960 – 2016	14,1	6,3	0,29	-0,08	-0,89	0,35
HUNGARY	1995 – 2016	23,7	4,7	0,22	-0,04	0,14	-0,71
IRELAND	1960 – 2016	19	3,7	0,35	-0,02	-1,25	-0,20
ITALY	1960 – 2016	21,9	7,1	0,21	-0,02	0,07	-0,11
LATVIA	1995 – 2016	21,7	4,8	0,49	-0,07	-4,06	-0,25
LITHUANIA	1995 – 2016	25	5	0,46	-0,10	-1,53	-0,46
LUXEMBOURG	1960 – 2016	19,6	3,1	0,28	-0,03	-1,21	0,03
MALTA	2000 – 2016	11,6	1,5	0,12	-0,02	-0,12	-0,07
NETHERLANDS	1960 – 2016	24,3	4,4	0,28	-0,03	-0,38	0,39
POLAND	1995 – 2016	13,2	1	0,16	-0,01	-0,01	0,00
PORTUGAL	1960 – 2016	18,8	4,1	0,25	-0,03	-0,73	0,14
ROMANIA	1995 – 2016	15	6	0,25	-0,05	-2,07	-0,37
SLOVAKIA	1993 – 2016	29,3	2,5	0,45	-0,08	-3,01	-0,59
SLOVENIA	1995 – 2016	23,7	6,5	0,28	-0,07	-2,18	-0,64
SPAIN	1969 – 2016	35,5	15,7	0,40	-0,03	0,43	-0,14
SWEDEN	1969 – 2016	24,7	8,4	0,23	-0,03	-0,02	-0,23
UK	1955 – 2016	35,5	6,4	0,33	-0,03	-1,26	-0,72
Average EU28		22,2	6,1	0,30	-0,04	-0,98	-0,21

Table 4. Growth cycle features for entire sample. Average for EU28.

		Duration (q)		Amplitude (%)	
		Expansion	Recession	Expansion	Recession
AUSTRIA	1960 – 2016	7,6	6,0	0,06	0,02
BELGIUM	1960 – 2016	6,3	8,3	0,05	0,05
BULGARIA	2000 – 2016	6,3	22,5	0,08	0,18
CROATIA	2001 – 2016	4,5	10,5	0,03	0,02
CYPRUS	1995 – 2016	7,8	11,3	0,05	0,05
CZECH REPUBLIC	1994 – 2016	8,2	9,4	0,06	0,06
DENMARK	1960 – 2016	3,9	4,4	0,03	0,01
ESTONIA	1995 – 2016	7,6	7,5	0,09	0,07
FINLAND	1960 – 2016	4,4	5,0	0,05	0,02
FRANCE	1949 – 2016	7,8	9,5	0,08	0,06
GERMANY	1960 – 2016	7,1	7,0	0,07	0,02
GREECE	1960 – 2016	3,6	4,5	0,06	0,00
HUNGARY	1995 – 2016	6,8	12,8	0,03	0,08
IRELAND	1960 – 2016	6,1	5,7	0,09	0,05
ITALY	1960 – 2016	6,7	5,4	0,06	0,01
LATVIA	1995 – 2016	6,2	7,3	0,07	0,08
LITHUANIA	1995 – 2016	4,8	5,9	0,06	0,06
LUXEMBOURG	1960 – 2016	5,9	6,9	0,08	0,04
MALTA	2000 – 2016	2,8	2,7	0,04	0,00
NETHERLANDS	1960 – 2016	3,8	4,4	0,04	0,02
POLAND	1995 – 2016	5,5	5,0	0,07	0,04
PORTUGAL	1960 – 2016	8,8	10,9	0,08	0,08
ROMANIA	1995 – 2016	3,9	7,6	0,05	0,03
SLOVAKIA	1993 – 2016	8,0	15,3	0,10	0,16
SLOVENIA	1995 – 2016	4,2	5,8	0,03	0,03
SPAIN	1971 – 2016	7,1	7,4	0,06	0,03
SWEDEN	1971 – 2016	7,6	5,8	0,06	0,01
UNITED KINGDOM	1955 – 2016	7,2	6,5	0,07	0,02
Average EU28		6,1	7,9	0,06	0,05

Table 5. Business cycle features before and after the accession to EU.

		Duration (q)		Amplitude (%)		Excess (%)	
		Expansion	Recession	Expansion	Recession	Expansion	Recession
BELGIUM	After EU	29,6	3	0,30	-0,02	-1,07	0,04
FRANCE	Before EU	35	-	0,56	-	-0,76	-
	After EU	24	5,1	0,28	0,00	-1,04	0,04
GERMANY	After EU	25	8,3	0,23	-0,01	-0,62	0,26
ITALY	After EU	21,9	7,1	0,21	-0,02	0,07	-0,11
LUXEMBOURG	After EU	19,6	3,1	0,28	-0,03	-1,21	0,03
NETHERLANDS	After EU	24,3	4,4	0,28	-0,03	-0,38	0,39
DENMARK	Before EU	26	2	0,35	-0,01	0,16	0,17
	After EU	16,6	4,6	0,12	-0,03	-0,05	0,25
IRELAND	Before EU	29,5	3	0,42	-0,00	0,16	0,00
	After EU	16,4	3,8	0,34	-0,03	-1,60	-0,22
UK	Before EU	78	-	0,80	-	-4,06	-
	After EU	27	6,4	0,24	-0,03	-0,70	-0,72
GREECE	Before EU	18	3,3	0,52	-0,07	-1,61	0,39
	After EU	11,9	8	0,16	-0,08	-0,47	0,32
PORTUGAL	Before EU	20,8	3,5	0,38	-0,03	-1,54	-0,12
	After EU	17,5	4,6	0,16	-0,04	-0,19	0,34
SPAIN	Before EU	45	17	0,54	-0,00	6,12	0,42
	After EU	32,3	15	0,35	-0,05	-1,47	-0,41
AUSTRIA	Before EU	30,5	6,3	0,38	0	-2,24	-0,49
	After EU	24,3	3,7	0,14	-0,01	0,09	0,03
FINLAND	Before EU	15	4	0,18	-0,03	-0,34	-0,30
	After EU	19	5	0,21	-0,05	-0,40	0,36
SWEDEN	Before EU	15	9,8	0,15	-0,02	0,29	-0,47
	After EU	44	3	0,39	-0,06	-0,64	0,75
Average EU15	Before	31,3	6,1	0,43	-0,03	-0,38	-0,05
	After	23,6	5,7	0,25	-0,04	-0,65	0,09
CYPRUS	Before EU	54	-	0,66	-	-4,39	-
	After EU	5,5	9,5	0,04	-0,07	0,32	-0,34
CZECH REPUBLIC	Before EU	26,5	5	0,32	-0,02	-2,56	0,13
	After EU	21,7	4	0,22	-0,04	-1,88	-0,08
ESTONIA	Before EU	23,5	4	0,55	-0,03	-3,74	0,30
	After EU	30,5	7	0,57	-0,21	-0,61	0,71
HUNGARY	Before EU	48	5	0,53	-0,01	0,34	-0,04
	After EU	11,5	4,5	0,07	-0,05	0,05	-1,04
LATVIA	Before EU	22,5	2,5	0,62	-0,02	-7,01	0,20
	After EU	20	7	0,22	-0,11	1,85	-0,69
LITHUANIA	Before EU	24,5	4	0,57	-0,03	-3,43	0,34
	After EU	30,5	6	0,56	-0,17	-1,56	-1,26

MALTA	Before EU	15	2	0,12	-0,02	0,91	-0,22
	After EU	10,8	1,3	0,12	-0,03	-0,38	-0,02
POLAND	Before EU	12,8	1	0,18	-0,02	0,17	0,00
	After EU	19	1	0,20	-0,00	-1,34	0,00
SLOVAKIA	Before EU	29,5	4	0,55	-0,06	-4,73	-1,18
	After EU	32,5	1	0,47	-0,09	-3,39	0,00
SLOVENIA	Before EU	53	-	0,75	-	-6,68	-
	After EU	9	6,5	0,05	-0,07	0,08	-0,64
BULGARIA	Before EU	35	-	0,66	-	-4,26	-
	After EU	10,5	4	0,06	-0,02	0,57	0,06
ROMANIA	Before EU	20	7	0,41	-0,05	-3,56	0,68
	After EU	10	5	0,08	-0,05	-0,57	-1,41
CROATIA	Before EU	29	25	0,39	-0,14	-1,85	-2,86
	After EU	7	-	0,03	-	-0,14	-
Average EU28	Before	30,7	6,0	0,46	-0,04	-1,94	-0,17
	After	20,4	5,3	0,23	-0,06	-0,60	-0,12

Table 6. Growth cycle features before and after the accession to EU.

		Duration (q)		Amplitude (%)	
		Expansion	Recession	Expansion	Recession
BELGIUM	After EU	6,3	8,3	0,05	0,05
FRANCE	Before EU	29	9	0,45	0,09
	After EU	6,4	9,6	0,06	0,06
GERMANY	After EU	7,1	7	0,07	0,02
ITALY	After EU	6,7	5,4	0,06	0,01
LUXEMBOURG	After EU	5,9	6,9	0,08	0,04
NETHERLANDS	After EU	3,8	4,4	0,04	0,02
DENMARK	Before EU	7	7	0,08	0,07
	After EU	3,3	4	0,03	0,00
IRELAND	Before EU	8,3	5,3	0,10	0,06
	After EU	5,5	5,9	0,09	0,05
UK	Before EU	6,8	9,5	0,08	0,05
	After EU	7,3	5,5	0,06	0,01
GREECE	Before EU	3,5	4,3	0,09	0,03
	After EU	3,7	4,6	0,04	-0,02
PORTUGAL	Before EU	6,4	9,4	0,08	0,11
	After EU	12	13,5	0,07	0,04
SPAIN	Before EU	7,8	7	0,08	0,03
	After EU	7,3	7,6	0,06	0,03
AUSTRIA	Before EU	10,5	7,9	0,09	0,03
	After EU	5	4,6	0,03	0,01
FINLAND	Before EU	4,1	4,4	0,05	0,02
	After EU	5	6,3	0,04	0,02
SWEDEN	Before EU	8	6,8	0,06	0,01
	After EU	7,1	5	0,06	0,02
Average EU15	Before	9,1	7,1	0,12	0,05
	After	6,2	6,6	0,06	0,02
CYPRUS	Before EU	7,5	16	0,08	0,16
	After EU	8	6,5	0,03	-0,05
CZECH REPUBLIC	Before EU	9	9,7	0,06	0,09
	After EU	7,7	9	0,06	0,01
ESTONIA	Before EU	4	10,7	0,08	0,18
	After EU	10	4,3	0,1	-0,03
HUNGARY	Before EU	3	16,5	0,01	0,17
	After EU	9,3	9	0,04	-0,00
LATVIA	Before EU	2,3	6,2	0,06	0,10
	After EU	14	13	0,09	-0,03
LITHUANIA	Before EU	3	7,5	0,05	0,13
	After EU	6,5	4,3	0,07	-0,01

MALTA	Before EU	2,8	1,8	0,04	-0,02
	After EU	2,9	3,3	0,04	0,01
POLAND	Before EU	5,5	3,8	0,08	0,02
	After EU	5,5	6,3	0,06	0,05
SLOVAKIA	Before EU	14	20	0,15	0,29
	After EU	6	10,5	0,08	0,03
SLOVENIA	Before EU	2,5	3,2	0,03	0,02
	After EU	7,7	10	0,04	0,04
BULGARIA	Before EU	7	21	0,10	0,37
	After EU	5	24	0,04	-0,01
ROMANIA	Before EU	2,4	6,4	0,03	0,04
	After EU	6,3	10,5	0,09	-0,01
CROATIA	Before EU	4,7	9,3	0,04	0,04
	After EU	4	14	0,02	-0,03
Average EU28	Before	6,9	8,8	0,09	0,09
	After	6,6	8,0	0,06	0,01

Table 7. Summary of business and growth cycle features before and after EU.

		Business Cycle					
		Duration		Amplitude		Excess	
		E	R	E	R	E	R
EU15	Before EU	31.3	6.1	0.43	-0.03	-0.38	-0.05
	After EU	23.6	5.7	0.25	-0.04	-0.65	0.09
EU28	Before EU	30.7	6	0.46	-0.04	-1.94	-0.60
	After EU	20.4	5.3	0.23	-0.06	-0.60	-0.12

		Growth Cycle			
		Duration		Amplitude	
		E	R	E	R
EU15	Before EU	9.1	7.1	0.12	0.05
	After EU	6.2	6.6	0.06	0.020
EU28	Before EU	6.9	8.8	0.09	0.09
	After EU	6.6	8	0.06	0.01

Table 8. Business cycle features during the last financial crisis.

		Duration (q)		Amplitude (%)		Excess (%)	
		Expansion	Recession	Expansion	Recession	Expansion	Recession
AUSTRIA	2002 – 2016	26,5	5	0,13	-0,05	0,36	0,46
BELGIUM	1993 – 2016	44	5	0,28	-0,05	-0,43	0,46
BULGARIA	2000 – 2016	18,7	4	0,26	-0,02	-1,04	0,06
CROATIA	2001 – 2016	18	25	0,21	-0,14	-1,00	-2,86
CYPRUS	1995 – 2016	21,7	9,5	0,24	-0,07	-1,25	-0,34
CZECH REPUBLIC	1998 – 2016	21,7	4	0,22	-0,04	-1,88	-0,08
DENMARK	1998 – 2016	17,7	10	0,10	-0,04	-0,32	0,99
ESTONIA	1999 – 2016	30,5	7	0,10	-0,17	-0,61	0,71
FINLAND	1993 – 2016	19	5	0,21	-0,05	-0,40	0,36
FRANCE	2003 – 2016	13,7	5	0,06	-0,02	-0,09	0,35
GERMANY	2003 – 2016	24	3	0,13	-0,07	0,09	1,34
GREECE	1995 – 2016	26	16	0,32	-0,15	-2,02	0,26
HUNGARY	1996 – 2016	23,7	4,5	0,22	-0,05	0,14	-1,04
IRELAND	2005 – 2016	7,7	9	0,20	-0,07	-1,17	-0,93
ITALY	1994 – 2016	23,3	10	0,10	-0,06	0,36	0,39
LATVIA	1995 – 2016	27,5	7	0,62	-0,11	-5,68	-0,69
LITHUANIA	1999 – 2016	30,5	6	0,56	-0,17	-1,56	-1,26
LUXEMBOURG	1960 – 2016	15	3,5	0,20	-0,06	0,15	0,25
MALTA	2006 – 2016	12,3	1,5	0,14	-0,03	-0,70	-0,02
NETHERLANDS	2003 – 2016	13,3	5,5	0,08	-0,03	-0,43	0,27
POLAND	2001 – 2016	19	1	0,20	0,00	-1,34	0,00
PORTUGAL	2003 – 2016	13	6,5	0,05	-0,06	0,02	0,80
ROMANIA	1999 – 2016	19	5	0,30	-0,05	-3,18	-1,41
SLOVAKIA	2000 – 2016	32,5	1	0,47	-0,09	-3,39	0,00
SLOVENIA	1995 – 2016	23,7	6,5	0,28	-0,07	-2,18	-0,64
SPAIN	1994 – 2016	33,5	22	0,36	-0,09	-1,90	-0,35
SWEDEN	1993 – 2016	44	3	0,39	-0,06	-0,64	0,75
UK	1992 – 2016	28	6,5	0,22	-0,01	-0,28	-1,01
Average EU28		23,13	7,04	0,24	-0,07	-1,08	-0,11

Table 9. Growth cycle features during the last financial crisis.

		Duration (q)		Amplitude (%)	
		Expansion	Recession	Expansion	Recession
AUSTRIA	2008 – 2016	4,5	5,3	0,02	-0,01
BELGIUM	1996 – 2016	7,3	9,5	0,03	0,02
BULGARIA	2006 – 2016	7,5	24	0,10	-0,01
CROATIA	2006 – 2016	5	12	0,02	-0,05
CYPRUS	2007 – 2016	8	6,5	0,03	-0,05
CZECH REPUBLIC	2006 – 2016	7,7	9	0,06	0,01
DENMARK	2006 – 2016	4,4	4,8	0,01	-0,01
ESTONIA	2005 – 2016	10	4,3	0,10	-0,03
FINLAND	2006 – 2016	6	5,7	0,03	-0,02
FRANCE	2005 – 2016	9,3	7,5	0,04	-0,01
GERMANY	2005 – 2016	6	7	0,04	0,00
GREECE	2006 – 2016	8	8,5	0,01	-0,12
HUNGARY	2005 – 2016	9,3	9	0,04	0,00
IRELAND	2005 – 2016	5,3	7	0,08	0,02
ITALY	2005 – 2016	8,7	10	0,02	-0,04
LATVIA	2005 – 2016	14	13	0,09	-0,03
LITHUANIA	2006 – 2016	8,3	5,3	0,09	-0,01
LUXEMBOURG	2006 – 2016	7	8,5	0,07	0,02
MALTA	2006 – 2016	3,2	3,8	0,04	0,01
NETHERLANDS	2006 – 2016	7,7	9	0,04	0,00
POLAND	2006 – 2016	5,5	5,3	0,06	0,03
PORTUGAL	2006 – 2016	7,3	8,5	0,01	-0,02
ROMANIA	2006 – 2016	6,3	10,5	0,09	-0,01
SLOVAKIA	2006 – 2016	6	10,5	0,08	0,03
SLOVENIA	2006 – 2016	7,7	8	0,04	-0,02
SPAIN	2004 – 2016	9,3	9	0,05	-0,03
SWEDEN	2005 – 2016	10,3	6,5	0,07	0,00
UK	2005 – 2016	6,8	3,7	0,04	-0,01
Average EU28		7,4	8,3	0,05	-0,01

Table 10. Summary of Business and Growth cycle features for the whole sample and crisis.

Business Cycle						
	Duration		Amplitude		Excess	
	E	R	E	R	E	R
Total	22.2	6.1	0.30	-0.04	-0.98	-0.21
Crisis	23.1	7	0.24	-0.07	-1.08	-0.11

Growth Cycle				
	Duration		Amplitude	
	E	R	E	R
Total	6.1	7.9	0.06	0.05
Crisis	7.4	8.3	0.05	-0.01

Table 11. Skewness and kurtosis of distances in growth and business cycle.

	Business cycle	
	Skewness	Kurtosis
All sample	0.88	3.07
Crisis period	0.71	2.85
	Growth cycle	
	Skewness	Kurtosis
All sample	1.71	5.91
Crisis period	1.92	6.76

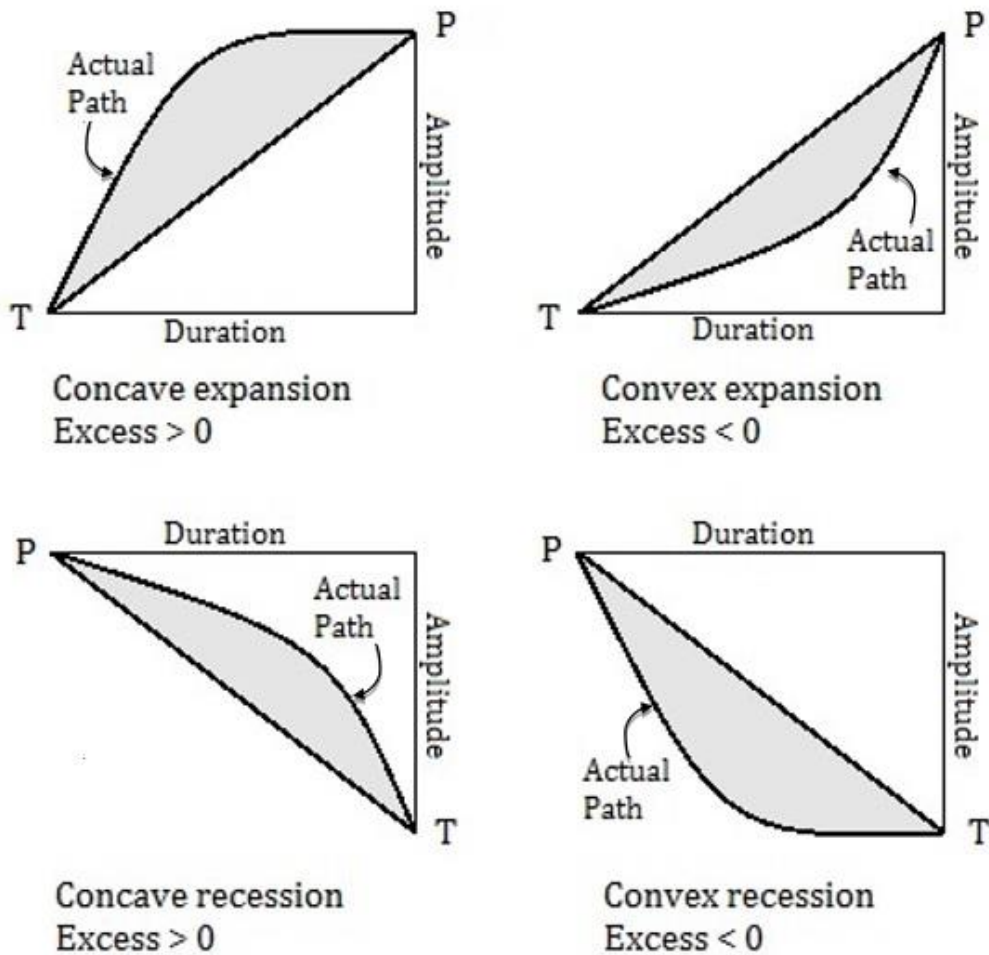Figure 1. Duration, amplitude and excess. Stylized pictures of expansions and recessions depending on the excess.

Figure 2. MDS map of Business Cycle features. All sample.

Figure 3. MDS map of Growth Cycle features. All sample.
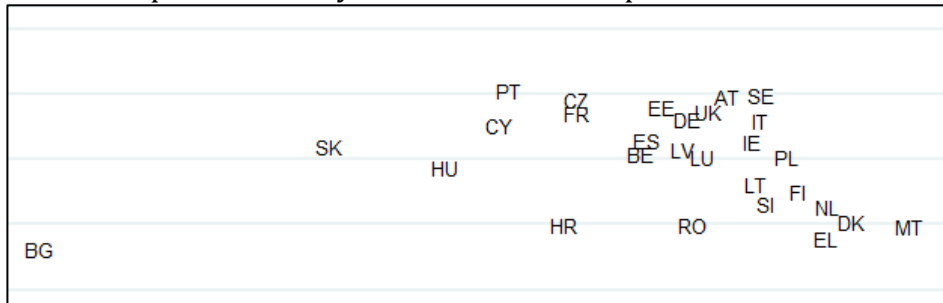
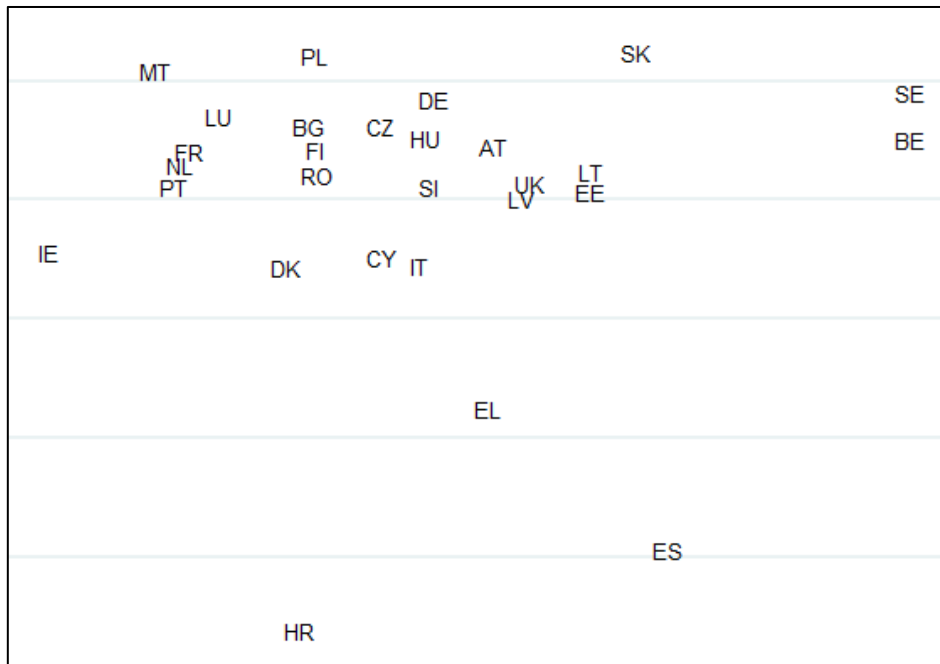Figure 4. MDS map of Business Cycle features. Period of crisis.

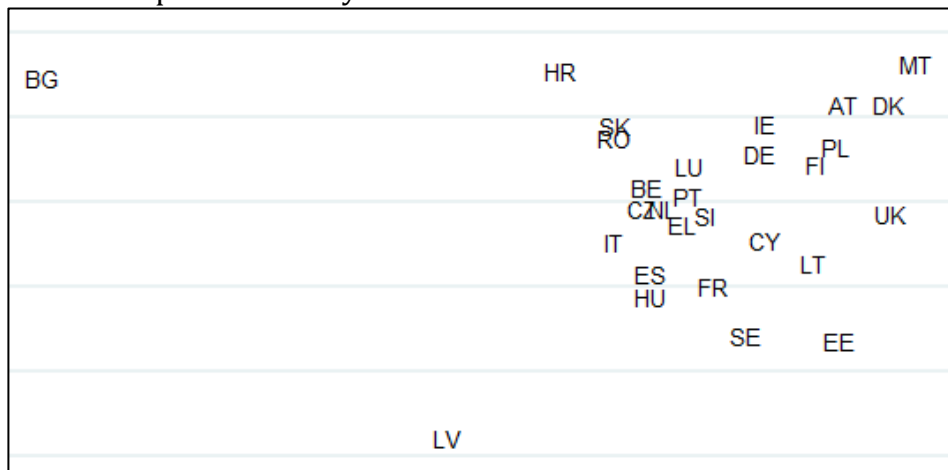Figure 5. MDS map of Growth Cycle features. Period of crisis.

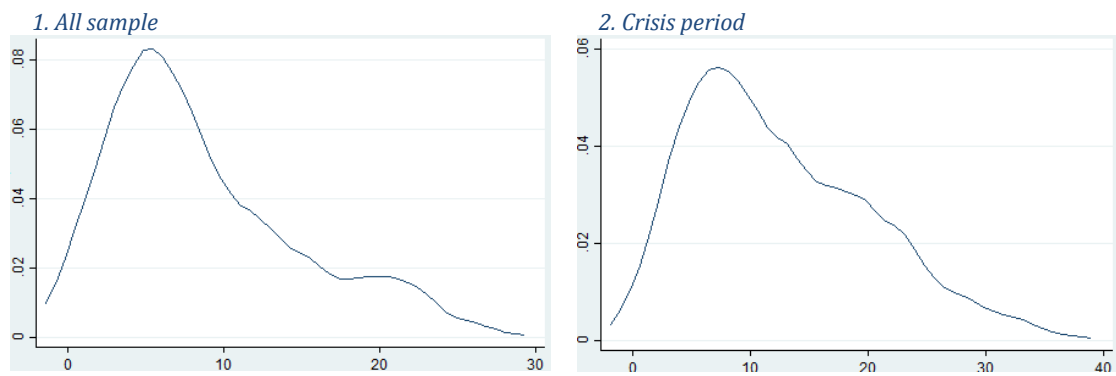Figure 6. Kernel density function of distances on business cycle features.

Figure 7. Kernel density function of distances on growth cycle features.