ASSESSING CONVERGENCE ACROSS THE EUROPEAN UNION

A REGIONAL ANALYSIS

Facultat de Ciències Jurídiques i Econòmiques

UNIVERSITAT JAUME·I

ALEJANDRO MUÑOZ SÁEZ
Email: al204171@alumail.uji.es
Grado en Economía 4º Curso
Tutor: Mariam Camarero

ABSTRACT

This paper assesses the convergence of 131 regions from 13 countries belonging to the European Union. The variable analysed is the log per capita GDP. For the assessment of this convergence we propose two steps: First, in the neoclassical context, the analysis of β and σ convergence. Second, in the time series framework, we analyse convergence based on the deviation of the regions' GDP from the benchmark, in this case the mean of the group. The gist is to determine whether the deviation is stationary and, therefore, can be taken as an evidence of convergence. In order to test for stationarity, two tests are applied: the ADF and the KPSS tests. Moreover, we have analysed the European regions as a whole, as well as two groups that we consider relevant: the Mediterranean Arc and the Core European regions.

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I Introduction

The study of convergence has become an important topic in applied economics and most papers have assessed convergence among OCDE countries.

Convergence is one of the most controversial topics for the different growth theories. The neoclassical growth theory would predict, with economic integration and free factor movement, that production factors would be allocated optimally. The mechanism behind this process is the existence of diminishing returns of capital and labour. For this reason, allowing free factor movement countries would be able to converge. According to this theory, the dispersions inside a country will tend to disappear through time. Nonetheless, this may not always be the case, as Romer (1986) argued that firms will tend to be located together to benefit from the economies of scale and, due to constant returns of capital, countries will not converge.

From an economic and social point of view, the study of convergence may be interesting since it helps to get conclusions on economic integration and to test whether trade opening would facilitate convergence between countries in the long-term. To measure convergence, economic researchers have used different variables, for instance: Per capita GDP, absolute GDP, or natural rate of unemployment. For this reason, the study of convergence has become very important in the evaluation of macroeconomic politics and processes of integration.

Due to this continuous progress of the integration process in the European Union, we will focus our study on this group of countries Therefore, it is important to identify which countries or regions are converging in order to evaluate macroeconomic policies and, after identifying them, to analyse and find why other regions are not converging.

The present paper assesses economic convergence using regional data from some countries inside the European Union, known as Europe 15[1] (EU-15). Later, the reason why the regions of Denmark and Ireland have been removed will be explained. Convergence is tested using the log per capita GDP, which is one of the most common measures of well-being. Moreover, this research contributes to the empirical literature on convergence by using regions instead of countries, which lets us reach deeper conclusions on convergence, mainly because country analysis may be too aggregated. By using regions we can assess which regions have converged, whereas the country level only allows us to identify whether a country has converged as a whole.

1 In the European Union there are different degrees of integration. Some of its members, such as UK, Sweden and Denmark are not part of the monetary union, even if Sweden and Denmark satisfy many of the criteria to be members of the Eurozone.

Instead, it may be the case that a country has not converged as a whole, whereas some regions are converging to the most developed one in the sample. To identify this type of convergence, convergence behaviour is one of our main goals.

In order to test for convergence, the methodology will consist on: firstly, a more descriptive analysis as proposed by the neoclassical theory, using the concepts of β and σ convergence. However, the concept and the way to measure convergence have changed across time, along with econometric techniques. The assessment of convergence could be improved by using panel data or time series: both of them concentrate on the long run behaviour of the variables. Secondly, for the reasons explained above, convergence will be tested using time series methodology and the analysis of stationarity. In that context, the strategy is based on calculating the Log per capita GDP deviations from the benchmark. In our case, the benchmark will be the mean of the group. If the deviations are stationary, we will consider it evidence in favour of convergence, that is, the regions has converged to the mean. Two tests will be performed: The Augmented Dickey-Fuller (ADF) and the KPSS test. With the aim of getting a better outcome to solve the autocorrelation problem, we include lags in both tests in order to avoid this problem. We use the two tests to compare the outcome when we use different hypotheses: the null hypothesis of non-stationarity in the ADF test and the null of stationarity in the KPSS. Nonetheless, KPSS has better power than ADF in short samples.

When looking for convergence through regions, the main objective is to analyse convergence for the whole group. Sequentially, the second objective is to separate the groups into sub-groups to identify some clusters of convergence. Following the clustering process, the sample is separated into the following groups: one group for the Mediterranean arc and one group for the Core European Regions (that is, those that have the highest level of per capita GDP). Characteristically, those regions are located in the centre of Europe, from the South of England to the North of Italy. Nonetheless, other regions[2] will be included to observe if they have converged to the most developed regions.

The data has been collected from the OCDE database and the sample is only available between 1995 and 2011.The variable analysed is the log per capita GDP at constant price, at constant PPP and using 2000 as base year.

[2] As Madrid and Basque Country.

As it has been said before, the subjects to assess convergence are regions (large regions (TL2)), being these 131 regions from the whole group, 26 from the core European Region and 38 from the Mediterranean arc.

This research is organised as follows: Section 2 deals with the concept of convergence and explains the ways to measure it and how it has evolved across time. In section 3, we expose the econometric methodology, whereas sections 4 and 5 show and describe the results from the traditional convergence definition, (β and σ convergence) and the results from the time series analysis, respectively. Since it is too hard to show all the time series results, a separate section (section 6) shows the outcome in thoroughly. Finally, the main conclusions are discussed in section 7.

II EVOLUTION OF THE CONCEPT OF CONVERGENCE

2.1 THE CONCEPT THROUGH THE USE OF CROSS-SECTION

The concept of convergence is closely linked to the growth theory and, in particular, to the neoclassical one after the Solow model (1956). This model has different hypothesis in its basis; one of them, diminishing returns to capital are crucial to predict convergence across countries:

$$\frac{\partial F}{\partial K} > 0 \quad \frac{\partial^2 F}{\partial K^2} < 0$$

Convergence in the neoclassical context is accomplished through the movement of capital. From those countries or regions whose per capita GDP was higher than others, (due to diminishing return to capital), a movement of the capital towards those poorer countries which have a higher performance will appear. Therefore (due to capital accumulation in a country) it will grow, reaching convergence.

In contrast to Solow's model, models of Endogenous Growth are based on a constant return to capital and therefore they predict no convergence. These models exposed that due to the constant return to capital, it will not move into the poorer countries, mainly because performance keeps being higher in richer countries. A different research made by Paul Krugman exposes that firms will tend to locate where the human capital is available, and moreover there will be an interest to stay together to get benefit from the economy of scale. For this reason, models of Endogenous Growth expose that the argument of constant return to capital seems to fit better into reality.

From the neoclassical growth theory emerge two concepts of convergence, which are called *beta β convergence and sigma σ* convergence[3].

On the one hand, if there is evidence in favour of *β convergence*, it would imply that poorer economies will exhibit higher growth rates than richer countries for the period referred. Therefore, if poorer countries catch up with the highest ones, there will be, indirectly, an inverse relation between growth rate and the log per capita GDP for the beginning year. That is, if a country, for instance Spain, has a log per capita GDP in 1995 lower than Italy's and the period referred is from 1995 to 2011, under the *β convergence* context Spain will exhibit *β convergence* if Spain has a higher growth rate than Italy for the whole period.

[3] These concepts were used firstly by Xavier Sala-I-Martín to refer to both kind of convergence in the neoclassical growth theory.

In order to apply it in a formal way, the concept would be:

Being $\gamma_{i,t} = \log(y_{i,t}) - \log(y_{i,t-1})$ the growth rate from the whole period.

$$\gamma_{i,t} = a - \beta \log(y_{i,t-1}) + u_{i,t}$$ [4]

In order to fulfil beta convergence, our coefficient β must be among $0 < \beta < 1$

If the β parameter shows the speed of convergence, the closer to 1 the faster the convergence would be.

On the other hand, if we analyse convergence by observing dispersion, once dispersion is reduced over time, it is called *sigma convergence.*

In a formal way, it would be:

If we use σ^2 to measure dispersion, then

$$\sigma^2 \cong (1-\beta)^2 \cdot \sigma_{t-1}^2 + \sigma_u^2$$

Observing that in order to fulfil σ convergence, it is needed that $0 < \beta < 1$, due to the stability condition of the function. In spite of both convergences being different, beta convergence is a *necessary condition*[5] for the existence of sigma convergence. Looking at the *sufficient condition*:

$$\sigma_t^2 = (\sigma^2)^* + \left[\sigma_o^2 - (\sigma^2)^*\right] \cdot (1-\beta)^{2t}$$

Being $(\sigma^2)^*$ [6] the stationary value and under the assumption $0 < \beta < 1$, it cannot be said that beta convergence is sufficient condition for the existence of sigma convergence. Therefore, the existence of σ convergence without β convergence is not possible.

2.2 THE EMPIRICAL EVIDENCE

Baumol (1986) tested both σ and β convergences for 13 countries since 1870, finding convergence (more abrupt after the Second World War).

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[4] u_{it} is referred to the error when convergence is measured, such as save rate shifts or shocks in the output level $u_{i,t} \approx (0, \sigma^2)$

[5] This condition means that if dispersion has been reduced between two countries (σ convergence), it necessarily implies that one country has caught up with the other (β convergence).

[6] $(\sigma^2)^* = \sigma_u^2 / [1 - (1-\beta)^2]$

Romer (1986) and Delong (1988) criticised this results because, arguing that the sample was biased in what it had to do with industrialized countries.

Another research testing σ convergence and β convergence was carried out by Alan Heston and Robert Summers (1991), who used 110 countries since 1960. In the charts below it can be observed what they found:

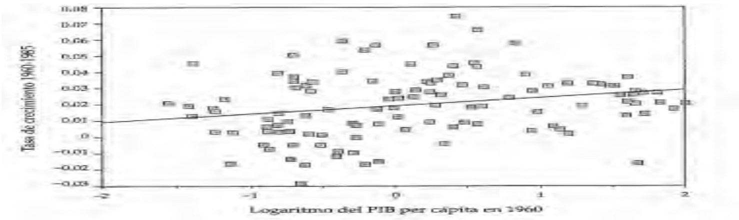

Gráfico 10.1. Convergencia del PIB per cápita entre 114 países.

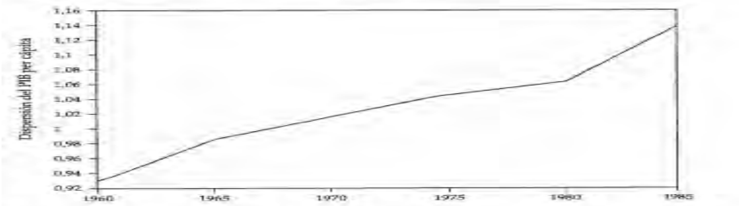

Gráfico 10.2. Dispersión del PIB pdr cápita entre 114 países.

These charts show a strong divergence instead of convergence, which gave more credibility to endogenous models because they don't predict convergence.

As an argument against endogenous models, Sala-i-Martin (1990), Barro and Sala-i-Martin (1991-1992), Mankiw, Romer and Weil (1992) exposed that neoclassical models don´t predict absolute convergence but each country will converge to his own steady state. Therefore, countries which submit similar economic structures and whose steady state revolves in the same orbit will converge, whereas countries with different steady states will not converge. In this new context, the concept of *conditional convergence*[7] is created.

$$\gamma_{i,t,t+T} \equiv a - b\log(y_{i,t}) + \Psi X_{i,t} + \varepsilon_{i,t,t+T}$$

Where $\mathbf{X_{i,t}}$ is a vector with descriptive variables from the steady state. After restructuring the concept of convergence, it was found that empirical evidence of conditional convergence was about 2% per year.

[7]. The conditional convergence concept is actually based on that convergence that is determined by: firstly, the economic characteristics (such as saving rate, population with certain years of schooling, consumption and government spending, among others.) that will determine the state stationary, and secondly, the distance separating the economy from its own steady state. Therefore, convergence between countries will be fulfilled if their steady states are similar.

In 1996, Danny Quah argued in his paper entitled "Twin Peaks: Growth and Convergence in Models of Distribution Dynamics" that convergence in the context of the neoclassical growth theory encompasses two concepts that would have to be clearly defined: firstly, economic growth by changes in technology, and secondly, convergence due to changes in performance between poor and rich countries. Quah presented a new approach by measuring convergence with dynamic distribution models in the context of cross-section. In its practical approach he found evidence of clubs of convergence, as well as of polarization between them.

2.3 THE CONCEPT USING TIME SERIES

Bernard and Durlauf (1995) exposed that the convergence of the neoclassical models could be measured more accurately in the context of time series looking at long-term movements. At first they defined two types of convergence:

1st definition: *Catching up*

That is, two countries *i* and *j* converge in a defined period *t* to *t* + *T* if the difference between the logarithm of GDP per capita[8] between them is reduced from t to t + T, where the information available at time t.

$$\mathrm{E}\left(y_{i,t+T} - y_{j,t+T} \;\middle|\; \mathrm{I}_t\right) < y_{i,t} - y_{j,t}$$

2nd definition: full convergence

It is defined when for a couple of countries i and j there is convergence, in the sense that at any point in time, differences between the logarithm of GDP per capita in both countries is zero and it will remain like that in any future projections.

$$\lim_{k \to \infty} E(y_{i,t+k} - y_{j,t+k} \mid \mathrm{I}_t) = 0$$

In order to test convergence, these authors used cointegration tests developed by Phillips and Ouliaris (1988) and Johansen (1988).

Despite the extent to which convergence improved through cross section, the hypothesis was too strict to collect convergence when it had already occurred, since the concept of convergence in many cases is a process that has not happened in full, i.e. an ongoing process.

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[8]Variable per capita GDP has been used because Bernard and Durlauf use it in their surveys.

As this definition was too strict to find empirical evidence, Bernard and Durlauf (1995, 1996), Oxley and Greasley (1995) (1997) eased the concept to collect that ongoing process.

1st Definition: *Convergence.* This concept would correspond to the set defined above, in the context of cointegration being stationary series with zero mean and defined in the vector [1,-1].

2nd Definition: *Common trend or business cycle synchronization*. This would be a case that usually occurs in the integrated economies, which have not reached convergence in terms of catching up, but have synchronized their bussiness cycles. This cointegrating relationship would be defined in the vector [1,α] being α <0.

3rd Definition: *Catching up*. This definition was, at first, provided by Bernard and Durlauf. In this case, the differences decrease due to a stochastic element, which prevents them from being equal in the long run. That is, a cointegrating relationship defined in the vector [1,-1], but stationary in respect to a tendency and nonzero mean.

Other authors such as Reichlin (1999) proposed searching for convergence clubs by cointegrating clubs as the way to find different countries which are converging toward the same point. The main advantage is that it is a very strict requirement to assume that all countries converge towards the same point and, by seeking convergence clubs, better conclusions can be reached.

Following the studies from Carlino (1993) and Mills, Li and Papell (1999) developed two approaches of convergence considered in the context of time series.

A first approach is called *stochastic convergence*, that is, when the series follow a stationary trend. On the other hand, a second approach defined as *deterministic convergence*[9] defined as being level stationary with zero mean.

[9] deterministic convergence concept defined in the context marking the authors Durlauf and Bernard (1995)

III METHODOLOGY

In this section, the methodology used in the measurement and assessment of convergence is developed. This research includes the 15 European countries excluding Denmark and Ireland since the length of the sample was 15 years instead of 17. Therefore, these two countries are removed.

3.1 TRADITIONAL CONVERGENCE

Firstly, we start applying the traditional definition, which has been explained in the previous section, that is, β and σ convergence. According to what neoclassical growth theory predicts, we will expect to observe that those regions with a lower log per capita GDP at the beginning of our sample period have higher rates of growth (β convergence). In order to measure the evolution of σ convergence, standard deviation will be used to look at what happens with dispersion. The method implementation will be graphics, where both types of convergence are clearly shown.

3.2 TIME SERIES

Secondly, we continue following the evolution of econometric techniques and the concept of convergence leaving behind the use of cross-section to implement time series. In this context, we base ourselves on the deviations of the region from the benchmark (in our case the benchmark is the mean of the group[10]), as performed by Flores et al. (1999) multivariate unit root test:

$$deviation_i = (y_{region\,i} - y_{mean})$$

$$being\ y\ the\ \log per\ capita\ GDP\ \ and\ i\ any\ region$$

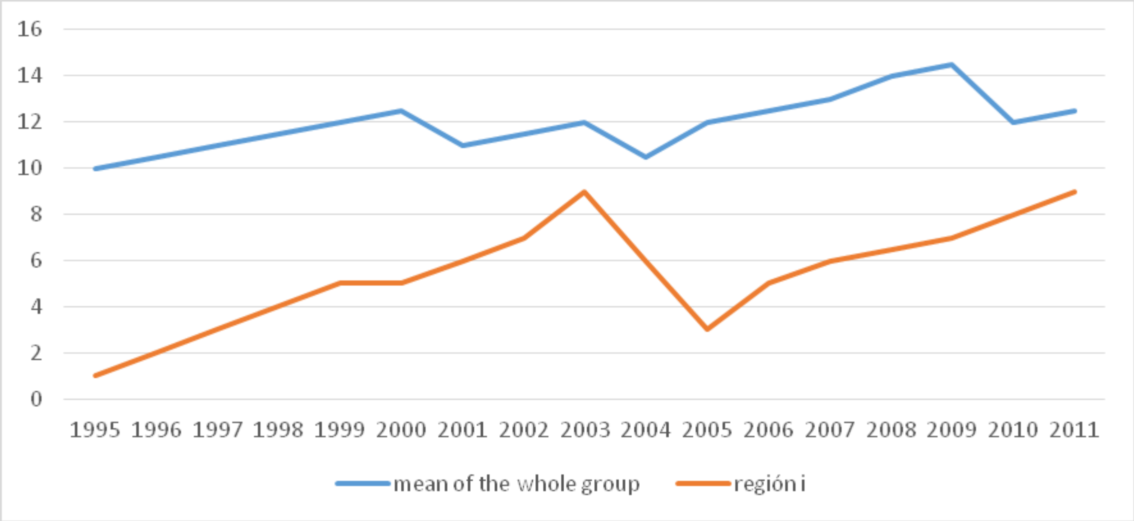
The key is to test for stationarity, because if the deviation is stationary, it will lead us to say that our series and specifically our region has converged toward the mean.

The methodology applied here is influenced by applying unit root test to test for stationarity in the field of economic integration[11].

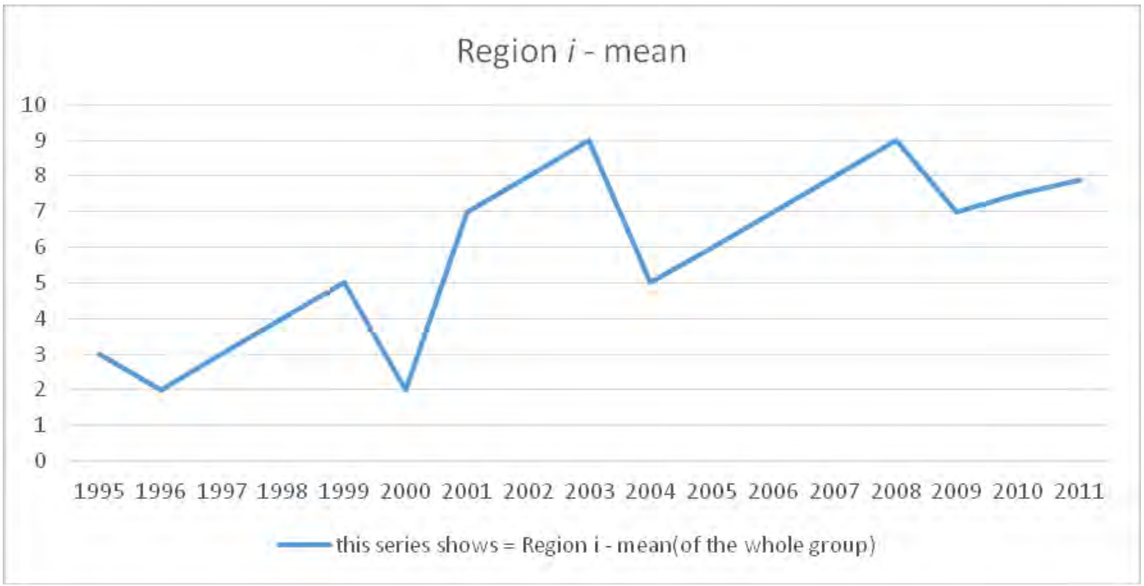
[10] the mean will be: The mean for the whole group, the mean for the Mediterranean group, and the mean for the core European regions.

[11] For further details, look at Camarero, M., Castillo, J., Picazo-tadeo, A., & Tamarit, C. (2013). Eco-efficiency and convergence in OECD countries.Environmental and Resource Economics, 55(1), 87-106 and Camarero, M., Flôres, R.,G., & Tamarit, C. (2008). A "SURE" approach to testing for convergence in regional integrated areas: An application to output convergence in mercosur. Journal of Economic Integration, 23(1), 1-23.

For a better understanding the target, as discussed above, is observed as the series are moved relatively to the mean, for example:



But instead of using the series and the mean separately, we look at the deviation from the mean.



Therefore, what we are going to test is whether this deviation is stationary or not using the unit root test and the stationarity test.

Hereafter, we will call series to the deviation between the region and the mean

An individual test is proposed in order to test what has been previously mentioned.

$$dy_{it} = \mu_i + \rho_i dy_{it-1} + \mu_{it} \quad i = 1 \ldots, N$$

In this way, we allow each series to present an individual reversion towards their own mean, and we can identify, separately, which regions are converging towards the mean of the whole group.

The tests we use to find out whether the series is stationary or not are the following:

Unit root test: AUMENTED DICKEY FULLEY (ADF)

$$\Delta y_t = \gamma y_{t-1} + \beta_1 \Delta y_{t-1} + \cdots + \beta_p \Delta y_{t-p} + u_t \qquad (1)$$

$$\Delta y_t = \alpha + \gamma y_{t-1} + \beta_1 \Delta y_{t-1} + \cdots + \beta_p \Delta y_{t-p} + u_t \ (2)$$

$$\Delta y_t = \alpha + \gamma y_{t-1} + \beta_1 \Delta y_{t-1} + \cdots + \beta_p \Delta y_{t-p} + u_t \ (3)$$

$$Being\, \gamma = \rho - 1$$

ADF tests whether there is a unit root, that is:

$$H_0 : \gamma = 0$$

$$H_1 : \gamma \neq 0$$

If we cannot reject it, it implies that our series is non-stationary and therefore, it does not exhibit convergence.

The advantage of using ADF is that it solves the problem of autocorrelation, which may invalidate the test. There is still another advantage of testing each series separately: it allows each test to have different lags imposed and provides more flexibility.

It should be noted that, due to the rigidity of the concept, collecting the on-going process of convergence is not allowed, whereas if we allow introducing a constant or a trend or both, we are allowed to collect this process by giving this flexibility to the concept of convergence.

Another point to consider is the choice of the lag: here, the approach that has been chosen in order to get the optimal lag was the maximisation of the Akaike criterion. Therefore, the maximum lags were chosen, in this case six lags due to the time period of 17 years, and it goes decreasing lags in order to maximize Akaike criterion, therefore each series may have different lags.

STATIONARITY TEST: KPSS

This test has greater power when working with samples that are not long enough. This test separates series into two parts: the random and the deterministic behaviour, so the test can be performed with or without trend.

$$y_t = \xi t + r_t + \epsilon_t$$

$$r_t = r_{t-1} + u_t$$

Unlike the unit root test, the KPSS null hypothesis means stationarity

$$H_0 = ESTATIONARITY$$

$$H_1 = NO\ ESTATIONARITY$$

Finally, this test solves the problem of autocorrelation in errors by allowing the inclusion of lags. The choice of the lags has been chosen subjectively in order to stabilize the test, i.e., 2 have been used but, if we make use of 3, the outcomes barely change.

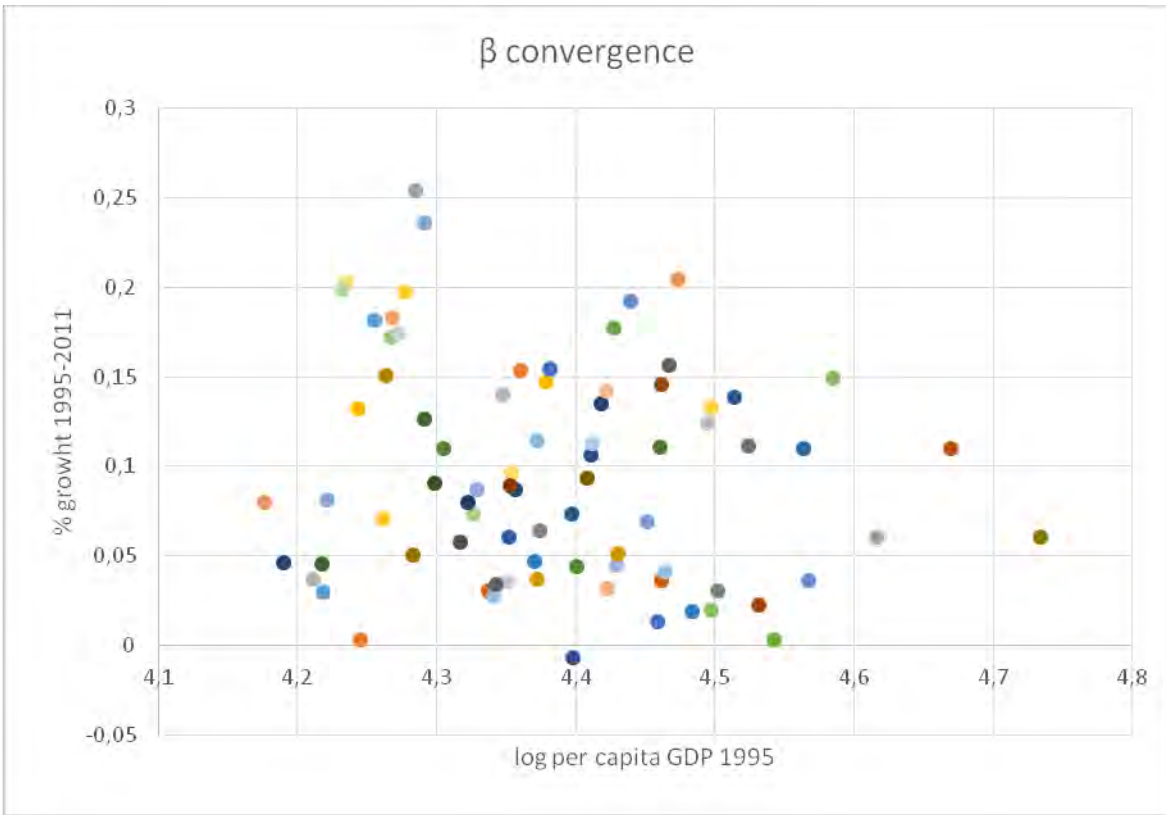
IV ANALYSIS OF THE β AND σ CONVERGENCE ACROSS REGIONS IN THE EUROPEAN UNION

This section tests directly convergence emerging from the neoclassical growth model of Solow (1956), in which it is predicted that countries with a lower log per capita GDP at the initial moment of the sample, have higher growth rates (β convergence) and their dispersion tend to fall (σ convergence). In this sense, this type of convergence is analysed through the sample of 131 regions inside the European Union (13 countries) during the period 1995-2011. Although it is not a long period to perform a thorough analysis itself, it leads to valuable conclusions on economic integration and in this stage, mainly because it has suffered an acceleration in economic integration with the creation of the euro area and, thereby, has improved the mobility of production factors and despite the argument conducted by Sala-i-Martin and Barro (1991, 1992), which explains that for both types of convergence[12] to occur, their stationary states should be in the same circle of attraction. However, in this analysis the addition of descriptive variables is excluded from steady state to make a gross analysis [13]of how convergence has evolved in the neoclassical context in an economic integration process, as the one produced in the euro zone and the European Community. The pursuit for the convergence of all the regions is followed by a sequencing analysis in order to seek convergence clubs.

[12] Β and σ convergence
[13] It is observed, through the chart, that the log per capita GDP and the growth rate for the whole period 1995-2011 show an inverse relation between both measures, as expected.

4.1 β AND σ CONVERGENCE: ALL REGIONS

CHART 1



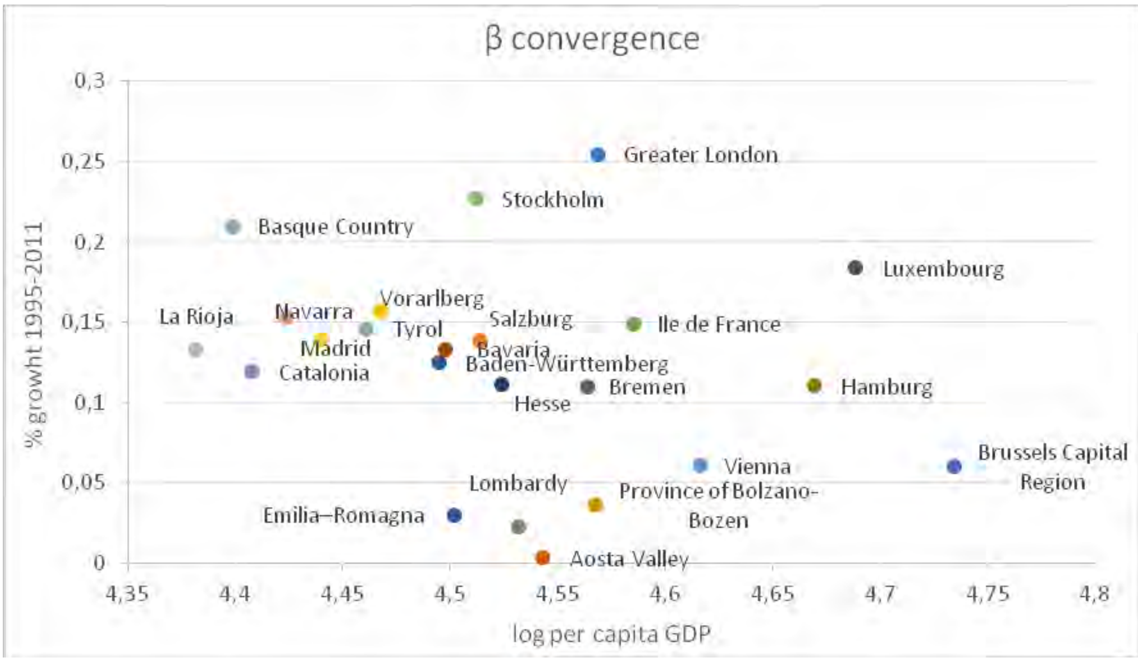
Source: own calculations

Chart 1 shows the log per capita GDP in 1995 for each region of the sample in the x-axis, while in the y-axis it shows the growth rate. For the existence of a perfect relationship of convergence, regions with lower log per capita GDP in 1995 would have to have higher growth rates throughout the whole period. However, this relationship is not observed. What can be seen is a mix between regions in which the β convergence is produced and others where it does not occur[14]. In this way, the need to separate the regions to look for a more specific analysis, in an attempt to obtain better conclusions, arise.

[14] In this sense, for example, Athens has converged towards those with a higher log per capita GDP, for instance, Brussels. However, no convergence is observed for Central Greece towards Brussels, so we referred to them as Mix.

4.2 β AND σ CONVERGENCE: COMPARING THE MOST DEVELOPED REGIONS IN SPAIN WITH THE MOST DEVELOPED REGIONS IN THE SAMPLE

CHART 2



Source: own calculations

In this analysis, the most developed regions in Spain and the most developed regions in the sample have been chosen.

The conclusions drawn from the second graph are:

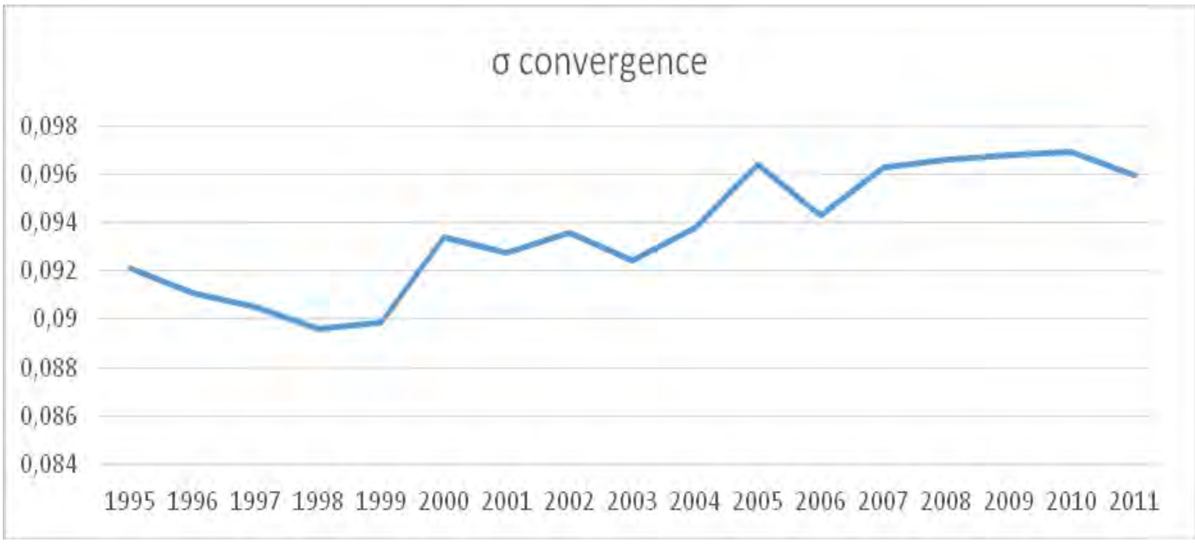
First, we can appreciate a mix rather than a clear β convergence, as shown in the first graph.

Second, if we look specifically, the only region of Spain that meets the convergence β is the Basque Country[15], which does meet the conditions for almost all regions with a higher per capita GDP.

By contrast, the rest of the regions of Spain do not show convergence β towards the most developed ones except for Italian regions. In this case, Spanish regions are converging towards the Italian ones. Regarding the whole set of Spanish regions, it is observed that Madrid, La Rioja, Navarra and Catalonia have very similar growth rates to the others.

[15] The Basque Country is converging towards the most developed regions in the sample, excluding Greater London and Stockholm.

CHART 3



Source: own calculations

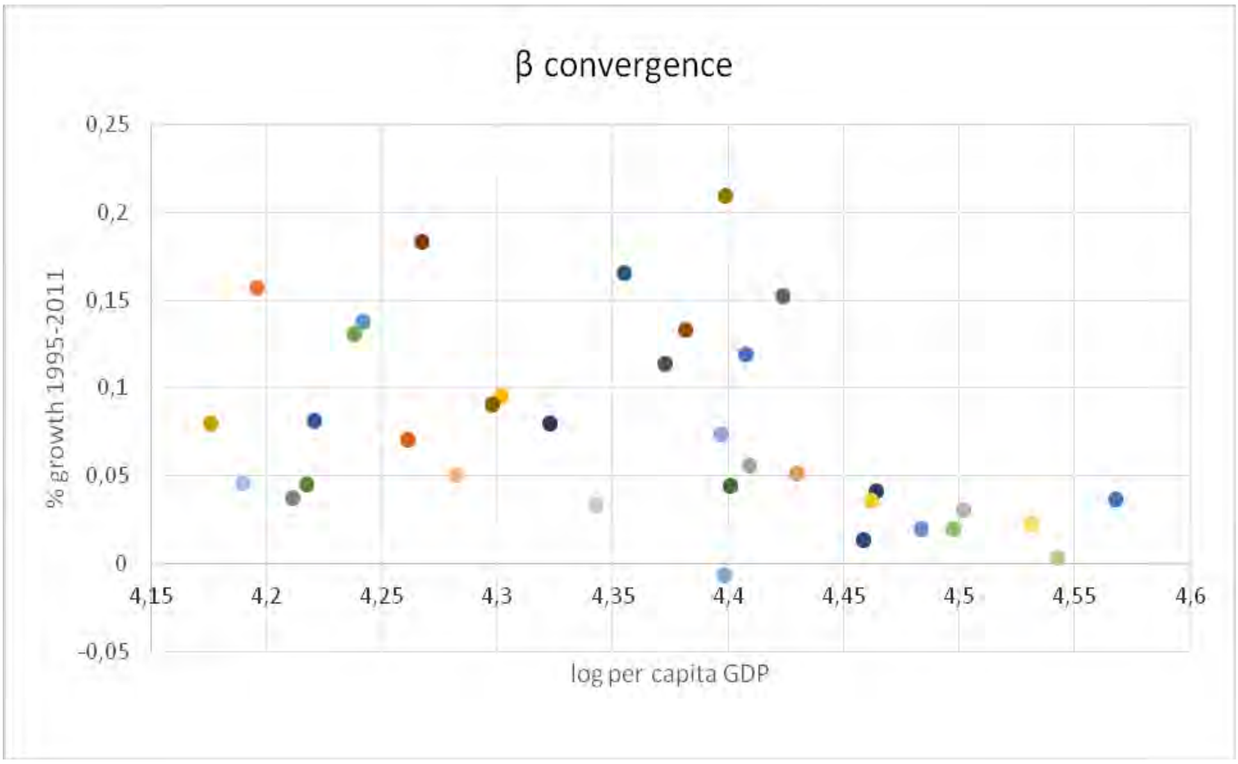
By analysing the σ convergence, it can be observed that it is not fulfilled, since the dispersions tend to increase over time. Returning to the concept of convergence σ, we realise that β convergence is a necessary condition for σ convergence, so if β convergence is not observed previously, the σ convergence will not occur.

<u>4.3 β AND σ CONVERGENCE: ASSESSING THE MEDITERRANEAN ARC</u>

Francia	**Italia(1)**	**Italia(2)**	**Italia(3)**	**España(1)**	**España(2)**
Midi-Pyrénées	Basilicata	Piedmont	Tuscany	Basque Country	Andalucia
Limousin	sicily	Aosta Valley	Marche	Navarra	Murcia
Rhône-Alpes	Sardinia	Liguria	Lazio	La Rioja	Valencia
Auvergne	Province of Bolzano-Bozen	Lombardy	Umbria	Balearic Islands	Catalonia
Languedoc-Roussillon	Province of Trento	Abruzzo	Apulia	Castile-La Mancha	Aragón
Provence-Alpes-Côte d'Azur	Veneto	Molise	Emilia-Romagna		
Corsica	Friuli-Venezia Giulia	Campania			

In the pursuit of convergence in a more disaggregated level and keeping in mind the identification of groups of convergence, we analyse the Mediterranean area, concretely the regions of France, Italy and Spain.

CHART 4

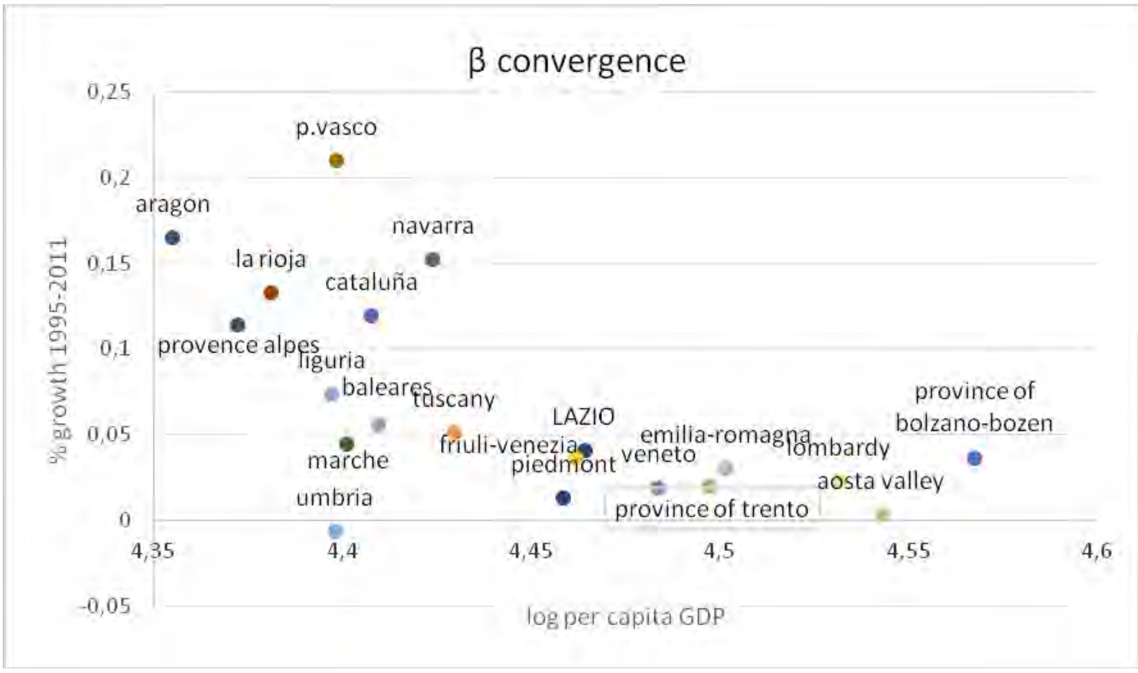


Source: own calculations

Observing Figure 4, it clearly shows that there are not sights of β convergence for the whole selected sample. We have a mix of regions again. On the one hand, some regions meet β convergence towards others that are more advanced, but not for the entire set. On the other hand, very similar growth rates are still observed in all regions, rates that are clearly shown if we focus on one of the regions with one log per capita highest GDP in 1995, i.e., Province of Bolzano-Bozen and conversely one of the lowest per capita GDP, Campania, and what we can see is that both have very similar growth rates. Therefore, there are no sights of β convergence.

However, we should note that the sample is separated into two groups: those regions which had a log per capita GDP between [4.15, 4.35] in 1995 and those which had a log per capita GDP between [4.35, 4.6]. Focusing on this second group we can draw clearer conclusions as seen in the chart 5.

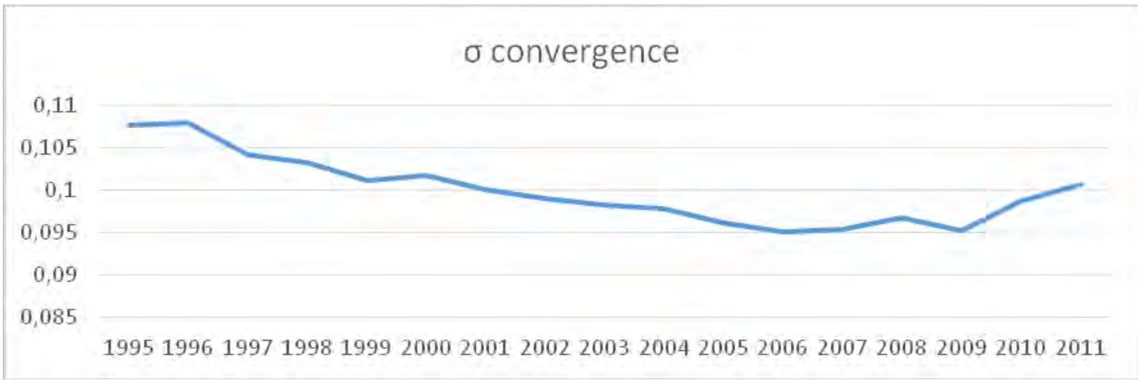
CHART 5



Source: own calculations

By breaking down the sample, we are able to get better conclusions, and by observing the Chart 5, which shows that convergence has occurred since those regions that started behind in 1995 have had higher grown rates than those regions that are more developed, except some cases[16] in which β convergence is not fulfilled. Therefore, there is β convergence for the upper segment of the sample, that is, all regions with a log per capita GDP higher than 4.35.

CHART 6

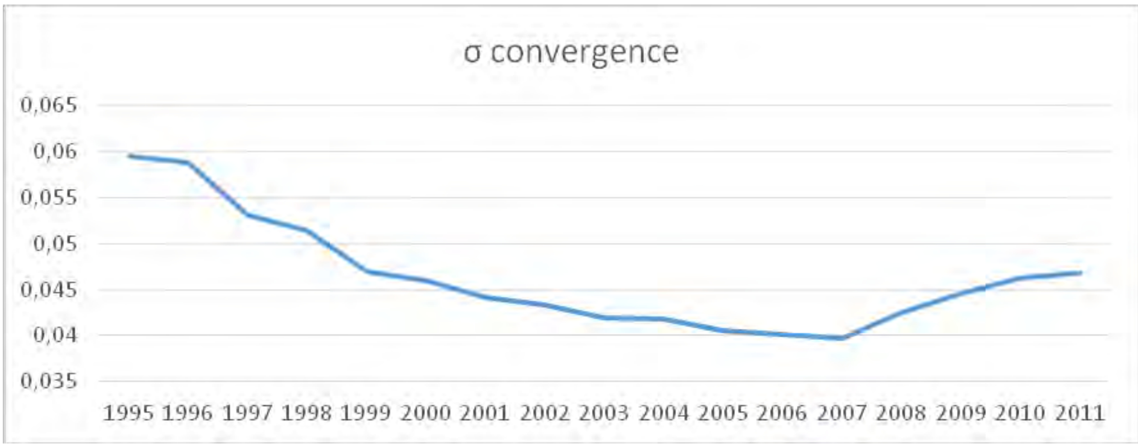


Source: own calculations

[16] Umbria, Marche and Tuscany have had very similar growth rates to those of the most advanced regions and, therefore, no β convergence is observed for these regions.

Returning to the entire group of Mediterranean regions, chart 6 shows how the dispersion of the sample has evolved over this period. It is observed a decrease and, therefore, evidence of σ convergence. However, it is noteworthy that if we look at chart 4, β convergence is not observed throughout the whole sample, which suggests that σ convergence has been fulfilled because there have been beta convergence for a particular segment of the sample, no because all regions have reduced their disparities but because those that have fulfilled beta convergence, have diminished their disparities in a stronger way than those which have not fulfilled it.

CHART 7



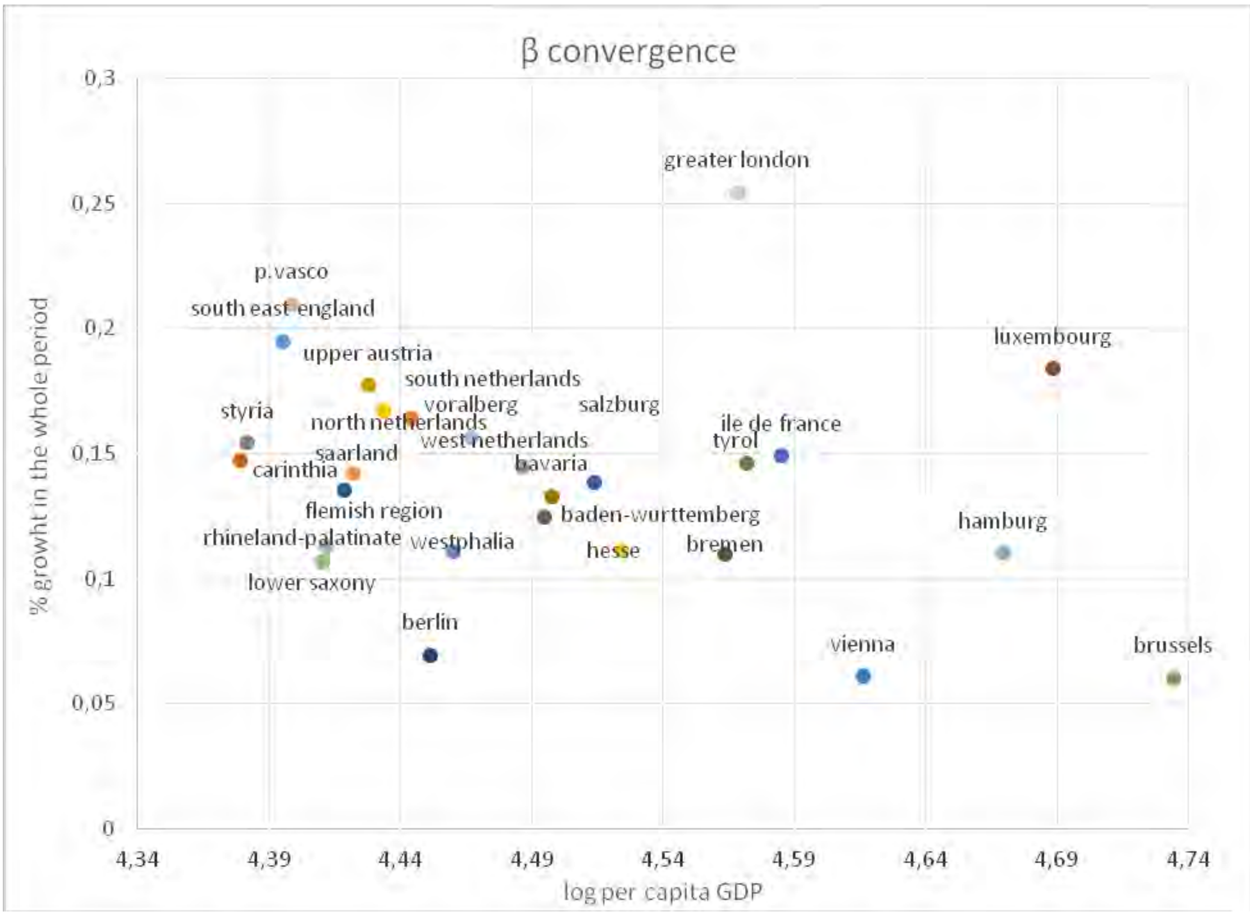
Source: own calculations

In chart 7, it is shown how σ convergence has evolved for the upper segment of the Mediterranean sample. That is, those regions with a higher log per capita GDP than 4.35. As it can be seen in chart 5, this segment fulfils β convergence and, as it could be seen in the chart 7, there has also been σ convergence for the period 1995-2011 for the highest segment of the sample.

4.4 β AND σ CONVERGENCE: THE CORE EUROPEAN REGIONS

This segmentation shows all regions characterized by having the highest log per capita GDP, which are also located in the centre of Europe, forming a path crossing from the South of the UK to the North of Italy. Subjectively, the Basque Country has been included because it is one of the most advanced regions of Spain and it has had one of the highest growth rates for the entire period.

CHART 8



Source: own calculations

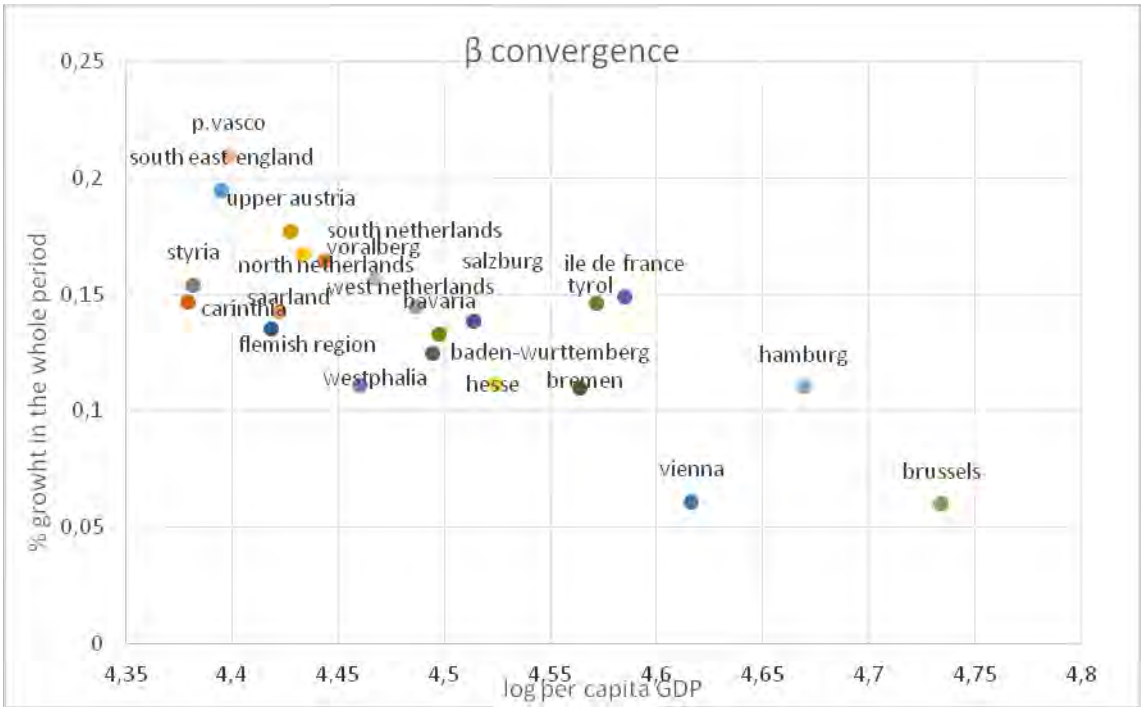
In chart 8 it is shown that, although the condition of perfect convergence β [17] is not reached, positive conclusions can be drawn:

Firstly, except in the case of Vienna, all regions have experienced β convergence towards the most advanced region of the sample, in this case, Brussels.

Secondly, this sample seems to fit better the concept of convergence β treated in other analysis, since we can appreciate an inverse relationship between the log per capita GDP and the growth rate for the whole period. Therefore, it can be deduced that advanced regions show a clearer convergence relationship than other cases. This could be due to the fact that they are regions whose steady state is on the same wavelength as the one the contribution of Barro and Sala-i-Martin predicted for the neoclassical theory of growth.

[17] Perfect β Convergence understood as follows: The condition that a region with a lower log per capita GDP in 1995 must have had a higher rate of growth than other regions, which had a higher per capita GDP in 1995.

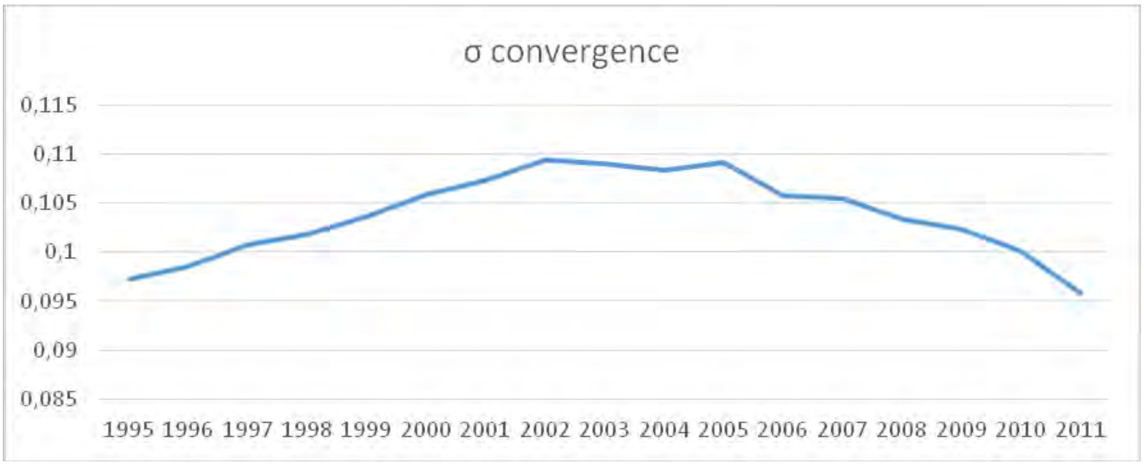
CHART 9



Source: own calculations

Following the positive conclusions that can be drawn from this segmentation, in chart 9 all those regions that did not exhibit β convergence have been eliminated to draw deeper conclusions. Once selected those which show convergence, an almost perfect inverse relationship is observed. Finally, note that the Basque Country was introduced subjectively in the highest group of regions in terms of per capita GDP and we can conclude that this region has embarked on convergence with the most advanced regions of the European Community.

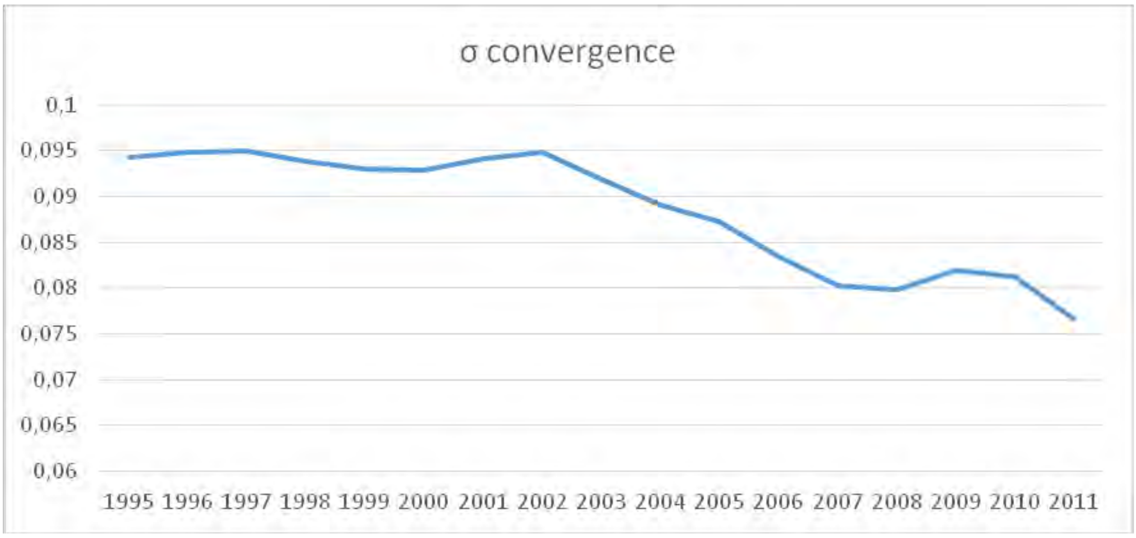
CHART 10



Source: own calculations

Chart 10 shows the evolution of the dispersions for all the regions of this sub-group, we see that it looks like a quadratic function: it increases until 2002, but after this rise the dispersion is stabilised in the period 2002-2004 and it falls down since 2005-2011, being the same as the initial one. As a result, we cannot talk of σ convergence for the full sample of the most developed regions plus the Basque Country.

CHART 11



Source: own calculations

In chart 11 the regions that have converged in the β convergence sense are included. In order to test σ convergence, it is observed that the dispersion tends to decrease over the period, especially after 2000 with a clear tendency to fall down, which indicates that convergence has been fulfilled for this period and the trend seems to continue.

Hence, it is concluded that for the sample of the most developed regions in the European Union, β convergence is fulfilled for almost the entire the segment. Therefore, it should be thought that there is a club of convergence to the central regions including the Basque country. The neoclassical growth theory gets stronger, arguing that the regions with similar steady state tend to converge, as it may occur.

V ANALYSIS OF CONVERGENCE USING TIME SERIES

Leaving behind the concept of convergence, understood as the inverse relationship between the rate of growth in a given period and the level of per capita GDP in the initial moment, we turn to the observation of long-term movements by analysing time series in the context of its unit root and stationary test, taking benefit from the advancement of econometric techniques in this field.

In this sense, it is observed whether the deviation between the region *i* and the mean follows a stationary way, i.e. if the series does not include a unit root, the region *i* and the mean are cointegrated.

Keeping in mind our aim, we continue with the objective of testing the convergence, expecting to find signs of convergence in our sample. The hypothesis here is that economic integration has positive aspects for growth, but also for economic restructuring and convergence. Therefore, next section will test convergence for the whole group. In a second place, there will be a very similar structure to the one from the previous section. The sample is broken down into two regions: first, the Mediterranean arc, and second, the core European regions: characteristically, they form a path across the centre of Europe, from the South of England to the North of Italy. It is expected to find that in this economic integration, or at least in the nearest regions, there have been converged.

The problem arises again in the analysis of convergence to observe the movements in the long term. However, the sample length is limited to 17 years, from 1995-2011, not for voluntary reasons but due to the availability of data and the inability to get a longer period. A more powerful analysis could have been since 1950, where various agreements within what is now the European community make their first appearance. Therefore, better conclusions about the effect of economic integration to convergence would be reached. In this case, unit root tests should be used, which include structural changes[18]. Despite time limitation, the benefit obtained through analysis of convergence at a regional level is greater, and although the sample may not be as long as desired, it coincides with a period of acceleration in economic integration, with the creation of the euro.

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[18] Tests such as; Perron (1989) unit root test with breaks or Zivot and Andrews (1992) Unit root test

First of all, the analysis will be carried out for the whole sample. Sequentially, as it was explained in the third section, the sample will be broken down. Two tests will be used: ADF and KPSS, in order to test for a unit root and stationarity respectively.

5.1 ANALYSIS USING TIME SERIES: THE WHOLE GROUP

ADF TEST

Firstly, the results of the ADF test will be shown using the three specifications mentioned in the methodology, i.e. a function without constant or trend(τ), a function with constant (τ_{μ}) and finally a function with constant and trend(τ_{τ}). The fact to include the constant or trend in the different specifications allows the concept of convergence to be more flexible, and it allows us to take the gradual process of convergence.

The next pages show the results for ADF:

TABLE 1

VARIABLE	τ	τ_μ	τ_τ
DBurgenland	-2,053**	-0,628	-2,188
DLower Austria	-1,05	0,042	0,190
DVienna	0,301	-2,724*	0,792
DCarinthia	0,708	-0,129	0,07
DStyria	0,824	0,042	-1,60
DUpper Austria	2,277	0,866	-0,319
DSalzburg	0,786	-0,162	-0,075
DTyrol	1,164	-0,022	-2,814
DVorarlberg	2,483	0,320	-0,343
DBrussels Capital Region	-1,665*	0,319	-2,59
DFlemish Region	1,39	0,487	-1,039
DWallonia	-0,250	-1,416	0,289
DWestern Finland	-2,304**	-1,161	-2,764
DHelsinki-Uusimaa	0,746	-0,808	-2,390
DSouthern Finland	-1,116	-1,394	-2,165
DEastern and Northern Finland	-1,525	-0,523	-2,343
DÅland	0,314	-3,000**	-2,10
DIlle de France	0,083	-0,636	-0,757
DChampagne-Ardenne	0,753	0,010	-2,676
DPicardy	0,695	-1,369	-0,098
DUpper Normandy	0,036	-0,58	-2,62
DCentre (FR)	1,42	0,063	-2,313
D Lower Normandy	1,560	-0,30	-1,588
D Burgundy	1,271	-3,09	-2,310
DNord-Pas-de-Calais	0,364	-2,267	-0,049
DLorraine	2,303	-0,532	-2,04
DAlsace	-1,455	-1,414	0,239
DFranche-Comté	0,187	-0,42	-1,953
DPays de la Loire	0,778	-0,856	-2,597
DBrittany	0,72	-0,382	0,207
DPoitou-Charentes	1,296	1,203	-2,07
DAquitaine	0,290	-0,050	-4,261***
DMidi-Pyrénées	0,632	0,00	-1,07
DLimousin	1,91	0,218	-0,277
DRhône-Alpes	-1,452	-1,327	-0,302

*Note: The asterisks (*),(**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.*

TABLE 1 CONTINUATION

VARIABLE	τ	τ_μ	τ_τ
DAuvergne	0,938	-0,095	-3,10
DLanguedoc-Roussillon	1,522	-1,465	-3,442**
DProvence-Alpes-Côte d'Azur	-0,558	-3,554***	-3,10
DCorsica	-1,58	-0,320	-0,603
DBaden-Württemberg	0,124	-1,30	-0,029
DBavaria	0,722	-0,829	-0,366
DBerlin	-1,01	-1,96	-1,30
DBrandenburg	-0,537	-0,819	0,455
DBremen	-0,211	-2,998**	-2,873
DHamburg	-0,045	-2,39	-2,461
DHesse	-0,087	-2,966**	-1,488
DMecklenburg-Vorpommern	-0,352	-1,49	-1,91
DLower Saxony	-0,892	-1,03	1,44
D North Rhine-Westphalia	0,445	-0,868	0,102
DRhineland-Palatinate	-1,26	-0,718	1,803
DSaarland	0,583	-0,232	-1,57
DSaxony	-0,689	0,269	-1,161
DSaxony-Anhalt	-0,938	0,632	-0,622
DSchleswig-Holstein	-2,43**	-2,390	0,722
DThuringia	-0,913	-0,013	0,202
DNorthern Greece	0,857	0,287	-2,232
DCentral Greece	1,422	0,839	-0,068
D Athens	-2,09**	-2,67	-0,154
DAegean Islands and Crete	0,140	-1,641	0,031
DPiedmont	-0,691	-0,25	-0,790
DAosta Valley	-0,751	-4,283***	-3,311*
DLiguria	-1,28	0,716	-0,307
DLombardy	-1,89*	-1,34	-1,53
DAbruzzo	0,33	-0,895	-0,633
DMolise	1,59	0,102	-3,63**
DCampania	1,962	1,32	0,094
DApulia	2,43	0,385	-1,70
DBasilicata	1,79	0,116	-2,750

*Note: The asterisks (*),(**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.*

VARIABLE	τ	τ_{μ}	τ_{τ}
DCalabria	2,096	2,131	0,089
DSicily	2,333	-0,241	-1,673
DSardinia	2,291	0,473	-4,313***
D Province of Bolzano-Bozen	-2,56***	0,328	0,260
DProvince of Trento	-3,447***	-1,641	-1,230
DVeneto	-2,735***	0,254	-1,411
DFriuli-Venezia Giulia	-1,69*	0,389	-3,40*
DEmilia–Romagna	-2,328**	0,015	-2,903
DTuscany	-1,611	-0,397	-1,839
DUmbria	0,316	1,030	-1,919
DMarche	-1,763*	-0,286	-2,197
DLazio	-1,512	0,194	-1,383
DLuxembourg	-0,245	-2,805*	-0,801
D North Netherlands	-0,336	-0,501	-1,453
DEast Netherlands	-0,261	-2,016	-2,074
DWest Netherlands	0,141	-2,555	-2,595
D South Netherlands	0,435	-1,681	-2,170
DNorth (PT)	0,432	-1,712	-1,859
DAlgarve	1,539	0,571	-0,256
DCentral Portugal	0,336	-1,388	-1,917
DLisbon	-0,991	-1,227	-3,628**
DAlentejo	0,356	-0,505	-3,99***
DAzores (PT)	-0,038	-2,071	-1,799
D Madeira (PT)	-4,488***	-3,53***	-0,295
DGalicia	-1,239	-1,557	-0,033
DAsturias	-1,717*	-0,548	-2,079
DCantabria	-2,046**	-2,796*	0,706
DBasque Country	-0,058	-1,225	-3,184*
DNavarra	0,010	-2,310	-3,328*
D La Rioja	0,277	-1,490	-3,658**
DAragon	-0,368	-1,371	-2,151
D Madrid	-0,023	-2,526	-2,272
DCastile and León	-1,607	-0,005	-1,668
DCastile-La Mancha	-0,122	-1,447	-1,046
DExtremadura	-1,598	-0,935	0,073
DCatalonia	-0,910	-0,540	-3,948**
D Valencia	0,427	0,264	-0,965

*Note: The asterisks (*),(**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.*

TABLE 1 CONTINUATION

VARIABLE	τ	τ_μ	τ_τ
D Balearic Islands	-1,015	0,392	-4,282***
D Andalusia	-0,285	-1,764	-0,244
DMurcia	0,067	-0,928	2,865
DCeuta	-1,190	-0,424	-2,703
DMelilla	0,760	-1,636	-1,656
DCanary Islands	0,683	-0,110	-0,076
DStockholm	1,227	-0,033	-2,729
DEast Middle Sweden	-0,949	0,214	-4,219***
DSmåland with Islands	-0,190	0,339	-4,100***
DSouth Sweden	-0,452	-0,455	-2,996
DWest Sweden	1,047	-0,874	-0,390
DNorth Middle Sweden	-1,114	-0,108	-2,827
DCentral Norrland	0,749	-0,090	-2,207
DUpper Norrland	0,621	0,935	-2,057
DNorth East England	-0,313	-2,408	-2,465
DNorth West England	-1,483	-1,418	-1,572
DYorkshire and The Humber	-0,844	-2,247	-2,235
DEast Midlands	0,289	-2,374	-2,350
DWest Midlands	0,164	-2,175	-2,493
DEast of England	-0,263	-1,604	-0,178
DGreater London	2,245	-1,904	-2,214
DSouth East England	-0,269	-3,108**	-1,205
DSouth West England	-1,154	-1,843	-1,448
DWales	-0,801	-2,729*	-2,496
DScotland	-0,128	-1,168	-1,790
DNorthern Ireland	-0,784	-1,575	0,324

*Note: The asterisks (*),(**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.*

In table 1 (A-D) we can see the results of the ADF test, starting with the first column on the left, which shows the variable that has been tested. For example, *DNorthern Ireland* shows the deviation between the variable Northern-Ireland and the mean of the sample for each year between 1995 and 2011. The second column τ shows the test without constant or trend, while the third column τ_μ shows the test with constant and finally, the fourth column τ_τ runs the test with constant and trend.

As explained in the methodology, the choice of the lag is made by maximizing the criterion Akaike. Therefore, lags can vary in the use of each variable, and even within each one: it will depend on the chosen specification. For instance, for the variable Northern-Ireland, there has been chosen one lag for τ , four lags for τ_μ and two lags for τ_τ. As it can be seen, for the same variable the lags have changed and it can be extended to any variable.

Being introduced in the analysis of the results obtained in the ADF test for the entire sample. Firstly, we will begin by including trend and constant τ_τ *(column 4*) and we selected those series, which have rejected the $\mathbf{H_0}$ unit root and, therefore, are stationary, this is, they have converged. To show results in a better way, we will separate those series that are stationary according to the level of significance that we could reject $\mathbf{H_0}$.

<u>Function with constant + trend</u>

1- Rejection $\mathbf{H_0}$ at *10%* * these are*:* Basque Country, Navarra, Friuli-Venezia Giulia, Aosta Valley.

2- Rejection $\mathbf{H_0}$ at 5%** these are*: Catalonia, La Rioja, Lisbon, Molise,* Languedoc-Roussillon.

3- Rejection $\mathbf{H_0}$ *at 1%* *** these are: Smaland With Islands, East Middle Sweden, Balearic Islands, Alentejo, Sardinia, Aquitaine.

<u>Function with constant</u>

1- Rejection $\mathbf{H_0}$ at *10%* * these are: Wales, Cantabria, Luxembourg, Vienna.

2- Rejection $\mathbf{H_0}$ at 5% ** these are: South East England, Hesse, Bremen, Åland.

3- Rejection $\mathbf{H_0}$ at 1% *** these are: Madeira, Aosta Valley[19],Provence-Alpes-Côte d'Azur.

[19] Stationary with trend and constant at 10% and Stationary with constant at1%.

Function without constant or trend

1- Rejection H_0 at 10% * these are: Asturias, Marche, Friuli-Venezia Giulia[20], Lombardy, Brussels Capital Region.

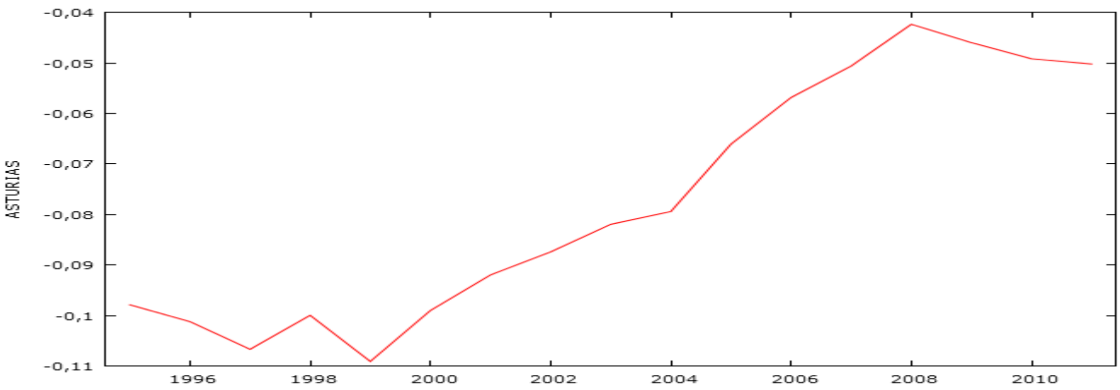
2- Rejection H_0 at 5% ** these are: Cantabria[21], Emilia–Romagna, Athens, Schleswig-Holstein, Western Finland, Burgenland.

3- Rejection H_0 at 1% *** these are: Madeira[22], Province of trento, Veneto, Province of Bolzano-Bozen.

To sum up, those regions, which have converged are: Madeira, Province of trento, Veneto, Province of Bolzano-Bozen, Cantabria, Emilia–Romagna, Athens, Schleswig-Holstein, Western Finland, Burgenland, Asturias, Marche, Friuli-Venezia Giulia, Lombardy, Brussels Capital Region, Aosta Valley,Provence-Alpes-Côte d'Azur, South East England, Hesse, Bremen, Åland, Wales, Luxembourg, Vienna, Småland with Islands, East Middle Sweden, Balearic Islands, Alentejo, Sardinia, Aquitaine, Catalonia, La rioja, Lisbon, Molise, Languedoc-Roussillon, Basque Country, Navarra.

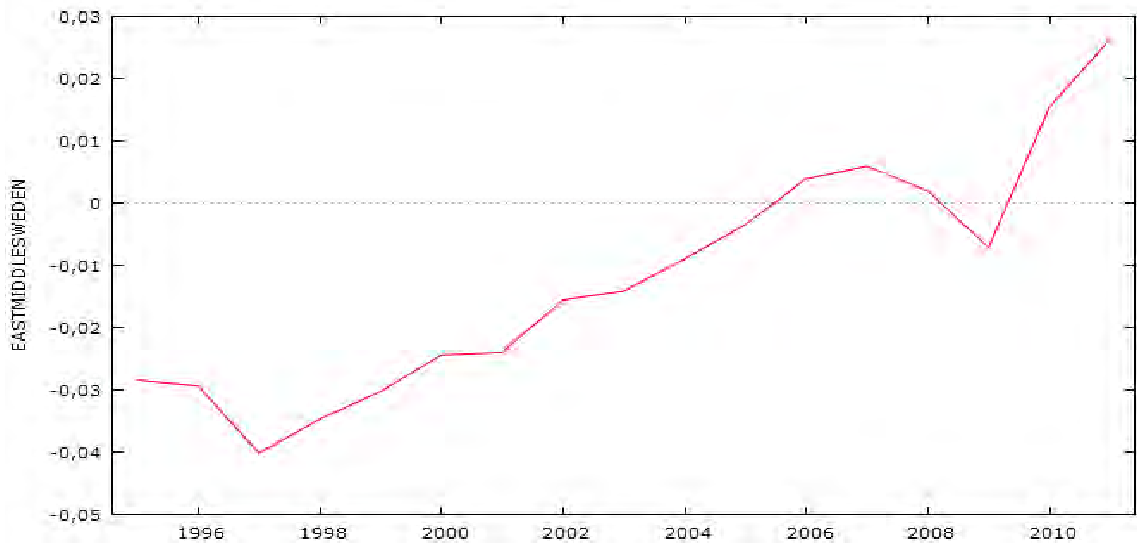
After the identification, 37 regions from 131 are the ones that have converged. That is, according to our analysis, 28% of the regions have converged to the sample mean, including the following features that have been picked for the concept of convergence that we have defined:

1 Convergence in process (positive sense). Those which have already reached the mean of the whole sample, or have almost reached it .In the positive sense, it means that the series started below the mean and they have moved towards it, i.e. the difference between the region *i* and the mean tend to 0 $d \to 0 \ as \ t \to \infty$, as in the case of Asturias.

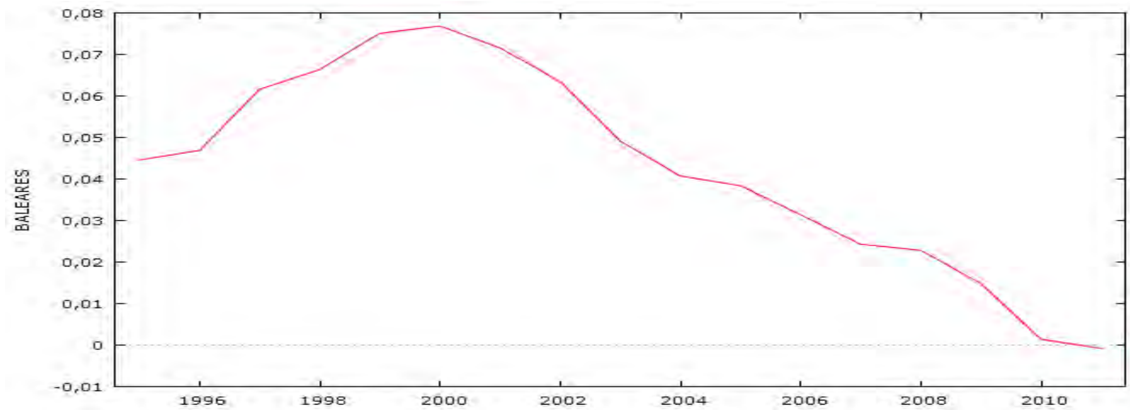


[20]Stationary with trend and constant at 10% and Stationary without trend or constant at 10%.
[21] Stationary with constant at10% and Stationary without trend or constant at 5%.
[22] Stationary with constant at 10% and without trend or constant at 10%.

2 Complete convergence. That is to say, when the series have reached the complete convergence to the mean, and therefore, the difference is 0, or almost 0. For Middle East Sweden, it is observed that it even becomes higher than 0, but 0,03 is considered 0, because the scale makes it look like there is too much difference.

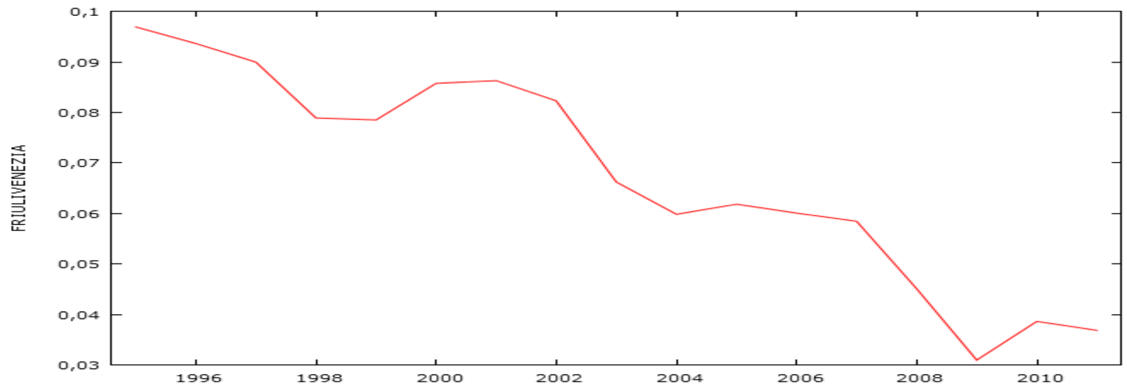


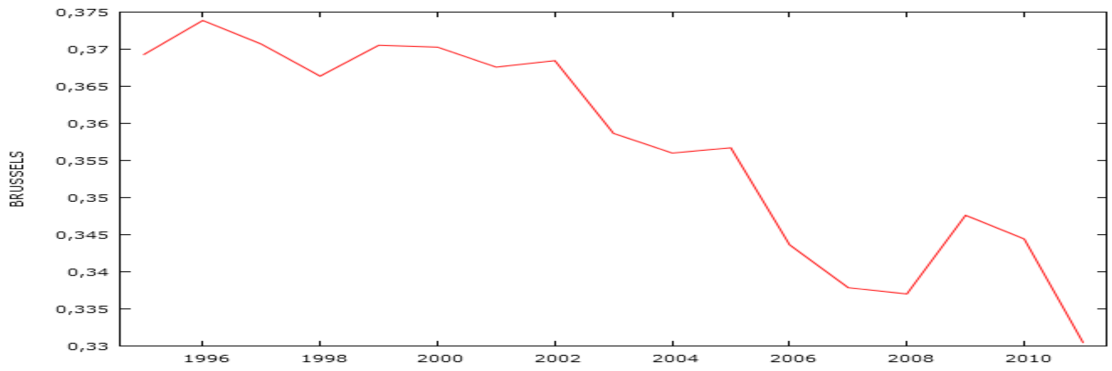
Another example is the case of the Balearic Islands.



In this case there is complete convergence, but in the sense of a region that was above and has converged to fall. Although negatively, this process is also collected by our definition of convergence.

3 Convergence in process (negative sense). Those based on an upper mean position tend to converge to this. That is to say, they have zero, but because the difference between the series and the media is becoming smaller and smaller, tending to 0 as the case of Brussels and Emilia-Romagna. Note that this situation is repeated in other Italian regions, such as Friuli-Venezia Giulia.





4 Convergence in the sense of stability. In this case, some of the most advanced regions of the sample are, in this sense, converging because they synchronize their movements with the mean; in other words, they follow the same common trend. However, we must acknowledge the fact that inside the sample there are different economic structures and they suffer the shocks in a different way, and some regions could not reach the most developed ones.

KPSS TEST

In order to compare the results for a better analysis, we tested the same group using the KPSS test, which has a greater power in samples whose time period is not too long, like in this example.

For this test, $\mathbf{H_0}$ means that the series presents stationarity. Therefore, if $\mathbf{H_0}$ is rejected, then the series is not stationary and it does not converge. As for the test, it is presented in two forms; the first one without trend, and the second one with trend. The lags to the test are also included in order to eliminate the autocorrelation in the errors that may exist. In such form, it has been decided to include 2 lags, but this does not appear reflected. KPSS has also been tested with 3 lags without observing a change in the outcomes.

The next pages show the test KPSS:

TABLE 2

VARIABLE	η_μ	η_τ
DBurgenland	0,567**	0,065
DLower Austria	0,492**	0,169**
Dvienna	0,549**	0,163**
Dcarinthia	0,436*	0,180**
Dstyria	0,538**	0,172**
Dupper Austria	0,583**	0,170**
Dsalzburg	0,355	0,184**
Dtyrol	0,561**	0,131*
Dvorarlberg	0,515**	0,162**
Dbrussels Capital Region	0,626**	0,116
Dflemish Region	0,440*	0,154**
Dwallonia	0,177	0,165**
Dwestern Finland	0,66**	0,099
Dhelsinki-Uusimaa	0,60**	0,091
Dsouthern Finland	0,268	0,102
Deastern and Northern Finland	0,58**	0,096
Dåland	0,286	0,16**
DIlle de France	0,232	0,131*
Dchampagne-Ardenne	0,621**	0,078
Dpicardy	0,649**	0,149*
Dupper Normandy	0,634**	0,082
Dcentre (FR)	0,663**	0,071
D Lower Normandy	0,648**	0,056
D Burgundy	0,646**	0,070
Dnord-Pas-de-Calais	0,263	0,176**
Dlorraine	0,662**	0,081
Dalsace	0,624**	0,156**
Dfranche-Comté	0,604**	0,132*
Dpays de la Loire	0,570**	0,107
DBrittany	0,43*	0,147*
Dpoitou-Charentes	0,603**	0,083
Daquitaine	0,605**	0,087
Dmidi-Pyrénées	0,578**	0,117
Dlimousin	0,604**	0,148*
Drhône-Alpes	0,569**	0,131*
Dauvergne	0,595**	0,095

*Note: Asterisks * and ** denote rejection of stationarity, 10% and 5% respectively.*

TABLE 2 CONTINUATION

VARIABLE	η_μ	η_τ
Dlanguedoc-Roussillon	0,65**	0,113
Dprovence-Alpes-Côte d'Azur	0,122	0,085
Dcorsica	0,469**	0,135*
Dbaden-Württemberg	0,238	0,162**
Dbavaria	0,196	0,169**
Dberlin	0,285	0,165**
Dbrandenburg	0,201	0,170**
Dbremen	0,212	0,096
Dhamburg	0,134	0,091
Dhesse	0,292	0,094
Dmecklenburg-Vorpommern	0,170	0,170**
Dlower Saxony	0,258	0,177**
D North Rhine-Westphalia	0,209	0,177**
Drhineland-Palatinate	0,233	0,177**
Dsaarland	0,331*	0,170**
Dsaxony	0,384*	0,173**
Dsaxony-Anhalt	0,461*	0,169**
Dschleswig-Holstein	0,515**	0,174**
Dthuringia	0,333	0,165**
Dnorthern Greece	0,383*	0,090
Dcentral Greece	0,529**	0,146
D Athens	0,576**	0,120
Daegean Islands and Crete	0,412*	0,147*
Dpiedmont	0,642**	0,134*
Daosta Valley	0,575**	0,142*
Dliguria	0,569**	0,159**
Dlombardy	0,647**	0,090
Dabruzzo	0,621**	0,104
Dmolise	0,633**	0,098
Dcampania	0,626**	0,165**
Dapulia	0,640**	0,138*
DBasilicata	0,582**	0,113
Dcalabria	0,606**	0,184**
Dsicily	0,664**	0,090

*Note: Asterisks * and ** denote rejection of stationarity, 10% and 5% respectively.*

TABLE 2 CONTINUATION

VARIABLE	η_μ	η_τ
Dsardinia	0,670**	0,085
D Province of Bolzano-Bozen	0,569**	0,175**
Dprovince of Trento	0,645**	0,095
Dveneto	0,654**	0,114
Dfriuli-Venezia Giulia	0,638**	0,100
Demilia–Romagna	0,648**	0,120
DTuscany	0,64**	0,114
DUmbria	0,65**	0,160**
DMarche	0,640**	0,136*
DLazio	0,573**	0,145*
DLuxembourg	0,568**	0,158**
D North Netherlands	0,32	0,165**
DEast Netherlands	0,175	0,116
DWest Netherlands	0,27	0,086
D South Netherlands	0,307	0,104
DNorth (PT)	0,43*	0,107
DAlgarve	0,38*	0,177**
DCentral Portugal	0,366*	0,108
DLisbon	0,24	0,116
DAlentejo	0,464*	0,125*
DAzores (PT)	0,549**	0,145*
D Madeira (PT)	0,554**	0,180**
DGalicia	0,619**	0,129*
DAsturias	0,604**	0,109
DCantabria	0,568**	0,171**
DBasque Country	0,652**	0,120
DNavarra	0,535**	0,173**
D La Rioja	0,186	0,150**
DAragon	0,614**	0,094
D Madrid	0,197	0,160**
DCastile and León	0,605**	0,118
DCastile-La Mancha	0,414*	0,118
DExtremadura	0,637**	0,097
DCatalonia	0,195	0,178**
D Valencia	0,246	0,181**
D Balearic Islands	0,511**	0,153**
D Andalusia	0,467**	0,155**

*Note: Asterisks * and ** denote rejection of stationarity, 10% and 5% respectively.*

TABLE 2 CONTINUATION

VARIABLE	η_μ	η_τ
DMurcia	0,341546	0,178603**
DCeuta	0,58852**	0,0712314
DMelilla	0,22448	0,0844442
DCanary Islands	0,46643*	0,16953**
DStockholm	0,65791**	0,064054
DEast Middle Sweden	0,646719**	0,0900619
DSmåland with Islands	0,640502**	0,085912
DSouth Sweden	0,614276**	0,0792153
DWest Sweden	0,626428**	0,111031
DNorth Middle Sweden	0,555752**	0,106208
DCentral Norrland	0,516595**	0,142652*
DUpper Norrland	0,607721**	0,137468*
DNorth East England	0,115449	0,0835323
DNorth West England	0,527619**	0,0892218
DYorkshire and The Humber	0,182191	0,085343
DEast Midlands	0,229796	0,0844755
DWest Midlands	0,19659	0,127535*
DEast of England	0,36116*	0,166632**
DGreater London	0,653218**	0,147817*
DSouth East England	0,46236*	0,177233**
DSouth West England	0,52169**	0,120025
DWales	0,146115	0,0970906
DScotland	0,48109*	0,0949781
DNorthern Ireland	0,39681*	0,148028*

*Note: Asterisks * and ** denote rejection of stationarity, 10% and 5% respectively.*

Table 2 shows the results of the KPSS test with 2 lags. From the left, the first column shows the variable tested. As in the ADF test, the variable is the difference between the real variable minus the mean of the group for each year. The second column η_μ shows the test results when they do not include trend. Finally, the third column shows the test result with a trend included.

We move on to identify regions that have converged to facilitate the exposure to those regions that have converged for different significance levels, and according to the function to be used.

<u>Test with trend</u>

1 H_0 cannot be rejected at 10% : Scotland, wales, South west England, North West England, Yorkshire and The Humber, East Midlands, North East England, North Middle Sweden, Stockholm, East Middle Sweden, Småland with Islands, South Sweden, West Sweden, Ceuta, Melilla, Castile and León, Castile-La Mancha, Extremadura, Aragón, Basque Country, Asturias, Central Portugal, Lisbon, East Netherlands, West Netherlands, South Netherlands, North (PT), Tuscany, province of Trento, Veneto, Friuli-Venezia Giulia, Emilia–Romagna, Sicily, Sardinia, Basilicata, Lombardy, Abruzzo, Molise, Northern Greece, Central Greece, Athens, Bremen, Hamburg, Hesse, Auvergne, Languedoc-Roussillon, Provence-Alpes-Côte d'Azur, Poitou-Charentes, Aquitaine, Midi-Pyrénées, Pays de la Loire, Lorraine, Upper Normandy, Centre (FR), Lower Normandy, Burgundy, Champagne-Ardenne, Western Finland, Helsinki-Uusimaa, Southern Finland, Eastern and Northern Finland, Brussels Capital Region, Burgenland.

2 H_0 cannot be rejected at 10% but is rejected at 5%: Northern Ireland, West Midlands, Greater London, Central Norrland, Upper Norrland, Galicia, Alentejo, Azores (PT), Lazio Marche, Apulia, Aegean Islands and Crete, Piedmont, Aosta Valley, Corsica, Brittany, Limousin, Rhône-Alpes, Franche-Comté, Picardy, Ille de France, Tyrol.

We must note that KPSS is a more potent test than ADF. Therefore, it is going to be more restrictive; in other words, those series which cannot be rejected $\mathbf{H_0}$ at any level of significance or 10%, excluding those which reject $\mathbf{H_0}$ at 5%. will have converged

Test without trend

1 H_0 cannot be rejected at 10%:Wales, West Midlands, East Midlands, Yorkshire and The Humber, North East England, Melillas, Murcia, Valencia, Catalonia, Madrid, La rioja, Lisbon, South Netherlands, North Netherlands, East Netherlands, West Netherlands, Thuringia, Baden-Württemberg, Bavaria, Berlin, Brandenburg, Bremen, Hamburg, Hesse, Mecklenburg-Vorpommern, Lower Saxony, North Rhine-Westphalia, Rhineland-Palatinate, Provence-Alpes-Côte d'Azur, Nord-pas-de-Calais, Ille de France, åland, Wallonia, Salzburg.

2 H_0 cannot be rejected at 10% but is rejected at 5%: Scotland, Northern Ireland, South East England, East of England, Canary Islands, Castile-La Mancha, Alentejo, North (PT), Algarve, Central Portugal, Aegean Islands and Crete, Northern Greece, Saxony-Anhalt, Saxony, Saarland, Brittany, Flemish Region, Carinthia.

In the same way as before, convergence is excluded for those regions in which we can reject H_0 at 5%.

In short, the unit root test ADF found evidence of convergence in 28% of the sample, whereas performing KPSS, we find that when we include a trend, the convergent regions were 86, i.e., 65% of regions from the total. When no trend is included, it is obtained that there are 52 convergent regions: 40% of the regions have shown convergence towards the mean of the whole sample. Therefore, it seems that the test KPSS gives more signs of support to the hypothesis that economic integration has positive aspects for convergence, especially when it is tested including a trend. On the location of the regions, they do not seem to follow any pattern and those regions which have converged belong to different countries, located in different parts of the map of the European Union.

5.2 ANALYSIS USING TIME SERIES: THE MEDITERRANEAN ARC

In this section, the sample is divided into the Mediterranean regions of Spain, France and Italy, although inland regions are also included. The objective is to examine in a more focused way how convergence has evolved through convergence clubs. This is a better way to find convergence, mainly because the fact of the entire sample converging to the mean of the whole group is a too strict course. Therefore, it can be observed that regions have not converged to the mean of the whole group, but they have converged to the mean of another subgroup, thus forming the Mediterranean area.

ADF TEST

TABLE 3

VARIABLES	τ	τ_{μ}	τ_{τ}
DBasque Country	1,335	-1,402	-3,742**
D Navarra	2,253	-0,979	-3,956**
DLa Rioja	1,797	-1,926	-1,962
DAragon	0,329	-0,525	-2,768
DCastile-La Mancha	-1,09	-1,189	-2,091
DCatalonia	0,344	-2,349	-1,246
DValencia	-0,49	-1,482	-0,971
DBalearic Islands	-0,65	0,2128	-4,488***
DAndalusia	-0,89	-1,867	-1,15
DMurcia	-0,951	-1,273	3,217
DPiedmont	-2,059**	-0,845	-1,089
DAosta Valley	0,1018	-4,779***	-3,365*
DLiguria	-0,216	-1,650	-2,84
DLombardy	-1,996**	-2,083	0,325
DAbruzzo	-0,086	-2,167	-0,144
D Molise	0,671	-1,356	-2,83
DCampania	1,052	0,261	0,130
DApulia	1,680	-0,116	-2,070
D Basilicata	0,203	0,475	-2,37
DCalabria	0,314	-1,65	-0,62
D Sicily	1,434	-1,826	-3,34*
DSardinia	-0,02	-2,197	-2,10
DProvince of Bolzano-Bozen	-1,172	-2,958**	0,286
DProvince of Trento	-2,441**	-2,244	-0,664
DVeneto	-2,250**	-1,204	-1,897
DFriuli-Venezia Giulia	-1,093	0,704	-4,241***
DEmilia–Romagna	-1,867*	-0,42	-1,57
DTuscany	-1,472	0,146	-1,79
DUmbria	-0,366	0,906	-2,45
D Marche	-1,785*	-0,533	0,281

Note: The asterisks (*),(**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.

TABLE 3 CONTINUATION

VARIABLES	τ	τ_μ	τ_τ
DLazio	-0,913	-0,806	-1,540
DMidi-Pyrénées	-1,308	-0,263	-2,375
D Limousin	0,566	0,498	-2,103
DRhône-Alpes	0,589	-0,758	-0,679
DAuvergne	1,030	-2,391	-2,908
DLanguedoc-Roussillon	-0,799	0,260	-2,110
D Provence-Alpes-Côte d'Azur	0,796	-0,082	-2,458
DCorsica	-1,923*	0,284	-0,265

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.

Following the similar structure to the ADF analysis for the whole group, we proceed to the identification of the regions which have converged according to whether we include constant, constant and trend or neither.

Function with constant + trend

-1 Rejection H_0 at 10% * these are: Sicily, Aosta Valley.

2- Rejection H_0 at 5%** these are: Navarra, Vasque Country.

3- Rejection H_0 at 1% *** these are: Friuli-Venezia Giulia, Balearic Islands.

Function with constant

-1 Rejection H_0 at 10% * these are: neither

2- Rejection H_0 at 5%** these are: Province of Bolzano-Bozen.

3- Rejection H_0 at 1% *** these are: Aosta Valley.

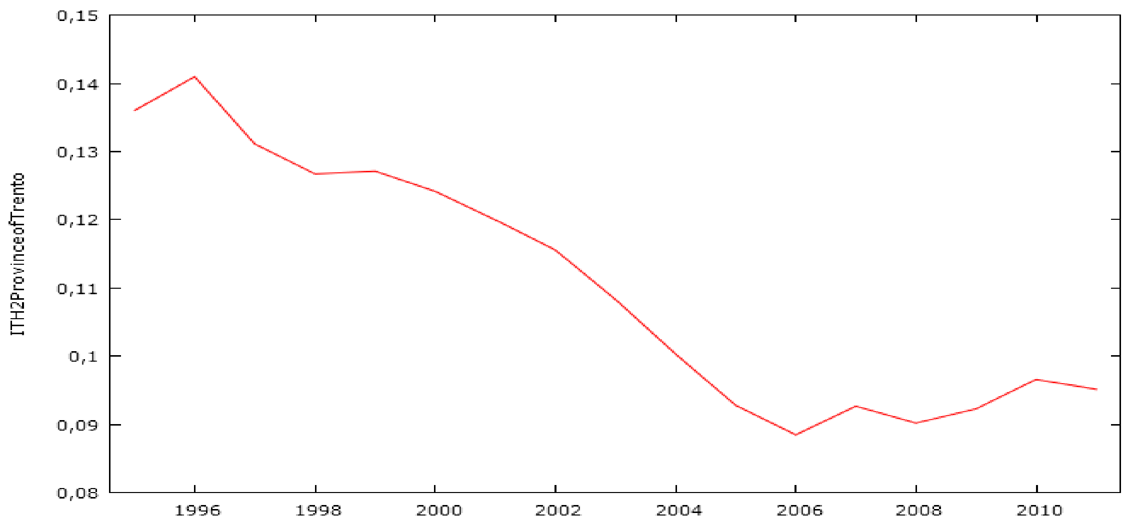
Function without constant or trend

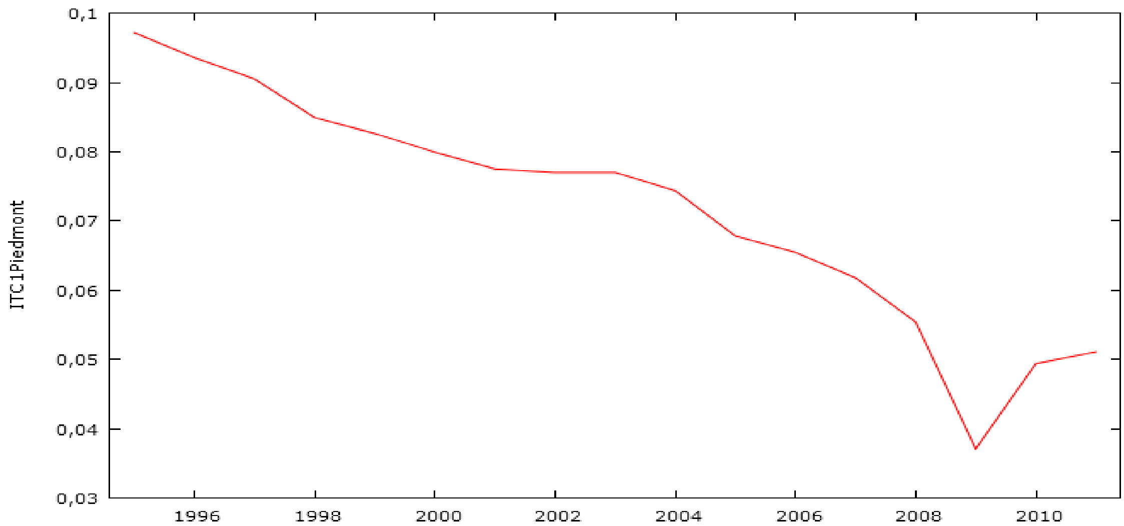
-1 Rejection H_0 at 10% * these are: Corsica, Marche, Emilia-Romagna,

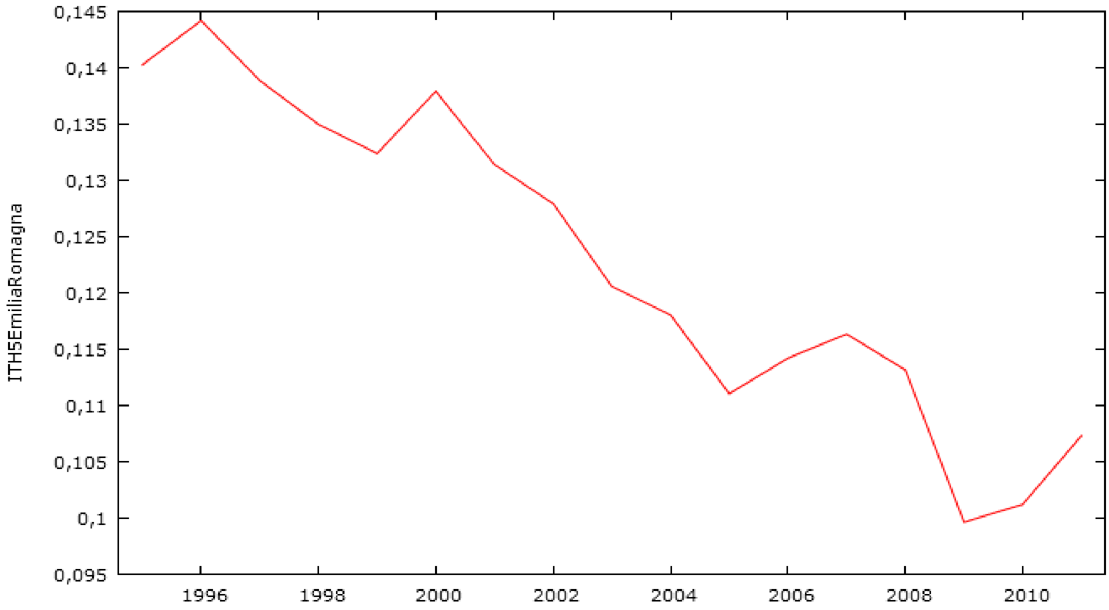
2- Rejection H_0 at 5%** these are: Veneto, Province of Trento, Lombardy, Piedmont.

3- Rejection H_0 at 1% *** these are: neither

After ordering the test results for ADF identifying which regions have converged to the mean of this segment, it has been obtained that 14 regions have converged from the total group of 38, i.e. 37% of the regions have converged. It is also noteworthy that many of the convergent regions are Italian, concretely, 10, 1 French and 3 Spanish. It can be seen that the vast majority of the regions were Italian. Moreover, it is also observed that some of them have converged in the negative sense, i.e., they were located above the mean, but they have reduced distance, as is the case of the Province of Trento, Piedmont or Emilia Romagna, as it is shown in the following graphs.







KPSS TEST

We apply the KPSS test for the Mediterranean segment with constant and without constant, moreover 2 lags[23] are included.

The next page shows the results from KPSS test:

[23] The test has been proved by using 3 lags but the outcomes have not changed.

TABLE 4

VARIABLES	η_μ	η_τ
DBasque Country	0,663**	0,063
D Navarra	0,670**	0,128*
DLa Rioja	0,644**	0,102
DAragon	0,644**	0,093
DCastile-La Mancha	0,592**	0,095
DCatalonia	0,495**	0,177**
DValencia	0,251	0,180**
DBalearic Islands	0,370*	0,142**
DAndalusia	0,591**	0,139*
DMurcia	0,547**	0,172**
DPiedmont	0,633**	0,093
DAosta Valley	0,394*	0,155**
DLiguria	0,134	0,134*
DLombardy	0,600**	0,137*
DAbruzzo	0,540**	0,136*
D Molise	0,443**	0,068
DCampania	0,501**	0,142*
DApulia	0,623**	0,098
DBasilicata	0,495**	0,125*
DCalabria	0,463*	0,135*
D Sicily	0,532**	0,114
DSardinia	0,144	0,142*
DProvince of Bolzano-Bozen	0,391*	0,177**
DProvince of Trento	0,609**	0,125*
DVeneto	0,644**	0,089
DFriuli-Venezia Giulia	0,606**	0,055
DEmilia–Romagna	0,638**	0,074
DTuscany	0,610**	0,077
DUmbria	0,662**	0,133*
D Marche	0,606**	0,086
DLazio	0,386*	0,120
DMidi-Pyrénées	0,547**	0,106
D Limousin	0,461*	0,113
DRhône-Alpes	0,209	0,155**
DAuvergne	0,194	0,055
DLanguedoc-Roussillon	0,445*	0,158**
D Provence-Alpes-Côte d'Azur	0,542**	0,138*
DCorsica	0,569**	0,150**

*Note: Asterisks * and ** denote rejection of stationarity at 10% and 5% respectively.*

Test with trend η_τ

1 H_0 cannot be rejected at 10%: Auvergne, Limousin, Marche, Lazio, Midi-Pyrénées, Veneto, Friuli-Venezia Giulia, Emilia–Romagna, Tuscany, Sicily, Apulia, Molise, Piedmont, La Rioja, Aragon, Castile-La Mancha, Vasque Country.

2 H_0 cannot be rejected at 10% but is rejected at 5%: Provence-Alpes-Côte d'Azur, Umbria, Province of Trento, Sardinia, Calabria, Campania, Basilicata, Abruzzo, Lombardy, Liguria, Navarra, Andalucia.

Test without trend η_μ

1 H_0 cannot be rejected at 10%: Rhône-Alpes, Auvergne, Sardinia, Liguria, Valencia.

2 H_0 cannot be rejected at 10% but is rejected at 5%: Languedoc-Roussillon, Limousin, Lazio, Province of Bolzano-Bozen, Calabria, Aosta Valley, Balearic Islands.

In both cases, as in the case of the entire sample, we take as stationary those series which cannot reject stationarity (convergence) at 5%. Then, if this series is rejected at 5% it will be understood as non-stationary and therefore, there will be no convergence.

To sum up, observing the results, in the case of the KPSS with trend was obtained that 29 of the 38 regions of the Mediterranean arc have shown convergence (in percentage, the 76%). KPSS without trend showed that 13 from 38 have converged, that is, 34% from the total. Note that most regions that are exhibiting convergence are Italian. The Spanish regions, on the other hand, do not show a strong relationship of convergence towards the mean; for example, in the case of KPSS without trend, convergence cannot reject to Valencia and Balearic Islands. However, when KPSS is performed with trend, there are more convergent regions, in this case, 6 regions whose convergence cannot be rejected. There is a similar analysis for the French regions. By performing KPSS with or without trend, it is showed that 4 regions have converged.

5.3 ANALYSIS USING TIME SERIES: THE CORE EUROPEAN REGIONS

In this section, the objective is to observe how convergence has evolved in those regions which have the highest per capita GDP. In the sample, characteristically, these regions are located in the centre of the European map. Moreover, it is interesting to observe if any region which was not initially located in this group has converged into these groups[24]. Regarding the choice of the lags, as it was done before, they are selected by maximizing the Akaike criterion.

ADF TEST

The next page shows the results from ADF for the core European regions.

[24] Basque Country and Madrid have been included to assess if they have converged into the group of the most advanced regions

TABLE 5

Variable	τ	τ_μ	τ_τ
DMadrid	-0,269	-1,719	-1,530
DBasque Country	-2,244**	-0,295	-1,063
DLuxembourg	0,665	-2,935**	0,047
DNorth Netherlands	0,373	-0,740	-1,73
DWest Netherlands	0,428	-3,844***	-1,588
DSouth Netherlands	-0,828	-2,59*	-2,553
DGreater London	-0,07	-2,708*	-0,253
DIle de France	0,602	-1,242	-1,273
DAosta Valley	0,337	-2,658*	-3,195*
DLombardy	0,576	-0,374	-2,634
D Province of Bolzano-Bozen	-1,75*	-3,081**	-1,119
D Emilia–Romagna	1,877	0,180	0,494
DBrussels Capital Region	-1,739*	0,600	-0,089
DUpper Austria	-1,733*	0,574	-2,442
DSalzburg	-0,809	-0,179	-2,510
DTyrol	-2,669**	-0,691	-1,063
DVorarlberg	-1,00	0,408	-5,910***
DVienna	-0,778	-2,336	0,906
D North Rhine-Westphalia	-0,411	-1,133	-0,137
DBaden-Württemberg	0,293	-1,782	0,794
DBavaria	-0,600	-1,27	0,688
DHamburg	-0,658	-0,980	-2,053
DHesse	-0,571	-1,29	-2,182
DBremen	-0,744	-0,333	-1,176
DHelsinki-Uusimaa	-0,143	-2,587	-1,513
DStockholm	0,534	-1,688	-3,202*

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.

Function with constant + trend

-1 Rejection H_0 at 10% * these are: Stockholm, Aosta Valley.

-2 Rejection H_0 at 5%** these are: neither

-3 Rejection H_0 at 1% *** these are: Vorarlberg

Function with constant

-1 Rejection H_0 at 10% * these are: Aosta Valley, Greater London, South Netherlands.

-2 Rejection H_0 at 5%** these are: Province of Bolzano-Bozen, Luxembourg.

-3 Rejection H_0 at 1% *** these are: West Netherlands.

Function without constant or trend

1 Rejection H_0 at 10% * these are: Upper Austria, Province of Bolzano-Bozen, Brussels Capital Region.

-2 Rejection H_0 at 5%** these are: Tyrol, Basque Country.

-3 Rejection H_0 at 1% *** these are: neither.

Therefore, the regions, which have converged, have been: Stockholm, Aosta Valley, Vorarlberg, Greater London, South Netherlands, Province of Bolzano-Bozen, Luxembourg, Netherlands West, Upper Austria, Brussels Capital Region, Tyrol, Basque Country.

Presented the results of the ADF test it shows that, regardless of the specification of the function (it can reject the unit root for 12 of 26 regions), 46% of the regions in this segment have converged towards the mean of this segment. Also, an objective was to assess if any Spanish region had converged into the most advanced groups. In this case, we see that unit root can be rejected for Basque Country in the specification without constant or trend.

KPSS TEST

TABLE 6

VARIABLES	η_μ	η_τ
DMadrid	0,181	0,178**
DBasque Country	0,626**	0,170**
DLuxembourg	0,510**	0,165**
DNorth Netherlands	0,3102	0,158**
DWest Netherlands	0,172	0,097
DSouth Netherlands	0,278	0,085
DGreater London	0,634**	0,171**
DIle de France	0,189	0,116
DAosta Valley	0,598**	0,113
DLombardy	0,656**	0,073
D Province of Bolzano-Bozen	0,615**	0,164**
D Emilia–Romagna	0,641**	0,168**
DBrussels Capital Region	0,619**	0,173**
DUpper Austria	0,621**	0,164**
DSalzburg	0,329	0,171**
DTyrol	0,540**	0,091
DVorarlberg	0,546**	0,141*
DVienna	0,650**	0,169**
D North Rhine-Westphalia	0,294	0,181**
DBaden-Württemberg	0,399*	0,164**
DBavaria	0,279	0,169**
DHamburg	0,256	0,136*
DHesse	0,524**	0,078
DBremen	0,384*	0,075
DHelsinki-Uusimaa	0,577**	0,132*
DStockholm	0,634*	0,074

*Note: Asterisks * and ** denote rejection of stationarity, 10% and 5% respectively.*

Test with trend η_τ

1 H_0 cannot be rejected at 10%: Stockholm, Bremen, Hesse, Tyrol, Lombardy, Aosta Valley, Ille de France, West Netherlands, South Netherlands.

2 H_0 cannot be rejected at 10% but is rejected at 5%: Helsinki-Uusimaa, Hamburg, Vorarlberg.

Test without trend η_μ

1 H_0 cannot be rejected at 10%: Hamburg, Bavaria, North Rhine-Westphalia, Salzburg, Ille de France, North Netherlands, West Netherlands, South Netherlands, Madrid

2 H_0 cannot be rejected at 10% but is rejected at 5%:Stockholm, Bremen, Baden-Württemberg.

In both cases, as in the case of the entire sample, we take as stationary those series in which stationarity cannot be rejected at 5%. However, if the series is rejected at 5%, it will be understood as non-stationary and therefore, non-convergent.

In the case of test with trend, we cannot reject stationarity for 12 of 26, as with ADF test 46% of the regions exhibit convergence, whereas the test without constant shows that 11 regions have converged, in others words, 42% of regions have converged.

VI A SUMMARY OF THE RESULTS IN TIME SERIES

In this chapter, the results for the entire sample and those segments which have been studied separately will be summarised. The purpose is to facilitate the understanding of the results. Moreover, in order to contrast both tests, their outcomes will be shown and they will be put in table in order to appreciate whether both results coincide.

6.1 RESULTS FOR THE WHOLE SAMPLE: ONLY THE CONVERGENT ONES

ADF

TABLE 7

VARIABLES	τ	τ_{μ}	τ_{τ}
DBurgenland	**		
Dbrussels Capital Region	*		
Dwestern Finland	**		
Dschleswig-Holstein	**		
Dathens	**		
Dlombardy	*		
D Province of Bolzano-Bozen	***		
Dprovince of Trento	***		
Dveneto	***		
Dfriuli-Venezia Giulia	*		*
Demilia–Romagna	**		
Dmarche	*		
Dmadeira(PT)	***	***	
Dasturias	*		
Dcantabria	**	*	
Dvienna		*	
Dåland		**	
Dprovence-Alpes-Côte d’Azur		***	
Dbremen		**	
Dhesse		**	
Daosta Valley		**	*
Dluxembourg		*	

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.

TABLE 7 CONTINUATION

VARIABLES	τ	τ_μ	τ_τ
Dsouth East England		**	
Dwales		*	
Dlanguedoc-Roussillon			**
Dmolise			**
Dsardinia			***
Dlisbon			**
Dalentejo			***
DBasque Country			*
DLa Rioja			**
DNavarra			*
DCatalonia			**
DBalearic Islands			***
DEast Middle Sweden			***
DSmåland with Islands			***
DAquitaine			***

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of unit root at 10, 5 and 1% respectively.

37 of 131 regions have converged (28%) according to the ADF test with Akaike criterion for choosing the lags.

KPSS

In this case convergent regions are included with and without trend,

The next pages show the convergent regions from KPSS test (table 8)

TABLE 8

VARIABLES	η_μ	η_τ
DBurgenland	No	Yes
Dcarinthia	Yes	No
Dsalzburg	Yes	No
Dtyrol	No	Yes
Dbrussels Capital Region	No	Yes
Dflemish Region	Yes	No
Dwallonia	Yes	No
Dwestern Finland	No	Yes
Dhelsinki-Uusimaa	No	yes
Dsouthern Finland	Yes	Yes
Deastern and Northern Finland	No	Yes
Dåland	Yes	No
DIlle de France	Yes	Yes
Dchampagne-Ardenne	No	Yes
Dpicardy	No	Yes
Dupper Normandy	No	Yes
Dcentre (FR)	No	Yes
D Lower Normandy	No	Yes
D Burgundy	No	Yes
Dnord-Pas-de-Calais	Yes	No
Dlorraine	No	Yes
Dfranche-Comté	No	Yes
Dpays de la Loire	No	Yes
DBrittany	Yes	Yes
Dpoitou-Charentes	No	Yes
Daquitaine	No	Yes
Dmidi-Pyrénées	No	Yes
Dlimousin	No	Yes
Drhône-Alpes	No	Yes
Dauvergne	No	Yes
Dlanguedoc-Roussillon	No	Yes
Dprovence-Alpes-Côte d'Azur	Yes	Yes
Dcorsica	No	Yes
Dbaden-Württemberg	Yes	No
Dbavaria	Yes	No
Dberlin	Yes	No
Dbrandenburg	Yes	No

Note: "Yes" means stationarity (convergence), whereas "no" means non convergence

TABLE 8 CONTINUATION

VARIABLES	η_μ	η_τ
Dhamburg	Yes	Yes
Dbremen	Yes	Yes
Dhesse	Yes	Yes
Dmecklenburg-Vorpommern	Yes	No
Dlower Saxony	Yes	No
D North Rhine-Westphalia	Yes	No
Drhineland-Palatinate	Yes	No
Dsaarland	Yes	No
Dsaxony	Yes	No
Dsaxony-Anhalt	Yes	No
Dthuringia	Yes	No
Dnorthern Greece	Yes	Yes
Dcentral Greece	No	Yes
D Athens	No	Yes
Daegean Islands and Crete	Yes	Yes
Dpiedmont	No	Yes
Daosta Valley	No	Yes
Dlombardy	No	Yes
Dabruzzo	No	Yes
Dmolise	No	Yes
Dapulia	No	Yes
DBasilicata	No	Yes
Dsicily	No	Yes
Dsardinia	No	Yes
Dprovince of Trento	No	Yes
Dveneto	No	Yes
Dfriuli-Venezia Giulia	No	Yes
Demilia–Romagna	No	yes
DTuscany	No	Yes
DMarche	No	Yes
DLazio	No	Yes
D North Netherlands	Yes	No
DEast Netherlands	Yes	Yes
DWest Netherlands	Yes	Yes

Note: "Yes" means stationarity (convergence), whereas "no" means non convergence

TABLE 8 CONTINUATION

VARIABLES	η_μ	η_τ
D South Netherlands	Yes	Yes
DNorth (PT)	Yes	Yes
DAlgarve	Yes	No
DCentral Portugal	Yes	Yes
DLisbon	Yes	Yes
DAlentejo	Yes	Yes
DAzores (PT)	No	Yes
DGalicia	No	Yes
DAsturias	No	yes
DBasque Country	No	Yes
D La Rioja	Yes	No
DAragon	No	Yes
D Madrid	Yes	No
DCastile and León	No	Yes
DCastile-La Mancha	Yes	Yes
DExtremadura	No	Yes
DCatalonia	Yes	No
D Valencia	Yes	No
DMurcia	Yes	No
DCeuta	No	Yes
DMelilla	Yes	Yes
DCanary Islands	Yes	No
DStockholm	No	Yes
DEast Middle Sweden	No	Yes
DSmåland with Islands	No	Yes
DSouth Sweden	No	Yes
DWest Sweden	No	Yes
DNorth Middle Sweden	No	Yes
DCentral Norrland	No	Yes
DUpper Norrland	No	Yes
DNorth East England	Yes	Yes
DNorth West England	No	Yes
DYorkshire and The Humber	Yes	Yes

Note: "Yes" means stationarity (convergence), whereas "no" means non convergence

COMPARING RESULTS FROM ADF-KPSS

It is observed that using KPSS the number of convergent regions rises. Moreover, it is interesting to compare if the outcomes from both tests coincide between them. In order to compare them, since KPSS has more number of convergent regions, the question will be if KPSS coincide in all regions with ADF.

TABLE 9

VARIABLES	**ADF**	***KPSS***
DBurgenland	*Yes*	*Yes*
Dbrussels Capital Region	*Yes*	*Yes*
Dwestern Finland	*Yes*	*Yes*
Dschleswig-Holstein	*Yes*	*No*
Dathens	*Yes*	*Yes*
Dlombardy	*Yes*	*Yes*
D Province of Bolzano-Bozen	*Yes*	*No*
Dprovince of Trento	*Yes*	*Yes*
Dveneto	*Yes*	*Yes*
Dfriuli-Venezia Giulia	*Yes*	*Yes*
Demilia–Romagna	*Yes*	*Yes*
Dmarche	*Yes*	*Yes*
Dmadeira(PT)	*Yes*	*No*
Dasturias	*Yes*	*Yes*
Dcantabria	*Yes*	*No*
Dvienna	*Yes*	*No*
Dåland	*Yes*	*Yes*
Dprovence-Alpes-Côte d'Azur	*Yes*	*Yes*
Dbremen	*Yes*	*Yes*
Dhesse	*Yes*	*Yes*
Daosta Valley	*Yes*	*Yes*
DLuxembourg	*Yes*	*No*
DSouth East England	*Yes*	*Yes*
DWales	*Yes*	*Yes*
DLanguedoc-Roussillon	*Yes*	*Yes*
DMolise	*Yes*	*Yes*
DSardinia	*Yes*	*Yes*
DLisbon	*Yes*	*Yes*

Note: "Yes" means stacionarity (convergence), whereas "no" means non-convergence

TABLE 9 CONTINUATION

VARIABLES	**ADF**	***KPSS***
DAlentejo	*Yes*	*Yes*
DBasque Country	*Yes*	*Yes*
DLa Rioja	*Yes*	*Yes*
DNavarra	*Yes*	*No*
DCatalonia	*Yes*	*Yes*
DBalearic Islands	*Yes*	*No*
DEast Middle Sweden	*Yes*	*Yes*
DSmåland with Islands	*Yes*	*Yes*
DAquitaine	*Yes*	*Yes*

Note: "Yes" means stationarity (convergence), whereas "no" means non-convergence

For 37 cases of convergence in ADF, 8 are not contrasted with KPSS, whereas in the rest, convergent regions in both tests coincide. In short, the cases which were detected as convergent by using ADF, coincide with KPSS in a 78%. It is clearly observed that the KPSS test has more power and, therefore, it shows more sights of convergence than ADF. If KPSS is performed for the period 1995-2011 on the one hand including a trend, it is found that 86 regions are converging, that is, 65% of the whole sample. On the other hand, if KPSS is performed without trend, it gives evidence of convergence in 52 regions, i.e. 40% for the whole sample. In conclusion, if we are based on the KPSS test, it embraces a greater number of convergent regions towards the mean.

6.2 MEDITERRANEAN ARC: CONVERGENT REGIONS

ADF

The ADF test shows that there are 14 regions that converge in the sample of the Mediterranean arc. As previously said, the country whose regions show more convergent regions towards the mean is Italy with 10 convergent regions, followed by Spain with 3 and finally France with 1.

TABLE 10

VARIABLES	τ	τ_μ	τ_τ
DPiedmont	**		
DLombardy	**		
DProvince of Trento	**		
DVeneto	**		
DEmilia–Romagna	*		
DMarche	*		
DCorsica	*		
DAosta Valley		***	*
DProvince of Bolzano-Bozen		**	
DBasque Country			**
DNavarra			**
DBalearic Islands			***
DSicily			*
DFriuli-Venezia Giulia			***

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of unit root (stationarity) therefore, convervence at 10, 5 and 1% respectively.

KPSS

TABLE 11

VARIABLES	η_μ	η_τ
DBasque Country	No	Yes
D Navarra	No	Yes
DLa Rioja	No	Yes
DAragon	No	Yes
DCastile-La Mancha	No	Yes
DValencia	Yes	No
DBalearic Islands	Yes	No
DAndalusia	No	Yes
DPiedmont	No	Yes
DAosta Valley	Yes	No
DLiguria	Yes	Yes
DLombardy	No	Yes
DAbruzzo	No	Yes
D Molise	No	Yes
DCampania	No	Yes
DApulia	No	Yes
D Basilicata	Yes	Yes
DCalabria	Yes	Yes
D Sicily	No	Yes
DSardinia	Yes	Yes
DProvince of Bolzano-Bozen	Yes	No
DProvince of Trento	No	Yes
DVeneto	No	Yes
DFriuli-Venezia Giulia	No	Yes
DEmilia–Romagna	No	Yes
DTuscany	No	Yes
DUmbria	No	Yes
D Marche	No	Yes
DLazio	Yes	Yes
DMidi-Pyrénées	No	Yes
D Limousin	Yes	Yes
DRhône-Alpes	Yes	No
DAuvergne	Yes	Yes
DLanguedoc-Roussillon	Yes	No
D Provence-Alpes-Côte d'Azur	No	Yes

Note: "yes" means stationarity (convergence), whereas "no" means non convergence

COMPARING THE RESULTS FROM ADF-KPSS

TABLE 12

VARIABLES	**ADF**	***KPSS***
DPiedmont	*Yes*	*Yes*
DLombardy	*Yes*	*Yes*
DProvince of Trento	*Yes*	*Yes*
DVeneto	*Yes*	*Yes*
DEmilia–Romagna	*Yes*	*Yes*
DMarche	*Yes*	*Yes*
DCorsica	*Yes*	*No*
DAosta Valley	*Yes*	*Yes*
DProvince of Bolzano-Bozen	*Yes*	*Yes*
DBasque Country	*Yes*	*Yes*
DNavarra	*Yes*	*Yes*
DBalearic Islands	*Yes*	*Yes*
DSicily	*Yes*	*Yes*
DFriuli-Venezia Giulia	*Yes*	*Yes*

Note: "Yes" means stacionarity (convergence), whereas "no" means non-convergence

We note that the test KPSS is still embracing more stationarity (convergent regions) than ADF. In the case of the Mediterranean regions, in the KPSS test with trend it was obtained that 29 of the 38 regions have converged, and when KPSS is run without trend it is got 13 convergent regions. Moreover, by comparing KPSS and ADF, we should note that for 14 convergent regions which were identified by ADF, KPSS coincides in 13 cases. In other words, KPSS supports ADF in 93% of the regions, in spite of identifying more convergent regions

THE CORE EUROPEAN REGIONS: CONVERGENTES: CONVERGENT REGIONS

ADF

TABLE 13

VARIABLES	τ	τ_{μ}	τ_{τ}
DBasque Country	**		
D Province of Bolzano-Bozen	*	**	
DBrussels Capital Region	*		
DUpper Austria	*		
DTyrol	**		
DLuxembourg		**	
DW Netherlands		***	
DSouth Netherlands		*	
DGreater London		*	
DAosta Valley		*	*
DVorarlberg			***
DStockholm			*

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of unit root (stationarity) therefore convergence at 10, 5 and 1% respectively.

KPSS

TABLE 14

VARIABLES	η_μ	η_τ
DMadrid	Yes	No
Dnorth Netherlands	Yes	No
Dwest Netherlands	Yes	Yes
Dsouth Netherlands	Yes	Yes
Dile de France	Yes	Yes
Daosta Valley	No	Yes
Dlombardy	No	Yes
Dsalzburg	Yes	No
Dtyrol	No	Yes
Dvorarlberg	No	Yes
D North Rhine-Westphalia	Yes	No
Dbaden-Württemberg	Yes	No
Dbavaria	Yes	No
Dhamburg	Yes	Yes
Dhesse	No	Yes
Dbremen	Yes	Yes
Dhelsinki-Uusimaa	No	Yes
Dstockholm	Yes	Yes

Note: "yes" means estacionariety (convergence), whereas "no" means non convergence

COMPARING THE RESULTS FROM ADF-KPSS

TABLE 15

VARIABLES	***ADF***	***KPSS***
DBasque Country	*Yes*	*No*
D Province of Bolzano-Bozen	*Yes*	*No*
DBrussels Capital Region	*Yes*	*No*
DUpper Austria	*Yes*	*No*
DTyrol	*Yes*	*Yes*
DLuxembourg	*Yes*	*No*
DW Netherlands	*Yes*	*Yes*
DSouth Netherlands	*Yes*	*Yes*
DGreater London	*Yes*	*No*
DAosta Valley	*Yes*	*Yes*
DVorarlberg	*Yes*	*Yes*
DStockholm	*Yes*	*Yes*

In the segment of the most developed regions of the sample, it is observed that ADF identifies more convergent relationships than KPSS without including a trend, and the same than KPSS including a trend. On the one hand, ADF shows that 12 regions are converging towards the mean of 26 regions, the whole sample; that is, 46% of the regions have converged. On the other hand, when KPSS is run without trend, 11 regions are converging, whereas KPSS with trend embraces 12 convergent regions. As a result, both tests show very similar outcomes. As it was done before, we move on to contrast both tests. In this case, it is found that there are no similar outcomes or, at least, not as good as there were in the other cases[25]. Basing on the 12 convergent regions and founding in ADF and in order to compare them with KPSS, it is found that only 5 regions coincide between both tests, which are: Stockholm, Vorarlberg, Aosta Valley, South Netherlands, West Netherlands and Tyrol. As it can be observed, whereas through ADF, Basque country is identified as convergent regions, KPSS does not shown that outcome, like Madrid but in the opposite way.

[25] We refer to the case of the whole sample and the Mediterranean arc.

VII CONCLUDING REMARKS

The aim of this paper is to study how convergence has evolved for the period 1995-2011 on a continuous process of economic integration for the main countries of the European Union. In this research, in order to get a better analysis of convergence, we use of regions instead of countries. The main reason is that, even if a country may not be converged as a whole, a few regions may be converging to the most developed regions in the sample. Therefore, using regions allows us to assess convergence in a more disaggregated context, which could help us to reach more detailed conclusions about convergence.

Convergence emerges from the neoclassical growth theory. In the end, what it is being tested here is how convergence has evolved since 1995 until 2011. Moreover, we can use it as an indirect test of the neoclassical theory because, in the European case, many of the conditions of this model are fulfilled.

In order to test for convergence across regions, we have followed two steps. In the first one, we test the traditional concept of convergence, β convergence and σ convergence. Second, in the time series framework we perform two different tests in order to show if this series are stationary or not, where stationary would imply convergence. The joint use of the traditional convergence approach together with time series is to allow us to show how the concept of convergence and the way to measure it has changed across time.

Moreover, we have applied the analysis to the whole sample of regions in a first stage. As the whole sample is quite heterogeneous, in a second stage we have selected two groups, and we have tested for convergence among the restricted group members.

Regarding the outcome of the analysis of convergence, we can highlight several conclusions:

Firstly, when the traditional concept of convergence was tested the outcome was:

-When the whole sample is used, there is no evidence of β convergence and no clear conclusion is possible.

-Breaking down the sample helps us to get better conclusions, as it is shown from the charts 2 to 11.

-We find some signs of β convergence among the Mediterranean regions, which have a log per capita GDP higher than 4,35. It means that only the richer regions are converging.

-Looking at the core regions in the sample, we can observe that there is clearer evidence of β convergence than in the other groups. The reason may be that, as the neoclassical theory growth explains, only the countries (in this case regions) which have the same stationary state or whose stationary state is similar will tend to convergence, and this is what apparently happens.

- Another gist of this survey is to find out if any regions less developed than the richer ones have converged towards them. Evidence from chart 8 and 9 shows that two regions, the Basque Country and Southeast England, are converging on the β convergence sense.

- Taking a look at σ convergence, in some cases the σ convergence is fulfilled, mainly when the sample is broken down into two groups inside the Mediterranean regions, only in the subgroups of regions whose per capita GDP is higher than 4,35. Although σ convergence is fulfilled for the whole group of Mediterranean regions too, that is not true because the β convergence is not produced and, as it has been mentioned before, σ convergence could not exist without β convergence. The same case occurs when we analyse the most developed regions. In chart 9 we can see that there is no evidence of σ convergence, but when we focus on the regions, they are converging in the β convergence sense, then we realise how chart 11 shows that σ convergence is fulfilled.

Now we move on to the analysis of the time series context and the determination of which of those series are stationary. In that context, it means that those series are converging to the mean of the whole groups.

As in the previous section, firstly we apply the test ADF and KPSS for the whole sample. Sequentially, the sample is broken down into different groups: the first one is the Mediterranean arc and the second one is consists of the core European regions.

We use both tests, ADF and KPSS, to compare the outcomes obtained from different tests. Although the KPSS has better power, when the sample is not long enough what we find is that, in almost all groups, the KPSS test gives more support to convergence only in the case of the segment of the most developed regions where both tests have similar number of convergent regions. However, in this case, the results from both tests are different, whereas for the rest of cases, that is, for the whole sample and the Mediterranean arc, KPSS often confirms the ADF results and moreover, there are more stationarity series using KPSS.

The main outcomes are obtained:

-For the whole sample, ADF shows that 37 regions have converged to the mean, that is, 28% from the total. Whereas KPSS shows that 86 regions have converged when it is performed with a trend. KPSS, without no trend, shows 52 have converged. To compare the results from the two tests, 37 convergent regions for ADF coincide with KPSS for the 78% of the cases.

-For the Mediterranean arc, the ADF shows that 14 regions are converging, and we should point out that almost all regions are Italian. In contrast, when KPSS is performed with trend, there is evidence of convergence for 29 regions. The 76% from the Mediterranean segment are converging, but when KPSS with no trend is performed, only 13 regions exhibit convergence, less than ADF. Comparing all the regions, which are converging running the ADF and those from KPSS, they coincide in 13 of 14 cases. Almost all stationarity series from ADF shows the same outcome in KPSS but moreover, KPSS with trend embrace more stationarity series.

-The last group includes the core European regions. ADF shows convergence for 12 regions, that is, 46% from the whole group, whereas KPSS exhibit similar sings of convergence than ADF. 12 regions are stationary with trend and 11 with no trend is run, but unlike the other cases, comparing ADF and KPSS, they coincide just in 5 regions.

Finally, we should take into account that this analysis is limited by the unavailability of longer data spans for this disaggregation level. A potential extension for future research would be to include more European countries and have a longer data span. It is important to point out that the choice of regions instead of countries that has been incorporated this paper is something not so usual when testing for convergence in the Euro zone or the European Union, therefore using regions is the best way to get deeper and more detailed conclusions on how convergence has evolved in Europe.

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