Regional Convergence in Europe: Evidence from the Perspective of Capital Accumulation in Services

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Abstract

The integration process within Europe has resulted in a reduction of regional disparities. It is, however, unfortunate that little or no attention has been given to how this regional convergence has occurred, particularly in the growing services sector. Therefore, this paper analyses the impact of capital accumulation in the services sector in European regional convergence. We use a spatial correlation to analyze the services sector in 121 European regions at the NUTS-2 level in nine European Union (EU) countries. The results show the polarisation of economic activity in the central area of Europe, which creates synergies that slow down the process of regional convergence. It also reveals the significant role of the non-market services sector in this process, which highlights the importance of maintaining high rates of investment for continued convergence.

JEL classification codes: Q18, R11, R12
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1. Introduction

In the past decades, numerous empirical studies, coupled with several European Commission reports, have drawn attention to the process of regional convergence taking place among different territories of the European Union. The concept of regional convergence in economics is the hypothesis that poorer regions tend to grow at faster rates than richer regions. Therefore, this convergence should be viewed as a process that is not necessarily linear, with a long-term reduction of differences in terms of per capita income; it can also be used for sectoral analyses or to determine the variables that determine it. Moreover, it can be analyzed from a spatial perspective rather than in dynamic terms. In any case, the outcome of this process is that of growing cohesion among the different European regions, an issue that has been addressed in numerous regional policy studies (Goecke & Hüther, 2016; Funck and Pizzati, 2003; Rodríguez-Pose and Fratesi, 2004; Ertur et al., 2006; Cuadrado-Roura and Parellada, 2013).

The formulation of convergence as a process in which the only variable that determines the situation is that of per capita income at an initial stage (absolute or unconditional beta-convergence), does not allow us to satisfactorily explain recent developments in regional disparities. It is, therefore, necessary to include in the analysis other variables that could affect this process. Undoubtedly, the sectoral structure and the productivity factor are two components that have affected regional convergence; hence, they must be analyzed to determine which factors and industries have contributed to regional growth.

The traditional study of convergence from a sectoral perspective has focused on the industrial sector, where mobility of factors of production fits into the concept of beta-convergence. However, the introduction into the analysis of different ratios related to the capital accumulation in the service sector (productivity, investment rate, capital-labor ratio), along with the consideration of their spatial distribution, can explain the convergence of the regions towards its steady state. Furthermore, convergence results directly from the movement and accumulation of capital (Konz, 1997). Therefore, a certain gap between the traditional and linear analysis of convergence and the spatial and sectorial analysis of convergence arises. Moreover, considering the different branches of service activities, we can observe the special contribution to the process of non-market services. This would demonstrate the need to consider the presence of spatial autocorrelation in the capitalization of the services sector as a factor determining beta-convergence, and the role that the public sector can play as a driver of regional convergence.

The aim of this paper is to analyze the process of convergence in terms of per capita income in a sample consisting of 121 European regions, considering both the existence of spatial autocorrelation as the capital accumulation in the service sector. This study has focused on a limited number of EU member states, based on the quantity and quality of regional information available. Thus, the dataset includes: Belgium, Germany, France, Italy, the Netherlands, Austria, Portugal, Sweden and Spain.

The rest of the article is organised as follows. In section 2, we review the literature on the concept of regional convergence, with particular attention given to the analysis of spatial autocorrelation. In section 3, we present the methodology. In section 4, the explanatory variable is broken down into three ratios, which are related to capital accumulation in the service sector, highlighting the importance of these processes in the European regional convergence. Considering the significant presence of services in these territories, we included

various service indicators that are related to the capital accumulation process to determine their impact on convergence while concluding the paper in the final section 5.

2. Literature review

According to several models, economic growth is associated with a reduction in regional disparities, based on empirical evidence that regions with lower income per capita often have above-average levels of economic growth, thus eventually producing similar levels of income in different regions. The concept of regional convergence originated in the neoclassical growth model, which was developed in the 1950s by Solow (1956) and Swan (1956), who argued that the slowdown of growth in per capita income is as a result of diminishing returns from the accumulation of capital. This model was extended in the following decade by authors such as Koopmans (1965), Diamond (1965) and Romans (1965), who considered the saving rates to be an endogenous variable and examined the full mobility of trade flows and productive factors from a regional perspective. From this standpoint, the most abundant factor, in relative terms, would have greater marginal productivity, thereby stimulating its displacement towards regions where these values were lower.

Similarly, Konz (1997, p. 289) pointed out that "convergence results directly from the competitive movement of capital according to differences in rates of return". According to this author, capital accumulation matters, and there is a necessity of incorporating capital flows in inter-regional convergence analysis, particularly "for small open economies which are reliant upon capital account transactions for the balance of payments (Konz,1997, p. 305). Also, the neoclassical approach to convergence highlights the role of capital accumulation (Eicher et al., 1999). Capital and output converge, but at different long-run equilibrium growth rates. Accordingly, Bernard and Jones (1996a, 1996b) confirmed that different sectors show different convergence rhythms.

Despite the efforts to provide empirical evidence (Baumol, 1986), the limited empirical support to these models for a group of industrialized countries (twelve European countries including Canada, United States and Japan) was studied using a long-term data series, which provoked a search for alternatives to the neoclassical approach, and one of such alternatives is the theory of endogenous growth. Endogenous growth models are based on the assumption of constant or increasing returns on capital, which turns into a worldview that is very different from the one offered by neoclassical models. In this approach, the return on investment is an increasing function of the stock of accumulated capital and, therefore, growth tends to be explosive during a finite time when systems have positive feedback (Yatsenko et al., 2009), even in the absence of technological progress. Moreover, as the wealthiest regions grow faster, inequality tends to increase over time (De la Fuente, 1996).

To empirically differentiate between neoclassical and endogenous growth models, traditionally the literature has considered the contrast between two alternative hypotheses: convergence and divergence; confirming the existence (or otherwise) of diminishing returns in the cumulative factors. The presence or absence of convergence between regions ultimately depends on the structural characteristics of each regional economy. If they are similar, the income per capita in the regions is expected to converge (absolute convergence) and it is estimated by means of a linear regression based on cross-sectional data, as follows (Sala-i-Martín, 1996):

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = a + b\ ln(y_{i,t-T}) + u_{i,t} \quad (1)$$

Where $y_{i,t}$ and $y_{i,t-T}$ are income per inhabitant at the final and initial moments in region i, respectively, T is the length of the period analyzed, $\left(\frac{1}{T}\right) log\left(\frac{y_{i,t}}{y_{i,t-T}}\right)$ is the annual accumulative growth rate of region i in the period t to $t+T$, b is the estimated coefficient, and $u_{i,t}$ represents the error term of the random disturbance. If these characteristics determine a variety of stationary states for each territory, the neoclassical model predicts that, in the long run, each region will tend toward its own equilibrium, leading to what is known as conditional convergence (López-Bazo et al. 1999; Fingleton and López-Bazo 2006). The latter may be estimated in two ways: i) by creating groups of regions with common features, which will result in different steady states; ii) by introducing into the equation (1) different variables (X_{t-T}), acting as a proxy of such a state.

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = a + b\ ln(y_{i,t-T}) + \phi\ ln(x_{i,t-T}) + u_{i,t} \quad (2)$$

Among these variables, the industry mix has called the attention of many scholars (Esteban, 2000), however, the service sector has been afforded comparatively lesser importance than manufacturing (Azzoni and Andrade, 2005), although this sector currently accounts for the largest share, both in terms of GDP and employment rates of all developed economies (Cuadrado-Roura and Parellada, 2013). Traditionally, the influence of sectoral structure in regional convergence has been analyzed using shift-share techniques for different European countries (Spain, Turkey, Germany, etc.), including beta-convergence analysis in different service ratios as explanatory variables (Marelli, 2007). Moreover, when considering regions in different countries, there is no need to observe convergence, as there may be several steady states if the regions are located in different contexts (technology, savings rate, public policies, infrastructure, etc.) (Battisti and De Vaio, 2008). For this reason, the spatial dimension must be integrated into the estimation of beta-convergence. This phenomenon underscores the importance to the regional growth of spatial location, or spatial autocorrelation (Anselin, 1988). This can be positive or negative, depending on whether the values of the variable for the region are similar or different from those of its neighbours respectively.

3. Methodology

The existence of spatial autocorrelation is usually verified by Moran's Index (1950), which estimates the linear dependence between a variable for a specific location and an average of the same variable for its neighbours. From an econometric point of view, when exploratory spatial data analysis (ESDA) detects the presence of spatial effects, OLS estimates are unreliable. To avoid potential bias, we must determine which part of the spatial autocorrelation function affects either the independent variable or the error term (spatial lag or spatial errors, respectively). Since the Moran Index does not reveal which type of phenomenon is present, it is necessary to apply a series of tests based on the Lagrange multiplier (LM) and to set a requirement that the error term follows in a normal distribution: i) the pair that detects the autocorrelation in the dependent variable, both in its conventional version (LM

lag) and in the robust one (MRLs lag); and ii) the pair that detects the presence of autocorrelation in the error term, normal and robust (LM error and MRLs error, respectively).

In all cases, we test the null hypothesis that the respective autoregressive coefficient is zero and, therefore, that there is no spatial autocorrelation. For that, we have applied the usual methodology in spatial econometrics (Anselin, 2005; Florax et al., 2003). If the hypothesis of no spatial autocorrelation is rejected, the most appropriate β-convergence model – spatial lag or spatial error – must be specified. As seen, the spatial error model is a special case of regression with a non-spherical error term (Anselin, 2001), in which the off-diagonal elements of the covariance matrix express the structure of spatial dependence. Consequently, OLS remains unbiased, but it is no longer efficient and the classical estimators for standard errors will be biased. For an absolute β-convergence model, the equations would be as follows – see equations (3) and (4), respectively – (Elhorst, 2014).

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right)= a+\rho W\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right) + b\ ln(y_{i,t-T}) + u_{i,t} \tag{3}$$

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right)= a+b\ ln(y_{i,t-T}) + u_{i,t} \quad where\ \ u_{i,t} = \lambda W u_{i,t} + \varepsilon_{i,t} \tag{4}$$

Where ρ is the spatial autoregressive coefficient of the lagged component, λ is the autoregressive spatial coefficient of the error term, $\varepsilon_{i,t}$ is the error term, t and t-T are the final and initial period (2007 and 1995, respectively), and W is the distance matrix among the regions. In our case, the spatial weights matrix has been constructed using contiguity; particularly the queen contiguity based on first order neighbours.

The conditional β-convergence model for spatial lag, or spatial error model, can be specified as follows, respectively:

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right)= a+\rho W\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right) + b\ ln(y_{i,t-T}) + \phi\ ln(x_{i,t-T}) + u_{i,t} \tag{5}$$

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{i,t}}{y_{i,t-T}}\right)= a+b\ ln(y_{i,t-T}) + \phi\ ln(x_{i,t-T}) + u_{i,t} \quad where\ \ u_{i,t} = \lambda W u_{i,t} + \varepsilon_{i,t} \tag{6}$$

Where ϕ is the vector of unknown parameters to be estimated corresponding to $ln(x_{i,t-T})$, which is the matrix of exogenous explanatory variables related to the capital accumulation process in the service sector.

Having defined the absolute and conditional β-convergence models with spatial effects, together with the decision-making process needed to implement them, we then perform an Exploratory Spatial Data Analysis (ESDA) to verify the existence of spatial autocorrelation in GVApi (Gross Value Added per inhabitant) for all the selected regions and thereby estimating the most appropriate model of absolute beta-convergence. This analysis also provides useful information for selecting variables related to the rising importance of services in the European economies, which may influence the process of regional convergence. We can then estimate the conditional beta-convergence model.

This approach determined the source of statistics to be used (BD.EURS). This database (Escribá-Pérez and García-Murgui, 2013) provide researchers with a wide range of basic macroeconomic variables, such as production (in current and constant prices, following the methodology of the European System of Accounts), employment, investment and capital

stock of 121 European regions at the NUTS-2 level in nine EU countries (Belgium, Germany, France, Italy, the Netherlands, Austria, Portugal, Sweden and Spain), EU-9, disaggregated by sector, as classified by Eurostat (NACE Rev.1) for the period 1995-2007. This database was published in 2014 and, in the middle of 2017, there was no additional data available after 2007. Although most of the previous contributions have used data from EUROSTAT and/or from the Cambridge Econometrics databases, we have exploited information from the BD.EURS dataset. The basic source of statistical information in this database is the annual regional series of EUROSTAT, using it as reference national data from AMECO and EU-KLEMS databases, the latter detailed at sectoral level. The BD.EURS database includes annual statistical information from those countries in which the available regional information is better, in terms of quantity and quality, for the period of 1995-2007.

4. Capital stock in services as a conditioning factor for spatial convergence

Growth patterns in Europe do not follow a random distribution in space, and the analysis of standard deviation at the initial point and at the growth rate in the period reveals the presence of beta-convergence. An initial approach to the analysis of GVApi was made with the generation of map quartiles, both for 1995 and for the cumulative growth rate from 1995-2007, and also by using box maps. However, a more rigorous analysis of spatial dependence can be performed by calculating the Moran Index. This produces a value of 0.4480 for GVApi, which is above the value at which the null hypothesis of no spatial autocorrelation could be rejected (E (I) = - 0.0083). The spatial pattern observed in 1995 remained largely unaltered until 2007, when the Moran Index for GVApi reached 0.4116. The growth rate of GVApi behaved in a similar fashion, producing a Moran Index of 0.4700.

Given the existence of spatial autocorrelation phenomena that affect the application of cross-section methods in our analysis of convergence, equations (3) to (6) must be used, with the choice of the equation depending on the location of the source (the dependent variable or the error term) and the type of convergence (absolute or conditional) to be analyzed. First, we have examined the unconditional beta-convergence, using the spatial cross-section analytic method summarised in equations (3) and (4). This analysis was performed at constant prices, in order to determine the real influence of the initial economic situation on regional growth. The results of this analysis (see Table 1) confirm the existence of beta-convergence in the analyzed dataset; the negative sign of coefficient b indicates an inverse relationship between income per capita in 1995 and growth during the study period.

After identifying the presence of spatial dependence, we then re-estimate the beta-convergence model under the maximum likelihood (ML) approach, while controlling for spatial dependence. In this process, it is observed that the degree of fit (R^2) rises to 39.4% for Spatial Error Model (SEM). However, in spatial regression models, this is not a measure of the goodness of fit and is not directly comparable with the values obtained by OLS, so the maximization of log-likelihood ratio function value will be a more appropriate measure of fit when the degrees of freedom for the alternative models are the same, in the other case, we should calculate the log-likelihood ratio test. When this was done, the log-likelihood increased from 450.9 (for OLS) to 469.5 (similar results are obtained with AIC and SC). Moreover, the analysis of the diagnostic test for spatial dependence (Lagrange Multipliers

and its robust versions) point to the SEM. Therefore, it can be seen in Table 1, the SEM gives a much better fit than others, and will be used in the rest of the paper.

Table 1. Estimation of beta-convergence in GVA per inhabitant at constant prices (ref. 2000 = PPP), 1995–2007

Determinants	Classic model (equation 1)	Spatial lag model (equation 3)	Spatial error model (equation 4)
Lag coefficient (ρ)	-	0.444***	-
Intercept term (a)	-0.012	-0.015**	-0.004
Ln(GVApi) in 1995 (b)	-0.007***	-0.006***	-0.005**
Lambda (λ)	-	-	0.597***
R^2	0.092	0.342	0.394
Log-likelihood	450.904	467.392	469.507
S.E. of regression	0.006	0.005	0.005
Number of observations	121	121	121
Number of variables	2	3	2

Note: The levels of variation are cumulative annual growth rates and are expressed in logs.
Statistic significant: * at 10% level, ** at 5% level, *** at 1% level.
Source: Author's elaboration

The existence of a higher degree of absolute beta-convergence when spatial models are introduced, together with the presence of spatial autocorrelation in EU-9, indicates the existence of polarisation, which can increase inter-regional disparities. Although some catching-up by the poorest regions can be detected (which is consistent with the patterns observed in the beta-convergence analysis), the polarisation of economic activity in the central area of EU-9 creates synergies that slow the process of regional convergence. As can be seen in Table 1, the estimated convergence coefficient in SEM model is smaller than the classic model (-0.0053 vs. -0.0073), while the goodness of fit is worst for the last. This is not contradictory because the SEM model is included in its specification for the spatial effect of the error term, whose estimated coefficient is significant and higher. This fact could be indicating the existence of unknown factors with spatial relevance included in the error term of the random disturbance. These findings suggest there is a need to improve the formulation of the beta-convergence model (absolute or unconditional), by introducing other variables, thus creating a conditional model. In view of the significant presence of service activities in the GVApi, we now pay special attention to various indicators of services related to the capital accumulation process.

Accordingly, attention must be paid to the factors that determine the localisation of economic activities, such as capital (human or productive), infrastructure or technology (McCann and Shefer, 2003). Increasingly, the question of location, which is influenced by the existence otherwise of important centers of activity in service areas where high demand arises from strong rates of growth in investment, capital stock and productivity. As we have done with the GVApi, we have calculated the Moran Index to verify the existence of spatial dependence for the capital stock per job and the investment, per output, in services. Their values are very high (0.5849 and 0.4107, respectively), indicating the existence of a positive spatial autocorrelation of these variables in the EU-9 in 1995, that is, regions with high values for these ratios tend to be closer to others with similar values. In addition, of the 56 European regions that presented this situation for the capital stock per job ratio, 46 were also

in this situation for GVApi, which shows the correlation between both variables and the need to include them as explanatory variables in our analysis. Therefore, it would be logical to consider how these variables determine the beta-convergence process as observed above. To do so, we calculate the following extended SEM:

$$\left(\frac{1}{T}\right) log\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = a + b_1\, ln(y_{i,t-T}) + b_2\, ln\left(\frac{Fs_{i,\,t-T}}{GVAs_{i,t-T}}\right) + b_3\, ln\left(\frac{Ks_{i,\,t-T}}{Ls_{i,t-T}}\right) + u_{i,t} \quad (7)$$

Where K is capital stock, F is gross fixed capital formation, L is employment, and s states that the variable preceding it belongs to the service sector. Thus, $Ks_{i,\,t-T}$ represents the capital stock in the services sector in region i in 1995, and so on. Thus, growth in GVApi would depend on the situation in 1995, as well as the initial values of investment per output ratio and capital stock per job in the service sector.

Table 2. Estimation of conditional beta-convergence in GVApi, 1995–2007

Determinants	SEM (including Ln(GVApi)	SEM (excluding Ln(GVApi)
Intercept term (a)	0.030**	0.020***
Ln(GVApi) in 1995 (b_1)	0.003	-
Fixed capital formation in services / GVA in services (b_2)	0.009***	0.007***
Capital stock in services/ Employment in services (b_3)	-0.004*	-0.003*
Lambda (λ)	0.604***	0.606***
R^2	0.454	0.452
Log-likelihood	475.734	475.363
S.E. of regression	0.005	0.005
Number of observations	121	121
Number of variables	4	3

Note: Statistic significant: * at 10% level, ** at 5% level, *** at 1% level. Dependent variable is cumulative annual growth rate of GVApi in 1995-2007.
Source: Author's elaboration

After estimating equation (7) with spatial interaction in the error term, the b_1 coefficient is not significant, and after its exclusion, the goodness of fit was basically unchanged (see Table 2). The capital stock per job ratio in services has a negative sign, whereas, for the investment-output ratio in services, this sign is positive. In other words, the regions which in 1995 had the smallest ratio presented the lowest rate of growth in GVApi, which highlights the importance of maintaining high investment flows and thus economic activity in the poorest regions.

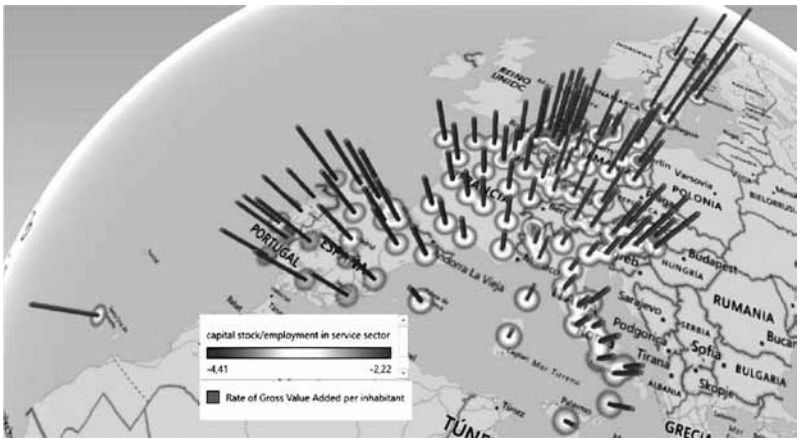
Table 3. Estimation of unconditional beta-convergence on indicators for capital accumulation in services 1995–2007

Determinants	Capital stock / employment	Gross fixed capital formation / GVA	GVA / capital stock	GVA / employment	Importance of services employment
Intercept term (*a*)	-0.010*	-0.061***	-0.034***	0.025**	-0.002*
Ln in 1995 (*b*)	-0.011***	-0.053***	-0.021***	-0.005*	-0.017***
Lambda (*λ*)	0.733***	0.641***	0.551***	0.469***	0.748***
R^2	0.712	0.700	0.587	0.199	0.649
Log-likelihood	475.795	352.199	465.804	473.876	556.287
S.E. of regression	0.004	0.012	0.005	0.005	0.002
Number of observations	121	121	121	121	121
Number of variables	2	2	2	2	2

Note: Statistic significant: * at 10% level, ** at 5% level, *** at 1% level. Each row of the Table 3 indicates the estimation of equation (4), where dependent variable is Capital stock / employment (second column), and so on.
Source: Author's elaboration

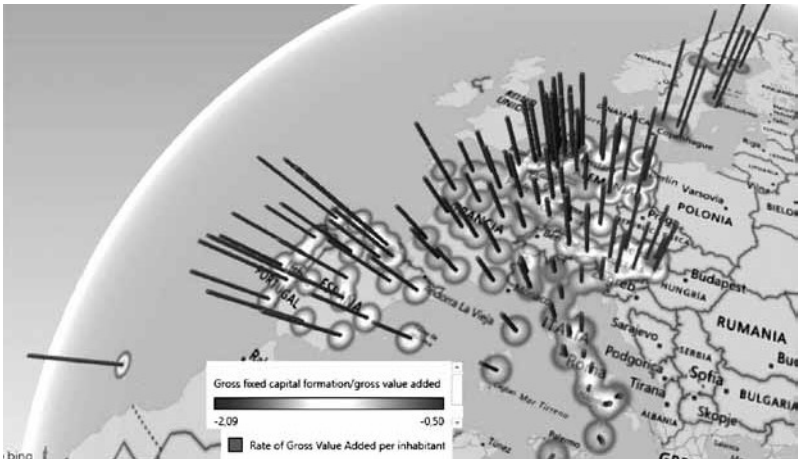
The evolution of different indicators of capital accumulation in services shows, in general, clear signs of beta-convergence between European regions, and at a high rate, as indicated by an R^2 between 58% and 71% (Table 3). Importance of the situation, observed with respect to the beta-convergence of capital stock per job, and the relative size of employment in the services sector, which is consistent with the lower capital stock in services and by the strong dependence between increases in production and employment.

Figure 1. Capital stock / Employment in services



Source: Author's elaboration

Figure 2. Gross fixed capital formation / GVA in services



Source: Author's elaboration

Figure 1 reveals certain patterns of national convergence in service variables, especially regarding the capital stock per employment and the gross value added per capita (represented in bars). It also shows the gross capital formation per GVA (Figure 2) ratios – because the largest areas of the circles correspond to regions with the lowest values of these ratios in 1995. This is clearly seen in the case of Sweden, and even more so in those of Spain and Portugal. The most noteworthy aspect of the investment-output ratio is that while beta-convergence is higher, the countries of the Iberian Peninsula present an unusual behavior pattern: although they have high starting levels, significant growth is achieved in both cases. So much so that, if we were to remove Spain and Portugal from the beta-convergence analysis, the R^2 would rise; moreover, a similar situation arises with the productivity of labor and capital services; on the contrary, the capital stock-employment ratio would be reduced dramatically. This outcome highlights the peculiarity of the capital accumulation process in the Iberian economies where, despite a significant increase in the capital per worker ratio, similar improvements in factor productivity have not been achieved, due to the part of the specialisation in production within these countries.

The regional evolution of capital stock for the services sector is reflected, albeit weakly, in the slowdown of relative importance of employment in the services sector, as shown by the sign of the estimated beta-convergence, its low rate and the acceptable degree of fit. However, there is no indication of beta-convergence in the relative importance of services output, even in the presence of a spatial component. This apparent contradiction is the outcome of the remarkable diversity of service specialisations in the various European regions and their unequal geographic distribution. It also reflects the economic growth experienced in the second half of the period, which has consolidated the relative importance of construction and industry in production, but not in employment, given the greater productivity of the former.

Focusing on the degree of relative importance of employment in the services sector, in 1995 there was a cluster of high values in central Netherlands and Belgium, while low values were concentrated in the north-eastern quadrant of the Iberian Peninsula, in eastern Austria and in two industrialized regions of northern Italy. These cluster regions, unlike the case of income

per capita, do not include southern Italy or the southern coast of Spain, due to the greater importance of tourism in these areas. However, because of the above-mentioned convergence, by 2007 the Moran Index had risen to 0.492, indicating a strengthening of the spatial component in the relative size of employment in the services sector, especially in northern Germany, the Netherlands, northern Italy, southern Austria and in the Iberian Peninsula.

The impact made by the service sector on the growth and convergence of GVApi is closely related to the contribution made by each of the different activities that include this sector. Accordingly, we must analyze whether the use of sectoral variables improves conditional convergence. To do this, we considered three areas within the services sector: i) productive market services (wholesale and retail trade; the repair of motor vehicles; hotels and restaurants; transport, storage and communications), ii) real estate, financial and business services (financial intermediation; real estate, renting and business activities); iii) non-market services (public administration, defence, compulsory social security, education, health and social work, other community, social and personal service activities, and domestic service). While beta-convergence was observed in all sectors, this was more pronounced in real estate, financial and business services and non-market services, especially in variables related to the capital accumulation process.

Real estate, financial and business services activities represent over 45% of the capital stock in the services sector for nearly all the European regions analyzed (the only exceptions were two regions in Portugal and one in Belgium in 1995, and one in Italy in 2007). A similar pattern was observed for gross fixed capital formation. In no case did employment in this sector exceed 35% and therefore, in the services sector productivity would be higher for capital and lower for labor.

Table 4. Estimation of conditional beta-convergence – capital accumulation in services by activity branches, 1995–2007

Determinants	Productive market services	Real estate, financial & business services	Non-market services
Intercept term (a)	0.002	0.019	0.010
Ln(GVApi) in 1995 (b_1)	-0.011***	0.001	0.000
Fixed capital formation by act. / GVA by act. (b_2)	0.001	0.005***	0.006***
Capital stock by act. / Employment by act. (b_3)	0.006***	-0.002	-0.004***
Lambda (λ)	0.648***	0.605***	0.592***
R^2	0.463	0.433	0.459
Log-likelihood	475.537	473.396	476.546
S.E. of regression	0.004	0.005	0.004
Number of observations	121	121	121
Number of variables	4	4	4

Notes: Statistic significant: * at 10% level, ** at 5% level, *** at 1% level. Dependent variable is cumulative annual growth rate of GVApi in 1995-2007.
Source: Author's elaboration

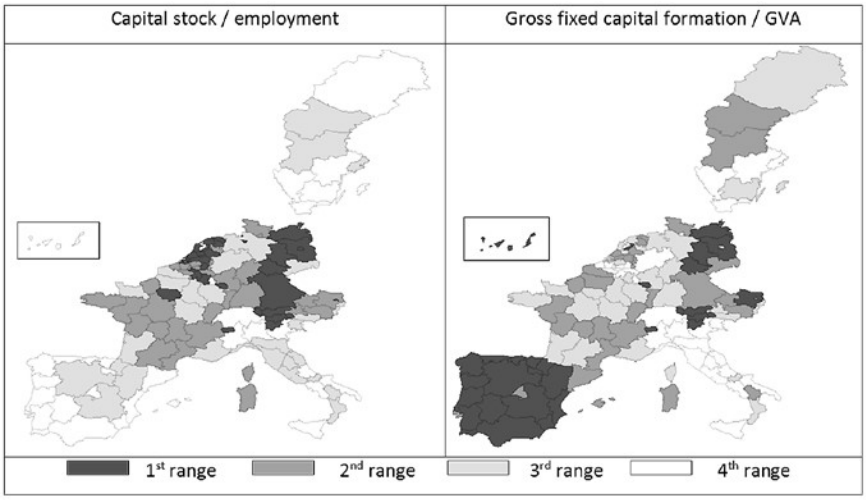
Although beta-convergence was observed for the service sector and for labor and capital productivity (see Table 3), these are not explanatory variables of growth in GVApi. Instead, the capital stock-employment and investment-output ratios are significant, primarily for Non-market services (see Table 4), while capital stock per job in Productive market services has a greater explanatory power. Moreover, for this activity branch, the initial value of

GVApi has the expected negative sign, so we concluded that this sector has a relevant contribution to the process of beta-convergence in income per inhabitant. This finding highlights the importance of maintaining a high rate of investment to advance the capital accumulation process and therefore, the regional convergence in EU-9.

Again, the presence of spatial autocorrelation was detected, so we estimated the SEM, thereby improving the fit, according to the Akaike and Schwarz criteria. This feature was especially noticeable in the Iberian Peninsula (Figure 3), where all regions were in the lower two quartiles in capital per job. However, in terms of investment per unit of output, these regions were in the upper quartile (except Madrid, Lisbon, Catalonia and the Balearic Islands). The fact that these investment flows were maintained in subsequent years drove the dynamics of growth and convergence.

Analysis of regional convergence in these countries from the mid-1990s until now reveals a significant reduction in disparities. Different authors (Soukiazis and Antunes, 2006; Badia-Miró et al., 2012; Ligthart, 2000; Viegas and Antunes, 2013) consider the structural and cohesion funds received have played a key role in maintaining the rate of convergence. Probably, the investment made in the implementation of the European regional policy, together with that of the public administrations of each country, contributed decisively to the beta-convergence towards European levels in the capital stock-employment ratio.

Figure 3. Quartile Map of capital stock per job and capital formation per output in non-market services, 1995



Source: Author's elaboration

5. Conclusion

Between 1995 and 2007, differences in per capita income in the EU-9 decreased, in terms of beta-convergence, thus narrowing the gap between rich and poor regions. However, the simple observation of growth patterns in Europe, together with the ESDA performed which led us to conclude that these patterns are not randomly distributed in space, and therefore,

our convergence analysis considered the possible presence of spatial autocorrelation. After identifying the presence of spatial dependence, we re-estimated the beta-convergence model using maximum likelihood and controlling for spatial dependence, thus improving the explanatory power of the model.

After incorporating the contribution of productive capital to economic growth, the goodness of fit was improved, due to the high significance of capital stock per job and capital formation per output. The introduction of the capital stock-employment and investment-output ratios (in both cases, for the service sector) as explanatory variables of growth in GVApi shows that the estimated coefficients have a positive and a negative sign, respectively. The negative coefficient of the parameter for the first ratio indicates that the regions which in 1995 had a higher degree of capitalization are those that have experienced lower growth in their GVApi, which is consistent with the assumption of diminishing returns established by Solow and Swan. On the other hand, the positive investment per output ratio reflects the importance of maintaining high investment flows for the poorest regions. Furthermore, the spatial component shows that, although there are evident catching-up effects in the regions with the lowest per capita level of development, the polarisation of economic activity in the central area of EU-9 creates synergies that slows the process of regional convergence. This central area of EU-9 benefits from the presence of important activity centers in services that enjoy high levels of demand, due to similarly high rates of growth in investment, capital stock and productivity. These factors mean that we must take into account the factors that are related to the process of capital accumulation in the services sector, which can ultimately determine where economic activities are located.

The capital stock-employment ratio reflects the presence of beta-convergence, which is consistent with the lower capital stock in services and with the close dependence of increased production and employment. This ratio also reveals the existence of certain patterns of convergence in capital accumulation in service activities within a given country. However, as regards to the investment-output ratio, the most noteworthy aspect is that, while convergence overall is higher within the Iberian Peninsula it presents unusual behavior with high start levels associated with significant growth. This is so much so that when Spain and Portugal are excluded from the beta-convergence analysis, the degree of fit in services productivity for labor and capital is significantly improved, while the stock capital-employment ratio is drastically reduced. These results are indications of the peculiarity of the process of capital accumulation in the Iberian economies where, despite a significant increase in capital per job, matching improvements in factor productivity have not been achieved. We suggest this outcome is due to the influence of productive specialisation in these countries. This regional evolution of the capital stock of the services sector is reflected, albeit weakly, in the progressive equalization of relative size of employment in the services sector. In this regard, It was observed to be a cluster of high values in central Holland and Belgium, and of low ones in the north-eastern quadrant of the Iberian Peninsula, and in eastern Austria and a few industrialized regions of northern Italy.

The impact made by the service sector on growth and convergence of GVApi is a direct consequence of the capital stock level in sectors such as real estate, financial and business services, and non-market services. In this respect, the highest explanatory power is presented by investment per unit of output in this sector. Therefore, we conclude that this parameter is primarily responsible for the process of beta-convergence in per capita income, which highlights the importance of maintaining high investment rates relative to production in

order for regional convergence in Europe to continue. This association is particularly evident in regions that receive investments made under European regional policy as well as those of the national government, as in the case of Spain and Portugal.

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