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Concentration and Diversity of Economic Activities in the EU27 Regions: Implications for Regional Convergence in Labour Productivity

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Abstract

In this paper the effects of two kinds of agglomeration externalities on EU27 regional productivity convergence are examined. The first is known as '*localisation*' externalities, and refers to effects stemming from the concentration of a specific activity in a region. The second kind of externality relates to the variety of activities in a given region, that is to say '*diversity*' externalities, often referred to as *urbanisation* externalities. Although, there is a long tradition in examining spatial externalities in the strand of economic geography, their impact on regional convergence remains a relatively unexplored area. In this paper a model is developed that explicitly takes the concept of 'externalities' in the mainstream analysis of regional growth. This model places particular emphasis upon the dynamic effects of spatial externalities and the significance of knowledge spillovers in shaping the pattern of regional convergence. An empirical specification, is then outlined and the model is tested using data for the NUTS2 regions of the European Union. The empirical application indicates slow tendencies for regional convergence in terms of labour productivity. It is established that the NUTS2 regions of the EU27 over the 1995-2006 period exhibit a relatively slow rate of absolute convergence (about 0.65% per-annum). This slow rate remains virtually unchanged even after conditioning for concentration and diversity externalities. However, when the model is extended for the effects of concentration/diversity externalities in conjunction with *spatial interaction*, an increase in the rate of convergence is detected. According to the econometric results, the effects of spatial interaction, captured by the spatially adjusted error-term, augment the average rate of convergence to 0.7% per-annum. In addition, the results reveal that convergence is strongly connected to the externalities associated with the degree of diversity, rather than localisation, in regional economic activities. An immediate implication of the results is that improvements in the diversity of lagging regions might constitute a source of convergence.

Key words: Agglomeration Externalities, Regional Convergence

JEL: R11; R12; R15

I. Introduction

The debate on regional convergence has bred, and continues to do so, several empirical studies (e.g. BUTTON and PENTECOST, 1995; 1999; NEVEN and GOUYETTE, 1995; EZCURRA *et al*., 2005). In this fast growing literature several variables are used to account for a region's structural characteristics that influence its growth-path and convergence. Nevertheless, the impact of agglomeration externalities has not received the due attention within this convergence literature. On the other hand externalities have been rather extensively studied within the economic-geography literature (see MULLIGAN, 1984 for a review) although with ambiguous impacts on regional growth and convergence. This paper aims to unify and balance the above two uneven and partial treatments of convergence and agglomeration externalities. That is, externalities relating to the localisation and diversity of economic activities; stemming from the concentration of a dominant activity in a region and from the variety in the range of the remaining (non-dominant) activities in that region respectively.

This is particularly pertinent as these two kinds of externalities can have both positive as well as negative impacts on a region; e.g. affecting both a region's growth-path and the outcomes of regional policies. Especially as a large part of regional policies boil down to altering the sources of such externalities (e.g. by attracting or supporting specific industrial specialisations) and as often policy makers have little clarity of the actual size and impact intensity of the externalities encroached by their policies.

Although justified to a certain extent by the lack of relevant knowledge and the gaps in the aforementioned literatures as most notably pointed out by MARTIN (2001, 2009) such gaps need to be filled sooner rather than later; given the present economic climate.

To that effect, a model is developed in this paper that takes explicitly into account localisation and diversity externalities in an extensive regional context, that of the EU27 NUTS2 regions. This effort is organised as follows. In section II the key efforts to explain the impact of spatial externalities in the process of regional growth are critically reviewed. This prepares the ground for the development of the aforementioned model in section III. Data related issues, together with some descriptive statistics, are discussed in section V. The econometric estimations are reported and discussed in section VI. The paper concludes in section VII with some policy implications.

II. Localisation and Diversification Externalities

As introduced in the previous section, from the perspective of an effective regional policy, the identification of a convergence or divergence pattern alone is not enough; since successful implementation of economic policies at the regional level requires information on the specific factors that determine the pattern of regional growth. It is quite possible that regional policies fail to operate effectively due to the differential effects of agglomeration externalities. Therefore, it is necessary to review the main literature on agglomeration externalities both for policy and model building purposes.

It is almost an article of faith in regional economics that production is characterised by substantial internal and external or agglomeration economies. CAPELLO (2007, p. 18) defined ‘agglomeration economies’ as “all economic advantages accruing to firms from concentrated location close to other firms”. Externalities, however, as RICHARDSON (1978, p. 304) suggested, are a ‘catch-all’ concept in the economic literature and are notoriously difficult to define and measure. They come in a variety of forms: they can be positive (i.e. a firm obtains a benefit at no extra cost) or negative (i.e. a firm accrues an additional cost), direct (i.e. when benefits and/or costs impinge directly on a firm) or indirect (i.e. when intermediated by some specific mechanism such as price). Externalities can also be static (i.e. when time appears to have no strong effect) or dynamic (i.e. when there are lagged or even accelerative effects) as when local historic trade secrets benefit a particular activity and/or concentration thereof up until today (HENDERSON, 2003). Moreover, externalities can appear in the form of pecuniary and technological externalities. Pecuniary externalities emerge primarily from demand or supply linkages (KRUGMAN 1991, p. 485), especially under conditions of imperfect competition (e.g. when price signals alone are insufficient), with one firm's actions affecting the demand for or supply of products of other firms and vice versa. Technological externalities emerge primarily from the increased number of firms using similar technologies as well as from the shared depositories (e.g. technical labour, suppliers, and customers) of codified, tacit, and even uncodifiable knowledge[1].

Generally speaking, it is possible to draw a distinction between two broad categories of agglomeration externalities: those relating to specialisation and those relating to diversity. The first category derives from MARSHALL (1890), ARROW (1962) and ROMER (1990) (hereafter MAR), while the second follows the perspective of JACOBS (1969). MAR externalities involve the mechanisms that generate a local and cumulative process of knowledge creation and the intra-industry transmission of innovation due to geographical proximity. Knowledge and information spillovers between spatially concentrated firms in the same industry facilitate local growth (GLAESER *et al*., 1992). Such knowledge is acquired at no monetary cost and hence constitutes a positive externality. MAR externalities are directly related to the concentration of an industry in a location, which increases the potential for knowledge spillovers between firms; hence, industries that are regionally concentrated and the regions hosting them are anticipated to grow faster.

Contrary to MAR (localisation) externalities, the second category refers to the diversity of economic activities and hence to the spread of new knowledge across different sectors. According to JACOBS (1969), the variety of local activities acts as a catalyst for the innovation process of a local economy. It follows that diversity externalities are more likely to operate within large urban areas encompassing a variety of activities where the incentives to innovate tend to be greater and their diffusion/adoption likely to be faster (HENDERSON *et al*., 1995). JACOBS (1969) claimed that the innovation and acceleration of local growth are more closely connected to the variety and diversity of geographically proximate industries than to the degree of local specialisation. Firms benefit from 'cost reductions stemming from the shared availability of public services as well as a wide range of specialised business and technical services not specific to any one industry' (OAKEY and COOPER 1989, p. 349), e.g. banking, insurance, marketing, public services, and utilities. According to HENDERSON *et al*. (2001), dynamic urbanisation effects also derive from a build-up of knowledge and ideas associated with historical diversity. This implies that growth in a region is enhanced if there is a history and tradition of economic and social interaction among diverse sectors, as is likely to be the case in urban areas.

Overall, gains from specialisation in one or more closely interrelated industries (i.e. MAR externalities) are more likely to have positive effects on the growth of output rather than on the growth of knowledge and technology overall. Localisation externalities may affect only the particular industry in which a region is specialised and are unlikely to create an appropriate environment for technology creation or adoption (SIMMIE, 2002, 2003 and 2005; MORGAN, 2004 inter alia). An appropriate environment for knowledge creation or technology adoption is more likely to be related to Jacobs externalities. Several theoretical models (e.g. BLACK and HENDERSON, 1999; OERLEMANS and MEEUS, 2005) and empirical studies (e.g. HENDERSON, 2003a; 2003b; ROSENTHAL and STRANGE, 2001) stressed the importance of the degree of diversity in creating such an appropriate environment; raising thus the question as to how can MAR and Jacobs externalities be measured?

A first approximation to measuring MAR externalities could be based on the share of the primary, secondary, and tertiary sectors of an economy. However, such an approximation would mostly capture the industrial structure rather than the MAR externalities of an economy. Furthermore, such an approximation is too 'aggregate' in the sense that it fails to distinguish between particular economic activities within each sector. This is particularly problematic for policy making purposes as the range of activities in each sector have different characteristics and impacts upon the growth of a region. It is though possible to improve upon such a proxy of MAR externalities, by using the contribution of each sector (to the total/national output) instead of the share of each sector. Better still, one could use the contribution of each economic activity. Unfortunately the last measure is hardly ever used in explaining the pattern of regional convergence in Europe, primarily due to the lack of such data at the regional level[2]. Attention therefore is turned to measures that approximate concentration in terms of employment contributions of particular economic activities.

Essentially, MAR externalities refer mainly to regional specialisation; an element which is approximated traditionally in terms of employment shares of a particular activity. Such a measure is widely used and is generally accepted as representing this kind of externality (e.g. HENDERSON, 1997; 2003; HENDERSON *et al*. 2001a). Thus, a set of localisation coefficients is calculated for each region using the following formula[3]:

$$LOC_{i,t} = \frac{e_{i,t}^{j}}{\sum e_{i,t}^{j}} \qquad (1)$$

where $e_{i,t}^{j}$ refers to the labour employed in activity j (approximated in terms of the NACE classification) in region i.

The highest localisation coefficient is then selected for each region to indicate the extent to which a particular activity is dominant in a region.

Moving to the main approaches for the measurement of the second type of agglomeration externality, a Hirschman-Herfindahl index (hereafter HH) is implemented, defined as follows:

$$HH_{i,t}^{j} = \sum_{j \neq l} \left(\varpi_{i,t}^{j} \right)^{2} \qquad (2)$$

where ϖ is the share of each activity j in region i.

In the calculation of the HH index, the activity in which a region is specialised (l) is excluded. The logic of this approach is to produce a measure of the diversity of the economic environment surrounding and interacting with the activity in which a region is specialised, i.e. the dominant activity. A low value of the HH index indicates a high degree of diversity while a more concentrated, less diverse environment in a region is associated with a higher HH index.

While there are several approaches to the measurement of the degree of diversity in a region (e.g. total population, degree of urbanisation, total number of establishments, etc), nevertheless a HH index is a standard measure and one of the most frequently used in the recent empirical literature (e.g. RIGBY and ESSLETZBICHLER, 2002; LUCIO *et al*., 2002; KETENCI and MCCANN, 2009). Furthermore, a HH index provides a better approximation of the 'Jacobs' effects, which refer to the enhancement of knowledge accumulation. This occurs as producers in any one industry can draw upon a greater range of ideas from other industries, through interacting socially and commercially. In this light, a measure of diversity, encapsulated by equation (2) seems to be more appropriate.

As already introduced, this paper addresses the question of the impact of localisation and diversity externalities in regional growth and convergence. To answer this question, the next section outlines the impact of agglomeration externalities in terms of a broad model of regional growth while in a subsequent section this will be integrated in a 'traditional' empirical context of conditional regional convergence.

III. A Model of Regional Growth and Convergence with Agglomeration Externalities

It has been argued that a number of factors contribute to labour productivity growth and convergence. ALEXIADIS and TSAGDIS (2009), for example, suggested that the ability of an economy to catch up may substantially depend on its capacity to absorb, imitate and adopt innovations developed in neighbouring regions. Of equal importance, however, is the impact of agglomeration externalities, which constitutes the main focus of this paper. It might be argued that agglomeration externalities are associated with divergent growth trends, or with limited convergence. This implies a *cumulative* mechanism that perpetuates productivity differences across regions (ALEXIADIS and TSAGDIS, 2010). It is possible to describe this mechanism with the aid of a model that attributes the growth of labour productivity in a region to the combined effect of localisation and diversification externalities.

Let us assume that the growth of labour productivity ($\dot{p}_i$) in a given region i is directly related to the externalities (E_i), which following the discussion in Section II, can be classified into two broad categories, localisation (L_i) and diversification (D_i). This assumption is not so unrealistic if one thinks that all regions, to a certain extend, are characterised by specialisation in an activity while their overall economic environment is diverse to a greater or lesser degree. Some further assumptions are necessary to fully develop this argument. In particular, that localisation externalities emerge from an activity dominant in a region, which is approximated by the share of the region's labour force employed in this activity (l_I): $L_i = f\left(l_{I,i}\right)$. Diversity externalities can be conceived as a function of the employment shares in the remaining activities (l_R): $D_i = g(l_{R,i})$. To keep the analysis simple, we concentrate on the effects of localisation externalities, which according to the structure of the model are assumed to be a function of the labour force engaged in a region's dominant activity. The share of this activity in the total regional employment is assumed to be a direct function of the wages in this respective industry ($w_{I,i}$), which in turn are assumed to be related to the level of productivity prevailing in a region (p_i)[4]:

$$l_{I,i} = \alpha + \varepsilon w_{I,i} \tag{3}$$

$$w_{I,i} = \beta + \zeta p_i \tag{4}$$

Combining equation (3) and (4) yields

$$l_{I,i} = \alpha + \varepsilon\beta + \varepsilon\zeta p_i \tag{5}$$

where α and β denote the autonomous parts.

Based on the assumptions of this model, the effects of externalities depend upon the sign attached to the parameters ε and ζ. To be more specific, according to equation (4) a value of $\zeta > 0$ indicates that a high level of productivity induces an increase in the wages of the main activity of the region. If wages differ across regions, then this will act, at least in the short-run, as an incentive to attract workers from the remaining sectors within the region or even from other regions. Based on the assumptions of this model, if $\varepsilon > 0$, then an increase in the share of this activity is expected, which by definition, constitutes a localisation externality. Of particular importance for the purpose of this paper is the process of regional productivity growth. This is a complex process and is the outcome of numerous interrelating factors. Nevertheless, this model is deliberately over simplified since it is our intention to study the effects caused by localisation and diversity externalities. This can be encapsulated in terms of the following equation:

$$\dot{p}_i = \tilde{a} + \lambda l_{I,i} + \delta l_{R,i}, \tag{6}$$

where $\dot{p}_i = \frac{dp_i}{dt}$ and the constant term $\tilde{a}$ includes all the remaining factors that may induce changes in labour productivity.

Parameter λ measures the impact of localisation externalities in a region's productivity growth while δ reflects the extent at which the activities surrounding a region's main activity affect productivity growth. The specific impact of each kind of externality is indicated by the signs attached to the parameters λ and δ. If $\lambda, \delta < 0$, then agglomeration externalities will cause negative effects on labour productivity. There is, of course, the case that $\lambda > 0$ and $\delta < 0$, which indicates that the effects of one kind of externality are offset by the effects of the other kind. Given that $l_{R,i} = 1 - l_{I,i}$, equation (6) can be written as

$$\dot{p}_i = \tilde{a} + \delta + (\lambda - \delta) l_{I,i} \quad (7)$$

According to equation (7) labour productivity in a region is the outcome of a 'mix' from effects of localisation and diversification. This 'mix' is approximated in terms of the relation between localisation and diversification effects. If it is assumed that localisation externalities tend to peter out as a region expands, then the diversity externalities, which emerge as a result of this expansion, will outweigh the potential localisation losses. Thus, the difference $(\lambda - \delta)$ measures the 'net' outcome of externalities determining, essentially, the growth path and, by extension, the pattern of convergence that a region follows.

Using equation (5), equation (7) is written as follows:

$$\dot{p}_i + \xi p_i = c \quad (8)$$

where $\xi = (\delta - \lambda)\varepsilon\zeta$ and $c = \tilde{a} + \delta + (\lambda - \delta)\alpha + (\lambda - \delta)\varepsilon\beta$.

Equation (8) is a first order differential equation with the following solution:

$$p_t = p_{i,0}^{\ -\xi t} + \left(1 - e^{-\xi t}\right)\frac{c}{\xi} \quad (7)$$

A process of cumulative causation is set up if during an initial time a region (or a group of regions) exhibits $(\delta - \lambda) > 0$ and $\varepsilon\zeta > 0$, implying that $\xi > 0$. This can be interpreted as a situation in which agglomeration externalities perpetuate an initial productivity advantage (captured in terms of the product $\varepsilon\zeta$) in a region. As argued above, this region will grow at the expense of the remaining regions. If the value of parameter ξ differs across regions, then the regions with a relatively high value of this parameter will grow at the expense of the regions with relatively low agglomerative effects or equivalently with a relatively low value of ξ. Broadly speaking, this model predicts that regions diverge in terms of labour productivity. Convergence is a property that characterises an exclusive group of regions with high-productivity, i.e. those with relatively high values of ξ. Convergence across all regions is possible if the 'net' outcome of both kinds of agglomeration externalities in regions with high-productivity yields negative effects on productivity growth. That is, if at some point in time $(\delta - \lambda) < 0$ for example due to increased congestion costs caused by over-concentration of establishments in a given area. Provided that in regions with low-productivity $\xi > 0$, convergence is then a possibility.

In empirical terms these arguments can be examined using a standard regional convergence-framework. Assume that production in a region can be expressed using a familiar Cobb-Douglas production function augmented with the impact of agglomeration externalities. Thus,

$$Y_i = K_i^{\alpha} (E_i L_i)^{1-\alpha} \tag{8}$$

where K and L stand for the physical capital and labour force, respectively while E denotes the agglomeration externalities, defined as the product of localisation (LOC) and diversity (DVR) externalities, i.e. $E_i = LOC_i \ DVR_i$.

Defining $\tilde{Q}_i = \frac{Y_i}{L_i E_i}$ and $k_i = \frac{K_i}{L_i E_i}$, we may write:

$$\tilde{Q}_i = k_i^{\alpha} \tag{9}$$

$\tilde{Q}_i$ converges towards its steady-state value $\tilde{Q}^*$, in accordance to the following relation:

$$\frac{\dot{\tilde{Q}}_i}{\tilde{Q}_i} \cong -\beta \log\left(\frac{\tilde{Q}_i}{\tilde{Q}_i^*}\right) \tag{11}$$

Equation (11) can be written equivalently as follows:

$$\frac{\dot{\tilde{Q}}_i}{\tilde{Q}_i} = -\beta\left(\log \tilde{Q}_i - \log \tilde{Q}^*\right) \tag{12}$$

which implies that

$$\frac{d \log \tilde{Q}_i}{dt} + \beta \log \tilde{Q}_i = \beta \log \tilde{Q}^* \tag{13}$$

Equation (13) is a differential equation in $\log \tilde{Q}_{i,t}$ with the following solution

$$\log \tilde{Q}_{i,t} = \left(1 - e^{-\beta t}\right) \log \tilde{Q}^* + e^{-\beta t} \log \tilde{Q}_{i,0} \tag{14}$$

Given that $\log \tilde{Q}_i = \log\left(\frac{Y}{L}\right)_i - \left(\log LOC_i + \log DVR_i\right)$, equation (14) can be written as follows:

$$g_{i,T} = c + b_1\left(\frac{Y}{L}\right)_{i,0} + b_2 \log LOC_{i,0} + b_3 \log DVR_{i,0} + \varepsilon_\tau \qquad (15)$$

where $g_{i,T} = \log\left(\frac{Y}{L}\right)_{i,t} - \log\left(\frac{Y}{L}\right)_{i,0}$, $T = t - 0$, $b_1 = -\left(1 - e^{-\beta t}\right)$,

$c = \left(1 - e^{-\beta t}\right)\log \tilde{Q}^* + \left(\log LOC_{i,t} + \log DVR_{i,t}\right)$ and $b_2, b_3 = -e^{-\beta t}$.

However, in order to have a more accurate view on the impact of agglomeration externalities in regional growth and convergence, account must be taken of the empirical approaches on convergence. Section IV outlines the main empirical test for regional convergence.

IV. Regional Convergence, Agglomeration Externalities, and Spatial Interaction

The empirical literature on regional convergence makes extensive use of two alternative tests for convergence, namely absolute and conditional convergence, described by equations (16) and (17).

$$g_i = a + b_1 y_{i,0} + \varepsilon_i \qquad (16)$$

$$g_i = a + b_1 y_{i,0} + b_{\mathbf{X}_\mathbf{i}} \mathbf{X}_\mathbf{i} + \varepsilon_i \qquad (17)$$

where y_i represents per capita output of the i[th] economy (in logarithm form), $g_i = \left(y_{i,T} - y_{i,0}\right)$ is the growth rate over the time interval $\left(0, T\right)$, and ε_i is the error term, which follows a normal distribution.

Absolute convergence occurs if $b_1 < 0$ while the speed at which regions move towards the same steady-state level of per capita output is calculated as $\beta = \ln\left(b_1 + 1\right)/-T$. Conditional convergence requires that $b_1 < 0$ and $b_{\mathbf{X}_\mathbf{i}} \neq 0$. If different economies have different technological parameters, captured by the vector ($\mathbf{X}_\mathbf{i}$) in equation (17), then convergence is conditional on these parameters, giving rise to different steady states. It follows, therefore, that a test for conditional convergence is more suitable to accommodate an empirical application of the model developed in section III. Thus,

$$\mathbf{g}_\mathbf{i} = a + b_1 \mathbf{y}_{\mathbf{i,0}} + b_2 LOC_{i,0} + b_3 DVR_{i,0} \qquad (18)$$

Following the discussion in section II, localisation externalities are measured by equation (1) while the index given by equation (2) approximates diversity externalities. Regarding these two variables, it is necessary to consider further their time dimension. HENDERSON (1997), in his industry-specific model, argued for the use of lagged values of these variables, in order to represent the role of ‘history’ or initial conditions, and the ‘stock of trade secrets’ in generating growth in a given location. In the context of the US states, HENDERSON (1997) used lags covering a 7 to 8 year time span, arguing that the ‘local stock of knowledge’ tends to depreciate after that period. In the present analysis, the LOC_i and DVR_i variables are measured at the start of the period under examination (viz. 1995). This adds a dynamic element to the spatial externalities, a procedure which, according to HENDERSON (1997), captures the contribution of the ‘history’ of a given location to its growth. Moreover, introducing these variables measured at the initial time not only has the potential to capture the long-run effects on growth, but also from an econometric point of view, helps in avoiding the problem of endogeneity.

Despite its simplicity, this model aims to highlight the importance of initial conditions regarding agglomeration externalities in the process of regional growth and convergence. Nevertheless, as it stands, this approach neglects spatial factors. Equation (17) treats regions as ‘closed’ economies. It is possible to overcome this, clearly unrealistic assumption, by introducing in equation (17) the effects of spatial interaction. Indeed, in light of the recent literature it may be argued that any empirical test for regional convergence is misspecified if the spatial dimension is ignored (e.g. REY and MONTOURI, 1999; REY and JANIKAS, 2005; LALL and YILMAZ, 2001), the presumption being that the extent of regional interactions are significantly dependent upon the location of regions relative to each other. Three *spatial* econometric techniques that are of particular importance to the aims of this paper are discussed next.

It has been argued, particularly in the case of regional economies, that spatial characteristics are significant in determining patterns of economic development[5] and hence in contributing to any convergence mechanisms. The location of a region within a system of regional economies is a unique characteristic, and in the same way as other structural characteristics, has the potential to impact on growth and development. MARTIN and SUNLEY (1988) claim that in the majority of empirical studies regions are treated as ‘isolated islands’ with no explicit recognition of interaction between economies. Such treatment tends to overlook the fact that regions are not dimensionless points but vital functional parts of an inter-dependent system of regional economies. Several studies (e.g. VERSPAGEN, 1995; QUAH, 1993; 1996; 1996a) have claimed that models of regional convergence only relate a region's growth to its own history, and not to the interregional system of which it is a part. As MARTIN and SUNLEY (1998, p. 207) argued:

> "[…] the growth trend of a region may actually depended crucially (either positively or negatively) on the growth *trajectories* of others." [*It*. added]

Thus, a 'conventional' model of convergence, captured by equation (9), when applied in a regional context, is misspecified if it does not take into account any geographical factors (REY and MONTOURI, 1999). As a response to this criticism, there have been a number of studies examining the process of regional convergence from a spatial econometric perspective in various regional contexts, for example the regions of Europe (e.g. RODRÍGUEZ-POSE, 1999; FINGELTON, 2001; CARRINGTON, 2003; BADINGER *et al*., 2004) or the regions of individual countries, (e.g. USA: DOBKINS and IOANNIDES, 2001; UK: ROBERTS, 2004; Greece: ALEXIADIS, 2010; Turkey: GEZICI and HEWINGS, 2004; Spain: VILLAVERDE, 2005).

Spatial dependence can be incorporated into convergence analysis, through three econometric models, namely the spatial error, the spatial lag and the spatial cross-regressive models[6]. Introducing the $LOC_{i,0}$ and $DVR_{i,0}$ variables yields three spatial specifications of the agglomeration externalities conditioned model. Thus,

$$\mathbf{g_i} = a + b_1\mathbf{y_{i,0}} + b_2 LOC_{i,0} + b_3 DVR_{i,0} + (\mathbf{I} - \zeta\mathbf{W})^{-1}\varepsilon_t \tag{19}$$

$$\mathbf{g_i} = a + b_1\mathbf{y_{i,0}} + b_2 LOC_{i,0} + b_3 DVR_{i,0} + \rho(\mathbf{W}\mathbf{g_i}) + \varepsilon_i \tag{20}$$

$$\mathbf{g_i} = a + b_1\mathbf{y_{i,0}} + b_2 LOC_{i,0} + b_3 DVR_{i,0}\gamma(\mathbf{W}\mathbf{y_{i,0}}) + \varepsilon_i \tag{21}$$

In the three spatial models[7] the spatial links between regions are generated by means of a spatial-weights matrix $\mathbf{W}_{(n\times n)}$, the elements of which (w) may be devised in various ways. For example, a common practice is to allow these weights to take the value of 1 if a region is contiguous to another and 0 otherwise. Alternatively, the spatial weights may be continuous variables, constructed so as to produce declining weights as the distance between regions increases, as follows:

$$w_{ij} = \frac{1/d_{ij}}{\sum_j 1/d_{ij}} \tag{22}$$

Here, d_{ij} denotes the distance between two regions *i* and *j*. The denominator is the sum of the (inverse) distances from all regions surrounding region *i*, within a selected boundary. Equation (22) implies that interaction effects decay as the distance from one area to another increases (weights decline as distance increases).

V. Units of analysis, data, and descriptive statistics

In this section the issues relating to the units and the data employed in the empirical application of the model are discussed, along with some descriptive statistics from their preliminary analysis. The regional groupings used in this paper are those delineated by EUROSTAT and refer to the 267 NUTS2 EU27 regions. The EU uses NUTS2 regions as targets for convergence, defined as the “geographical level at which the persistence or disappearance of unacceptable inequalities should be measured” (BOLDRIN and CANOVA, 2001, p. 212). Despite considerable objections for the use of NUTS2 regions as the appropriate level at which convergence should be measured, the NUTS2 regions are sufficiently small to capture sub-national variations (FISCHER and STIRBÖCK, 2006).

The time period for the analysis extends from 1995 to 2006, which might be considered as rather short. However, ISLAM (1995) and DURLAUF and QUAH (1999) pointed out that convergence-regressions are valid for shorter time periods, since they are based on an approximation around the steady-state and are supposed to capture the dynamics toward the steady-state.

Labour productivity is expressed in terms of Gross Value Added (GVA) per worker since this measure is a major component of differences in the economic performance of regions and a direct outcome of the various factors that determine regional competitiveness (MARTIN, 2001).

Before proceeding with the empirical application it is important to comment on the degree of diversity and localisation that characterises the European regions. Overall, the average values of the localisation and diversity indices have followed an increasing tendency throughout the examined period, as shown in Figure 1.

[Figure 1 about here]

About 60% of the EU27 regions exhibit values below the EU27 average in both indices, which can be taken as an indication that economic activities are not highly localised across Europe. Of particular importance, however, is the initial year of the analysis, since the main argument pursued in this paper is that the initial level of localisation and diversification creates external effects on regional growth. An overall impression of the prevailing situation can be obtained by the relation between the initial level of regional productivity and the initial level of concentration/localisation and diversification, expressed in relative terms (Figures 2 and 3).

[Figures 2 and 3 about here]

While it is observable from Figure 2 that the index of specialisation increases as the distribution of regional labour productivity moves toward relatively higher levels, nevertheless, for a group of regions an inverse relation is detected. In particular, in the range of an initial level of labour productivity approximately between 3 and 4 (in natural logarithms), a low index of specialisation is associated with high levels of productivity. It is also apparent from Figure 3 that several regions in the lower ranges of the productivity spectrum (with a level of labour productivity approximately less than 3, in natural logarithms) do exhibit a lower degree of specialisation. The relation between the index of diversification and the initial level of labour productivity is made visible in Figure 3. For regions with low levels of labour productivity (less than 3) a high degree of diversification, is noticeable. As the distribution of the initial level of labour productivity reaches higher levels, the diversity index also increases, suggesting low degrees of diversification[8]. However, as the initial level of labour productivity enters high ranges (above 4), the index of diversification shifts towards lower values, signalling that regions with high productivity encompass a high degree of diversity in their economic activities. Overall, Figures 3 and 4, suggest that regions with high levels of productivity obtained a growth advantage due to agglomeration externalities. Obviously, this implies a particular pattern of regional convergence in Europe, the nature of which is explored in the following section.

VI. Empirical Application

Following the discussion in section IV, convergence is identified with an inverse relationship between growth and initial level of labour productivity. Such a notion of convergence embodies the essence of the neoclassical argument that poor regions grow faster than rich regions, and produces estimates of the rate at which poor regions are catching up with rich regions, should convergence be detected. The potential for absolute convergence is indicated in Figure 4, which shows a scatterplot of the average annual growth rate against the initial level of labour productivity.

[Figure 4 about here]

At first sight, it could be argued that there are some tendencies for absolute convergence. A closer examination of Figure 4, however, suggests that the convergence property is restricted to a group of regions exceeding a certain level of initial labour productivity in 1995 (about 3 in natural logarithms). Bearing this in mind, one cannot be sure that the European regions exhibit fast convergence tendencies. Indeed, econometric estimation of equation (16) reveals a relatively low average rate of convergence (about 0.65% per annum).

[Table 1 about here]

It should be noted that all the examined models yield a negative convergence coefficient, implying a positive value for the rate of convergence (β), although in a relatively small range. However, the (β) rate of convergence is statistically significant in three out of five models.

The highest rate of convergence, viz. to 0.72% per annum is implied by the spatial error model (20); a model to be preferred from the rest, as the AIC and SBC criteria suggest[9]. Thus the subsequent discussion is to be confined to this model.

The results of this model identify the estimated coefficient of $LOC_{i,0}$ to be statistically insignificant and negative. This could be interpreted as suggesting that regions with a relatively higher degree of specialisation during the initial period do not experience any advantage in growth terms. It was anticipated that $b_2 > 0$, since MAR externalities, approximated by the $LOC_{i,0}$ variable, are predicted to promote regional growth, given that a high degree of specialisation, normally, leads to faster productivity growth. As the $LOC_{i,0}$ coefficient is statistically insignificant it could be further argued that the concentration effects are not consistent across the European regions. Regions with a higher degree of specialisation do not experience any advantage in growth terms[10]. This is possible if the dominant economic activity in a region is related to low value added activities (e.g. commodity production). In actual fact, according to the obtained results, a relatively high initial degree of specialisation induces *negative* effects in the process of regional growth. The estimated value of the localisation coefficient indicates that a 1% increase in the MAR externalities reduces the growth rate of a region by almost 6%, on average[11].

On the other hand, regional diversity, as measured by the HH index, does contribute to an explanation of regional growth, since the coefficient (b_3) on the $DVR_{i,0}$ variable is statistically significant. The econometric estimates yield a positive sign for the variable approximating the degree of diversification externalities. The interpretation of this outcome runs as follows. High (low) productivity regions are, normally, associated with a high (low) degree of diversity. Hence, $b_3 > 0$ can be taken as an indication that high productivity regions, associated with highly diversified areas, exhibit relatively lower rates of growth[12]. It may be argued, therefore, that the majority of benefits from moving to a more diversified economy have already been experienced, resulting to relatively slow rates of growth in highly diversified regions[13]. However, this does not seem to be the case for the low-productivity regions, with less diversified environments. In this light, therefore, $b_3 > 0$ may act as a source of convergence.

It is worth noting that the impact of the diversity variable has increased considerably after accounting for spatial interaction. While in the non-spatial version a 1% increase to the degree of diversification induces an 8% increase in the growth rate, the spatial-error model suggests that this impact is about 10%. The inference is that an increasing degree of diversity of their economic environments in low-productivity regions will put them into a fast path of convergence towards regions with high-productivity.

VII. Concluding Remarks, policy implications, and areas of further research

As introduced at the opening of this paper, the issue of regional convergence in Europe has produced a substantial and fast growing empirical literature in which the impact of localisation and diversification externalities has been somewhat neglected. This paper attempted to redress this imbalance by developing and testing a range of appropriate models using data for the EU27 NUTS2 regions during the 1995-2006 period. The results reported in the previous section clearly suggest that the EU27 regions exhibit a relatively slow rate of convergence in terms of labour productivity. Nevertheless, a faster rate of convergence is apparent after conditioning for agglomeration externalities and spatial interaction. According to the econometric results, the joint effect of agglomeration externalities and spatial interaction increases the average rate of convergence by almost 1%. While the non-spatial specifications of the absolute and conditional convergence model imply that the low-productivity regions of Europe catch-up with the high-productivity regions at an average rate 0.6% per annum, interaction among spatial units spurs this catch-up process to an average rate of 0.72%. A particularly interesting finding is that externalities associated with the diversity of a region's economic environment, play a positive role in promoting convergence between regions with high and low productivity and their impact increases with spatial interaction. If low productivity regions enhance the diversity of their activities, in conjunction with the emergence of negative externalities in high productivity regions, then a catch up is feasible. It should be noted, however, that negative externalities in leading regions only emerge after a maximum-threshold-value of agglomeration is reached. Assuming that such a threshold exists then it would be possible to estimate a similar minimum-threshold-value of agglomeration that is required to be reached for lagging regions to catch-up with leading regions. However, determining such threshold values goes beyond the scope of this paper and should thus be delineated as areas of further research[14].

Another interesting finding is that the coefficient attached to the variable describing localisation/specialisation effects is statistically insignificant. Such a finding does not necessarily imply that these effects are of no importance in the process of regional growth. The statistical insignificance of this coefficient may stem from the way that specialisation effects are measured, i.e. as the extent of specialisation in one particular sector. Specialisation or increasing returns to scale is a complex phenomenon and difficult to capture in terms of a single variable. In particular the variable employed in the empirical analysis does not distinguish between dynamic and non-dynamic sectors nor for that matter between the different sectors in which regions are specialised, some of which grow faster than others.

The primary aim of this paper is to provide a first approximation of the effects of localisation and diversification externalities in regional convergence. Clearly, more empirical research is required before a definite view on the relation between agglomeration externalities and regional growth can be offered. Such research should try to answer a series of critical questions concerning for example the appropriate ways to approximate localisation and diversity externalities in the ambit of single model of regional growth and convergence. Furthermore, what extent of concentration and kind of activity has positive impacts and what has negative ones? What kinds of externalities are more appropriate for lagging regions to catch-up with leading ones?

Do agglomeration externalities operate similarly (e.g. variation of threshold values) in each region? These are only some of the many questions in the research agenda on the relation between agglomeration externalities and regional convergence opened up by this paper. At this stage, suffice to say that exciting days await the researchers and policy makers alike who wish to pursue this agenda.

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Table 1. Externalities in Regional Convergence, EU27 NUTS2 Regions, 1995-2006

	Equation (16)	Equation (18)	Equation (19)	Equation (20)	Equation (21)
a	0.5746**	0.7298**	0.7444**	0.7535	0.7429*
b_1	-0.0753**	-0.0764**	-0.0833**	-0.0800	-0.0744
b_2		-0.0332	-0.0646	-0.0351	-0.0203
b_3		0.0796**	0.0991**	0.0979*	0.0614*
ζ			0.7667**		
ρ				0.1305	
c					0.0160
Implied β	0.0065**	0.0066**	0.0072**	0.0069	0.0064
LIK	151.501	154.345	272.075	272.063	270.152
AIC	-299.002	-300.691	-534.151	-534.127	-530.305
SBC	-291.791	-286.267	-516.214	-516.191	-512.369

Notes: ** indicates statistical significance at 95% level of confidence, * 90% level. LIK, AIC, SBC and denote the Log-Likelihood, the *Akaike* and the *Schwartz-Bayesian* information criteria and, respectively. b_1 , b_2 , b_3 denote the convergence, localisation and diversity coefficient, respectively.

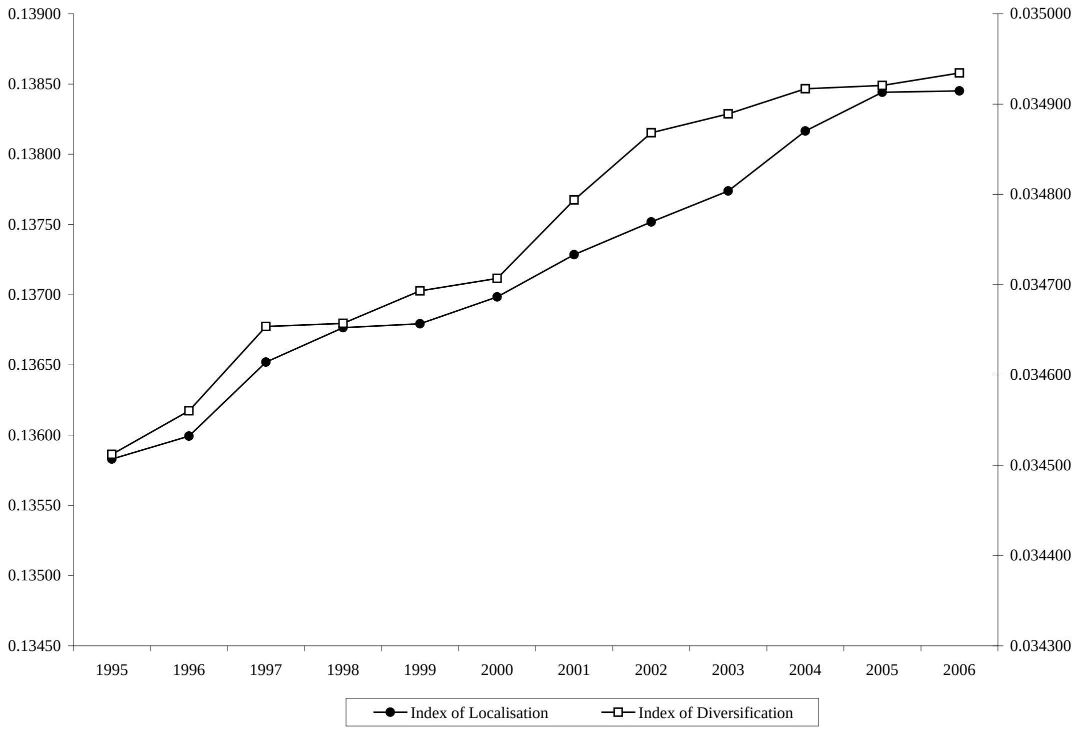

Fig.1. Index of Localisation and Diversification, EU27 Average, 1995-2006

Source: authors' creation based on Eurostat data

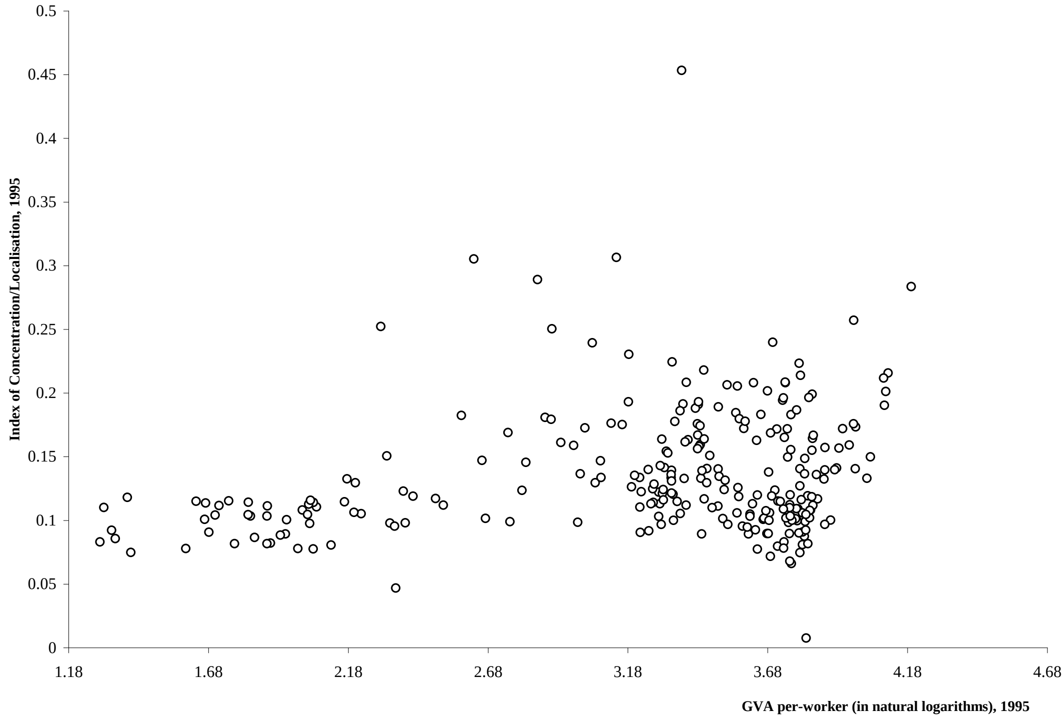

Fig. 2. Localisation Index and Initial Level of Labour Productivity, 1995

Source: authors' creation based on Eurostat data

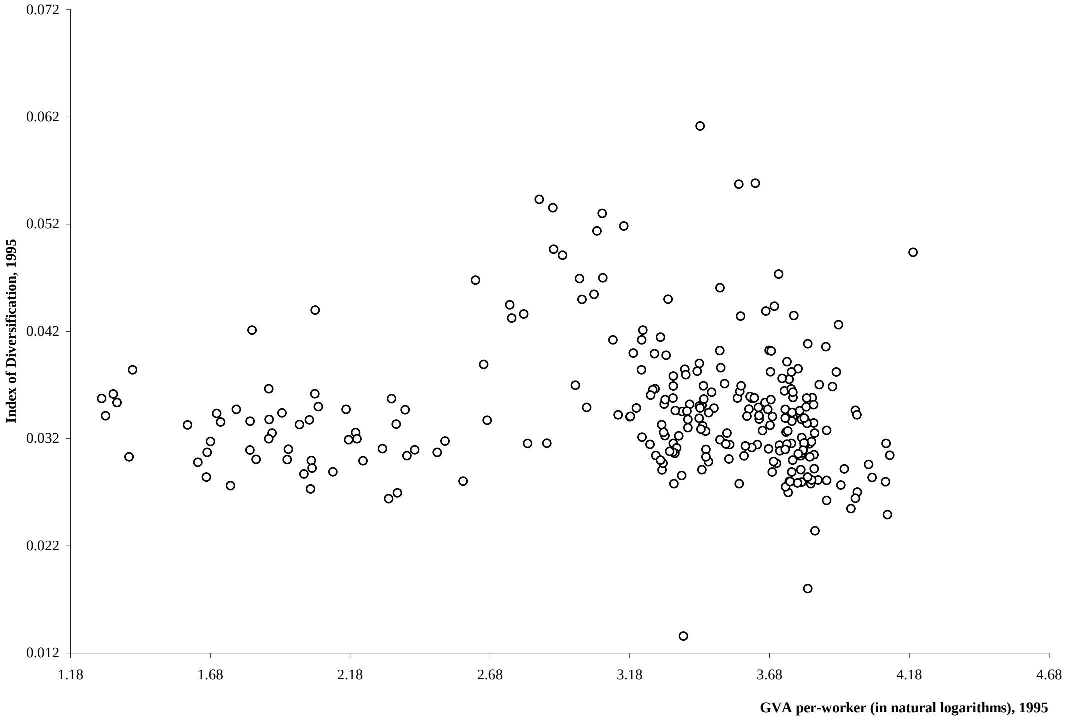

Fig. 3. Diversification Index and Initial Level of Labour Productivity, 1995

Source: authors' creation based on Eurostat data

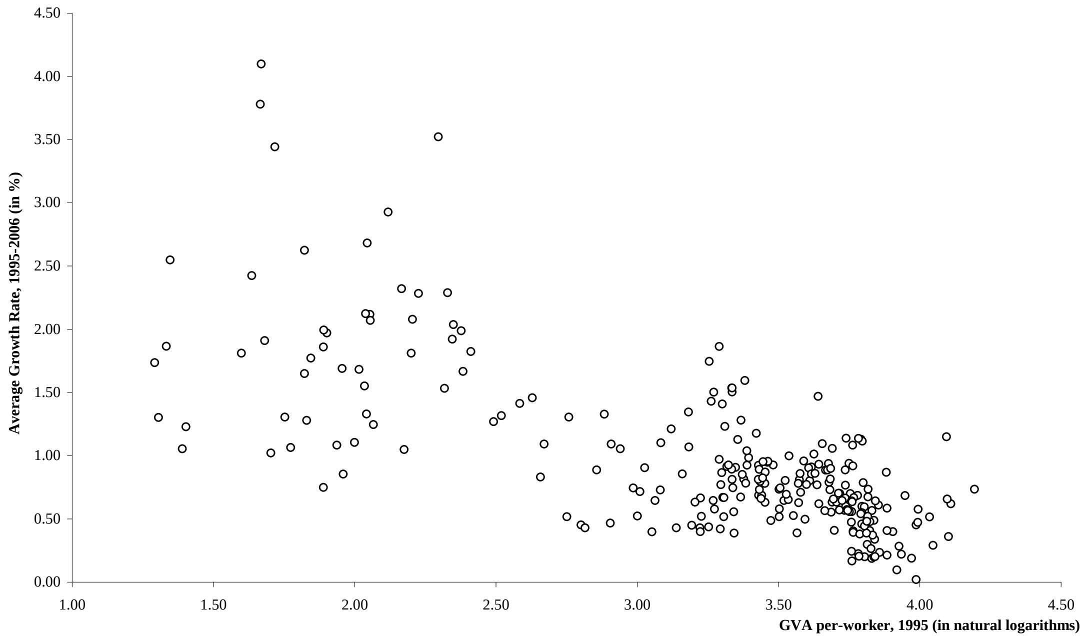

Fig. 4. Absolute convergence, GVA per-worker, EU27 NUTS2 Regions, 1995-2006

Source: authors' creation based on Eurostat data

Appendix I

The impact of contributions to National/European Output in regional convergence

Using the contributions of each region in total output, for each of the three sectors of the economy, modifies the test for regional convergence as follows:

$$g_i = a + by_{i,0} + b_j c_{\iota,0}^{\rho} + \varepsilon_i \qquad \text{(A1)}$$

In equation (A1) the term $c_{\iota,0}^{\rho}$ denotes a vector that includes the contribution of each region (i) in agriculture, industry, and services ($j = A, I, S$) for the national and European level ($\rho = N, E$). Table A1 reports the obtained results.

While the results at both levels indicate some convergence tendencies, as this is suggested by the negative sign attached to the initial level of labour productivity, nevertheless the conditioning variables are always statistically insignificant. However, three points are of particular interest. First, the obtained rates of convergence are low and similar to those obtained using the specification approximating externalities in terms of localisation and diversification. This provides further support for the argument that the process of regional convergence in an enlarged Europe is slow. Second, the rate of convergence obtained at the European level is higher, albeit marginally, relative to that implied at the national level. It follows then that increases in the contribution to European output accelerate the rate of convergence at the European level. On the other hand, increasing contributions nationally suggest a diverging tendency within countries, since regions with relatively high contributions to national GVA are few. Third, in each level of aggregation the sign attached to the contribution of industry is negative. Thus, a high (low) contribution of industry is related to low (high) rate of growth. Keeping in mind that regions with relatively high contributions to the GVA of the industrial sector are expected to be found among high productivity regions then a negative sign might indicate the presence of negative externalities in these regions. Conversely, if a low contribution to total industrial output characterises regions with relatively low productivity, then the negative sign might indicate some convergence tendencies. However, given the poor performance of the model, all these conclusions are tentative and should be treated with care.

Table A1. Regional Convergence and Contributions to output

Dependent Variable: g_i	National Level	European Level
a	0.4964**	0.5663**
b	-0.0623**	-0.0728**
b_A	0.0039	0.0036
b_I	-0.0101	-0.0026
b_s	0.0294	5.12285e-05
Implied β	0.00518*	0.0062**

Note: ** indicates statistical significance at 95% level of confidence, * 90% level.

Appendix II

Construction of the localisation and diversification ratios

Consider an economy consisting of i regions R_i, $i = 1,\ldots,n$ and j sectors S_i, $j = 1,\ldots,m$, where $e_{i.j}$ denotes the employment in sector j in region i. This economy can be portrayed in terms of the following matrix:

S_j / R_i	S_1	S_2	S_3	…	S_{m-1}	S_m	Total
R_1	$e_{1.1}$	$e_{1.2}$	$e_{1.3}$	…	$e_{1.m-1}$	$e_{1.m}$	$\sum_{j=1}^{m} e_{1.j}$
R_2	$e_{2.1}$	$e_{2.2}$	$e_{2.3}$	…	$e_{2.m-1}$	$e_{2.m}$	$\sum_{j=1}^{m} e_{2.j}$
R_3	$e_{3.1}$	$e_{3.2}$	$e_{3.3}$	…	$e_{3.m-1}$	$e_{3.m}$	$\sum_{j=1}^{m} e_{3.j}$
⋮	⋮	⋮	⋮		⋮	⋮	⋮
R_{n-1}	$e_{n-1.1}$	$e_{n-1.2}$	$e_{n-1.3}$	…	$e_{n-1.m-1}$	$e_{n-1.m}$	$\sum_{j=1}^{m} e_{n-1.j}$
R_n	$e_{n.1}$	$e_{n.2}$	$e_{n.3}$	…	$e_{n.m-1}$	$e_{n.m}$	$\sum_{j=1}^{m} e_{n.j}$
Total	$\sum_{i=1}^{n} e_{i.1}$	$\sum_{i=1}^{n} e_{i.2}$	$\sum_{i=1}^{n} e_{i.3}$	…	$\sum_{i=1}^{n} e_{i.m-1}$	$\sum_{i=1}^{n} e_{i.m}$	$\sum e_{n.m}$

The sum of each row measures total employment in each region while the sum of each column shows the total employment in each sector, nationally. The share of each sector in a region ($SH_{i.j}$) is calculated according as: $SH_{i.j} = \frac{e_{i.j}}{\sum_{\substack{i=1,\dots,n \\ j=1,\dots,m}} e_{i.j}}$.

The highest $SH_{i.j}$ is, then, chosen to represent the sector that exhibits localisation effects in each region. This process yields a $n \times 1$ vector, which is used to approximate the *LOC* variable in the empirical analysis.

Turning to the measurement of the *DVR* variable, the matrix above is reconstructed to include the squared employment shares, only this time the employment shares of localised sector (k) in each region are excluded: $SH_{i.j}^2 = \left(\frac{e_{i.j}}{\sum_{\substack{i=1,\dots,n \\ j=1,\dots,m}} e_{i.j}} \right)^2, \quad \forall j \neq k$. This process yields a $n \times 1$ vector with a *HH* ratio for each region, $HH_{i.j} = \sum_{j \neq k} SH_{i.j}^2$. This vector represents the *DVR* variable in the econometric application.

NOTES

[1] For a more detailed discussion see BORRAS and TSAGDIS (2008).

[2] However, data are available on the contribution of each sector, viz. Agriculture, Services and Industry. Their impact on regional convergence in Europe is examined empirically in Appendix I.

[3] Appendix II describes the construction of equations (1) and (2) in some detail.

[4] Similar approaches can be found in RICHARDSON (1978), MOOMAW (1988), GLAESER *et al*. (1992) inter alias.

[5] For a more detailed review see DICKEN and LLOYD (1990).

[6] For a more detailed analysis see REY and MONTOURI (1999).

[7] These models are consistent with the contemporary empirical literature on regional convergence, which combines conditional variables with spatial terms (that is to say 'spatial conditional convergence' models). This literature is focused mainly on the EU regions (e.g. MAURSETH, 2001; LOPEZ-BAZO *et al*., 2004) with fewer studies referring to individual countries (e.g. FUNKE and STRULIK, 1999; FUNKE and NIEBUHR, 2005; ALEXIADIS, 2010).

[8] Recall that diversity is approximated in terms of the Hirschman-Herfindahl index. A low value of this index corresponds to a high degree of diversity and vice versa.

[9] As a rule of thumb, the best fitting model is the one that yields the smallest values for the AIC or the SBC criterion. The SBC has superior properties and is asymptotically consistent, whereas the AIC is biased towards selecting an overparameterized model.

[10] The variable employed to approximate localisation in this paper does not distinguish between dynamic and non-dynamic sectors. That is, it does not distinguish between the different sectors in which regions are specialised, some of which grow faster than others. Dynamic sectors could be defined as promoting exports; in which case a location quotient would be a more suitable proxy (see for example, NORCLIFFE, 1983; MCDONALD, 1989 among others). However, using such a proxy gives similar results in econometric terms; which are available upon request.

[11] This impact varies according to each specification, with the spatial error model to score the highest impact (about 6.5%).

[12] This outcome can be interpreted also as evidence that negative externalities are present in regions with a high degree of diversity.

[13] It should be noted, however, that an analysis of the relation between the degree of localisation/diversification and productivity/wealth, using a filtering technique, developed by TSAGDIS and ALEXIADIS (2009) suggested that a high degree of localisation is associated with high levels of productivity/wealth. Nevertheless, this is a preliminary/tentative finding part of an ongoing research programme headed 'successful European regions'.

[14] Some indicative results on that respect can be found in ALEXIADIS and TSAGDIS (2006, 2010).