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PRODUCTIVITY GROWTH IN THE OLD AND NEW EUROPE: THE ROLE OF AGGLOMERATION EXTERNALITIES

Emanuela Marrocu
Raffaele Paci
Stefano Usai

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CRENoS – Cagliari
Via San Giorgio 12, I-09100 Cagliari, Italia
tel. +39-070-6756406; fax +39-070- 6756402

CRENoS - Sassari
Via Torre Tonda 34, I-07100 Sassari, Italia
tel. +39-079-2017301; fax +39-079-2017312

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Productivity growth in the Old and New Europe: the role of agglomeration externalities

Emanuela Marrocu, Raffaele Paci, Stefano Usai
University of Cagliari, CRENoS

Abstract

The recent history of the European Union is characterized by a dual picture showing the *Old* and the *New* countries in sharp contrast with respect to several economic dimensions. In particular, regions and industries in Eastern countries have shown an excellent performance whilst Western countries have kept moving on a rather slow track. Our aim is to assess the intertwined performance of regions and industries in New and Old economies within Europe by investigating the dynamics of total factor productivity over the period 1996-2007 and the role played by local externalities in the agglomeration process of economic activities. Among the determinants of local industry growth we analyse the agglomeration externalities and, in particular, we focus on the different impact of the specialisation and diversity externalities. Moreover, we analyse the potential influence of regional intangible assets such as human and technological capital while controlling for other territorial features which may affect the efficiency of the local industry. The empirical analysis makes use of spatial econometric techniques to take into account the possibility of cross-border externalities.

Keywords: Agglomeration externalities, Local industry growth, Total Factor Productivity, Spatial models, European regional cohesion.
Jel Classification: C31, O47, R11

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1. Introduction

Theoretical and empirical contributions in the past two decades have clearly stated that technological change is one of the most important drivers of economic growth since traditional inputs are declining in importance and are insufficient to ensure long-term growth, especially in advanced economies. At the same time the recent global crisis has revealed a scenario of increasing unemployment, public debt and uncertainty affecting the perspective of sustainable growth of different countries and regions in a differentiated manner.

Under these circumstances, Europe is trying to understand how countries and regions can get over the crisis more rapidly and with a competitive edge with respect to other areas in the world. The EU's Cohesion Policy is also still pursuing the objective of reducing economic and social disparities between the development levels of European regions. An objective which, in recent times, has been partially achieved thanks to the "miracle" of the Eastern countries (and regions), which have accessed the European Union (European Commission, 2008). Since 2000, these countries have grown at a pace close to 5%, whilst EU15 countries have experienced a growth path at half the speed, around 2.5%. This remarkable stylized fact poses some plain research questions, which are tackled in this paper. Firstly: what are the forces behind this huge discrepancy in the efficiency growth rate among these two Europes? Secondly, do these forces operate at the regional or at the country level? Thirdly, do these forces depend on the economic structure, that is, the industrial composition, of the local economic systems?

The purpose of the paper is therefore to provide convincing empirical evidence on these issues by assessing the intertwined performance of regions and industries in Western (Old) and Eastern (New) economies within Europe. We focus on the growth process of Total Factor Productivity (TFP), which represents a fully informative indicator of the economic performance of local industries. We thus bring together two streams of literature: growth and convergence across European regions (see the survey by Magrini, 2004) and the role of local externalities in the agglomeration process of economic activities and their performance at the local industry level (see the survey by Beaudry and Schiffaurova, 2009). More specifically, we investigate the growth performance of the local industries over the period 1996-2007 for 276 regions belonging to 29 European countries and covering 13 sectors.

The paper introduces some interesting novelties with respect to the previous empirical literature. First of all, we measure the performance of the local industry by means of the growth rate of TFP computed without imposing a priori restrictions on the inputs elasticities, as it is usually the case in the growth accounting literature. This allows us to construct a more reliable measure of the growth performance since it is able to account for the documented remarkable differences in the production technologies across sectors. Secondly, our analysis covers the whole of Europe, which allows comparing the differences in the growth performance and in its determinants between the Old EU15 members plus Norway and Switzerland and the 12 accession countries. Thirdly, our dataset is also disaggregated at the sectoral level and we consider 13 market sectors for both manufacturing and services, thus excluding only agriculture and public administration. This allows us to investigate, for the first time and for the whole Europe, the role of the local agglomeration economies, such as those induced by specialisation and diversity externalities, on the local industries growth process. Moreover, we analyse the potential influence of regional intangible assets, mainly human and technological capital, on the efficiency of the local industry, while controlling for other factors, like population density, physical infrastructures and accessibility. Finally, the empirical analysis makes use of spatial econometric techniques to test the possibility of some cross-border externalities.

From a policy-maker perspective, the evidence provided on the role played by local agglomeration externalities on productivity growth may be valuable in identifying different and more specific targets of policy interventions at the regional industrial level. In particular, the findings may help define a policy which differentiates regions according to their current growth paths and key growth sources in terms of specialisation, diversification and other externalities.

The remainder of the paper is organized as follows: section 2 presents the estimation procedures to compute TFP for each couplet of industry and region and describes the estimated TFP measures. Starting from a brief overview of the literature, section 3 defines the conceptual framework of our empirical analysis. The determinants of productivity growth at the local industry level are then described in details in section 4. Section 5 presents and discusses the main results of the estimated models. Section 6 concludes with some general remarks on the main findings and on their possible implications for the future strategies of the European Union.

2. Estimation of TFP for the local industry

The empirical evidence suggests that countries and regions do not differ just in traditional factor endowments (labour and physical capital) but mainly in productivity and technology (Easterly and Levine, 2001). Therefore, a crucial issue is to adequately measure these two phenomena. This is a prerequisite to the identification and study of how differences in efficiency and technological capability across countries and regions are determined and change over time.

A measure of economic performance which focuses on efficiency and technology is TFP. This indicator is preferred to other measures of economic growth, which are frequently used at the regional level (employment growth or value added growth), since it represents a direct and comprehensive measure of productivity (see Beaudry and Schiffaurova 2009, for an extensive comparison of several studies with different indicators for regional economic performance). Its use is often hindered by missing data for the computation of capital stocks, especially at the industrial level. In fact, we are aware of only three previous works (Dekle 2002, Cingano and Schivardi 2004, Scherngell et al. 2009) which have used a measure of TFP specific to both sectors and regions in order to investigate local industry externalities. The former two studies, however, focus on regions in just one country (Japanese prefectures in Dekle and Italian local labour systems in Cingano and Schivardi) and use predetermined input elasticities for the computation of TFP. The Scherngell et al. study is closer to our approach, since it analyses the European regions, even though it refers only to the 15 pre-2004 EU member states and their five major manufacturing industries.

In this paper we use a rich database which allows us to extend the analysis to a large set of European countries (29) and sectors (13) in both manufacturing and services. TFP levels have been estimated by following a quasi-growth accounting approach. More specifically, rather than imposing factor endowment elasticities, we estimate them for each of the 13 economic sectors within a traditional Cobb-Douglas production function model, which is reported in (1) in its log-linearized form:

$$va_{it} = \alpha + \alpha \; k_{it} + \beta \; l_{it} + \delta_t + u_{it} \qquad (1)$$

where i=1, … N=276 regions; t=1990, ... 2007 (18 years); *va* is value added, *k* is capital stock and *l* are units of labour; all variables are log-transformed; d_t are times dummies and *u* is the error term. Note that the capital stock has been constructed by applying the perpetual inventory method on investment series. See Table A1 in the Appendix for a complete description of all the variables and data sources. Once the estimates for the sectoral *a* and *b* coefficients are obtained, we calculate the TFP levels by applying the usual growth accounting approach and assuming parameter invariance over time. The average annual TFP growth rate is then computed for the eight-year period 1999-2007.

The estimation of varying elasticities at sectoral levels across regions allows us to adequately capture the well documented heterogeneity in traditional inputs production effectiveness (see, among others, the review by Durlauf et al. 2009a, b and references therein). For the case of the Italian regions, Marrocu et al. (2001) showed that more reliable TFP estimates are obtained when sectoral – rather than regional – heterogeneity is allowed for in the estimated input elasticities.

The sectoral Cobb-Douglas models are estimated by 2SLS (instruments are represented by one-period lagged capital and labour regressors) due to possible endogeneity problems. The results, reported in Table 1, confirm the existence of considerable variation in the estimated parameters: the capital stock elasticity ranges from 0.06 (Financial intermediation) to 0.61 (Coke, refined petroleum, chemicals), while for labour units the range is defined by the elasticity of the mining sector, 0.27, and the one associated with the financial intermediation sector, 1.03. At the bottom of Table 1 we also report the average elasticities obtained by pooling all the 13 sectors; with an estimated 0.34 for capital and 0.59 for labour, these results confirm the elasticities generally used within the growth accounting approach (0.3 for capital and 0.7 for labour) under the assumption of constant returns to scale. However, on the basis of our results, it is worth emphasising that such average elasticities mask a great deal of heterogeneity across sectors, which should be accounted for in order to get more reliable TFP estimates.

Table 2 reports some summary measures for the estimated TFP levels for the initial (1999) and the final (2007) year of the period over which we calculate its growth rate. Considering TFP as an index number with the European average set equal to 100, figures signal a significant economic divide between the Old European regions (EU15 plus Norway and Switzerland) and the regions of the new accession countries. Such a divide is also markedly evident from map (a) in Figure 1, where we report the index average values for the whole period from 1999 to 2007. In 1999, the EU15+ group exhibits a TFP level which is 15% higher than the total average level, whilst New regions account for just 40% of the average value. The divide, however, shows a decreasing trend as the values for 2007 are lower for Old Europe (113) and higher for the New one (50). Moreover, the annual average TFP growth rate (2.8%) of the New EU member countries' regions is almost six times as high as the one exhibited by the Old regions (see also map b).

Overall, these results point out that productivity disparities between Old and New Europe – although still present and sizeable – have shown a tendency to decrease, implying that a regional convergence process has been taking place in Europe over the last decade. In the subsequent sections we present the empirical analysis performed to shed some light on the main determinants of the different economic performance in the New and Old Europe.

3. The empirical framework

This section defines the empirical analysis framework adopted to investigate the factors determining the TFP performance of regions and sectors in Europe in the last decade. As reported in the previous section, one of the clearest stylized facts in the regional productivity growth is the huge disparity between the mature economies in Western Europe and the new accession countries. Indeed, the East-West divide has been an economic feature of countries and regions since the iron curtain fell down (Burda and Severgnini 2009, Wilhelmsson 2009 and Melchior 2008a, b). These regions have experienced a dramatic change in the transition period which has been characterized by a fundamental restructuring of their economic, social and institutional system. In the last twenty years, the outdated eastern agriculture and the oversized industrial sector have been both reduced and most importantly rationalized and modernized. At the same time, market and non-market oriented services have increased their relative importance (Raiser et al., 2008). This transition process has been accompanied by a reorientation of the main trade flows and factor movements. In particular, Old Europe has delocalized important portions of the production chain in manufacturing, especially among low-tech products, to the New Europe.

Table 3 provides some interesting evidence on the general specialization pattern which currently characterizes the Old and the New

Europe and how such a pattern has been changing over the last few years. In particular, the Old Europe is clearly specialized in knowledge intensive services (the employment quota is 21.8% in 2007), whilst the New Europe is still relatively more specialized in low tech manufacturing (the employment quota is 16.5%). Moreover, even though both regions are reducing their share in low tech manufacturing while increasing the one in knowledge intensive services, the specialization of new accession countries in low-tech manufacturing is quite stable.

This stylized fact calls for a comprehensive investigation on which type of factors and externalities have been driving the local economic performance in regions with such a different structural background. Previous studies (Henderson et al. 1995, Greunz 2004) showed that specialisation externalities are stronger in low-tech industries while diversity is usually more conducive to positive externalities among high-tech sectors and services. Moreover, we expect externalities to act with different intensity in accordance with the stage of the industry life cycle. Duranton and Puga (2001) and Boschma (2005) show, from different theoretical perspectives, that new products and industries benefit more from a diversified environment whilst mature industries concentrate, and can be delocalized, in more specialized areas when their production is standardized. Finally, specialisation might be (and it has been found to be) even harmful to economic growth at the latest stages of the industry cycle when lock-in effects may prevail (Cainelli et al., 2007; Paci and Usai, 2008).

In light of the above, we expect that one potentially important reason of the different development paths followed by the Western Old Europe and the Eastern New Europe rests on the distinctive role played by a set of externalities which are at the core of the process of knowledge creation and diffusion: specialization (Marshall, 1890) and diversity externalities (Jacobs, 1969) to begin with, and competitive externalities (Porter, 1990) to end. A large amount of literature has enquired about the influence of these local spillovers on local economic performance, with a large range of methodologies, data and, needless to say, results (Beaudry and Shiffauerova, 2009).

The estimation analysis presented in this paper is applied to a very detailed dataset which allows us to exploit information at both regional and industrial dimensions. The dependent variable is the annual average growth rate of TFP (*TFP_growth*) over the period 1999-2007, calculated from the sectoral TFP levels discussed in the previous section. The determinants of the TFP growth are divided into two groups: those ones which have a double dimension, referring both to region *i* and industry *j* (*X* variables) and those which refer only to the regional dimension (*Z* variables):

$$TFP\_growth_{ij} = f(X_{ij}, Z_i) \qquad (2)$$

Since the sectoral observations are collected with reference to geographical regions, in section 5 we adopt the specific estimation approach that allows taking into account the issue of spatial dependence between sectors belonging to neighbouring regions (LeSage and Pace, 2009). Such dependence may arise from the presence of spatial spillovers or from omitted explanatory variables related to the spatial features of the data. Moreover, in the estimated models we deal with heterogeneity across industries by including sectoral dummy variables.

This approach contains a number of original aspects with respect to previous contributions. The first one, as already mentioned, resides in the measurement of the local industry performance which is computed by the TFP growth rate estimated with no restriction on the factors elasticities. Secondly, the broad geographical coverage of Europe allows to discriminate the performance of the Old mature countries from the growth process of the New developing economies, unlike previous papers (such as Dettori et al., 2010; Scherngell et al., 2009; Le Sage and Fischer, 2010), which refer mainly to the EU15. Thirdly, the sectoral coverage allows us to distinguish, for the first time for the regions of the enlarged EU, between the potential role of specialisation and diversity agglomeration economies. The only previous works on this vein are Moreno et al. (2006) and Greunz (2004) but within a *knowledge production function* framework. Finally, we analyse the impact on the local industry performance of several characteristics of the regional environment such as the endowments of human and technological capital, the degree of accessibility and the settlement structure.

4. The determinants of productivity growth

In this section we discuss the nature of the explanatory variables we include as determinants of productivity growth.

Among the local industry variables we consider indicators of specialisation and diversity externalities. As it is well known, externalities are localised when proximity among agents is one of the features of such effects (for a critical view see, Caniëls and Romijn, 2005). Moreover, local externalities can be either pecuniary or technological, the former being market mediated and the latter referring to out-of-the market relations and links. It is important to bear in mind that our analysis and our indicators will not allow to discriminate between these two categories.

Specialisation (or Marshallian) externalities appear when firms within the same industry work side by side in order to exploit possible advantages coming from the reduction of transport costs of inputs and outputs, the provision of specific goods and services, the availability of suitable supplies of labour force and the transmission of knowledge. In particular, concentration of firms in a regional district specialised in a given production is believed to promote knowledge spillovers and facilitate innovation at the local-industry level (Maskell and Malmberg, 1999). The most common way to measure specialisation externalities (*SPE*) is by means of a location quotient based either on employment or on value added, since it better captures both the relative importance and the intensity of the phenomenon. The location quotient represents, as a matter of fact, the quota of industry employment in a region relative to the national share. In this paper, we prefer the indicator based on employment.

On theoretical grounds we expect a positive effect for the Marshallian externalities, even though the empirical evidence provided so far has been controversial with some authors (Cingano and Schivardi, 2004 and Henderson et al., 2001) reporting positive and significant results for specialization spillovers, while for others (Frenken et al., 2007; Paci and Usai, 2008) the effect is either not significant or even negative.

Diversity (or Jacobs) externalities exist when the source of local spillovers is external to the industry where the firm operates, as the presence of a variety of sectors facilitates imitation and recombination of ideas and cross-fertilisation across industries. In other words, complementary knowledge is conducive to the emergence of new perspectives and prospects which are not available within the usual industrial routines. There are several ways to measure diversity at the regional level. We employ the most common one, that is the Herfindahl concentration index based on employment (*DIV*), albeit with two important modifications. The first is quite common and envisages the use of the inversed index in order to get a direct measure of diversity and thus interpret the sign of the coefficient in a more straightforward way.

The second is more influential since the index is computed in such a way that the sum of the squares of value added for a given region and a given sector does not include the value added of such a sector. We, therefore, provide a proper measure of diversity of the sector we refer to with respect to the rest of the economy. This method of computation implies that the index is computed for the two available dimensions, that is sectors and regions.

The last local industry indicator is the average firm size (*FS*) measured by total employment over firms number in each local industry. Such an indicator has been sometimes used as a proxy for market structure and competition as larger firms imply more market power (Porter, 1990). However, this measure is a weak indicator of the competitive environment of the local industries since it is an average size indicator which does not take into account the number of firms operating in the market. Consequently, we interpret this indicator essentially as a measure of the presence of potential economies of scale at the firm level, which can have a role in enhancing the efficiency of the local sector.

The growth rate of TFP in a local industry may also be affected by some features which characterise each region but which are supposed to affect all sectors in a common way. Following a well established literature, we consider among these variables the availability of intangible assets in the local economy, that is human and technological capital, and regional accessibility.

The positive role played by human capital in promoting productivity has been stressed in the literature at the country level (Mankiw et al., 1992; Benhabib and Spiegel, 1994) and also at the regional one (Rauch, 1993). The availability of well educated labour forces represents an advantage for the localization of innovative firms thus promoting local productivity (Moretti, 2004). Therefore, as a proxy of "high" human capital (*HHK*) we use the share of population (aged 15 and over) that has attained at least a tertiary level of education, that is a university degree (ISCED 5-6). Moreover, to control for the robustness of our results, we also employ two further indicators of human capital, the so called "low" human capital (*LHK*), the quota of population who has attained only a primary education, and long-life learning (*LLL*), which measures the diffusion of education and training among adult population.

Following the original contribution by Griliches (1979) a large body of literature has examined the influence of knowledge capital on economic performance at the firm level and also at regional and country levels. In the macro approach firms benefit from the local availability of a higher degree of technological capital, since technology is partly considered as a public good, which leads to a productivity increase for the whole region (for a comprehensive survey see Audretsch and Feldman, 2004). A large body of research has been devoted to investigating the impacts of technology on the economic performance and also how these effects spill over the regional boundaries to influence contiguous areas. Some recent studies have examined the effects of technological capital on the economic performance of the European regions. Fischer et al. (2009) and Dettori et al (2010) find a positive influence of patent stock on TFP together with a significant interregional knowledge spillovers effect. Empirical support to the positive role exerted by R&D expenditure on GDP growth rate, controlling also for other regional determinants like human capital and infrastructures, is also provided by Sterlacchini (2008) and Rodriguez-Pose and Crescenzi (2008). In our contribution the amount of technological capital at the local level is quantified by an output indicator of innovation, that is, patents. In particular, we employ the stock of patents (*TK*) applied for at the European Patent Office in the ten years to 1999 by inventors resident in the region. Patent based indicators are sometimes criticised since they do not take into account the innovative effort which is not converted into a patent. Thus, to control for the robustness of this measure, two alternative proxies for the technological assets available in the local economy have been considered: the quota of regional R&D expenditure over GDP (*RD*) and the quota of regional employment in the high tech services (*HTS*).

Productivity is also affected by other intangible assets, especially in the transition economies, like social capital (Coleman, 1990; Fidrmuc and Gërxhani, 2008) and by the quality of the local institutions and the market oriented reforms (van Ees and Bachmann, 2006; Tabellini, 2010). However, these data are not available at the regional level for all the countries considered, therefore we cannot directly estimate their effect on TFP growth. Since they are usually characterised by a high degree of persistence we control for differences in the institutional and social environment by including an initial condition variable, which, as will be explained later on, also allows taking into account the converging dynamics of the TFP levels.

Another regional explanatory variable is the accessibility index (*ACC*) which is considered a proxy for infrastructure and public capital and has a distinctive geographic nature. A good network of public infrastructure facilitates the accessibility and thus it is considered as an important element for the success of an area[1]. In this paper we use a composite measure which classifies the regions into five groups according to their potential accessibility by road, train, air and to the time necessary to reach the market, therefore capturing both quantitative and qualitative aspects. This indicator takes the value 1 when accessibility is very low and reaches the value 5 for a very high accessibility level. In the robustness exercise we will also consider other two indices referring to geography: the density of population (DEN) and the so called Settlement Structure Typology index (SST), which distinguishes six groups of regions according to two dimensions (density and urban structure).

As stated in the introduction, this paper intends to contribute to the debate which aims at identifying the causes of the different growth paths experienced in recent years in Europe. Burda and Severgnini (2009) measure this phenomenon at the country level and show that while Eastern countries experienced a TFP growth of 5.5% from 2000 to 2005, Western countries showed a growth rate below unity. We aim at providing some evidence for the different TFP performance at the regional level for the enlarged Europe since previous evidence is either based on GDP per capita (Ertur and Koch, 2006 and Melchior, 2008b) or on TFP, but just for the EU15 (Di Liberto and Usai, 2010). To this aim, we insert the initial level of TFP as determinant of the subsequent growth path for each couple of region and sector.

Table 4 provides the usual summary statistics of the human and technological capital referring to their geographical dimension. It is clear that these phenomena are quite heterogeneous even though at different scales. Technological capital measured by the stock of patents, is by far the most uneven feature across regions. High and low human capital, on the contrary, are quite homogeneous across regions, and so is lifelong learning.

The geographical distribution of our main explanatory variables can be further analysed thanks to the maps reported in Figure 2. A general observation suggested by all the maps is that variability is clearly evident both across countries and across regions within countries, a sort of "country effect" is sometimes present but not in a regular fashion for

[1] See, among others, Eberts (1990) for the Unites States, Marrocu and Paci (2010) for the Italian regions; a useful survey is in Gramlich (1994).

all phenomena under examination. Map (a) shows that high human capital reaches its highest values in the Scandinavian area (but for Norway) and in the United Kingdom. At the same time there is quite a large area in the South-Eastern part of Europe (from Italy to Greece) where the indicator is far below the EU average. Map (b), which refers to the stock of patents, highlights the usual core-periphery pattern, where high-tech nations and regions are concentrated in the North-West of Europe, whilst backward regions are in the South-Eastern part. This is clearly the feature which reveals most plainly the existence of a dual technological system in the Western and Eastern macro-regions of Europe.

5. Estimation results

5.1 Basic model

In light of the discussion reported in the previous section on the potential determinants of TFP growth, model (2) is specified as follows:

$$TFP\_growth_{ij99\text{-}07} = \alpha_0 + \alpha_1 SPE_{ij} + \alpha_2 DIV_{ij} + \alpha_3 FD_{ij} + \beta_1 HHK_i + \beta_2 TK_i + \beta_3 ACC_i + \gamma \log(TFP_{ij}) + \text{sectoral dummies} + \varepsilon_{ij} \qquad (3)$$

where *i* refers to the 276 regions and *j* to the 13 sectors. We deal with heterogeneity across industries by including sectoral dummy variables which are meant to control for those features that are specific to each sector, such as technological opportunities, national and international market structure and international openness. The explanatory variables are measured at their initial period level (1999) in order to deal with potential endogeneity problems.

In order to take into account the possibility of some cross-regional externalities due to the presence of spatial effects, we carried out the LM robust tests[2] which checks for the presence of either a spatially

[2] For a comprehensive description of spatial models and related specifications, estimation and testing issues refer to Le Sage and Pace (2009) and references therein.

lagged dependent variable or a spatially autocorrelated error term under the alternative hypotheses. The test are computed on the OLS residuals of (3) using as a spatial weight matrix (*W*), the matrix of the square of the inverse distance in kilometers between each possible couple of regions; following the suggestions in Keleijan-Prucha (2010), *W* is normalized by dividing each element by its maximum eigenvalue[3]. As entries of the *W* matrix, we choose the square, rather than the linear, of the inverse distances as they allow to better discriminate between neighbouring and distant regions by increasing the relative weights of the closest ones. Note, however, that the results of the spatial dependence tests and of the spatial models are very similar when the weights are linear or when we use the row-standardized matrix (both with linear and square weights) for robustness checks. The results of the LM tests point out that spatial effects are indeed present and they are adequately accounted for by a spatial error model, for which the mean equation is as (3) but the error term is specified as follows:

$$\varepsilon_{ij}=\rho W\varepsilon_{ij}+u_{ij} \qquad (4)$$

where *r* is spatial autocorrelation coefficient, W is the weight matrix, defined as above, and *u* is now an i.i.d. error process.

The estimated spatial error model (3)-(4) is reported in Table 6 (6.1)[4]; note that the interpretation of the coefficients is the same as in a linear regression model. The first aspect which is worth noticing is the remarkable explanatory power of our model, with a square correlation

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[3] Such normalization is sufficient and avoids strong undue restrictions, as it is the case when the row-standardization method is applied (Keleijan-Prucha, 2010).

[4] All the estimated models also include two dummy variables for positive and negative outlier values of the local industry TFP growth rate (defined as observations with absolute values greater than two times the variable standard deviation), which are around 6% of the sample observations. We decide to use such dummies instead of dropping the extreme observations, because the reduced sample would result in a misspecified spatial pattern yielding biased estimates for the spatial error models. Nevertheless, it is worth noting that the sample with no outliers leads to the same results in the case of the OLS estimation.

coefficient between fitted and actual values around 0.50. As for our potential explanatory phenomena we have a combination of expected and unexpected results. Among the former, we find that specialisation externalities are present with a significant positive effect sign, while economies of scale, signaled by the firm dimension, are positively related to TFP growth too but with a marginal significance (p-value equal to 0.13) which raises doubts about their robustness. Among the latter, we realize that diversity externalities are negatively related to TFP growth and highly significant from a statistical point of view.

All the regional factors - that is human capital, technological capital and accessibility - show positive and significant coefficients, in accordance with previous empirical analysis and theoretical predictions. Finally the presence of "conditional" convergence is clearly proved by the negative sign and significance of the initial value of TFP.

Note that for the estimated model 6.1 (and for all the other specifications reported in Table 6 and in Table 7) we also guard against possible heteroskedasticity and remaining spatial correlation by applying the spatial heteroskedasticy and correlation consistent (SHAC) estimator for the variance-covariance matrix, proposed by Kelejian and Prucha (2007)[5]. The results, not reported to save space, confirm the empirical significance levels reported in Tables 6-7.

5.2 Robustness analysis

In this section we report the results of the robustness checks carried out in order to assess the strength and stability of our conclusions with respect to the choice of our indicators and proxies.

Firstly, in order to verify if productivity depends on the quality of the human capital employed in the production system, we use in column 6.2 an index of low human capital (LHK), i.e. primary education attainment. As expected, the estimated coefficient is significantly negative and this result reinforces the hypothesis that in order to develop new ideas, to intensify innovation and to increase productivity, the quality of the human capital involved in the production process is not inconsequential. Secondly, we try to understand whether a different

[5] We adopted the Parzen kernel function to estimate each element of the variance-covariance matrix; for the bandwidth we consider the following distances: 200, 400, 800, 1300 km. The first is a very short distance, the other distances approximately correspond to the first decile, the first quartile and the median of the distribution of all the regional distances considered.

dimension of education, the one which pertains to those who are already employed or simply adult, provides the same results in terms of boosting productivity. The Long Life Learning (LLL) variable included in model 6.3 is associated with a significant positive coefficient. It is worth noting that, due to multicollinearity problems, it is not possible to include in the same specification both HHK (or LHK) and LLL; given that high levels of human capital are more adequate in capturing the quality of the labour force the base model 6.1 is preferred to model 6.3.

We extend the robustness tests to the proxy of technological capital. We firstly use the R&D expenditure quota over GDP (RD) as an alternative to the stock of patents to measure technological opportunities at the regional level. Results in column 6.4 show that the RD coefficient is positive although not significant. It is worth remarking that the construction of this variable is very problematic, given that data for some regions are either missing or incomplete. Another proxy to measure the degree of innovation of the local economy is the employment share in high-tech service sectors (HTS). The model which includes this variable is shown in column 6.5. The coefficient is positive and significant as expected whilst all other variables maintain their sign and significance.

Finally, we focus on the geographical variables. The first exercise concerns the use of a simple indicator of agglomeration that is a density variable based on population per squared kilometers (DEN). This is the most commonly used indicator and it is usually positive and significant. However, this is not the case in our model, as reported in column 6.6, where the coefficient is positive but it is not significant. This can be due to the fact that density can have rather distinct effects when is associated to different scales of city size. Consequently, we introduce the Settlement Structure Typology index (SST), which distinguishes six groups of regions according to two dimensions, density and urban structure: the very densely populated regions with large centers are ranked first while the less densely populated areas without centers take the sixth position. In regression 6.7 this variable exhibits the expected negative coefficient, although it turns out to be not significant. It is apparent that the accessibility index is the most adequate proxy to capture the geographical patterns.

5.3 Old and New Europe

The results discussed in the previous sections provide robust evidence on the role played by regional intangible and infrastructure capital in determining productivity growth. However, the relevance of specialization externalities and economies of scale seems to depend to some extent on the model specification adopted. In this section we investigate whether such instability is due to the fact that the sectoral/regional impacts are restricted to be equal across the two great macro-areas of Europe. This sub-sample analysis is supposed to allow for a better understanding of the economic forces which are driving the different regional West/East productivities.

This goal is achieved by including a dummy variable (New countries) for the 56 regions of the countries which entered the EU in 2004 (eight Central and Eastern European countries, that is the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia, plus the Mediterranean islands of Malta and Cyprus) and in 2007 (Romania and Bulgaria). It is worth noting that such a dummy substitutes the initial conditions variable to avoid problems of multicollinearity since the two indices are rather correlated. According to the estimated model 7.1 in Table 7, for the same levels of industrial and regional determinants, TFP is growing more rapidly in the new accession countries; moreover, when the dummy for the new countries' regions is included the coefficient of the specialization externalities is no longer significant. This suggests a possible link between the two phenomena.

This result associated to the theoretical considerations reported in the previous sections hints at another extension of the model which discriminates further among the New and the Old regions of Europe by interacting the "new countries" dummy with the three local industrial variables in order to assess whether specialization, diversity and scale economies effects vary for regions in the Eastern rather than in the Western part of Europe.

Results are summarized in the bottom part of table 6 where computed coefficients for the two macro-areas can be compared: they are extremely interesting and confirm our expectations. First of all, specialization externalities maintain their positive impact on efficiency growth only in the new accession countries whilst their effect for EU15 is negative even though no longer significant. The impact of the diversity externalities on TFP growth is negative in all European countries but it is almost three times larger in absolute terms for the New countries with respect to Old Europe. Finally, economies of scale turn out to affect positively efficiency growth in the EU15, where we assume a greater role for large firms, whilst it exerts a negative effect in the New countries, where there is a prevalence of small and medium enterprises. The presence of different coefficients (in terms of either sign or size) implies that the growth patterns of these two macro-areas of Europe are distinct even though interdependent.

The interpretation of these results originates from the views presented in the previous sections on the different phase of the development path currently undertaken by the two European macro-regions. The Old Europe is in an advanced phase of industrial restructuring and service expansion and reorientation. Industrial districts in the Old Europe are either dismantled or transformed. This implies a process of delocalization which has often involved regions in the New Europe. This may lead to a new business core both for the Old Europe, with a focus on service oriented and high value added activities, and for the New Europe, more specialized in traditional and low-tech industrial activities where the Marshallian externalities still play an important role.

6. Discussion and concluding remarks

Economic integration among the Eastern and the Western sides of Europe is, by now, set along an irreversible course and is producing several considerable effects. Among them a general reduction of regional disparities and an associated complex economic restructuring which involves countries and regions on both sides of the former iron curtain in an integrated manner. On the one hand, the Old Europe has engaged in a process which relocates abroad some important segments of its manufactures and has refocused on high tech productions and high value added service activities. On the other hand, the New Europe experiences the transition with a fresh start of its economic system, based on a newborn agricultural system and, most importantly, on low-tech manufacture which is partly the result of capital mobility from the Western countries. At the same time both the Old and the New Europe are shifting gradually and constantly towards a service based economy. This process is associated with important gaps in TFP levels and growth rates in European regions. In particular, while the New Europe is still far behind the Old one in terms of GDP and TFP levels, a convergence process is at work and growth rates have been and are much higher in the East than in the West.

This paper argues that such different performances have to be studied at the regional and the industrial level where important externalities may trigger and then foster distinctive development paths. We mainly focused on two types of externalities, that is specialization and diversity externalities, because their actions and consequences can be very diverse depending on the economic context in which they apply.

After providing an accurate measure of the TFP at sectoral/regional level for 13 economic sectors and 276 regions, the empirical analysis presented in this paper is based on the estimation of spatial error models for explaining the TFP growth rate, over the period 1999-2007, as a function of local industry characteristics (specialization and diversity externalities, firms size) and regional human, technological and infrastructure capital. Spatial models represent an adequate estimation framework for data observed with reference to geographical regions, which are often characterized by dependence arising from the presence of spatial spillovers or from unobserved spatial features.

The main results show that agglomeration externalities have so far worked in a very different manner in the Old and the New Europe. In particular, specialization externalities are still at work in the New Europe while they have no role in the Old Europe. Diversity has, somewhat surprisingly, a negative effect on TFP growth in both macro-areas, which is larger in size for the New Europe regions. Finally, economies of scale operate positively in the West and negatively in the Eastern part of Europe.

The economic system of the New accession countries is exploiting at full range the typical Marshallian externalities which clearly affect production mainly in the traditional sectors. At the same time, the economic scenario of the richer regions of Old Europe are experiencing a phase which is no longer embedded in specialized industrial districts but rather on economies of scale and innovation capabilities.

This finding can be helpful in defining a dual policy strategy across Europe which still aims at specialised industrial clusters in manufactures in the New Europe whilst it is more oriented to diversification across manufactures and service in the Old Europe. Furthermore, policy interventions to foster human capital and technological progress are needed in the whole of Europe but they may have a different objective in the two big macro-areas according to their differentiated production structures and economic performances.

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Appendix 1. Data sources and definition

Variable		Source	Years	Definition
Value added	VA	Cambridge Econometrics	1990-2007	Millions euros, 2000
Capital stock	K	Own calculation	1990-2007	Millions euros, 2000
Units of labour	L	Cambridge Econometrics	1990-2007	Thousands
Total Factor Productivity	TFP	Own estimation	1999-2007	
Specialisation externalities	SPE	Cambridge Econometrics	1999	Normalised index of relative sectoral specialisation of employment, 13 sectors
Diversity externalities	DIV	Cambridge Econometrics	1999	Inverse of Herfindhal index computed on sectoral employment, 13 sectors
Firms size	FS	Eurostat - SBS	1999	Employment over local units (thousands), 13 sectors
High Human Capital	HHK	Eurostat	1999	Population aged 15 and over by highest level of education attained. Tertiary education - levels 5-6 (ISCED 1997), over population 15 and over
Low Human Capital	LHK	Eurostat	1999	Population aged 15 and over by highest level of education attained. Pre-primary, primary and lower secondary education - levels 0-2 (ISCED 1997), over population 15 and over
Long life learning	LLL	Eurostat	1999	Participation of adults aged 25-64 in education and training, over population 25 and over
Technological capital	TK	OECD, REGPAT	1999	Patent applications at EPO, stock for the years 1990- 1999, over thousands population
Research and Development	RD	Eurostat	1999	Total intramural R&D expenditure (GERD), over GDP
High tech services	HTS	Eurostat	1999	Employment in High Tech service sectors (over total employment)
Accessibility index	ACC	ESPON project 2.4.2	2001	1-5 values according to the potential accessibility by road, train, air and time to the market: 1=highly below average; 2=below average; 3=average; 4=above average; 5=highly above average
Population density	DEN	Eurostat	1999	Population per km^2, thousands
Settlement Structure Typology	SST	ESPON project 3.1 BBR	1999	1-6 values according to the settlement typology: 1=very densely populated with large centres; 2=densely populated with large centres; 3=densely populated with large centres; 4=densely populated without large centres; 5=less densely populated with centres, 6=less densely populated without centres

Appendix 2. Regions and NUTS level

Code	Country	NUTS	Regions
AT	Austria	2	9
BE	Belgium	2	11
BG	Bulgaria	2	6
CH	Switzerland	2	7
CY	Cyprus	1	1
CZ	Czech Republic	2	8
DE	Germany	2	39
DK	Denmark	2	5
EE	Estonia	1	1
ES	Spain (a)	2	16
FI	Finland	2	5
FR	France (a)	2	22
GR	Greece	2	13
HU	Hungary	2	7
IE	Ireland	2	2
IT	Italy	2	21
LT	Lithuania	1	1
LU	Luxembourg	1	1
LV	Latvia	1	1
MT	Malta	1	1
NL	Netherlands	2	12
NO	Norway	2	7
PL	Poland	2	16
PT	Portugal (a)	2	5
RO	Romania	2	8
SE	Sweden	2	8
SI	Slovenia	2	2
SK	Slovakia	2	4
UK	United Kingdom	2	37

(a) Territories outside Europe are not considered

Appendix 3. Sectors

	Sector Name	Sector Code	Typology
S1	Mining, quarrying and energy supply	C+E	
S2	Food, beverages and tobacco	DA	LTM
S3	Textiles and leather etc.	DB+DC	LTM
S4	Coke, refined petroleum, chemicals etc.	DF+DG+DH	
S5	Electrical and optical equipment	DL	
S6	Transport equipment	DM	
S7	Other manufacturing	DD+DE+DN+DI+DJ+DK	LTM
S8	Construction	F	
S9	Distribution	G	
S10	Hotels and restaurants	H	
S11	Transport, storage and communications	I	KIS
S12	Financial intermediation	J	KIS
S13	Real estate, renting and business activities	K	KIS

LTM: Low Tech Manufacturing

KIS: Knowledge Intensive Services

Table 1. Sectoral production functions elasticities estimates

Dependent variable: value added		Explanatory variables			
		Capital stock		Labour units	
		coefficient	t-stat	coefficient	t-stat
S1	Mining, energy	0.466	26.49	0.269	70.17
S2	Food, etc	0.455	26.20	0.375	47.90
S3	Textiles, etc	0.444	25.67	0.391	26.99
S4	Chemicals etc.	0.607	25.92	0.365	12.38
S5	Electrical, optical eq.	0.488	28.77	0.488	22.18
S6	Transport equipment	0.451	27.55	0.400	17.66
S7	Other manufacturing	0.501	36.65	0.431	44.95
S8	Construction	0.164	19.62	0.802	45.97
S9	Distribution	0.191	16.73	0.862	93.76
S10	Hotels, restaurants	0.125	10.50	1.029	66.91
S11	Transport, communications	0.249	17.57	0.689	77.95
S12	Financial intermediation	0.059	10.31	1.035	42.12
S13	Real estate, business ect.	0.160	16.84	0.792	112.92
All sectors		0.336	18.07	0.587	31.90

For each sector estimates are obtained from a balanced regional panel (N=276), observed over the period 1990-2007 (T=18), NxT=4968

Estimation method: 2SLS with one year lagged regressors as instruments

All regression include a constant and time period fixed effects

t-statistics are calculated using White consistent standard errors

Table 2. Total Factor Productivity

	1999		2007		Annual average growth rate % 1999-2007
	index Europe=100	variation coefficient	index Europe=100	variation coefficient	
EU15, Norway, Switzerland	115	0.86	113	0.59	0.48
New accession countries (12)	41	0.33	50	0.28	2.80
Whole Europe	100	0.93	100	0.65	0.95

Table 3. Sectoral employment shares, (% over total employment)

	Low tech manufacturing		Knowledge intensive services	
	1999	2007	1999	2007
EU15, Norway, Switzerland	11.7	9.8	19.5	21.8
New accession countries (12)	17.7	16.5	13.3	15.8
Whole Europe	12.9	11.1	18.3	20.6

Table 4. Regional explanatory variables - summary statistics

Variable	Mean	Median	Std. Dev.	Min	Max
Technological capital	623	408	770	4084	0
Research and Development	0.014	0.011	0.010	0.063	0.001
High tech services	0.298	0.293	0.089	0.582	0.074
High Human Capital	0.140	0.140	0.058	0.327	0.042
Low Human Capital	0.375	0.339	0.190	0.875	0.087
Long life learning	0.059	0.033	0.060	0.262	0.001

See Appendix A1 for variables definitions

Table 5. Determinants of TFP growth: basic model and robustness

Dependent Variable: TFP, % annual average growth rate 1999-2007							
Spatial error models	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**
Local industry variables							
Specialisation externalities	0.38 **	0.30	0.34 *	0.38 *	0.39 **	0.38 **	0.38 **
	(1.94)	(1.52)	(1.70)	(1.89)	(1.95)	(1.93)	(1.93)
Diversity externalities	-0.23 ***	-0.26 ***	-0.26 ***	-0.20 ***	-0.17 ***	-0.23 ***	-0.23 ***
	(-3.84)	(-4.56)	(-4.32)	(-3.48)	(-2.82)	(-3.92)	(-3.82)
Firms size	0.82	0.61	0.93 *	0.95 *	1.08 **	0.93 *	0.90 *
	(1.49)	(1.11)	(1.67)	(1.72)	(1.97)	(1.69)	(1.64)
Regional Variables							
High human capital	5.81 ***			6.47 ***	5.43 ***	5.91 ***	5.87 ***
	(5.72)			(6.09)	(4.52)	(5.79)	(5.77)
Technological capital	0.33 ***	0.25 ***	0.39 ***			0.42 ***	0.41 ***
	(3.74)	(2.81)	(4.31)			(5.24)	(4.94)
Accessibility index	0.11 **	0.06	0.13 ***	0.18 ***	0.17 ***		
	(2.06)	(1.06)	(2.49)	(3.74)	(3.63)		
Alternative proxies for regional variables							
Low human capital		-2.72 ***					
		(-8.92)					
Long life learning			2.52 **				
			(2.41)				
Research and development				4.66			
				(0.84)			
High tech services					1.81 **		
					(2.00)		
Population density						0.00	
						(-0.02)	
Settlement structure typology							-0.02
							(-0.53)
Initial TFP level	-1.28 ***	-1.16 ***	-1.22 ***	-1.19 ***	-1.25 ***	-1.29 ***	-1.29 ***
	(-14.5)	(-13.4)	(-13.8)	(-14.0)	(-13.9)	(-14.6)	(-14.6)
Spatial error autocorr. coefficient (ρ)	0.84 ***	0.84 ***	0.84 ***	0.84 ***	0.84 ***	0.84 ***	0.84 ***
	(27.2)	(28.0)	(27.2)	(27.2)	(27.8)	(28.0)	(26.6)
Square correlation (actual, fitted values)	0.52	0.53	0.52	0.52	0.52	0.52	0.52

Estimation method: ML
Observations: 276 regions, 13 sectors, total 3588
All regressions include a constant and 12 sectoral dummies
The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized
Asymptotic t-statistics in parenthesis. Significance: *** 1%; ** 5%; * 10%

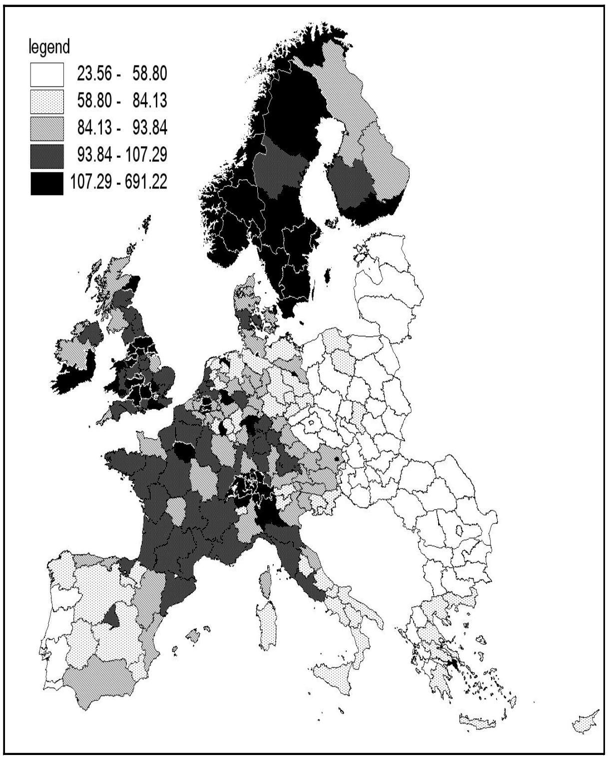
Table 6. Determinants of TFP growth: New and Old Europe

Dependent Variable: TFP, % annual average growth rate 1999-2007		
Spatial error models	**6.1**	**6.2**
Local industry variables		
Specialisation externalities	0.19	-0.21
	(0.95)	(-0.87)
Diversity externalities	-0.23 ***	-0.16 **
	(-3.67)	(-2.40)
Firms size	0.88	1.30 **
	(1.56)	(2.26)
Specialisation externalities * new countries[§]		1.74 ***
		(3.45)
Diversity externalities * new countries		-0.42 **
		(-2.39)
Firms size * new countries		-5.54 ***
		(-2.88)
Regional Variables		
High human capital	3.60 ***	3.52 ***
	(3.52)	(3.43)
Technological capital	0.17 *	0.15 *
	(1.80)	(1.65)
Accessibility index	0.14 ***	0.15 ***
	(2.58)	(2.75)
New countries	0.95 ***	4.30 ***
	(6.23)	(3.27)
Spatial error autocorr. coefficient (ρ)	0.84 ***	0.83 ***
	(27.03)	(26.47)
Square correlation (actual, fitted values)	0.50	0.50

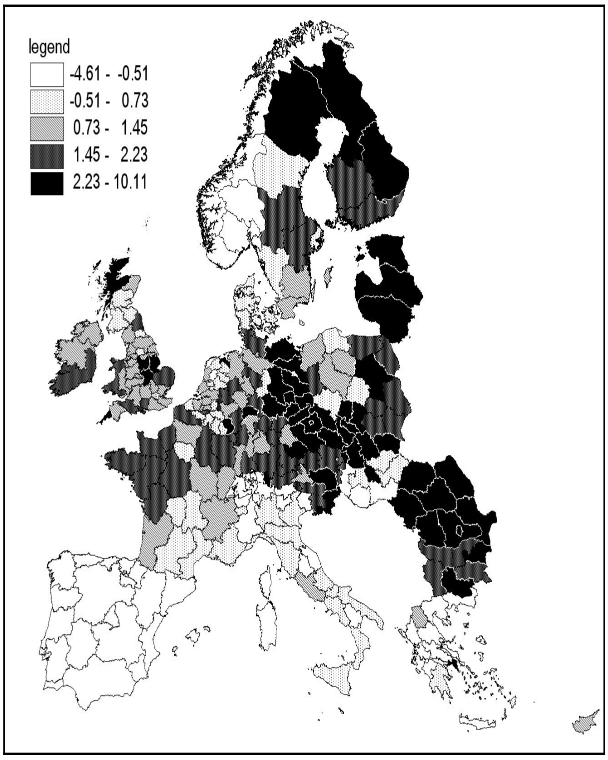
Computed coefficients for local industry variables from model 6.2	Old Europe	New Europe
Specialisation externalities	-0.21	1.54
Diversity externalities	-0.16	-0.58
Firms size	1.30	-4.24

[§] *New countries*: binary variable with value 1 for regions in the 12 new accession countries
Estimation method: ML; observations: 276 regions, 13 sectors, total 3588
All regressions include a constant and 12 sectoral dummies
The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized
Asymptotic t-statistics in parenthesis; significance: *** 1%; ** 5%; * 10%

Figure 1 Total Factor Productivity in the European regions.

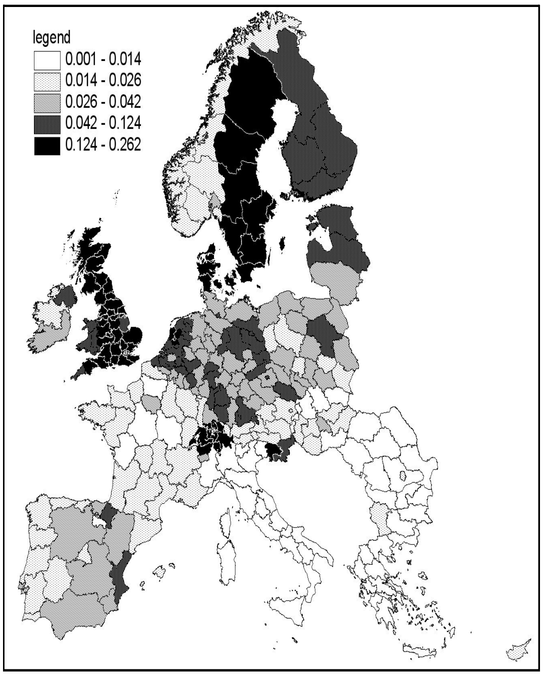


a) Average 1999-2007; index Europe=100

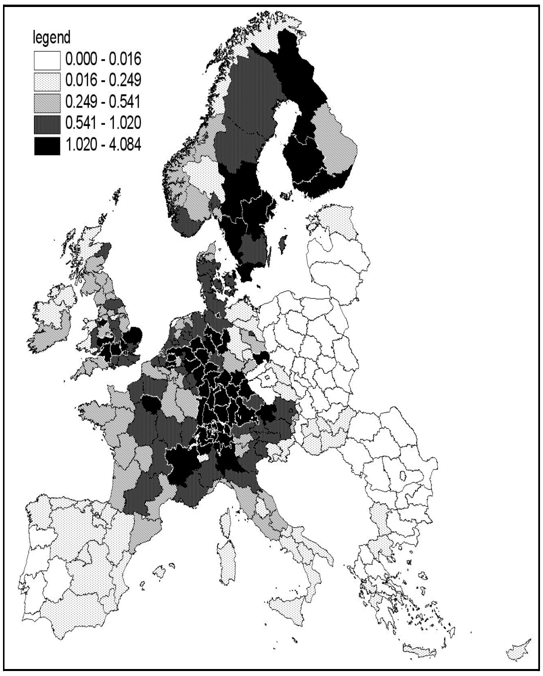


(b) Growth rate; % annual average 1999-2007

Figure 2 Geographical distribution of regional exploratory variables



(a) High human capital,1999
Population share with tertiary education



(b) Technological capital , 1999
Patents EPO, 10-years stock, per thousands population

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