JOURNAL OF REGIONAL SCIENCE

JOURNAL OF REGIONAL SCIENCE, VOL. 53, NO. 3, 2013, pp. 418–442

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

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ABSTRACT. As Europe is currently characterized by huge disparities in the economic performance of "old" and "new" states, we investigate whether this is the result of local agglomeration—specialization and diversity—externalities. Our spatial econometric analysis focuses on total factor productivity dynamics over the period 1996–2007 for 13 industries located in 276 European regions. Consistently with the "nursery cities" theory, we find that diversity exerts a positive effect in the knowledge-intensive services of the "old" Europe urban areas, while specialization is still effective in the "new" Europe low-tech manufacturing. Human and technological capital has also a positive impact.

1. INTRODUCTION

In the last decade Europe has been growing at a dual speed: total factor productivity (TFP) in the new accession countries (the *New* Europe) has progressed at a pace close to 2.8 percent per year, while western countries (the *Old* Europe) have experienced a productivity growth six times slower, around 0.48 percent. Such a dualist performance is also the result of the new institutional and economic scenario created by the European Union enlargement, which has both widened and strengthened the integration process for the whole sizeable set of 27 countries. This has induced the mature western economies to delocalize part of their traditional industries eastwards, generating a specialization in knowledge-intensive services (KIS) in the Old Europe while the New Europe specializes in low-tech manufacturing (LTM). This is clearly reflected by the sectoral employment shares: in 2007 the advanced services had an average share of 21.8 percent in the western countries and just 15.8 percent in the EU12 members; a reverse pattern was exhibited by the low-tech manufacturing sectors with shares of 9.8 percent and 16.5 percent, respectively. Hence, the European economy is characterized by a dualistic landscape, simultaneously shaped by geographical and industrial factors which are strictly interconnected and need to be examined together.

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*The research leading to these results has received funding from the ESPON project KIT, Knowledge, Innovation, Territory. We would like to thank Barbara Dettori for excellent research assistance. We have benefited from valuable comments by participants to DIME workshop in Pecs and to conferences RES in London, IEA in Beijing, EPI in Parma, EEA in Oslo, ERSA in Barcelona.

Received: November 2011; revised: July 2012; accepted: July 2012.

 DOI: 10.1111/jors.12000

These stylized facts can be interpreted according to the idea of "nursery cities" suggested by Duranton and Puga (2001). Their theoretical model, combining static and dynamic advantages of specialization and diversity externalities, predicts that firms create new products in diversified areas but, when production becomes standardized, they switch to mass-production and relocate to specialized regions. This model, thus, assigns a central role to different agglomeration externalities in determining industry location along industry life-cycle and provides a number of clear hypotheses to be assessed empirically.

The main purpose of our contribution is to analyze the different role played by agglomeration economies, namely specialization and diversity externalities, in determining the local industry productivity growth. Moreover, following Duranton and Puga's hypotheses, we investigate whether the effects of different types of agglomeration vary according to the development stage (Old vs. New Europe), the specialization pattern (low-tech manufactures vs. knowledge-intensive services) and the territorial features (urban vs. rural areas). We construct a new data set that allows us to introduce a number of original aspects in the empirical analysis. Our sample includes all the regions of Europe, that is, the EU15 members plus Norway and Switzerland (EU15+) and the new accession countries (EU12), which entered the EU in 2004 and in 2007 (10 eastern countries plus the Mediterranean islands of Malta and Cyprus). Differently from previous studies, which focus mainly on the EU15, our broad geographical coverage allows us to examine the linkages between productivity growth and agglomeration economies distinguishing between the old mature countries and the new economies in transition. The data set is also disaggregated at the sectoral level and consists of all market sectors for both manufacturing and services, excluding only agriculture and public administration.

We extend the standard approach to assess agglomeration economies, such as that of Glaeser et al. (1992), on three dimensions. First, we use an estimation-based measure of sectoral TFP derived without imposing *a priori* restrictions on inputs' elasticities and thus accounting for the remarkable heterogeneity observed across sectors. TFP is preferred to other measures of economic performance, which are frequently used at the regional level (employment or value added growth), since it represents a direct and comprehensive measure of productivity (Cingano and Schivardi, 2004). Second, we enrich the set of regional controls by introducing two intangible assets: human and technological capital endowments. Third, we use spatial econometric models to capture the potential cross-regional dependence arising from spatial spillovers or from unobserved spatial features.

Our results underline the differentiated effects of agglomeration externalities on productivity dynamics according to the product life cycle and the maturity stage of the two European macro areas, as predicted by Duranton and Puga's model. The main finding is that diversity externalities exert a positive effect on productivity growth only in the old developed countries. This growth enhancing impact is specific to the knowledge-intensive services in very densely populated urban areas, i.e., the nursery cities. On the other hand, Marshall's (1920) specialization externalities influence positively productivity growth in all macro-areas and macro-sectors with the notable exception of the mature low-tech industries in the old Europe where a congestion effect prevails. As expected, specialization externalities show the strongest positive impact in the low-tech manufacturing activities located in the new developing countries of Europe, which consist largely of standardized productions, relocated from the western regions, where the Marshall's economies are still relevant in affecting productivity growth. Among the other findings, it is worth remarking the positive effect on productivity growth exerted by the intangible assets and, in particular, by the regional endowment of human capital which shows a much stronger growth enhancing impact than technological capital. Finally, our estimates underline the presence of positive spatial association across the European regions.

The remainder of the paper is organized as follows: starting with a brief overview of the literature, Section 2 illustrates the conceptual and empirical framework of the analysis. Section 3 presents the estimation procedure adopted to compute the response variable, the TFP growth rate for each pair of industry and region. Section 4 describes the basic model, presents the identification and estimation strategy along with a brief discussion of the main preliminary results. These results are then tested with respect to the different hypotheses suggested by the nursery cities framework in Section 5. In Section 6 robustness checks and extensions of the general model are presented. Section 7 concludes with some general remarks on the main findings and on their indicative policy implications.

2. BACKGROUND LITERATURE

The influence of agglomeration and other forms of local externalities on regional economic performance, within the urban economics approach, has been at the center of a vast empirical research surveyed by Rosenthal and Strange (2004), Beaudry and Schiffaurova (2009) and examined in a meta-analysis by De Groot, Poot, and Smit (2009). At the same time, this is also the core theme of the theoretical research program of the New Economic Geography (see Puga, 2010, for a review), according to which geographical concentration, in the presence of open economies and localized spillovers, is beneficial for productivity and growth (Martin and Ottaviano, 1999; Baldwin and Martin, 2004; Ottaviano and Thisse, 2004).

Here we review and compare the evidence provided by the empirical contributions with a specific focus on the nature and sources of local increasing returns, i.e., agglomeration economies. Rosenthal and Strange (2004) emphasize that even though agglomeration extends its effects over at least three different dimensions (industry, space, and time), most studies have focused on just one or two of such dimensions. The only exception is Henderson (2003), who carries out a productivity-based analysis of agglomeration in an almost “ideal” empirical setting, thanks to the use of a panel dataset for U.S. plants. This study focuses on two macro-sectors, machinery and high-tech industries, and finds a positive and significant elasticity of TFP with respect to industry specialization, while urbanization economies do not seem to play any relevant role in enhancing productivity. More recently, Martin, Mayer, and Mayneris (2011) replicate this model for France, again using a panel of firms and plants but with a broader spectrum of sectors. They find that French firms benefit from industrial clustering mainly in the short run, but not from urbanization economies, which are more likely to unfold their effects in the long run.[1] Both papers are quite effective at tackling the usual problems of endogeneity, which is due either to unobserved heterogeneity or simultaneity bias, thanks to the panel structure of their data.[2]

However, such detailed data are available only for specific sectors in specific areas, which makes it difficult to extend the results to other contexts, in particular when

[1]The importance of the temporal dimension is also envisaged in another recent analysis on U.S. firms by Ellison et al. (2010), where the relative importance of within industry externalities is assessed thanks to Census data on co-agglomeration patterns. They find that all Marshall’s (1920) explanations of agglomeration, related to the reduction of the costs of moving either goods, people, or ideas, are proved right, but input-output linkages appear of crucial importance. On the other hand, knowledge externalities are less effective since they may be a more long-run phenomenon.

[2]The production function, in these cases, can be rewritten in first difference and lagged values of the right-hand side variables may be used as instrument in a Generalized Method of Moments (GMM) approach.

heterogeneity is a distinctive characteristic of the data, as it is usually the case when large sets of countries/regions/sectors are considered. For this reason, most of the literature has followed other approaches to assess the features and the scope of agglomeration economies and to tackle the related issue of causality. More specifically, Glaeser et al. (1992) and Henderson, Kunkoro, and Turner (1995) examine the impact of metropolitan areas agglomeration on economic dynamics (proxied by employment growth) and use the initial period levels of the main determinants to deal with endogeneity.[3] These two pioneering studies on the United States have been followed by many others on several European countries: Combes (2000) for France, Blien, Suedekum, and Wolf (2006) for Germany, Van Soest, Gerking, and Van Oort (2006) for the Netherlands, Paci and Usai (2008) for Italy.

The survey of Beaudry and Shiffaeurova (2009) shows that all these studies offer conflicting results depending on the level of geographical aggregation (employment zones, metropolitan areas, regions), the industrial level (2- or 3-digit) and scope (manufacturing or services). Most importantly, they observe that results are contingent on the indicator of economic growth used as dependent variable (employment, wages, rents, labor productivity, or TFP).

On this ground, the contributions by Dekle (2002) for Japanese prefectures and Cingano and Schivardi (2004) for Italian local labor systems are of fundamental importance because they cast doubts on the use of employment growth as a proxy of productivity dynamics, unless capital stock is constant and demand is not too inelastic at the local level. They, consequently, prefer to use local TFP growth as a response variable; their results indicate that specialization effects are often positive, while variety is not significant. De Lucio, Herce, and Goicolea (2005) extend this approach to Spain and find that specialization is not the only externality at work since diversity proves significant too. Therefore, results are still inconclusive even when the same performance indicator is used.

Some of these contradictory outcomes, according to the analytical framework of Duranton and Puga (2001), may be due to the fact that agglomeration externalities operate with different intensity in accordance with some features of the local industrial environment and in connection with the stage of the product life cycle. They argue that new products and industries benefit more from a diversified environment while mature industries concentrate, and can be delocalized, in more specialized areas when their production is standardized. In particular, they endow with solid micro-foundations the well-known Jacobs' (1969) argument on the importance of diversified urban areas in fostering innovation as variety is essential to promote search and experimentation of new prototypes. Once this search is over and the right product or process is found, firms start the mass-production and, if relocation is not too costly, they avoid congestion of urban areas by moving to a specialized area, where Marshall's externalities prevail. At the end of the life cycle, specialization might even prove harmful to economic growth since lock-in effects prevent economies from exploiting new promising technological trajectories (Boschma, 2005).[4] Empirical support to these hypotheses is provided by Neffke et al. (2011) for the case of 12 Swedish manufacturing industries.

We believe that one potentially revealing application of the Duranton and Puga's hypotheses is provided by the recent process of enlargement in Europe. This process,

[3]Another method to control for endogeneity implies the use of historical instruments, such as long lags of population as in Ciccone and Hall (1996), but such instruments are not always easily available and may turn out to be weak. For a critical review of different methodologies applied to identifying correctly the causal relationship between agglomeration and productivity one can refer to Combes et al. (2011).

[4]An inverted-U shape of productivity gains from agglomeration is found in the study for China by Au and Henderson (2006) and for France by Martin et al. (2011).

TABLE 1: Sectoral Employment Shares (% Over Total Employment)

	Low-Tech Manufacturing		Knowledge-Intensive Services	
	1999	2007	1999	2007
Old Europe: EU15, Norway, Switzerland	11.7	9.8	19.5	21.8
New Europe: 12 new accession countries	17.7	16.5	13.3	15.8
Whole Europe	12.9	11.1	18.3	20.6

in fact, offers an exceptional case study to analyze how market integration has affected economies which are very differentiated not only in terms of economic maturity, but also in terms of production structure and level and scope of specialization and diversification (see Burda and Severgnini, 2009 for a country level analysis and Ertur and Koch, 2006 for a spatial study). From a theoretical point of view, we expect integration to produce factor movements, mainly foreign direct investments and migration flows, which induce new patterns of specialization. Such effects are mainly the result of the combination of centripetal and centrifugal forces, i.e., agglomeration externalities which include specialization and urbanization spillovers. As a matter of fact, in Europe a relevant FDI flow and a delocalization process is at work from the mature economies toward new accession countries (Breuss, Egger, and Pfaffermayr, 2010). Consequently, as mentioned before, the specialization pattern of economic activities in both the western and the eastern regions has changed dramatically (EESC, 2006 for a comprehensive investigation). In particular, Old Europe has delocalized important portions of the production chain in manufacturing, especially among low-tech products, to the New Europe (ERM, 2007). Table 1 provides some interesting evidence on this phenomenon and its evolution over the last decade. As anticipated in the introduction session, Old Europe appears clearly specialized in KIS (in 2007 the employment quota is 21.8 percent vs. 15.8 percent in the EU12), while the New Europe is still relatively more specialized in LTM (the employment quota is 16.5 percent vs. 9.8 percent in EU15+).[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.

In light of these trends, we expect that one potential reason for the divergent development paths followed by the western Old Europe and the eastern New Europe rests on the distinctive role played by agglomeration externalities operating in different industrial settings at opposite stages of development within diverse urban environments. The Old Europe, as a matter of fact, hosts mainly diversified urban regions, the “nursery cities” in Duranton and Puga’s terminology, which are more and more specialized in services while the New Europe abounds with rural and less densely populated regions specializing in standardized manufacturing.

A similar perspective is shared by the recent contribution of Foster and Stehrer (2009), who extend the agglomeration model of Ciccone (2002) to the industry level in order to assess the role of externalities with respect to industrial and geographical dimensions.[6]

[5]Appendix B reports the list of sectors and the definition of knowledge intensive services (KIS) and low-tech manufacturing (LTM) according to Eurostat classification.

[6]Another parallel study is proposed by Brülhart and Mathys (2008) who find a dominant pattern of cross-sector urbanization economies, while productivity positive effects, due to own-sector density, are found in the financial services and not in the manufacturing sector. Moreover, they observe indirect evidence of agglomeration effects being stronger in EU new member states.

In particular, they consider differences in the extent of agglomeration effects between New and Old Europe, and conclude that such effects tend to be stronger for new member states. Nonetheless, they do not explicitly distinguish between different kinds of agglomeration effects. This is what is done in our study where, following Glaeser et al. (1992) and the ensuing literature, three different types of agglomeration externalities at the local industry level are considered.[7] Moreover, along the research path started by Dekle (2002), we proxy local economic performance by means of a measure of TFP growth estimated at both the industrial and the regional level.

3. ESTIMATION OF TFP FOR THE LOCAL INDUSTRY

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

TFP is a measure of economic performance that focuses on both efficiency and technology. 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, Fischer, and Reismann 2009), which use 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 labor 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 analyzes the European regions, even though it refers only to five major manufacturing industries in the fifteen pre-2004 EU member states.

In this study TFP is computed thanks to a time series dataset for the period 1990–2007, which includes 276 regions of 29 European countries and 13 sectors in both manufacturing and services.[8] 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:

$$\ln(\mathrm{VA}_{it}) = a + \alpha \ln(K_{it}) + \beta \ln(L_{it}) + \delta_t + u_{it}, \quad (1)$$

where $i = 1, \ldots N = 276$ regions; $t = 1990, \ldots.\ 2007$ (18 years); VA is value added, K is capital stock, and L are units of labor; δ_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.[9] Once the estimates for the sectoral α and β coefficients are obtained, we calculate the TFP levels for the initial year 1999 and for the final year 2007 by applying the standard growth accounting approach and assuming that factor

[7]A complete description of all the variables and data sources is reported in Appendix A.

[8]A more detailed sectoral breakdown would be preferred to analyze the impact of agglomeration externalities on local industry productivity growth, but this is the highest level of sectoral disaggregation available for the whole of Europe.

[9]The stock of physical capital is calculated by applying the perpetual inventory method to the flow of gross investment in the previous period and assuming an annual depreciation rate equal to 10 percent. The capital stock value for the initial year 1999 has been assumed to be equal to the cumulative sum of investment flows over the 10-year period 1989–1999.

TABLE 2: Sectoral Production Functions Estimated Elasticities

Dependent Variable: Value Added	Capital Stock	Labor Units
S1 Mining, energy	0.466	0.269
S2 Food, etc.	0.455	0.375
S3 Textiles, etc.	0.444	0.391
S4 Chemicals, etc.	0.607	0.365
S5 Electrical, optical eq.	0.488	0.488
S6 Transport equipment	0.451	0.400
S7 Other manufacturing	0.501	0.431
S8 Construction	0.164	0.802
S9 Distribution	0.191	0.862
S10 Hotels, restaurants	0.125	1.029
S11 Transport, communications	0.249	0.689
S12 Financial intermediation	0.059	1.035
S13 Real estate, business, etc.	0.160	0.792
All sectors	0.336	0.587

Notes: For each sector estimates are obtained from a balanced regional panel ($N = 276$), observed over the period 1990–2007 ($T = 18$), $N \times T = 4{,}968$. The estimation method is 2SLS with one year lagged regressors as instruments. Constant and time period fixed effects included, all coefficients are significant at 1 percent level.

elasticities are invariant over the period considered. The average annual TFP growth rate for each local industry is then computed for the eight-year period 1999–2007.

The estimation of varying elasticities at sectoral levels across regions is expected to adequately capture the well-documented heterogeneity in traditional inputs production effectiveness (see, among others, the review by Durlauf, Johnson, and Temple 2009 and references therein).[10]

Differently from the case when firms/plants level data are used, in our framework of regional aggregated data we cannot make use of the control function approach to deal with the usual production function endogeneity problem. Since there is no clear estimation strategy in the case of aggregate data, we tackle the endogeneity issue by applying the two stage least squares (2SLS) estimation method and by carrying out a robustness check on our results by computing also inputs' elasticities on the basis of the traditional Solow's method. Note that, although this latter method is robust to endogeneity threats, it comes at the cost of assuming perfect competition and imposing constant returns to scale. For each sector the labor elasticity (β) is thus obtained as the sectoral share of wages on value added[11] and the capital elasticity as $\alpha = 1\text{-}\beta$. The TFP growth indicator obtained on the basis of Solow's elasticities is used to carry out the robustness analysis discussed in Section 6.

Focusing on the estimation of sectoral production functions as formalized in (1), we apply the 2SLS method using as instrumental variables the one year lag for both capital and labor.[12] The results, reported in Table 2, 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 labor units the range is defined by the elasticity of the mining sector (0.27) and the one associated with

[10]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.

[11]As measure of wages we have used the compensation of employees for our 13 sectors obtained from the Eurostat database.

[12]We have also considered longer lags and the results remained broadly unchanged.

TABLE 3: Total Factor Productivity

	1999		2007		Annual Average Growth
	Index Europe = 100	Variation Coefficient	Index Europe = 100	Variation Coefficient	Rate % 1999–2007
Old Europe: EU15, Norway, Switzerland	115	0.86	113	0.59	0.48
New Europe: 12 new accession countries	41	0.33	50	0.28	2.80
Whole Europe	100	0.93	100	0.65	0.95

the financial intermediation sector (1.03). For the purpose of comparison with previous findings, at the bottom of Table 2 we also report the average elasticities obtained by pooling all the 13 sectors. With an estimated value of 0.34 for capital and 0.59 for labor, these results confirm the elasticities generally used within the growth accounting approach (0.3 for capital and 0.7 for labor) under the assumption of constant returns to scale. On the basis of our results, it is worth emphasizing that average values of elasticities mask the great deal of heterogeneity detected across sectors, which, following our methodology, is directly considered in the calculation of more accurate TFP estimates.

Table 3 reports some summary measures for the estimated TFP levels for the initial (1999) and the final (2007) year of the period for which the growth rate is calculated. Considering TFP as an index number with the European average set equal to 100, the figures signal a significant economic divide between the Old European regions and the regions of the new accession countries. In 1999, the EU15+ group exhibits a TFP level which is 15 percent higher than the total average level, while New regions account for just 40 percent of the average value. The divide, however, shows a decreasing trend as the 2007 values for Old Europe are lower when compared to the 1999 ones (113) and conversely, those for the New Europe are higher (50). Moreover, the annual average TFP growth rate (2.8 percent) of the New EU member countries' regions is almost six times as high as the one exhibited by the Old regions.

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 due to the integration process. In the subsequent sections we present the empirical analysis aimed at identifying the most relevant determinants of the different economic performance in the New and Old Europe.

4. BASIC MODEL AND METHODOLOGICAL ISSUES

In this section we define our basic empirical model and the estimation strategy. Our objective is to explain what are the structural forces driving the different regional TFP dynamics across Europe over the last decade. Consequently, our dependent variable is the TFP growth rate at the regional and industrial level from 1999 to 2007. The productivity gains recorded by TFP dynamics are, according to theoretical and empirical literature, influenced by at least three types of externalities: those related to intra-industry specialization or to inter-industry diversity and, finally, the degree of competition within each local market.

First, intra-industry specialization externalities, also named 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 labor force and the transmission of knowledge. In particular, concentration of firms in a regional district specialized in a given production is believed to promote knowledge spillovers and facilitate innovation at the local-industry level. It is worth noting, however, that concentration may also trigger local competition which may imply that dispersion forces are set in motion. The most common way to measure specialization externalities (SPE) is by means of a location quotient (the quota of industry employment in a region relative to the European share), since it captures both the relative importance and the intensity of the phenomenon. For region i (out of 276 regions) and industry j (within a set of 13 sectors) we then define our specialization index based on employment as:[13]

$$\mathrm{SPE}_{ij} = \frac{L_{ij} \Big/ \sum_j^{13} L_{ij}}{\sum_i^{276} L_{ij} \Big/ \sum_i^{276} \sum_j^{13} L_{ij}}.$$

On theoretical grounds we expect a positive effect for the Marshallian externalities, measured by specialization, unless congestion and competitive effects prevail generating additional costs and offsetting the advantages of firms concentration. These possible opposite effects of specialization externalities are actually reflected in the conflicting empirical evidence provided so far.

Second, 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-fertilization across industries. In other words, complementary knowledge is conducive to the emergence of new prospects which are not available within the usual industrial routines. This externality is usually attributed to urban regions, which are large and dense cities, and can be offset by the typical congestion effects of metropolitan areas. 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, 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, as in Combes (2000), in such a way that the sum of the squares of employment for a given region and a given sector does not include the employment of that sector. We, therefore, provide a proper measure of diversity (DIV) of sector j in region i with respect to the rest of the economy ($j' \neq j$). This method of computation implies that the index is calculated for the two available dimensions, that is sectors and regions. For a given region i and industry j it is computed as:

$$\mathrm{DIV}_{ij} = \frac{1}{\sum_{\substack{j'=1 \\ j' \neq j}}^{13} (L_{ij'}/L_i - L_{ij})^2}.$$

Which of the two forces actually dominates is, again, an empirical question and in previous contributions both positive (Glaeser et al., 1992; Van Soest et al., 2006) and negative (Henderson, 2003; Rosenthal and Strange, 2003) impacts have been found.

The last local industry indicator of agglomeration externalities is usually referred to the contribution of Porter (1990), who argues that a competitive environment can induce a boosting effect on productivity. Glaeser et al. (1992) introduce the average firm size (FS)

[13] In the regression models the specialization indicator is included in its normalized form: $\mathrm{SPEN}_{ij} = (\mathrm{SPE}_{ij} - 1)/(\mathrm{SPE}_{ij} + 1)$.

measured by total employment over the number of firms in each local industry as a proxy for this phenomenon, as larger firms imply more market power. 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 as a measure of potential economies of scale at the firm level, which can have a role in enhancing the efficiency of the local sector. As far as the effect of competition is concerned, some authors (Combes, 2000; Martin et al., 2011), use firm level data to provide an accurate measure, indicating that local competition has either a negative or a nonsignificant effect on growth. Results for firm size are similar, as the influence of dimension on productivity is mostly negative and significant (Paci and Usai, 2008).

Finally, the subsequent growth path for each region-sector pair is made conditional on the relative economic state at the beginning of the period considered by including the initial TFP level.

In light of the previous discussion on the potential determinants of TFP growth, we specify the basic empirical model as follows:

$$\text{TFP\_growth}_{ij,99-07} = \beta_0 + \beta_1 \text{SPE}_{ij} + \beta_2 \text{DIV}_{ij} + \beta_3 \text{FS}_{ij} + \beta_4 \ln(\text{TFP}_{ij,99}) + \sum_{j=1}^{12} \gamma_j \text{SD}_j + \varepsilon_{ij}, \quad (2)$$

where i refers to the 276 regions and j to the 13 sectors, the full sample comprises 3,588 local industries.

In specifying model (2) we follow a well-established approach proposed in the empirical literature (among others: Glaeser et al., 1992; Henderson et al., 1995) to estimate and identify the causal relationship between TFP growth and its determinants. Since (2) is a cross-section regression where the dependent variable is the annual average growth rate of TFP, calculated over a time span of almost a decade (1999–2007), and the set of explanatory variables are included at their initial period level value, it can be considered a long-run relationship, so that the estimated coefficients can be interpreted as the causal effects of agglomeration externalities. As discussed in Section 2, the inclusion of initial period regressors is expected to rule out endogeneity problems.

In model (2) we deal with heterogeneity across industries by including sectoral dummy variables (SD), 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. Moreover, to take into account the possibility of some cross-regional dependence arising from the presence of spatial spillovers, or from omitted explanatory variables related to the spatial features of the data, we adopt the specific estimation approach which contemplates spatial dependence between sectors belonging to neighboring regions.[14]

Given the high number of local industry observations (3,588), the TFP growth rate distribution exhibits a certain degree of variability, we found that about 6 percent of the observations are greater in absolute value than two times the sample standard deviation. Dropping the extreme value observation would result in an altered spatial structure, which would yield biased estimates. Therefore, in order to preserve the spatial pattern we follow what is common practice in the time series context (see among many authors, Franses 1998), where atypical observations are accounted for by the inclusion of indicator

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

TABLE 4: Agglomeration Externalities and TFP Growth

Dependent Variable: TFP, % Annual Average Growth Rate 1999–2007	4.1 OLS	4.2 ML, Error Model	4.3 ML, Lag Model
Specialization externalities	0.41**	0.27	0.40**
	(2.13)	(1.35)	(2.11)
Diversity externalities	−0.32***	−0.29***	−0.28***
	(−5.84)	(−5.09)	(−5.16)
Firms size	0.002***	0.001***	0.001***
	(3.18)	(2.70)	(2.73)
Initial TFP level (1999)	−0.95***	−0.97***	−0.93***
	(−11.81)	(−11.81)	(−11.87)
Spatial error autocorr. coefficient (ρ)		0.84***	
		(27.42)	
Spatial lag coefficient (λ)			0.80***
			(27.37)
Square correlation (actual, fitted values)	0.55	0.51	0.47
Robust LM test—spatial error	80.68		
P-value	0.00		
Robust LM test—spatial lag	1.65		
P-value	0.20		

Notes: Observations: 276 regions, 13 sectors, total 3,588. All regressions include a constant and 12 sectoral dummies. All explanatory variables refer to 1999; the initial period level of TFP is log-transformed. The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized. Asymptotic *t*-statistics in parenthesis. Significance: ***1 percent; **5 percent; *10 percent.

functions in order to maintain the general dynamic behavior of the variable. In our empirical spatial model we include two dummy variables for positive and negative extreme values. For robustness we estimate model (2) by Ordinary Least Squares (OLS) for the full sample including the two dummy variable and for the restricted sample excluding the extreme value observations. We found no significant evidence of differences in the estimated coefficients of all the explanatory variables.

Preliminarily, on the basis of the OLS regression (see model 4.1 in Table 4) we calculate the Lagrange multiplier (LM) robust tests, designed for the null hypothesis of no spatial correlation in the residuals of models such as (2); under the alternative hypothesis either a spatially lag dependent variable is omitted in (2) (LM test-spatial lag) or the error term is spatially autocorrelated (LM test-spatial error). The tests are computed using, as a spatial weight matrix (**W**), the matrix of the square of the inverse distance in kilometers between any two regions in the sample; **W** is normalized by dividing each element by its maximum eigenvalue.[15] As entries of the **W** matrix, we choose the square, rather than the linear, of the inverse distances as this allows to better discriminate between neighboring and distant regions by increasing the relative weights of the closest ones.[16] The results of the LM tests point out that spatial effects are indeed present and that the spatial error specification is to be preferred. For this specification the mean equation is represented by

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

[16]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.

(2) but the error term is specified as follows:

$$\varepsilon_{ij} = \rho \mathbf{W} \varepsilon_{ij} + u_{ij}, \quad (3)$$

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

The estimated spatial error model formed by Equations (2) and (3) is reported in the second column of Table 4, note that the interpretation of the coefficients is the same as in the case of the linear regression model; as for the spatial association, this is clearly present and signaled by the significance of the spatial autocorrelation coefficient; in the third column we also report the spatial lag model to provide a preliminary comparison and a robustness check. Focusing on the explanatory variables, specialization externalities show a positive effect on growth, although they are significant for the OLS and the spatial lag model but not for the spatial error one. A much more stable result comes from the diversity externalities and the economies of scale; in all models the former are negatively related to TFP growth while the latter have a positive relation. Finally, the relationship between TFP growth and its initial value is, as expected, negative and significant, implying the presence of "conditional" convergence.

These preliminary results are basically in line with the few previous studies on TFP growth and agglomeration externalities reviewed in Section 2, Dekle (2002) and Cingano and Schivardi (2004); results from other studies are not directly comparable since they use other proxies for economic growth (see Beaudry and Shiffeaurova, 2009 for an exhaustive account on the critical aspects related to this issue).

Note that, for the estimated models reported in Table 4 and for all the other ones discussed in the subsequent sections, 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).[17] The results, not reported to save space, confirm the empirical significance levels reproduced in our tables.

5. THE DIFFERENT EFFECTS OF AGGLOMERATION EXTERNALITIES IN OLD AND NEW EUROPE

As expected on the basis of the agglomeration externalities features, discussed in detail in Section 2, the results presented above provide contrasting evidence on their effects on productivity growth at the regional and industrial level. In this section we investigate whether such results are due to the fact that the local industry impacts are restricted to be equal across different regions and sectors, regardless of the countries' development stage (Old vs. New Europe), the specialization pattern (low-tech manufactures vs. knowledge-intensive services) or the territorial features (urban vs. rural areas).

In the first step of our estimation strategy we account for the different development stage by simply including an additive dummy variable (new countries) for the 56 regions of the EU12 countries. It is worth noting that such a dummy substitutes the initial conditions variable to avoid problems of multicollinearity since the two indices are strongly correlated. As before, we start by estimating the model by OLS (5.1 in Table 5) and testing for residuals spatial association and for the kind of model

[17] 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, 1,300 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.

TABLE 5: Differences between Old and New Europe

Dependent Variable: TFP, % Annual Average Growth Rate 1999–2007

	5.1 OLS	5.2 ML	5.3 ML	5.4 ML	5.5 ML
Specialization externalities	0.32*	0.16	−0.23	−0.49**	−0.48*
	(1.62)	(0.78)	(−0.95)	(−1.93)	(−1.90)
Diversity externalities	−0.28***	−0.26***	−0.18***	−0.16**	−0.17***
	(−4.72)	(−4.24)	(−2.80)	(−2.38)	(−2.53)
Firms size	0.002***	0.001***	0.002***	0.002***	0.002***
	(2.99)	(2.45)	(3.13)	(3.23)	(3.23)
Specialization externalities in new countries[(a)]			1.69***	1.28**	1.21**
			(3.33)	(2.21)	(2.09)
Diversity externalities in new countries			−0.46***	−0.51***	−0.49***
			(−2.65)	(−2.90)	(−2.82)
Firms size in new countries			−0.01***	−0.005***	−0.005***
			(−2.90)	(−2.48)	(−2.48)
Specialization externalities for LTM[(b)] sectors in new countries				3.22***	3.29***
				(2.81)	(2.87)
Specialization externalities for KIS[(b)] sectors in old countries[(a)]				1.98***	1.50**
				(2.61)	(1.93)
Diversity externalities for KIS sectors and Urban settlement pattern					0.03***
					(2.77)
New countries	0.66***	0.64***	4.34***	4.46***	4.37***
	(4.76)	(4.51)	(3.30)	(3.39)	(3.32)
Spatial error autocorrorelation coefficient (ρ)		0.85***	0.84***	0.84***	0.84***
		(29.29)	(27.82)	(27.03)	(26.66)
Square correlation (actual, fitted values)	0.53	0.49	0.50	0.50	0.50
Robust LM test—spatial error	65.41				
P-value	0.00				
Robust LM test—spatial lag	4.20				
P-value	0.04				

Notes: (a) New countries: dummy with value 1 for regions in the 12 accession countries; old countries: dummy with value 1 in EU15 plus Switzerland and Norway

(b) LTM = low-tech manufacturing sectors; KIS = knowledge-intensive services sectors (see Appendix B). Observations: 276 regions, 13 sectors, total 3,588. All regressions include a constant and 12 sectoral dummies; all explanatory variables refer to 1999. The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized. Asymptotic *t*-statistics in parenthesis. Significance: ***1 percent; **5 percent; *10 percent.

suggested by the diagnostics. LM tests point out that the spatial error model is still the most adequate specification. Accordingly, this model is proposed in column 5.2, where the positive and significant coefficient of the new countries' dummy shows that TFP, as anticipated, grows more rapidly in the 12 accession countries. As far as the other determinants are concerned, previous results are substantiated. In particular, specialization externalities are positive and marginally significant in the OLS but not so in the spatial error model.

This finding, associated with the theoretical considerations reported above, hints at another extension of the model that discriminates further the impact of agglomeration externalities according to the countries' development stage. We maintain that more mature, industrialized, and diversified economies are represented by the old EU15+ countries, while the less developed and more specialized regions are proxied by the new

TABLE 6: Computed Effects of Agglomeration Externalities

	Old Europe	New Europe
Model 5.3	All Sectors	All Sectors
Specialization externalities	−0.230	1.460
Diversity externalities	−0.180	−0.640
Firms size	0.002	−0.008
Model 5.4	LTM	LTM
Specialization externalities	−0.490	4.010
Diversity externalities	−0.160	−0.670
Firms size	0.002	−0.003
	KIS	KIS
Specialization externalities	1.490	0.790
Diversity externalities	−0.160	−0.670
Firms size	0.002	−0.003
Model 5.5	LTM	LTM
Specialization externalities	−0.480	4.020
Diversity externalities	−0.170	−0.660
Firms size	0.002	−0.003
	KIS	KIS
Specialization externalities	1.020	0.730
Diversity externalities, SST = 1	−0.140	−0.630
Diversity externalities, SST = 6	0.010	−0.480
Firms size	0.002	−0.003

Notes: The effects are computed from the regression models 5.3–5.5 reported in Table 5. LTM = low-tech manufacturing sectors; KIS = knowledge-intensive services sectors (see Appendix B).

accession EU12 countries.[18] Although we are aware that this is a broad distinction and that there are differences in the development stage within each macro-area,[19] we prefer to keep this simple distinction since it is also easily interpretable in terms of spatial policy implications.

In regression 5.3 we include three additional regressors obtained as interaction terms between the new countries dummy and each of the three kinds of agglomeration externalities considered. In Table 6, to facilitate the comparison across the estimated models, we summarize the computed overall effects for each agglomeration indicator and for the two macro-areas. The results reported are quite informative as specialization externalities maintain their positive impact on efficiency growth only in the new accession countries, while their effect for more mature western countries 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 positively affect efficiency growth in the EU15+, where a greater role for large firms is assumed, while it exerts a negative effect in the EU12, where there is a prevalence of small and medium enterprises. Evidence of different effects (in terms of either sign or size) implies

[18]The differences between Old and New European countries in terms of TFP are reported in Table 3, but the same wide territorial contrast emerges also by looking at the GDP per capita.

[19]Within the old countries there are lagging regions in Southern Italy, Greece, and Portugal with low GDP per capita; at the same time few regions in EU12 show a relatively high development stage as, for instance, Prague.

that the growth patterns of these two macro-areas of Europe are distinct even though interdependent.[20]

This analysis is coherent with the findings provided in Brülhart and Mathys (2008) and in Foster and Stehrer (2009), the only two previous works which introduce a potentially differentiated role for agglomeration externalities for Old and New Europe. These authors find that such externalities are stronger in regions of new member countries because of the concentration of productive activities in capital regions inherited from past centrally planned economies. Both works, however, focus on agglomeration externalities resulting from the simple polarization of economic activities rather than from specific sources as in our study.

Our interpretation relates the role of specialization and diversity externalities to the product life cycle and to the different phases of the development path currently undertaken by the two European macro-areas. The Old Europe is in an advanced phase of industrial restructuring, services expansion, and reorientation: industrial districts are either dismantled or transformed and this implies a process of delocalization which has often involved regions in the New Europe. This process is leading the Old Europe to a new business core focused on KIS and high value added activities and the New Europe to activities more specialized in traditional and low-tech manufactures, where the Marshallian externalities are still expected to play an important role. This view points to an additional extension of the model in order to account for possible differences in the effectiveness of Marshallian externalities according to the sectoral specialization within each macro-area. We thus augment model 5.3 by introducing two new regressors that are the result of a further interaction of specialization externalities with LTM sectors in the New Europe and with KIS ones in the Old Europe.

Results are reported in column 5.4 and show some remarkable novelties (see also the computed overall impacts in Table 6). The new variables' coefficients are both positive and significant, confirming theoretical predictions. Most interestingly, specialization externalities become now negatively related to productivity growth in the Old Europe, suggesting the prevalence of congestion effects. However, the negative impact of specialization is present only in old countries for low-tech manufacturing, while Marshall's predictions prove right for low-tech industries in the New Europe and in knowledge-intensive services in both Old and New Europe, with a greater impact in the former macro-area.

Our estimated impacts imply that if the share in the LTM sectors located in a given New country region increases in the economy by, say, 10 percent, TFP growth would rise by 0.2 percentage points, while the same increase in the share of a KIS sector would lead to an additional growth of productivity of 0.07 percentage points in an Old Europe region and of 0.03 in a New country one.[21] These results are consistent with previous works at the sectoral level (Dekle, 2002 and Brülhart and Mathys, 2008) which, however, do not relate this outcome to differences in the development stage.

The final extension of the empirical specification deals with another central aspect in Duranton and Puga's model, that is, the role of urban areas as nursery for innovation pulled by diversification. Consequently, we introduce the settlement structure typology index (SST), which distinguishes six types of regions according to two dimensions, density and city size: the less densely populated areas without centers take value one while

[20]We have also estimated a model where GDP per capita, as direct measure of the development stage, is included in the interaction terms in place of the dummy for NEW countries. The results confirm that, for the case of wealthier economies, specialization externalities have the expected negative sign but they are not significant, while diversity externalities are positive and more effective.

[21]Note that the estimated average annual growth rates for TFP are 4.6 percent for LTM sectors in new countries, 0.4 percent and 2.1 percent for KIS sectors in Old and New countries, respectively.

the very densely populated regions with large centers, that is the urban areas, take the maximum value of six. This index is interacted with the diversity externalities in knowledge-intensive services, since we aim at testing whether the "nursery cities" hypothesis that diversification is important in the first stages of product development holds true, at least for advanced services.

The estimated effects, reported in column 5.5 and summarized in Table 6 in terms of computed impacts, are quite informative. While previously discussed results on the varying effects of specialization externalities are confirmed, we now find that diversity externalities for KIS sectors in urban settlements appear to have a positive influence on productivity growth. This result is made more explicit when the computed effects are calculated for rural areas (SST = 1) and for very densely populated areas with large centers (SST = 6). In the former case, diversity for advanced services has still a negative effect, while in the latter case a positive impact emerges. Although the effect is not sizeable, we think that this result is quite relevant since it highlights the fact that in densely populated regions the positive forces of diversity are strong enough to contrast the general negative effects founds for the economy as a whole. Moreover, this finding can be considered reliable since the significant positive impact of diversity emerges even at the regional scale, which in general is too aggregate to adequately capture such kind of externalities; their positive role had been detected so far only at the finer scale of metropolitan areas (Glaeser et al., 1992; Van Soest et al., 2006).

Our result implies that the pro-innovative and pro-efficiency effect of diversification is limited to those sectors, which are based on the creation and exchange of knowledge and information. These ingredients are essential for the development of new products and processes thanks to cross-fertilization among sectors.

6. ROBUSTNESS CHECKS AND EXTENSIONS

In this section we first provide some robustness checks for our results and then we present an extension of the basic model by including the endowments of intangible factors available in each region as additional determinants of productivity growth.

As already discussed in Section 3, our results may be influenced by the methodology followed for TFP computation, which was based on the estimation of labor and capital elasticities within a Cobb-Douglas production function setting. However, such estimates may be biased by possible endogeneity problems or by errors in the computation of the capital stock series. We have thus calculated TFP growth rate by applying Solow's method, sectoral labor elasticities are computed as the share of wages on value added and the capital coefficients are derived consequently under the assumption of constant return to scale. Using this alternative dependent variable we have re-estimated all the specifications presented in Table 5; however, to save space, in Table 7 we report the results of the robustness checks only for the most general specification (regression 5.5 in Table 5).

The results reported in model 7.1 of Table 7, which refer to the TFP computed according to the Solow methodology, confirm all the previous findings. In particular, the general coefficient of diversity being not significant reinforces the positive effect (0.206) computed for the diversity externality in the KIS sectors in the urban areas of the Old Europe.

The second robustness exercise regards the inclusion of country dummies to control for omitted national factors, in addition to the dummy "new countries" already included in our regressions, which may affect productivity growth. We have tried to include a full set of country dummies but, as expected, this introduces too strong a requirement on the data. Thus, we have maintained the dummy "new countries" for the 12 countries of recent accession to the EU while including also a control for the largest western European countries—France, United Kingdom, and Italy—which have the highest

TABLE 7: Robustness Analysis

Dependent Variable: TFP, % Annual Average Growth Rate 1999–2007	7.1 TFP Computed with Solow's Method	7.2 Dummies for U.K., FR, IT Included	7.3 Scale Effect Included
Specialization externalities	−1.02***	−0.41*	−0.49**
	(−2.92)	(−1.61)	(−1.91)
Diversity externalities	−0.10	−0.14**	−0.17***
	(−1.15)	(−1.98)	(−2.64)
Firms size	0.00***	0.00***	0.00***
	(2.63)	(2.70)	(3.12)
Specialization externalities in new countries[(a)]	2.54***	1.13**	1.24**
	(3.19)	(1.95)	(2.12)
Diversity externalities in new countries	−0.42*	−0.52***	−0.47***
	(−1.74)	(−2.98)	(−2.68)
Firms size in new countries	0.00	0.00**	0.00***
	(0.36)	(−2.33)	(−2.52)
Specialization externalities for LTM[(b)] sectors in new countries	3.07**	3.27***	3.24***
	(1.96)	(2.86)	(2.82)
Specialization externalities for KIS[(b)] sectors in old countries[(a)]	2.97***	1.26***	1.47*
	(2.79)	(1.62)	(1.89)
Diversity externalities for KIS sectors and urban settlement pattern (SST)	0.03***	0.03***	0.03**
	(2.53)	(3.05)	(2.33)
Scale effect (total regional employment)			0.08
			−1.19
New countries	3.71**	4.43***	4.19***
	(2.06)	(3.36)	(3.17)
Spatial error autocorrelation coefficient (ρ)	0.81***	0.83***	0.84***
	(22.08)	(26.29)	(28.02)
Square correlation (actual, fitted values)	0.49	0.50	0.50

Notes: (a) New countries: dummy with value 1 for regions in the 12 accession countries; old countries: dummy with value 1 in EU15 plus Switzerland and Norway.

(b) LTM = low-tech manufacturing sectors; KIS = knowledge-intensive services sectors (see Appendix B). Observations: 276 regions, 13 sectors, total 3,588. All regressions include a constant and 12 sectoral dummies; all explanatory variables refer to 1999. Total regional employment is log-transformed. The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized. Asymptotic *t*-statistics in parenthesis. Significance: ***1 percent; **5 percent; *10 percent.

number of regional observations in our data. The dummy for Germany has been excluded since it is strongly correlated with the territorial typology variable SST, due to the fact that a large number of highly densely populated regions (SST = 6) are located in Germany. The results, reported in regression 7.2 of Table 7, provide further evidence in favor of all the main findings discussed in the previous section.

Finally, as third robustness check, in the general specification we have also included a measure of scale effects, as in Glaeser et al. (1992), proxied by the log of total employment in each region.[22] The estimation results (regression 7.3) show that the scale variable is not significant, signaling that its additional contribution is negligible once the specific kinds of agglomeration externalities at the local industry level are already accounted for. It is important to remark that our main results remain unchanged.

[22]Note that also an alternative proxy for the scale effect, the log of employment density, turns out to be not significant.

TABLE 8: The Role of Intangible Assets

Dependent Variable: TFP, % Annual Average Growth Rate 1999–2007	8.1	8.2	8.3
Regional Intangible Assets			
High human capital	3.48***		3.78***
	(3.37)		(3.52)
Technological capital	0.23***	0.32***	
	(2.78)	(3.72)	
Alternative Proxies for Regional Intangible Assets			
Life-long learning		0.17	
		(0.16)	
Research and development			7.44
			(1.38)
Local Industry Variables			
Specialization externalities	−0.39	−0.45*	−0.40
	(−1.56)	(−1.78)	(−1.58)
Diversity externalities	−0.16**	−0.19***	−0.14**
	(−2.38)	(−2.79)	(−2.07)
Firms size	0.002***	0.002***	0.002***
	(2.63)	(2.63)	(2.89)
Specialization externalities in new countries	1.18**	1.17**	1.19**
	(2.04)	(2.01)	(2.06)
Diversity externalities in new countries	−0.42**	−0.47***	−0.41**
	(−2.43)	(−2.71)	(−2.32)
Firms size in new countries	−0.005**	−0.005**	−0.005***
	(−2.41)	(−2.39)	(−2.46)
Specialization externalities for LTM sectors in new countries	3.33***	3.30***	3.40***
	(2.92)	(2.88)	(2.97)
Specialization externalities for KIS sectors in old countries	0.92	1.24	0.99
	(1.18)	(1.59)	(1.27)
Diversity externalities for KIS sectors and Urban Settlement pattern	0.02**	0.02**	0.02***
	(2.22)	(2.20)	(2.46)
New countries	4.13***	4.45***	3.85***
	(3.15)	(3.39)	(2.92)
Spatial error autocorrelation coefficient (ρ)	0.83***	0.84***	0.83***
	(26.47)	(27.42)	(26.47)
Square correlation (actual, fitted values)	0.51	0.50	0.51

Notes: Observations: 276 regions, 13 sectors, total 3,588

All regressions include a constant and 12 sectoral dummies; all explanatory variables refer to 1999. LTM = low-tech manufacturing sectors; KIS = knowledge-intensive services sectors (see Appendix B). The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized. Asymptotic *t*-statistics in parenthesis. Significant at ***1 percent; **5 percent; *10 percent.

In addition to the agglomeration externalities examined in the previous section, the growth rate of TFP in a local industry may also be affected by some regional characteristics, which are supposed to influence all sectors in a common way. Thus, we now extend our model by considering the availability in the local economy of two intangible assets: human and technological capital.[23]

[23]Productivity is also affected by other intangible assets; one of the most relevant ones is social capital, but the lack of data at the regional level for all the countries considered, prevents from directly estimating its effect on TFP growth. Since this variable is usually characterized by a high degree of

The positive role played by human capital in promoting productivity has been stressed in the literature at the country level (Benhabib and Spiegel, 1994) and also at the local one (Moretti, 2004). The availability of well-educated labor forces represents an advantage for the localization of innovative firms thus promoting local productivity. Therefore, as a proxy of "high" human capital (HHK) we use the share of population (aged 15 and over) who has attained at least a tertiary level of education, that is a university degree (ISCED 5–6).

Following the original contribution by Griliches (1979), a large body of literature has examined the influence of technological capital on economic performance at the firm level and also at regional and country levels. Since technology is partly considered as a public good, firms benefit from the local availability of a high degree of technological capital, which leads to productivity increases for the whole region (for a comprehensive survey see Audretsch and Feldman, 2004). In our contribution the amount of technological assets 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 10 years to 1999 by inventors resident in the region.

Starting from the most general specification presented in Table 5, we include both high human capital and technological capital as additional explanatory variables; the results reported in model 8.1 of Table 8—positive and highly significant coefficients—confirm that a high endowment of both the human and technological intangible assets is beneficial for the growth performance of all local industries in the regional economy. Our results are in line with previous findings on the positive effects of intangible assets in the European regions. Dettori, Marrocu, and Paci (2011) find a positive influence of human capital and patent stock on TFP together with significant interregional knowledge spillovers' effects. Empirical support to the positive effect exerted by technological activity on GDP growth rate, controlling for other regional determinants such as human capital and infrastructures, is also provided by Rodriguez-Pose and Crescenzi (2008).

It is worth remarking that all the results discussed in the previous section are maintained with only a slight reduction in the significance of the specialization externalities in the knowledge-intensive sectors in the western countries, which is likely due to multicollinearity, induced by the inclusion of the new measures of knowledge assets.

To control for the robustness of our results, we also employ a different indicator of human capital, life-long learning (LLL), which measures the diffusion of education and training among the adult population, and a new measure for the technological opportunities at the regional level, the R&D expenditure quota over GDP (RD). As a matter of fact, patent-based indicators are sometimes criticized since they do not take into account the innovative effort which is not converted into a patent. The results, reported in columns 8.2–8.3, show that the alternative proxies exhibit the expected positive sign, although they are not significant at conventional levels; in both regressions all the other coefficients remain quite stable confirming the robustness of our main findings. The construction of the RD variable is problematic, given that data for some regions are either missing or incomplete. Overall the results indicate that the proxies for the intangible assets included in model 8.1 are quite adequate in capturing the effects of the regional endowments of educational and technological capital.

7. CONCLUDING REMARKS

Economic integration between the eastern and the western sides of Europe is, by now, set along a distinct course and it is producing several substantial effects. Among them, a

persistence we control for differences in the social environment by including the initial condition variable and the dummy for the new countries.

general reduction of economic disparities and an associated economic restructuring which involves, in an integrated manner, countries and regions on both sides of the former iron curtain. On the one hand, the Old Europe has engaged in a process which relocates abroad some important segments of its manufactures while refocusing on high tech productions and knowledge-intensive services. On the other hand, the New Europe experiences the transition as a renewal of its economic system, mainly based on low-tech manufacture which, in turn, is partly the result of capital mobility from the western countries. Within this framework, both the Old and the New Europe are shifting gradually and constantly toward a service-based economy. This process is associated with significant differences in TFP levels and growth rates across 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 much higher in the East than in the West over the recent decade.

This paper argues that such different performances need to be studied simultaneously at the regional and the industrial level where important agglomeration externalities may trigger, and then foster, distinctive development paths. On the basis of Duranton and Puga's (2001) theory of nursery cities, we focus on different types of externalities, mainly those related to specialization and diversity, in order to test whether their impacts vary depending on the economic context, development stage, and territorial features in which they unwind their effects.

After providing an accurate measure of the TFP for 13 economic sectors and 276 regions, we estimate spatial error models to explain the TFP growth rate, over the period 1999–2007, as a function of local industry agglomeration externalities. Starting from a basic general model, in the econometric analysis we assess how the impact of agglomeration externalities varies according to the development stage (New vs. Old Europe), the macro sectors (low-tech manufactures vs. knowledge-intensive services) and the settlement typology (urban vs. rural areas). The main results for the two macro-areas are summarized as follows: in the Old mature countries specialization externalities in LTM sectors are negatively related to growth, suggesting the prevalence of congestion effects, while Marshall's predictions are confirmed for KIS sectors; moreover, diversity externalities show a positive influence on productivity growth only for KIS sectors in very densely populated areas with large urban centers. In the New developing countries specialization externalities exert a positive growth effect on the whole economy although their impact is five time higher in LTM; in addition, diversity externalities have a negative impact without significant differences among sectors and territorial settlements. Among the other findings, it is worth remarking the growth enhancing role played by the regional endowments of human capital and technological assets.

We, therefore, interpret our results in the light of the product life cycle model and specifically of the development path currently undertaken by the two European macro-areas. The Old Europe is in an advanced phase of industrial restructuring, services expansion, and reorientation: the traditional manufacturing districts are being either dismantled or transformed and this implies a process of delocalization which is often directed to the regions of the New Europe. Consequently, the Old Europe is focusing on knowledge-intensive services and high value added activities which are exploiting both types of agglomeration externalities: specialization and diversity. This process is strengthened within the urban environment that operates as nursery for the development of new products and processes through cross-fertilization based on the creation and exchange of knowledge and information among sectors. On the contrary, the new accession countries are still in an initial development stage and are exploiting a full range of the typical Marshallian externalities (provision of specific goods and services, suitable labor force availability, transport costs reduction, specialized knowledge transmission), which affect production mainly in the traditional low-tech manufactures through a self-reinforcing agglomeration process.

The positive evidence provided on the role played by local agglomeration externalities on productivity growth is also valuable from a policy-maker perspective as it may contribute to identifying different and more specific targets of policy interventions. In particular, the findings may help define more effective policies which differentiate economies according to their current development stage and their key growth sources in terms of specialization, diversification, and other externalities. Our results suggest the implementation of a twofold policy strategy across Europe, which still aims at specialized industrial clusters in manufactures in the New Europe, while it needs to be more oriented toward diversified urban economies in the Old Europe. Furthermore, policy interventions to promote a faster accumulation of both human and technological capital are needed in the whole of Europe, but they may have a different objective in the two macro-areas according to their differentiated production structures and economic performances.

APPENDIX A: DATA SOURCES AND DEFINITIONS

Variable		Primary 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 labor	L	Cambridge Econometrics	1990–2007	Thousands
Total Factor Productivity	TFP	Own estimation	1999–2007	
Specialization externalities	SPE	Cambridge Econometrics	1999	Normalized index of relative sectoral specialization 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
Life-long 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
Population density	DEN	Eurostat	1999	Population per km^2, thousands
Settlement structure typology	SST	ESPON project 3.1 BBR	1999	Without large centers, 1=less densely populated without centers, 2=less densely populated with centers, 3=densely populated without large centers, 4=less densely populated with large centers, 5=densely populated with large centers, 6=very densely populated with large centers

APPENDIX B: SECTORS

Sector Name		NACE 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

Notes: LTM = low-tech manufacturing; KIS = knowledge-intensive services.

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