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

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Abstract
The recent history of Europe is characterized by a dual picture showing the Old and New countries in sharp contrast with respect to their industrial specialisation and economic performance. We aim at analyzing the intertwined performance of regions and industries in New and Old European economies by investigating the effects of local agglomeration externalities (mainly specialisation and diversity externalities) on total factor productivity dynamics. More specifically, we analyse whether the agglomeration externalities effects vary according to the development stage (Old vs New Europe), the specialisation pattern (low-tech manufactures vs knowledge intensive sectors) and the settlement typology (urban vs rural areas). We also analyse the potential influence of regional intangible assets such as human and technological capital. The econometric analysis is carried out over the period 1996-2007 for 13 industries located in the 276 regions of the EU27 member countries and it makes use of spatial econometric techniques to take into account the possibility of cross-border externalities.

Keywords: Total Factor Productivity, Local industry growth, Agglomeration externalities, Spatial models, Europe.

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1. Introduction

In the last decade Europe has been growing at a dual speed: GDP in the new accession countries has progressed at a pace close to 5% per year, whilst EU15 countries have experienced a growth path at half the speed, around 2.5%. Besides, EU enlargement and the consequent economic integration has induced the Western economies to delocalize eastwards part of their traditional industries, generating a specialization in knowledge intensive services in the Old Europe and in low-tech manufacturing in the New Europe. This is clearly reflected in the sectoral employment shares, in 2007 the advanced sectors had an average share of 21.8% in the EU15 countries and just 15.8% in the EU12 members; a reverse pattern was featured by the low-tech sectors with shares of 9.8% and 16.5%, respectively.

Hence, the European economy is characterized by a dualistic scenario, shaped by geographical and industrial interconnected factors, which poses some plain research questions. Firstly, what are the forces behind this huge asymmetry in the development path among the two "Europes"? Secondly, at which territorial level do they operate and are they locally bounded? Thirdly, is there any role for agglomeration externalities which are industry-specific?

These questions represent the main motivation of this paper, which aims at analyzing the intertwined performances of regions and industries in Western/Old and Eastern/New economies in Europe by assessing the role played by agglomeration economies in determining economic performance.

Rather than focusing on the effects of a simple proxy for agglomeration, such as the spatial concentration of production (as in Brülhart and Sbergami, 2009), we examine the role of specific kinds of externalities, namely specialization and diversity. This issue has been at the centre of a copious empirical debate recently surveyed by Rosenthal and Strange (2004) and Beaudry and Schiffaurova (2009). At the same time, this is also the core theme of the theoretical research programme of the New Economic Geography, according to which geographical proximity, in the presence of localised spillovers, is beneficial for growth (Baldwin and Martin, 2004 and Martin and Ottaviano, 1999). Other contributions have, nonetheless, recognised that this effect is not guaranteed and may depend on the type of local externalities, the production structure and the development stage, as argued by Duranton and Puga (2001). They develop a model which, combining static and dynamic advantages of specialisation and diversity, predicts that firms create new products in diversified regions but, when production become standardised, they switch to mass-production and relocate to specialised regions. This model, thus, assigns a central role to plants relocations and provides a number of clear conjectures to be assessed through empirical tests.

One potentially revealing application of such tests can be the recent process of enlargement in Europe, a sort of “natural experiment” for our purpose of analysis. The enlargement, preceded by a deep reform of the institutional, social and economic system of the former centralized economies, has implied stronger economic integration and favoured a considerable process of production restructuring within and across countries and regions. In particular, we have witnessed a process of delocalization from the mature European economies towards new accession countries. 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 this paper we aim at contributing to the existing debate by carrying out a thorough empirical investigation of the specialization pattern that is markedly shaping the current European economic scenario. More specifically, following Duranton and Puga’s hypotheses, we analyse whether the agglomeration externalities effects vary according to the development stage (Old *vs* New Europe), the specialisation pattern (low-tech manufactures *vs* knowledge intensive sectors) and the settlement typology (urban *vs* rural areas).

This is done thanks to an ample dataset which allows to introduce in our analysis a number of original aspects. We investigate the regions of the whole Europe, that is, the Old EU15 members plus Norway and Switzerland (EU15+) and the New twelve countries (EU12), which entered the EU in 2004 and in 2007 (ten Eastern countries plus the Mediterranean islands of Malta and Cyprus). This broad geographical coverage of Europe permits to discriminate the performance of the old mature countries from the growth process of the new developing economies, unlike previous papers which refer mainly to the EU15. The dataset is also disaggregated at the sectoral level and consists of all market sectors for both manufacturing and services, thus excluding only agriculture and public administration. This allows us to focus, for the first time for the whole Europe, on the specific role played by specialisation and diversity externalities on the local industries’ growth process.

Other original aspects of the paper which are worth remarking are the following. The local industry performance is represented by an estimation-based measure of sectoral TFP; this was derived without imposing a priori restrictions on inputs’ elasticities and 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 growth or value added growth), since it represents a direct and comprehensive measure of productivity. Moreover, we control for the role played by the regional environment on productivity growth by considering two intangible assets, the endowments of human and technological capital. Finally, the empirical analysis makes use of spatial econometric techniques to control for the presence of some cross-border externalities.

The remainder of the paper is organized as follows. Starting with a brief overview of the literature, section 2 defines the conceptual framework of our empirical analysis. The determinants of productivity growth at the local industry level are then described in detail in section 3. Section 4 presents the estimation procedure adopted to compute the dependent variable, the TFP growth rate for each couplet of industry and region. Section 5 presents and discusses the main results of the estimated models. The role played by regional intangible assets is presented in section 6. Section 7 concludes with some general remarks on the main findings and on their possible policy implications.

2. Background and empirical specification

This section briefly outlines the theoretical and empirical framework adopted to investigate the factors determining the TFP performance of regions and sectors in Europe in the last decade.

The EU enlargement provides an exceptional case study to analyse the impact of market integration on the economies in the West and in the East of Europe. From a theoretical point of view, we expect increased specialization, economies of scale opportunities, workers (and thus consumers) migration and firms delocalization, to name just some of the most obvious consequences. Such effects are commonly included in the NEG models where localization decisions are the result of the combination of centripetal and centrifugal forces, which are usually labelled “agglomeration externalities” (Krugman, 1991). Such externalities may include labour market pooling, input sharing, better access to markets and technological and knowledge spillovers within and across sectors. Baldwin and Martin (2004) claim that these agglomeration forces enhance local productivity and, therefore, have an effect on growth. Most importantly, such aggregate economic gains may be associated with a restructuring of national economies with important consequences on sectoral and geographical distributions (Brülhart and Koenig, 2006).

This general conceptual background provides an adequate interpreting scenario of the main stylized fact reported above: the huge disparity in productivity trends between mature economies in the West and new accession countries in the East. In fact, the East-West divide has been an important economic phenomenon since the iron curtain fell down and formerly centralized economies started their transition towards the market system (Ertur and Koch, 2006 and Burda and Severgnini, 2009). During this period, these countries have experienced a dramatic transformation, characterized by an intense restructuring of their economic, social and institutional systems. In the last twenty years, the outdated 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., 2004, Mora et al., 2006 and EESC, 2009). This transition process, as expected, 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 (ERM, 2007).

Table 1 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 decade. In particular, the Old Europe is clearly specialized in knowledge intensive services (KIS) (in 2007 the employment quota is 21.8% *vs* 15.8% in the EU12), whilst the New Europe is still relatively more specialized in low-tech manufacturing (LTM) (the employment quota is 16.5% *vs* 9.8% in EU15+). 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 additional 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) 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. From different theoretical perspectives, Duranton and Puga (2001) and Boschma (2005) show 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. In particular, Duranton and Puga (2001), while endowing with solid micro-foundations the well-known Jacobs' (1969) argument on the importance of diversified urban areas in fostering innovation, claim that diversified urban environments are essential to promote search and experimentation of new prototypes. Once this search is over and the right product and/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 (1890) externalities prevail. At the end of the life cycle, according to Boschma (2005), specialisation might even prove harmful to economic growth since lock-in effects prevent economies from exploiting new promising technological trajectories. Empirical support to these hypotheses is provided by Neffke et al (2011) for the case of twelve Swedish manufacturing industries.

In light of the above, we expect that one potentially important reason for 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 externalities (Marshall, 1890), diversity externalities (Jacobs, 1969) and competitive externalities (Porter, 1990). A large amount of literature has inquired about the influence of these local spillovers on local economic performance, with a large range of methodologies, data and results. From our point of view, the recent contributions of Brülhart and Mathys (2008) and Foster and Steher (2009), who extend the agglomeration model of Ciccone (2002) to the industry level, deserve special attention. Contrary to our analysis, these studies do not explicitly distinguish between different kinds of agglomeration externalities. However, the work by Brülhart and Mathys presents an interesting focus on Manufacturing and Financial Services, that is, those sectors whose firms are relatively more footloose and thus tend to move in order to exploit agglomeration-induced productivity effects. They find evidence in favour of a dominant pattern of cross-sector urbanization economies, while productivity positive effects due to own-sector density are found only for Financial Services. Foster and Steher (2009) 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.

In the next sections, after providing a detailed description of how we measure the three kinds of agglomeration externalities, we present our empirical analysis based on the theoretical framework discussed above.

3. The determinants of productivity growth

In this section we discuss the main explanatory variables included as determinants of productivity growth. A complete description of all the variables and data sources is reported in Appendix 1 while the sectoral classification is shown in Appendix 2.

First of all, we consider three different types of agglomeration externalities which can be computed for each couple of industry and region. 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. 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 specialisation externalities (*SPE*) is by means of a location quotient (the quota of industry employment in a region relative to the national share), since it captures both the relative importance and the intensity of the phenomenon. On theoretical grounds we expect a positive effect for the Marshallian externalities, measured by specialisation, up to the point when congestion and competitive effects start to prevail. Not surprisingly, the empirical evidence provided so far has been controversial, with some authors (Cingano and Schivardi, 2004) reporting positive and significant results for specialization spillovers while others (Paci and Usai, 2008) find the effect to be 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 prospects which are not available within the usual industrial routines. This externality is usually attributed to urban regions, that is large and dense cities, and can be offset by the typical congestion effects of metropolitan areas. Which force dominates is, again, an empirical question. 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 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 of the sector we refer to with respect to the rest of the economy. This method of computation implies that the index is calculated 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 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.

Finally, in light of previous empirical literature, one last potential determinant of TFP growth to be included in our basic estimation is its relative economic state at the beginning of the period under examination. We, therefore, insert the initial level of TFP as determinant of the subsequent growth path for each couple of region and sector.

4. 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, adequately measuring these two phenomena is a crucial issue. This is a prerequisite to study how differences in efficiency and technological capability arise across countries and regions and how they change over time.

A measure of economic performance which focuses on both efficiency and technology is TFP. 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 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 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 five major manufacturing industries in the 15 pre-2004 EU member states.

In this study TFP is computed thanks to a time series dataset (from 1990 to 2007), which includes 276 regions of 29 European countries and 13 sectors 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:

$$\ln(VA_{it}) = a + \alpha \ln(K_{it}) + \beta \ln(L_{it}) + \delta_t + u_{it} \qquad (1)$$

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; 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. Once the estimates for the sectoral α and β 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 is expected to adequately capture the well documented heterogeneity in traditional inputs production effectiveness (see, among others, the review by Durlauf et al. 2009 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 TSLS due to possible endogeneity problems. 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 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). 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 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 the great deal of heterogeneity detected across sectors, which, following our methodology, is directly accounted for in order to get 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, figures signal a significant economic divide between the Old European regions (EU15 plus Norway and Switzerland) and the regions of the new accession countries. 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 when compared to the 1999 ones 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.

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 on the main determinants of the different economic performance in the New and Old Europe.

5. The effects of agglomeration externalities

5.1 Basic model and methodological issues

In light of the discussion reported in the previous sections on the potential determinants of TFP growth and on the computation of the dependent variable, we can specify the empirical model as follows:

$$TFP\_growth_{ij,99-07} = \beta_0 + \beta_1 SPE_{ij} + \beta_2 DIV_{ij} + \beta_3 FS_{ij} + \beta_4 \ln(TFP_{ij,99}) + \sum_{j=1}^{12} \gamma_j SD_j + \varepsilon_{ij} \quad (2)$$

where *i* refers to the 276 regions and *j* to the 13 sectors.

It is worth reminding that 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. The explanatory variables are measured at their initial period level (1999) in order to deal with potential endogeneity problems. Moreover, to take into account the possibility of some cross-regional externalities 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 neighbouring regions.[1] Finally, note that the estimated models include also 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.

Preliminarily, on the basis of the OLS regression (see model 4.1 in table 4) we calculate the 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 each possible couple of regions; *W* is normalized by dividing each element by its maximum eigenvalue[2]. 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

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

[2] 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).

distant regions by increasing the relative weights of the closest ones[3]. 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 (2) but the error term is specified as follows:

$$\varepsilon_{ij} = \rho W \varepsilon_{ij} + u_{ij} \tag{3}$$

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 (2)-(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, results seem to depend on the model specification selected: specialisation externalities have 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, the former are negatively while the latter are positively related to TFP growth in all models. Finally, the relationship between TFP growth and its initial value is, as expected, negative and significant, implying the presence of “conditional” convergence (as in Cingano and Schivardi, 2004).

Our results are basically in line with the few previous studies on TFP growth and agglomeration externalities. Dekle (2002), for example, in his studies on Japanese prefectures finds some weak evidence for Marshallian externalities, but no one of Jacobs’s externalities, whilst Cingano and Schivardi (2004) for Italian local labor systems find that TFP growth is enhanced by specialization but not by urban diversity. Results from other studies are more ambiguous and they 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)[4]. The results, not reported to save space, confirm the empirical significance levels reproduced in our tables.

[3] 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.
[4] 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

5.2 Differences between Old and New Europe

The results discussed in the previous section provide contrasting evidence on the general role played by agglomeration externalities in influencing productivity growth at the regional and industrial level. In particular, the relevance of specialization externalities proves uncertain and dependent, to some extent, on the model specification adopted. In this section we investigate whether such instability is due to the fact that the local industry impacts are restricted to be equal across countries and across sectors. At the same time a more adequate specification of our model should bring about a better understanding of the economic forces which are driving the differing West/East productivities.

This goal is achieved by expanding model (2)-(3) above with some additive and interactive dummies which are meant to distinguish among countries, sectors and regions depending on their development stage, their geographical mobility and their settlement typology, respectively. The first step of this process is the simple inclusion of a dummy variable (New countries) for the 56 regions of the EU12. 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 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 twelve 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 outcome, associated to the theoretical considerations reported above, 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 all our explanatory variables in order to assess whether specialization, diversity and scale economies effects vary significantly when considering regions in the Eastern rather than in the Western part of Europe.

The results reported in regression 5.3 and summarized in Table 6, where computed coefficients for the two macro-areas can be more easily compared, are quite interesting. Specialization externalities maintain their positive impact on efficiency growth only in the new accession countries whilst their effect for more mature Western countries is negative even though

approximately correspond to the first decile, the first quartile and the median of the distribution of all the regional distances considered.

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, whilst it exerts a negative effect in the EU12, where there is a prevalence of small and medium enterprises. Evidence 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.

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 polarisation of economic activities rather than from specific sources as in our study[5].

Our interpretation relates the role of specialization and diversity externalities to the product life cycle and to the different phase of the development path currently undertaken by the two European macro-areas. The Old Europe is in an advanced phase of industrial restructuring and service 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 knowledge intensive services 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 sectoral and macro-area differences. We augment model 5.3 by introducing two new regressors which are the result of the interaction of specialization externalities with, on the one hand, low-tech manufacturing in the New Europe and, on the other hand, knowledge intensive services in the Old Europe.

Results are reported in column 5.4 and show some remarkable novelties (see also the computed coefficients in Table 6). The new variables are both positive and significant, confirming our expectations and theoretical predictions. Most interestingly, specialization externalities become now negatively related to growth in the Old Europe, suggesting the prevalence of congestion effects. However, this effect has to be decomposed into two parts: the negative impact of

[5] In alternative specifications we also included the population density variable, however it always turned out to be not significant as its additional contribution was negligible once the specific kinds of agglomeration externalities were already accounted for.

specialization is present only in Old countries for low-tech manufacturing. Marshall's predictions have still a role to play in 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. This result is 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 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 hypothesis that diversification is important in the first stages of product development holds true, at least for advanced services in urban areas.

The estimated effects, reported in column 5.5 and summarized in Table 6 in terms of computed coefficients, are quite informative. Diversity externalities for KIS sectors in urban settlements appear to have now a positive influence on productivity growth. This result is made more explicit when the computed coefficients are calculated for rural areas (SST=1) and for very densely populated areas with large centres (SST=6). In the former case diversity for advanced services has still a negative effect, while in the latter case a positive and significant coefficient emerges. This 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. Extending the analysis: the role of intangibles assets

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, in this section we extend our model by considering the availability in the local economy of two intangible assets: human and technological capital[6].

[6] 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.

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; Faggian and McCann, 2006). The availability of well-educated labour 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 a productivity increase 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 ten years to 1999 by inventors resident in the region.

Starting from the last specification presented in Table 5, we include both high human capital and technological capital as additional explanatory variables; the results reported in model 7.1 of Table 7 - 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 intangibles assets in the European regions. Dettori et al. (2010) find a positive influence of human capital and patent stock on TFP together with a significant interregional knowledge spillovers effect. A positive role of human capital on TFP growth has been also detected by Di Liberto et al. (2008) for the case of the Italian regions. 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 Sterlacchini (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 specialisation externalities in the knowledge intensive sector 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

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Since this variable is usually characterised by a high degree of persistence we control for differences in the social environment by including the initial condition variable and the dummy for the New countries.

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 criticised since they do not take into account the innovative effort which is not converted into a patent. The results, reported in columns 7.2-7.3, 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. It is worth remarking that 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 7.1 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 general reduction of regional disparities and an associated complex 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 and has refocused on high tech productions and knowledge intensive services. On the other hand, the New Europe experiences the transition with a fresh start of its economic system, mainly based on low-tech manufacture which, in turn, 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 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 at the regional and the industrial level where important agglomeration 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 impacts and consequences can be very diverse depending on the economic context, development stage and territorial features in which they unwind their effects.

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 agglomeration externalities: specialization and diversity externalities, firm size.

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.

Starting from a basic general model, in the econometric analysis we have assessed how the impact of the agglomeration externalities on TFP growth changes according to the development stage (New *vs* Old Europe), the macro sectors (low-tech manufactures *vs* knowledge intensive services) and the territorial characteristics (urban *vs* rural areas). The main results for the two macro-areas are summarized below.

In the Old mature countries:

- specialization externalities in LTM are negatively related to growth suggesting the prevalence of congestion effects, while Marshall's predictions have still a role to play in KIS;
- 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 effect is five time higher in LTM;
- 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 and also the presence of positive spatial spillover.

We interpret our results on the differentiated role of specialization and diversity externalities in the light of the product life cycle and development path currently undertaken by the two European macro-areas, as suggested by the theoretical new economic geography literature. The Old Europe is in an advanced phase of industrial restructuring and service expansion and reorientation: the traditional manufacturing districts are 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 which 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 other hand, 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 labour force availability, transport costs reduction, specialised 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 in 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 specialisation, diversification and other externalities. Our results suggest the implementation of a dual policy strategy across Europe which still aims at specialised industrial clusters in manufactures in the New Europe, whilst it needs to be more oriented towards 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.

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Appendix 1. Data sources and definition

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 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
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	1=less densely populated without centres, 2=less densely populated with centres, 3=densely populated without large centers, 4=less densely populated with large centres, 5= densely populated with large centres, 6=very densely populated with large centres

Appendix 2. 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

LTM: Low Tech Manufacturing
KIS: Knowledge Intensive Services

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

Table 2. Sectoral production functions estimated elasticities

Dependent variable: value added		Capital stock	Labour 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 ect.	0.160	0.792
All sectors		0.336	0.587

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: TSLS with one year lagged regressors as instruments

Constant and time period fixed effects included, all coefficients are significant at 1% level

Table 3. Total Factor Productivity

	1999		2007		Annual average growth rate % 1999-2007
	index Europe=100	variation coefficient	index Europe=100	variation coefficient	
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

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
Specialisation 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		

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 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
Specialisation 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)
Specialisation externalities in New countries(1)			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)
Specialisation externalities for LTM(2) sectors in New countries				3.22 ***	3.29 ***
				(2.81)	(2.87)
Specialisation externalities for KIS(2) sectors in Old countries(1)				1.98 ***	1.50 **
				(2.61)	(1.93)
Diversity externalities for KIS sectors and Urban settlement pattern (SST)					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 autocorr. 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				

(1) 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
(2) LTM: Low Tech Manufacturing sectors; KIS: Knowledge Intensive Services sectors (see Appendix A2)
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. Computed effects of agglomeration externalities

		Old Europe	New Europe
Model 5.3		all sectors	all sectors
	Specialisation externalities	-0.230	1.460
	Diversity externalities	-0.180	-0.640
	Firms size	0.002	-0.008
Model 5.4		LTM	LTM
	Specialisation externalities	-0.490	4.010
	Diversity externalities	-0.160	-0.670
	Firms size	0.002	-0.003
		KIS	KIS
	Specialisation externalities	1.490	0.790
	Diversity externalities	-0.160	-0.670
	Firms size	0.002	-0.003
Model 5.5		LTM	LTM
	Specialisation externalities	-0.480	4.020
	Diversity externalities	-0.170	-0.660
	Firms size	0.002	-0.003
		KIS	KIS
	Specialisation 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

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 A2)

Table 7. The role of intangible assets

Dependent Variable: TFP, % annual average growth rate 1999-2007

ML spatial error models

	7.1	7.2	7.3
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			
Specialisation 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)
Specialisation 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)
Specialisation externalities for LTM sectors in *new* countries	3.33 ***	3.30 ***	3.40 ***
	(2.92)	(2.88)	(2.97)
Specialisation 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 autocorr. 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

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%

LTM: Low Tech Manufacturing sectors; KIS: Knowledge Intensive Services sectors (see Appendix A2)