Agglomeration Economies and the Location of Industries: A Comparison of Three Small European Countries

Luisito Bertinelli, Eric Strobl, Salvador Barrios, Antonio-Carlos Teixeira

Agglomeration Economies and the Location of Industries: A Comparison of Three Small European Countries

Journal:	*Regional Studies*
Manuscript ID:	CRES-2006-0202.R1
Manuscript Type:	Main Section
JEL codes:	C21 - Cross-Sectional Models|Spatial Models < C2 - Econometric Methods: Single Equation Models < C - Mathematical and Quantitative Methods, R12 - Size and Spatial Distributions of Regional Economic Activity < R1 - General Regional Economics < R - Urban, Rural, and Regional Economics, R30 - General < R3 - Production Analysis and Firm Location < R - Urban, Rural, and Regional Economics
Keywords:	agglomeration, spatial autocorrelation, Belgium, Ireland, Portugal

CRES-2006-0202.R1

Spatial distribution of manufacturing activity and its determinants: A Comparison of Three Small European Countries

Salvador Barrios[1], Luisito Bertinelli[2], Eric Strobl[3] and Antonio Carlos Teixeira[4]

September 2007

Abstract

We investigate and compare the spatial distribution of manufacturing activity and its determinants in Belgium, Ireland, and Portugal using comparable, exhaustive micro-level data sets. We find some similarities between Portugal and Belgium, but little for Ireland. Moreover, there is some evidence that forward and backward linkages, R&D activity, and labour market pooling of skilled labor can be important determinants of agglomeration, although this crucially depends on the country examined.

Keywords: agglomeration, spatial autocorrelation, Belgium, Ireland, Portugal

JEL classification: R12, C21, R30

CRES-2006-0202.R1

Répartition spatiale des activités manufacturières et de leurs déterminants : comparaison de trois petits pays européens

Salvador Barrios, Luisito Bertinelli, Eric Strobl et Antonio Carlos Teixeira

Résumé

Dans cet article, nous analysons et nous comparons la répartition spatiale des activités manufacturières et de leurs déterminants en Belgique, en Irlande et au Portugal, en utilisant des ensembles exhaustifs de microdonnées comparables. Nous trouvons des similitudes entre le Portugal et la Belgique mais peu pour l'Irlande. De plus, il s'avère que des liens avant et arrière, d'activités de R&D et de mise en commun du marché des emplois qualifiés peuvent être des déterminants importants d'agglomération bien que cela dépende étroitement du pays analysé.

Mots-clés : agglomération, autocorrélation spatiale, Belgique, Irlande,

Portugal.

Classement JEL : R12, C21, R30

CRES-2006-0202.R1

Die räumliche Verteilung von produzierender Arbeit und ihren Determinanten: ein Vergleich zwischen drei kleinen europäischen Staaten

Salvador Barrios, Luisito Bertinelli, Eric Strobl and Antonio Carlos Teixeira

Abstract

Wir untersuchen und vergleichen die räumliche Verteilung von produzierender Arbeit und ihren Determinanten in Belgien, Irland und Portugal mit Hilfe von vergleichbaren, umfassenden Datensätzen auf Mikroebene. Wir stellen einige Ähnlichkeiten zwischen Portugal und Belgien fest, jedoch wenige für Irland. Darüber hinaus weist einiges darauf hin, dass die Vorwärts- und Rückwärtsverbindungen, die Forschungs- und Entwicklungsarbeit sowie die Konzentration von Fachkräften auf dem Arbeitsmarkt wichtige Determinanten für eine Agglomeration darstellen können, wobei dies aber im Wesentlichen vom jeweils untersuchten Land abhängt.

Keywords:
Agglomeration
Räumliche Autokorrelation
Belgien
Irland
Portugal

JEL classification: R12, C21, R30

CRES-2006-0202.R1

Distribución espacial de la actividad manufacturera y sus determinantes: comparación entre tres pequeños países europeos

Salvador Barrios, Luisito Bertinelli, Eric Strobl and Antonio Carlos Teixeira

Abstract

Con ayuda de un grupo de datos comparables y exhaustivos a nivel micro, investigamos y comparamos la distribución espacial de la actividad manufacturera y sus determinantes en Bélgica, Irlanda y Portugal. Observamos algunas similitudes entre Portugal y Bélgica pero pocas con Irlanda. Asimismo existen evidencias de que los vínculos hacia delante y atrás, la actividad de I+D y la concentración de mano de obra cualificada en el mercado laboral pueden ser determinantes importantes de aglomeración si bien esto depende básicamente del país que sea analizado.

Keywords:
Aglomeración
Autocorrelación espacial
Bélgica
Irlanda
Portugal

JEL classification: R12, C21, R30

---

[1]European Commission, Joint Research Centre, Institute for Prospective Technological Studies, C/ Inca Garcilaso s/n, 41092 Seville; E-mail: Salvador.BARRIOS@ec.europa.eu.
[2]CREA, Université du Luxembourg, 162A av. de la Faïencerie, 1511 Luxembourg ; E-mail : Luisito.Bertinelli@uni.lu.
[3] Ecole Polytechnique, Department of Economics, 91128 Palaiseau Cedex, France ; E-mail : eric.strobl@shs.polytechnique.fr.
[4] CETE, Faculdade de Economia do Porto, R. Dr. Roberto Frias, 4200-464 PORTO, Portugal; E-mail: acarlos@fep.up.pt

Comments by Thierry Mayer, Giordano Mion and Henry Overman are gratefully acknowledged.
Views expressed represent exclusively the position of the authors and do not necessarily correspond to those of the European Commission.

SECTION I: Introduction

It has long been recognized that economic activity is unevenly distributed across space. For example, Fujita and Thisse (2002) illustrate this feature by pointing out that the Japanese core regions with a mere 0.18 per cent of the total area account for about 29 per cent of East Asia's GDP. There is also plenty of similar evidence for other regions in the world, for instance, the Blue Banana in Europe, the Manufacturing Belt in the US, industrial districts in Italy (Pyke et al. (1990)), Route 128 and Silicon Valley in the US (Saxenian (1996)). But are these examples the rule or the exception? And how general and how strong is the tendency of industries to agglomerate?

While a now large body of theoretical studies have provided micro-foundations to explain why agglomeration may arise, theorists have pointed to the necessity of "buttressing [their] approach with empirical work" (Fujita et al. (1999, p.345)). Ideally, empirical studies would rely on micro level data in order to illustrate the mechanisms explaining how and why activities concentrate across space, and also provide results that are comparable across countries. Unfortunately, up to now, existing empirical studies on these matters have either used micro level data while being limited to one country,[1] or have used aggregated data at the macro/regional level in order to obtain cross-country evidence.[2] The present study is an attempt to push the analysis a step further by reconciling the use of micro level data and the need for comparative cross-country evidence. The objective of the present study is to provide thus a rigorous analysis of whether, how, and why agglomeration patterns of similar sectors differ across three European countries, namely Belgium, Ireland and Portugal. Specifically, we provide evidence for the agglomeration of manufacturing activities across space using exhaustive and comparable micro-data for three different countries, namely Belgium, Ireland, and Portugal.

This type of empirical work is arguably important for the realm of location theory since it provides results that can help to gauge the relevance (or to invalidate) of existing theoretical models, as well as to indicate areas in which further theoretical analysis is called for. Importantly, the type of study undertaken here can also allows one to check if industry agglomeration forces are invariant across countries – in this case empirical research on different countries would be just about studying the same economic mechanism with different data - or differ significantly across countries – in this case empirical analysis should devote more attention to explaining country-specific features. In particular, regarding the latter approach, one should note that the three countries under scrutiny arguably make for an interesting comparison group. On the one hand, these countries differ in aspects that may constitute important factors of the process of agglomeration. For example, while Portugal and Ireland are peripheral countries, Belgium is located in the core of the EU. Much of the theoretical literature about the impact of economic integration in the EU context has provided numerous results concerning the influence of economic integration on the location of economic activities.[3] Moreover, the countries under scrutiny differ considerably in terms of industrial expenditures devoted to R&D, the benefits of which have long been claimed to be bounded geographically.[4] Finally, Belgium, Ireland, and Portugal also have rather varied industrial labour force compositions as well as quite different institutional labour market settings which, for instance, may influence labour mobility and, by the same token, the location of economic activities.[5] One the other hand, these countries are similar in aspects that may influence agglomeration. For instance, they are all members of the European Union. This fact implies, inter alia, that they all have implemented the European Single Market Program, which provoked a strong need for modernisation and adaptation to increased competition with a consequent impact on the distribution of economic activities. Moreover, these countries, because they have small open economies, have strong export-led sectors, which may well manifest itself in similar agglomeration patterns.

Last, but not least, our study is important to the location theory because, as Combes and Overman (2005) have recently pointed out, ``a deeper understanding of the similarities among industries of European countries may have profound implications for on going research because one needs to be able to understating those patterns with reference to a large body of existing literature (mostly based on US data''. To our knowledge, this is the first study that explicitly addresses the important issue of cross-country comparison using a unified microeconomic dataset.

Our analysis of the patterns of agglomeration in these three countries relies on the index developed by Ellison and Glaeser (1997) - from now on referred to as the EG index. Importantly, this index, unlike more traditional measures, has explicit theoretical foundations and is based on (plant-level) microeconomic behaviour. Moreover, once plant-level data is available, Ellison and Glaeser (1997) claim "the index is designed to facilitate comparisons across industries, across countries, or over time" (Ellison and Glaeser (1997), p.890). Despite this assertion, no explicit comparative study across countries has been undertaken so far. Rather, existing applications of the EG index (and of its extensions) have been limited to the intersectorial comparisons across studies using different aggregation levels (see Ellison and Glaeser (1997) for the US as well as the study by Maurel and Sédillot (1999) for the French case). An important limitation of this index is that it is based on the distribution of activity over discrete spatial units and, consequently, if agglomeration forces are not geographically bounded and extend to neighbouring areas, the index will be biased downwards (and detect less agglomeration) the smaller the size of the area considered. This issue relates to the so-called Modifiable Area Unit Problem (MAUP) and more specifically to the choice of the appropriate spatial unit. We thus also use t the Moran's I statistic to reduce this scale problem by selecting a high spatial level when autocorrelation is detected in small spatial units. While the Ellison and Glaser index is complemented with an indicator of spatial auto-correlation, the Moran I's statistic, its measurement of agglomeration is built on a discrete version of space. Since space differs from one country to another ,one cannot exclude that marked agglomeration similarities or dissimilarities among countries reflects some spurious effect due to the application of the EG index to countries with different internal geographies[6].

Of course, whatever patterns of concentrations are established, it is also important in any analysis to seek to understand the underlying forces driving these. To this end, we gather a consistent set of explanatory variables across countries and sectors aiming to proxy the different theoretical explanations as to why agglomeration of economic activities occurs. The main theoretical arguments can roughly be classified according to so-called Marshallian externalities (for a survey, see Duranton and Puga, 2004). More specifically, Marshall's first theory claims that the existence of scale economies in input production could induce firms to locate close to their inputs. Elaborating on Marshall's concept, the New Economic Geography literature stipulates that such input-output linkages, alongside increasing returns, may give firms an incentive to locate near markets (and near their suppliers) in order to save on transport costs. In this context, market-size effects expand in a self-reinforcing process of agglomeration as if plants agglomerate for the reason stated above, this will in turn attract more firms (see Fujita and Thisse, 2002). Labor market pooling may also be an agglomerative force because industrial agglomeration should encourage the formation of thick local labor markets so that employees could find it easier to match with employers and vice-versa (see Helsley and Strange, 1990, and Monfort and Ottaviano, 2000). Finally, knowledge spillovers could lead to agglomeration because they can generate externalities that are bounded geographically, increasing the productivity of firms in the region where the new economic knowledge was created. Firms may thus locate where they are likely to learn from other firms (see Henderson 1974, 1988, and Glaeser 1999).

Nevertheless, despite these numerous theoretical contributions, evidence concerning the determinants of agglomerations also remains scarce and relatively recent. In particular, among the few, Dumais et al. (2002) decompose the index developed by Ellison and Glaeser (1997) to determine the contribution of plant entry and exit on agglomeration. Holmes and Stevens (2002) also decompose an index of agglomeration, isolating the impact of establishment scale on agglomeration. Kim et al. (2000), Rosenthal and Strange (2001) and Teixeira (2002), in contrast, shed light on the causes of agglomeration by using standard parametric estimation techniques. In an approach similar to these latter three studies we, in the current paper, also try to disentangle the different sources of agglomeration found by running parametric estimations and using as dependent variable the EG index and a number of other data intended to proxy the various theoretically proposed determinants of agglomeration.

The rest of the paper is organized as follows. In Section II, we provide some details about the tools being used to analyze the patterns of agglomeration. Section III proceeds with a description of our data sources. Observed patterns of agglomeration using these data and tools are presented and discussed in Section IV. Section V explores the sources of agglomeration econometrically. Section VI concludes.

SECTION II: Measuring Agglomeration

Ellison and Glaeser (1997) proposed an index of spatial concentration, which has the desirable feature of neutralizing the possible influence of industrial concentration resulting from internal economies of scale. Its expression for a particular industry *i* is given by:

$$\gamma_i = \frac{G_i - \left(1 - \sum_c x_c^2\right) H_i}{\left(1 - \sum_c x_c^2\right)\left(1 - H_i\right)}$$

where G_i is a measure of geographic concentration, defined as the sum of squared deviations of s_{ic} (the share of industry *i*'s employment in area *c*) to x_c (the share of aggregate manufacturing employment in area *c*), i.e., $G_i = \sum_c \left(s_{ic} - x_c\right)^2$. The term $H_i = \sum_j z_{ij}^2$ represents the classical Herfindahl-Hirschman index defined as the sum of squared plant employment shares of industry *i*, with *j=1...N*, the plant-indices. In a situation where there is random location, random market shares and the number of plants in a sector increases, H_i tends to 0. Thus the EG index tends to the measure of geographic concentration G_i times an industry invariant term, and its mathematical expectation tends to 0.

An important aspect of the EG index with respect to the current study is its distinctive feature of being comparable across time and sectors regardless of plants' size distribution. A further important property of the EG index lies in its theoretical foundation as it is based on a location model, i.e., where firms choose location following a Bernoulli process according to the presence of natural advantage and/or spillovers. The EG index thus asks the question whether concentration is greater than would be expected to arise randomly.

However, it must also be noted that the EG index suffers from two major drawbacks: Firstly, as noted by the authors themselves, the major theoretical limitation is that the EG index cannot distinguish between spillovers and natural advantages to explain the reasons why plants agglomerate. This is simply due to the fact that in their location model there is an observational equivalence between natural advantages and spillovers. In this regard one should add that it also is not able to distinguish home market effect or any other mechanism, other than scale economies, leading to agglomeration. Following the original authors and other subsequent researchers using the EG index, we are thus also not able to investigate this aspect any further.

A second and potentially more important issue is related to the choice of spatial unit, the so-called *Modifiable Areal Unit Problem* (MAUP).[7] Theory tells us that pecuniary externalities may reach wider geographical areas than technological externalities (see for instance Lamorgese and Ottaviano (2002) for a discussion on this issue). This seems thus to imply that while all externalities are important at small spatial scales only pecuniary externalities play a decisive role on agglomeration at high spatial scales. Clearly, because these externalities have different geographic scales, a much denser agglomeration may result from technological externalities that require strong interactions between agents in activities where information is more important than from pecuniary externalities that can also arise through inter-regional trade.

Since the EG index is based on the distribution of activity over discrete spatial units and if, as discussed by Ellison and Glaeser (1997), agglomeration forces are not geographically bounded and extend to neighbouring areas, then the index will be biased downwards (and detect less agglomeration) the smaller the size of the area considered. The use of Moran's I is a good solution to reduce the scale problem by choosing the regional rather that the local level when autocorrelation is detected [8]. Spatial autocorrelation considers the possibility that observations of a variable (here the location of industries) may not be independent across space. In this regard, clusters of events, people, or facilities are likely to be affected by positive spatial autocorrelation, whereas negative spatial autocorrelation refers to arrangements where people, events or facilities are dispersed.

The Moran statistic compares the value of a continuous variable at any location with the value of the same variable at surrounding locations. Formally, it is defined as:

$$I = \frac{N}{S} \cdot \frac{\sum_c \sum_{c'} w_{cc'} (x_c - \bar{x})(x_{c'} - \bar{x})}{\sum_c (x_{c'} - \bar{x})^2}$$

with $S = \sum_c \sum_{c'} w_{cc'}$, $\bar{x} = \sum_c x_c / N$ and $c \neq c'$, where x_c represents the value of the observation in region c, N is the total number of observations, x is the mean of the variable across all observations and $w_{cc'}$ is a weight between region c and region c'. Our $w_{cc'}$ has been set equal to 1 when regions c and c' are contiguous and 0 elsewhere. Values of I significantly larger than the expected value of the Moran statistic, $E[I] = -1/(N-1)$, indicate positive spatial association, i.e., similar values are more spatially clustered than could be caused purely by chance, whereas values of I smaller than $E[I]$ indicate negative spatial association.

SECTION III: Data

In order to compute a comparable EG index across our three countries we utilise three different data sources. For Ireland we draw on information from the Forfàs Employment Survey, for Belgium we used data on employment from the Social Security database, and for Portugal data originates from the Ministry of Employment. Detailed description of our various data is given in the Appendix. In choosing the year of our analysis, we used the latest year that was common to all our data, namely 1998.

An important task when undertaking a cross-country study is to unify the data. Essentially, we had to take care of two dimensions: the sectorial and the spatial one. In terms of the sectorial classification issue, data was either in NACE (Nomenclature générale des activités économiques dans les Communautés européennes - General Industrial Classification of Economic Activities within the European Communities) or in ISIC (International Standard Industrial Classification) classification, depending on the country in question. Portuguese data was readily available as ISIC Rev. 2 and it was converted into ISIC Rev.1, while Irish data was available at NACE Rev.1 at a four-digit level of disaggregation. For Belgium, data was originally collected according to the NACE-BEL sectors, which, apart from some small differences, very closely follow NACE Rev.1 classification. In order to work with a common set of sectors we made use of the concordance tables between ISIC and NACE available from Eurostat (the European statistics office) in order to convert the Irish and Belgian data.[9] Four-digit ISIC sectors roughly corresponded to three-digit NACE sectors, for which Belgian and Irish data had been collected so we took ISIC Rev.1 as the common classification for which no changes for Portugal data was required.[10] After having put this data together and keeping only those sectors that were common to the three countries, we ended up with 63 common four-digit ISIC sectors, which represent between 85 to 95 per cent of total manufacturing employment for these three countries.

In terms of the choice of spatial units the task of unification was more cumbersome. The only common spatial unit at the European level is the *Nomenclature des unités territoriales statistiques/Nomenclature of territorial units for statistics* (NUTS), where NUTS is a five-level hierarchical classification (three regional levels and two local levels).[11] However, the regional classification available to us did not always correspond to this spatial classification, especially for Ireland. As a result, our choice of spatial units was essentially restricted by data availability. In the end two spatial units were used, one regional and one local. For Belgium, NUTS3 (43 *arrondissements*) and NUTS5 (589 *communes*) spatial units have been selected. In the Irish case, at the regional level, NUTS4 (27 *counties*) spatial units were chosen, whereas for the local level an intermediate level between NUTS4 and NUTS5 (504 *townships*) spatial units was used.[12] Finally, for Portugal, no analogous regional level was available, therefore we used a somewhat rougher spatial unit than NUTS3 for the regional level, namely districts (18 *distritos*), and for the local level NUTS4 (275 *concelhos-municipos*).[13]

It is also worth noting that some descriptive statistics on the sectoral share of employment show that specialization patterns are rather different across countries. Portugal appears to be more specialized in more traditional industries like textiles and wood industries, while Ireland highlights an important share of its employment in high-tech industries such as machinery equipment. The picture is, in contrast, quite mixed for Belgium, as shown in Table 2..

SECTION IV: Patterns of Agglomeration

As noted earlier, in terms of calculating the EG index we have two spatial units at our disposal, the regional and the local level, and we initially calculated the EG index using both of these. Doing so we found that the correlation between EG indices at the regional level and at the local level is relatively high in Belgium and in Portugal (statistically significant spearman rank correlation coefficients of 0.7 and 0.5, respectively), but very low for Ireland (0.1 and not significant)[14]. This would suggest that the underlying pattern of agglomeration differs strongly, depending on the spatial units employed, and perhaps that the analysis should have proceeded using both comparatively. However, as noted earlier, one concern with regard to the EG index is the potential bias introduced via spatial autocorrelation, which is likely to be larger for smaller units. To examine this we calculated in Table 3 the Moran index for local spatial units using binary decay effects based on contiguity matrices. Except for Ireland, one finds that about a third of all sectors are characterised by positive and statistically significant spatial autocorrelation.[15] Clearly this represents a non-negligible number of sectors and suggests that some care should be taken when interpreting EG index results obtained from *local* spatial units. We thus henceforth proceed using the regional rather than the local level as our spatial unit.

Our results on the EG index at the regional level for the three countries are given in Tables 4-6. When comparing results among countries, a striking feature is that Portugal's level of agglomeration is much higher than for Belgium and Ireland. More precisely, the weighted average EG index is 0.027 for Belgium and 0.038 for Ireland, whereas for Portugal it stands at 0.133.[16] In the case of Portugal, one obvious reason why the average EG index is higher is related to the fact that the industrial concentration, measured by the Herfindahl-Hirschman index, is quite low in Portuguese industry (see Barrios et al., 2005).

Whereas the Portuguese aggregate level of concentration clearly departs from the Belgian and Irish ones, the picture changes when it comes to comparing the patterns of agglomeration of individual sectors. Taking the rank correlations in Table 7, Ireland appears to clearly diverge from Portugal and Belgium, whereas the two latter have a positive (although not very high) and statistically significant spearman rank correlation coefficient. Several explanations can be put forward possibly explaining this result. First, whereas Belgium and Portugal have roughly similar population levels of around 10 million, Ireland has 3.5 million. Smaller population size in turn implies fewer plants, meaning that agglomeration patterns are harder to disentangle for particular sectors. Put differently, few plants imply that the marginal impact of one plant's location on the EG index is more important, which could well explain our results. A second explanation relates to fact that Ireland is an island, hence the centrifugal and centripetal forces at work are likely to act differently. In particular, cross-border effects, which are likely to be important particularly for Belgium, but also to a lesser extent for Portugal, are obviously not relevant in the case of Ireland. That is, Belgium is located at the heart of Western Europe and is geographically close to countries such as France, Netherlands, and Germany with intense trade relationships with all of these. One thus could easily expect that industry clusters exist across borders, an example of which are the traditional steel industries, which are common to French and Belgium bordering regions.

Another feature, common to both Ireland and Portugal, is the peripheral location with respect to the rest of Europe. Coupled with the fact that these two countries entered the European Common Market relatively late (in 1973 for Ireland and 1986 for Portugal), one might thus expect to find common features of agglomeration across these two countries. In particular, both countries have strong export-led economies, as it is generally the case of small open economies. As has been shown elsewhere, exporting firms tend to be larger on average and have different patterns of agglomeration (Bernard and Jensen (1995), Holmes and Stevens (2002)). It should also be noted that FDI has played a large role with multinationals increasingly choosing Ireland in order to get access to the EU market (Barry and Bradley (1997)). Multinationals' presence may, in turn, have influenced the location pattern of industries if externalities arise between domestic and foreign plants (see Barrios et al. (2006) for evidence concerning Ireland).

Comparing the sectorial indices individually within and across countries also reveals a number of interesting patterns. As shown in Tables 4-6, the most agglomerated sectors in Belgium and Portugal are Misc. Products of Petroleum and Coal (3540), Shipbuilding and Repairing (3841). This may not be very surprising given that this sector is obviously very dependent on location. It thus is supportive of Heckscher-Ohlin type of models, where trade and specialization depends on the factor endowments of countries/regions. We also find that traditional sectors as Tanneries and Leather Finishing (3231), Manufacture of Wood and Cork Products NEC (3319), Jewelry and Related Articles (3901), Pottery, China and Earthware (3610), Knitting Mills (3213), Manufacture of Carpets and Rugs (3214) appear to be highly agglomerated, especially in Portugal, but also in Ireland. Ellison and Glaeser (1997) and Maurel and Sédillot (1999) find similar results for the US and France, respectively. In contrast, we discover that sectors related to food and beverages tend to be dispersed. This is particularly true for Manufacture of Dairy Products (3112), Slaughtering, Preparing and Preserving Meat (3111), Grain Mill Products (3116), and Manufacture of Food Products, N.E.C. (3121) in Belgium and Portugal, and to a lesser degree, in Ireland. As a potential explanation one should note that since most of these products are perishable, it is likely important for their producers to locate close to their consumption market. In a way, these results also confirm the market potential story, popular in the economic geography literature. Accordingly, industries will choose their location by taking into account distance to and size of the customers. Ideally, production would then have to settle near each consumer. However, given that there are indivisibilities in production, there is also a trade off that producers have to solve - the less constraining indivisibilities are, the more dispersed activities will be relative to all other activities.

A further interesting observation is related to high-tech sectors.[17] We find that high-tech sectors have a lower average EG index than the rest. This result is consistent across the three countries under scrutiny. One should note that similar results have also been found using German (Alecke et al. (2003)) and UK data (Devereux et al. (2004)). Three factors, not necessarily mutually exclusive, may explain such a finding. First, the widely held belief that well known high-tech clusters, such as Silicon Valley in the US or Sofia Antipolis in France, are representative of general agglomeration processes is untrue. A second explanation derives from the possibility that our sectorial disaggregation is too rough to capture very specific high-tech clusters.[18] Finally, it may be due to the fact that our choice of spatial unit is not appropriate to identify high-tech clusters. Indeed, taking the Belgian local level spatial units, the average high-tech EG index is 0.0035, and 0.026 for the non high-tech sectors. Thus, whereas for non high-tech sectors, the EG index has been halved, it has tripled for high-tech sectors. Still, agglomeration of high-tech sectors remains far below the rest of the manufacturing industry.

Ellison and Glaeser (1997) use a non-statistically based value range of the EG index according to which they classify sectors as not very concentrated (smaller than 0.02), relatively concentrated (between 0.02 and 0.05), and highly concentrated (larger than 0.05). However, using the variance of the index across sectors it is straightforward to check whether sectors are statistically significantly concentrated by using the two standard deviation rule. The two-standard deviation rule supposes the studied random variable is roughly normal, so that 95 % of its realizations are around the expectation, and in the interval limited by two standard deviations, below or over it. More precisely, since the expected value of the EG index is zero one can check whether the absolute values of it for an individual sector is larger than twice the standard deviation of the index under the null hypothesis of random location. Since Ellison and Glaeser (1997) give the analytic expression of the variance of their index, it seems quite obvious to use this rule. The main thing is to use the correct variable: The EG mean and its analytical variance hold under the hypothesis of random distribution of the firms of a sector.

We denote the significant sectors in this regard using an asterisk in Tables 4-6. Accordingly, about 25 per cent of the EG indices are found to be significant in the Irish, 49 per cent in the Belgian, and 75 per cent in the Portuguese case.[19] One may want to note that in this regard the number of significant sectors rises with population size of the countries. Also unreported results on the standard deviations reveal that the variance of the EG indices decreases with country size. This result immediately proceeds from the expression of the variance of G_i used by Ellison and Glaeser (1997, p.907), which increases with the Herfindahl-Hirschmann index. Thus, as smaller countries tend to have higher industrial concentration due to fewer firms, they will also have larger Herfindahl-Hirschmann indices. As the variance of the EG index depends positively and linearly on the variance of G_i, everything else being constant, smaller countries will have a larger variance of their EG indices. This result is consistent with unpublished results on Italy, where about 90 per cent of the EG indices turn out to successfully pass the two standard deviation rule.[20] The same is also true for Maurel and Sédillot (1999) who work on French data and find that for their index (which is very close to Ellison and Glaeser's), 270 out of 273 sectors are statistically significant.

SECTION V: The Determinants of Agglomeration

As noted in the introduction, there are many theoretical but few empirical analyses of the determinants of agglomeration. To provide an empirical analysis of the determinants of agglomeration for our three countries we proceeded in the spirit of the studies of Kim et al. (2000), Rosenthal and Strange (2001), and Teixeira (2002) and estimate a simple regression where the EG index is regressed on a number of variables intended to proxy the various theoretical explanations put forward in the theoretical literature on agglomeration. A major issue in doing so is to assemble the desired control variables using comparable data across countries and we use mostly Eurostat data in this regard.[21] Our chosen explanatory variables are as follows:

Total purchases of goods and services (total inputs): this variable, expressed in millions of Euros, includes the value of all goods and services purchased during the accounting period for resale or consumption in the production process (excluding capital goods). The goods and services concerned may be either resold with or without further transformation, completely used up in the production process or, finally, be stocked.. This variable is intended to capture the forward and backward linkages that have become important in the so-called New Economic Geography type models of agglomeration (see Fujita and Thisse, 2002). Accordingly, producers may want to choose locations that have good access to large markets and to suppliers of intermediates, while a concentration of producers tends to offer a large market and a good supply of inputs and consumer goods, hence attracting new producers and new consumers. A positive effect on agglomerations is thus expected from this variable.

Sectorial share of skilled works: this variable measures the percentage of the total population that has obtained a higher education diploma and stems from the respective national data sources. It is intended to capture labor pooling effects, which is viewed in the literature as an agglomerative force because it allows for easier matching between employers and employees (see Helsley and Strange, 1990 and Monfort and Ottaviano, 2000). An increasing effect on agglomeration is thus expected from this variable.

Total intra-mural Research and Development expenditure: this variable is expressed in millions of Euros. Intra-mural expenditures are all expenditures for R&D performed within the unit, regardless of the source of funds. It must be distinguished from expenditures for a wide range of related activities. The following are therefore excluded: expenditures on education and training; expenditures on other scientific and technological activities; expenditures on other industrial activities; expenditures on purely financing activities. Intra-mural expenditures are valued at production cost and include all operating costs including the labour cost and capital expenditure. R&D typically captures knowledge spillovers. It has been shown elsewhere (see for instance Audretsch and Feldman (1996), Feldman and Audretsch (1999), Bottazzi and Peri (2003) and Jaffe et al. (1993)) that knowledge spillovers could lead to agglomeration because they may generate externalities that are bounded geographically, increasing the productivity of firms in the region where the new economic knowledge was created. Hence, one might expect R&D intensive sectors to concentrate in order to fully benefit from these knowledge spillovers.

Purchases of energy products: this variable, expressed in millions of Euros, includes energy products only if they are used as fuel, and hence excludes energy products purchased for resale without transformation. To derive their index, Ellison and Glaeser (1997), start from a model, where agglomeration either results from externalities or common natural advantages. Although scholars have mainly been interested in the former explanation in order to provide a rationale for Silicon Valley-type of agglomerations, natural advantages play a crucial role in explaining the distribution of manufacturing activity, especially when the concerned industries are natural resources intensive. For instance, Ellison and Glaeser (1999) show that for the US manufacturing activity, about 20 per cent of observed geographic concentration can be explained by a small set of natural advantages in the United States. Here we consider energy as a generic variable to account for natural advantages. Ideally, one would have liked to include purchases of natural resources as well, but no comparable data is available for the three countries. Note however that in Ellison and Glaeser (1999), they use 3 energy variables (electricity, coal, gas) in their regression that are all statistically significant.

Gross investment in tangible goods: expressed in millions of Euros. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e., capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Purchased goods are valued at purchase price, i.e. transport and installation charges, fees, taxes and other costs of ownership transfer are included. Own produced tangible goods are valued at production cost. The introduction of this variable follows the same idea as for the purchase of inputs and hence one would have an a priori positively expected impact on agglomeration.

Gross investment in machinery: this variable, available in millions of Euros, covers machinery (office machines, etc.), special vehicles used on the premises, other machinery and equipment, all vehicles and boats used off the premises, i.e. motor cars, commercial vehicles and lorries as well as special vehicles of all types, boats, railway wagons, etc. acquired new or second hand during the reference period. Current maintenance costs are excluded.

Average plant size: this is the ratio of the number of persons employed (per 1000) by the number of enterprises (i.e., all units active during at least a part of the reference period).

In a recent contribution, Holmes and Stevens (2002) show that there is a strong link between plant size and agglomeration. Plant size may also be interpreted as a proxy for the presence of increasing returns to scale, which are central in the models of the New Economic Geography.

As countries are of very different sizes, all variables listed above have been weighted by the number of workers in each sector of the individual countries. We also experimented with total production weights, but this led to qualitatively analogous results. One should note that for some variables and some countries, information at the four-digit sectorial level was not available so that we had to fill these gaps by using their three-digit counterparts. Details of this are provided in the data appendix.

We first used simple OLS for each of our three country samples separately, as shown in Table 8. The first notable feature of these is that our econometric specification explains little for Ireland, displaying a very a low R-squared and insignificance for all control variables of interest.[22] In contrast, the R-squared is substantially higher for both Belgium and Portugal. Nevertheless, for Belgium only total input purchases is significant, displaying the a priori expected positive sign. A similar result on purchased inputs is also found for Portugal, suggesting that backward linkages may be important. For Portugal we also find that R&D expenditures play a significant positive role in explaining agglomeration, thus indicating that there are benefits to agglomerating in sectors where there are externalities generated through innovative activity. Finally, under OLS one also discovers that education in Portugal serves as a positive determinant of the localisation of activities, suggestive of the possibility of the importance of labour market pooling. In terms of our other, non-significant variables, one may want to note that some of them do have the expected sign. For instance, in congruence with our arguments earlier, purchase of energy products and gross investment in tangible goods have positive coefficients.

Comparing our results with Rosenthal and Strange (2001), we unearth some common features. First, the labor market pooling hypothesis, proxied by educational attainments, highlights positive and significant coefficients for the US and the Portuguese case. This result is also consistent with Dumais et al. (2002). Second, there is evidence that input sharing favours agglomeration in the US as well as in Belgium and Portugal at high aggregate spatial levels. Third, innovation, as proxied by R&D spending in the present study, is shown to support the existence of knowledge spillovers for one country in our sample, namely Portugal. A similar result is evidenced by Rosenthal and Strange (2001) for large firms in the US case. Last, neither for the US case, nor for the three countries under scrutiny in our sample there is evidence for agglomeration in sectors highlighting reliance on energy resources.

If one assumes the relevance of our empirical specification of the determinants of agglomeration despite the statistical insignificance of many of these, it may be of interest to try and disentangle how much differences in agglomeration across countries is driven by differences in the means of the determinants rather than their relative importance across countries. A convenient method to examine this can be borrowed from the labour literature due to Oaxaca (1973). Accordingly, if we consider two countries i and j and the estimates of β from regressing the EG index on a number of covariates using OLS for each separately, then the difference in the means of the EG index, $EG_i - EG_j$, between these two countries can be decomposed into:

$$EG_i - EG_j = (\beta_i - \beta_j)X_i + \beta_j (X_i - X_j)$$

where X is a vector of the means of the control variables and β is the estimated OLS coefficient appropriately subscripted for countries i and j. The first term is the part of the difference in means due to differences in the response of agglomeration to the determinants measured at the mean of country i's determinants. In contrast, the second component serves to measure any difference in the means of the determinants across the two countries measured at the 'returns' (i.e;, for a given β_j) of country j.

We executed this decomposition using the OLS estimates of our specifications along with the variable means for the three country pairs and report results in Table 9. As can be seen, the difference in means of *EG* index is highest between Portugal and Ireland, and this difference is both about equally due to higher level of mean of the determinants as well their greater responsiveness in Portugal. In contrast, while the difference in average agglomeration between Portugal and Belgium is nearly as high as between the country-pair above, the factors underlying this difference are substantially different. More precisely, while the difference in the means of the determinants acts to decrease agglomeration relatively more in Portugal, this is counteracted by the EG index's greater (positive) responsiveness to these. A similar pattern also emerges when one compares the relatively similar means of agglomeration for Belgium and Ireland – while the means of the determinants in Ireland have a greater positive influence, its level of agglomeration is less (positively) responsive to these. It follows that, while the econometric results presented in Table 8 appear to explain part of the agglomeration patterns observed in each of the three countries considered separately together with existing differences in agglomeration forces across countries, a closer, bilateral, analysis of these differences shows that no uniform patterns emerges as to whether differences in agglomeration are due the responsiveness of agglomeration to the determinants considered or to the difference in levels of the determinants of agglomeration considered in Table 8.

Finally, some remarks concerning the robustness of our results are in order. In particular, the estimated coefficients obtained in Table 8 are not always completely robust and this thus requires further clarification. First, there is the problem of data quality, in particular, our explanatory data, which stem from the Eurostat Regio database are not of an ideal quality. More precisely, as discussed in more detail in the appendix, on several occasions we needed to resort to alternative methods to fill any 'gaps' or otherwise would have been faced with severe sample size problems. Besides the data quality issue, there is more fundamentally the problem of whether proceeding with cross-industry regressions is the right way to capture the determinants of agglomeration. Indeed, by its very nature, there is no spatial dimension in the EG index. If, however, such factors as inputs, R&D, and energy production are very concentrated spatially and the sector under scrutiny relies heavily on these inputs, R&D, energy source, then the production should be very concentrated. In order to check this rigorously, one would then need sector-region share-regressions, rather than regressions on sector-specific EG indices. This may then explain poor results of our regressions, and on these types of regressions in general, as can be deduced from Rosenthal and Strange (2001)'s analysis.

SECTION VI: Conclusion

This paper analyses the spatial distribution of manufacturing activity and its determinants across three European countries: Belgium, Ireland, and Portugal. To our knowledge, this is the first comparative study of the location of manufacturing activities using plant level data across countries. Our analysis mainly relies on the index developed by Ellison and Glaeser (1997), which has been designed to allow for comparisons across industries and countries. Results confirm some previous findings on French, UK and US data, with traditional sectors ranking among the most agglomerated. Among the three countries under scrutiny, Ireland clearly stands out with significantly different patterns of spatial distribution of manufacturing activity. More precisely, despite being two peripheral countries, Ireland and Portugal appear to have rather different distribution of industries across space.

We also econometrically attempted to investigate potential determinants of the observed agglomeration patters as suggested by theoretical contributions. Our results suggest, tentatively, that one may want to be careful when conducting cross-country comparisons of the spatial distribution of economic activities, as there may be a lot of country-specific factors that can drive the findings. More specifically, while we find some evidence that backward linkages, innovative activity, and the pooling of skilled labour can act to increase agglomeration, this result crucially hinges on which country is being examined. When compared with the available evidence for the US, our results also suggest that some industry agglomeration forces are invariant across very different economies. Furthermore, while the variables mentioned above appear to explain part of the agglomeration patterns observed in each of the three countries, a closer examination of cross-country differences in results shows that no uniform patterns emerges as to whether differences in agglomeration are due the responsiveness of agglomeration to the determinants considered here or to the difference in levels of these determinants.

References

ALECKE B., ALSLEBEN CH., SCHARR F. AND UNTIEDT G. (2003) New Empirical Evidence on the Geographic Concentration of German Industries: Do Clusters Really Matter?, mimeo University of Dortmund.

AMITI M. (1999) Specialization Patterns in Europe, *Weltwirtschaftliches Archiv* 135(4), 1-21.

ANSELIN L. and BERA A. (1998) Spatial Dependence in Linear Regression Models with an Application to Spatial Econometrics, in ULLAH A. and GILES D. (Eds), *Handbook of Applied Economic Statistics*, Springer Verlag, Berlin.

AUDRETSCH DB. and FELDMAN MP. (1996) R&D Spillovers and the Geography of Innovation and Production, *American Economic Review* 86(3), 630-640.

BARRIOS S., BERTINELLI L., STROBL E. and TEIXEIRA A.-C. (2005) The dynamics of agglomeration: evidence from Ireland and Portugal, *Journal of Urban Economics* 57(1),170-188.

BARRIOS S. and STROBL E. (2004) Industry mobility and geographic concentration in the European Union, *Economics Letters* 82(1), 71-75.

BARRIOS S., BERTINELLI L., and STROBL E. (2006) Coagglomeration and Spillovers, *Regional Science and Urban Economics* 36 (4), 467-481.

BARRY F. and BRADLEY J. (1997) FDI and Trade: The Irish Host-Country Experience, *Economic Journal* 107(445), 1798-1811.

BERNARD A. and JENSEN J. (1995) Exporters, Jobs, and Wages in U.S. Manufacturing, 1976-1987, *Brookings Papers on Economic Activity*, Microeconomics, Washington DC.

BERTINELLI L. and DECROP J. (2005) Geographical Agglomeration: The Case of Belgian Manufacturing Industry, *Regional Studies* 39(5), 567-583.

BOTTAZZI L. and PERI G. (2003), Innovation, Demand and Knowledge Spillovers: Theory and Evidence from European Regions, *European Economic Review* 47(4), 687-710.

BRULHART M. and TRAEGER R. (2005) An Account of Geographic Concentration Patterns in Europe, *Regional Science and Urban Economics* 35(6), 597-624.

CICCONE A. (2002) Agglomeration Effects in Europe, *European Economic Review* 46(2), 213-27.

CICCONE A. and HALL R. (1996) Productivity and the Density of Economic Activity, *American Economic Review* 86(1), 54-70.

COMBES P-Ph. and OVERMAN H. (2004) The spatial distribution of economic activities in the European Union, in THISSE JF. and HENDERSON JV. (Eds), *Handbook of Regional And Urban Economics*, Volume 4, Amsterdam: North Holland.

CROZET M. (2004) Do Migrants Follow Market Potentials? An Estimation of a New Economic Geography Model, *Journal of Economic Geography* 4 (4), 439-458.

DEVEREUX M., GRIFFITH R. and SIMPSON H. (2004) The geographical Distribution of Production Activity in the UK, *Regional Science and Urban Economics* 34(5), 533-564.

DUMAIS G., ELLISON G. and GLAESER E. (2002) Geographic Concentration as a Dynamic Process, *Review of Economics and Statistics* 84(2), 193-204.

DURANTON G. and OVERMAN H. (2005), Testing for Localisation using Micro-Geographic Data, *Review of Economic Studies* 72(4), 1077-1106.

DURANTON G. and PUGA D. (2004) Micro-foundations of urban agglomeration economies, in THISSE JF. and HENDERSON JV., *Handbook of Regional And Urban Economics*, Volume 4, Amsterdam: North Holland.

ELLISON, G and GLAESER E. (1997) Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach, *Journal of Political Economy* 105(5), 889-927.

ELLISON, G and GLAESER E. (1999) The Geographic Concentration of Industry: Does Natural Advantage Explain Agglomeration?, *American Economic Review*, Papers and Proceedings 89(2), 311-316.

FELDMAN MP. and AUDRETSCH, DB. (1999) Innovations in cities: science-based diversity, specialization and localised competition, *European Economic Review* 43(2), 409-429.

FUJITA M., KRUGMAN P. and VENABLES AJ. (1999) *The Spatial Economy: Cities, Regions and International Trade*, Cambridge, MA: MIT Press.

FUJITA M. and THISSE J-F. (2002) *Economics of Agglomeration: Cities, Industrial Location, and Regional Growth*, Cambridge, UK: Cambridge University Press.

GLAESER E. (1999) Learning in Cities, *Journal of Urban Economics* 46: 254-277.

GLAESER, E., H. KALLAL, J. SCHEINKMAN and A. SHLEIFER (1992) Growth in Cities, *Journal of Political Economy* 100(6), 1126-1152.

HATZICHRONOGLOU T. (1997) Revision of High-Technology Sector and Product Specification, *STI Working Paper Series* 1997/2 OECD, Paris.

HELSLEY RW. and STRANGE WC. (1990) Matching and Agglomeration Economies in a System of Cities, *Regional Science and Urban Economics* 20, 189-212.

HENDERSON JV. (1974) The Sizes and Types of Cities, *American Economic Review* 64, 640-656.

HENDERSON JV. (1988) *Urban Development: Theory, Facts and Illusion*, Oxford University Press, Oxford.

HENDERSON V., KUNCORO A. and TURNER M. (1995) Industrial Development in Cities, *Journal of Political Economy* 103(5), 1067-90.

HOLMES T. and STEVENS J. (2002) Geographic Concentration and Establishment Scale, *Review of Economics and Statistics* 84(4), 682-690

JAFFE A., TRAJTENBERG M. and HENDERSON R. (1993) Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, *Quarterly Journal of Economics* 108(3), 577-98.

KIM Y., BARKLEY D. and HENRY M. (2000) Industry Characteristics linked to Establishment Concentrations in Nonmetropolitan Areas, *Journal of Regional Science* 40(2), 231-259.

LAMORGESE A. and OTTAVIANO GIP. (2002) Space, Factors and Spillovers *Banca d'Italia*.

MARCON E. and PUECH F. (2003) Evaluating the Geographic Concentration of Industries using Distance-Based Methods, *Journal of Economic Geography* 3(4), 409-428.

MAUREL, F and SÉDILLOT B. (1999) A Measure of the Geographic Concentration in French Manufacturing Industries, *Regional Science and Urban Economics* 29(5), 575-604.

MIDELFART-KNARVIK KH., OVERMAN H., REDDING S. and VENABLES A. (2000) The Location of European Industry, Commission of the EEC, *Ecofin* Economic Papers n°142.

MONFORT P. and OTTAVIANO GIP. (2000) Local Labor Markets, Skill Accumulation and Regional Disparities, *mimeo IRES*, Université catholique de Louvain.

MOOMAW R. (1981) Productivity and City Size: A Critique of the Evidence, *Quarterly Journal of Economics* 96(4), 675-88.

MORPHET, C.S. (1997) A statistical method for the identification of spatial clusters, *Environment and Planning A* 29(6), 1039-1055.

OAXACA R. (1973) Male-Female Wage Differentials in Urban Labor Markets, *International Economic Review* 14, 693-709.

OPENSHAW S. and TAYLOR P. (1979) A million or so correlation coefficients: three experiments on the modifiable areal unit problem. In: WRIGLEY N. (Ed), *Statistical Applications in the Spatial Sciences*, Pion, London: 127-144.

PUGA D. (1999) The rise and fall of regional inequalities, *European Economic Review* 43(2), 303-334.

PYKE F., BECCATINI G. and SENGENBERGER W. (Ed) (1990) *Industrial Districts and Interfirms Cooperation in Italy*, International Institute for Labour Studies, Geneva.

RAUCH J. (1993) Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities, *Journal of Urban Economics* 34(3), 380-400.

ROSENTHAL S. and STRANGE W. (2001) The Determinants of Agglomeration, *Journal of Urban Economics* 50(2),191-229.

SAXENIAN A. (1994) *Regional Advantage : Culture and Competition in Silicon Valley and Route 128*, Cambridge: Harvard University Press.

SVEIKAUSKAS L. (1975) The Productivity of Cities, *Quarterly Journal of Economics* 89(3): 393-413.

TABUCHI T. (1986) Urban Agglomeration, Capital Augmenting Technology, and Labor Market Equilibrium, *Journal of Urban Economics* 20(2), 221-228.

TEIXEIRA AC. (2002) The Geographic Distribution of Economic Activity in Portugal and its Determinants, *mimeo CORE*.

Appendix: Data

Belgium

Social Security data on employment

The database that has been used for the present study covers all plants established in Belgium in 1998. For each plant, we have the number of jobs, the industry it belongs to (up to five-digit classification), and the township it is located in. Employment data come from the national office for social security (ONSS), which collects employment data for all wage earners in Belgium. The notion of a plant is clearly distinguished from the employer, the latter corresponding to the notion of a firm in a general sense. If the employer has only one activity in one location, then it is considered a plant. But if the employer carries out its activity in two or more locations (branches or operation units) and/or carries out two different types of activity, each operation unit is seen as a separate plant. However, if several operation units of the same firm are located in the same township, only one plant is taken into account.

Ireland

Forfás Employment Survey

This is an annual plant level survey collected by Forfás since 1972, the policy and advisory board for industrial development in Ireland. The response rate to this survey is argued by Forfás to essentially be nearly 100 per cent, i.e., our data can be seen as including virtually the whole population of manufacturing plants in Ireland. Information at the plant level include time invariant variables such as the nationality of ownership, sector of production, and detailed regional location of each plant, as well as the level of employment in each year.

Portugal

Ministry of Employment

This is an annual plant level survey collected by the Portuguese Ministry of Employment since 1985, for all the companies operating in Portugal. It matches employers and employees and reported data include the companies' location, age, sector of activity, sales, ownership structure and number of employees as well as worker's age, skill, occupation, tenure and schooling. A company may be a single or a group of plants, which can be at different locations. The locations, reflecting the spatial units used, take place at the municipalities (NUTS 5) and districts levels. Portugal is divided into 275 municipalities and 18 districts.

Eurostat data

Treatment of missing data

Whenever data was missing or unavailable at a given sectorial level, we extrapolated with data from the next available aggregation level. Only for R&D expenditure in Ireland, no data was available. In this case, we had recourse to national data sources – namely the *Annual Business Survey*, which is a survey of plants larger than 10 employees and covers about 80 per cent of the total population of these. Henceforth, we studentized this variable so as make cross-country pooled regressions feasible.

Belgium:

Sectors (nacecode) with no data : 1592, 192, 193, 242, 246

Sectors with missing data : 1591 (inputs, energy, R&D exp.); 1753, 1754, 231, 232 (inv. in tang.)

Ireland:

Sectors (nacecode) with no data : 1591, 1596, 1597, 1598, 182, 191, 192, 23, 232, 246, 247, 265, 266, 271, 272, 273, 282, 2912, 334, 36,362, 365, 366

Sectors with missing data : 154, 158, 262, 263 (inputs, inv. in tang., inv. in machines, energy); 262, 263, 364 (inputs, inv. in tang., energy)

Sectors with only zeros : 1592, 176, 231

Portugal

Sectors (nacecode) with no data : 1597

Sectors with missing data : 1592, 314 (inv. in tang., inv. in machines, R&D exp.)

Sectors with only zeros : 231

Table 1a: Average Areas

	Regional level	Local level
Belgium	43 arrondissements: 710skm	589 communes: 52skm
Ireland	27 counties: 2603skm	504 Townships: 139.4skm/ 3445 DEDs: 20.4skm
Portugal	18 distritos: 4887skm	275 concelhos: 320skm
United States	51 States: 70322skm	3141 Counties: 1142skm

Note: areas are average ones. One square kilometer corresponds to 0.3861 square miles.

Table 1b: Average Population (Density)

	Population (in 1000)		Population Density (pop/skm)
	regional	*local*	
Belgium	240	17.5	338
Ireland	144.5	7.5 / 1	55.5
Portugal	576	37.5	118
United States	5518	89.5	78.5

Note: figures are averages for 2002 (respectively 2000 for the US)

Table 2: Share of total manufacturing employment

	ISIC 2-digit	Belgium	Ireland	Portugal
Manufacturing of food, beverages and tobacco	31	*14.19%*	*19.81%*	*10.38%*
Textile, wearing apparel and leather industries	32	*9.31%*	*7.06%*	*34.94%*
Manufacture of wood and wood products	33	*4.81%*	*4.83%*	*9.05%*
Manufacture paper, paper prods., printing, publishing	34	*7.64%*	*6.08%*	*5.06%*
Manufacture of chemicals and chemical products	35	*15.25%*	*13.33%*	*1.83%*
Manufacture non-metallic mineral prods. except fuel	36	*5.35%*	*4.58%*	*7.22%*
Basic metal industries	37	*6.37%*	*0.39%*	*1.41%*
Fabricated metal products, machinery and equipment	38	*30.33%*	*39.71%*	*12.04%*
Other manufacturing industries	39	*0.88%*	*2.04%*	*1.08%*
Total		*94%*	*98%*	*83%*

Note: *percentages only include sectors that are effectively used in the present study, so they do not sum up to 100 per cent.*

Table 3: Moran indices

		Belgium (communes)		Ireland (DEDs)		Portugal (concelhos)	
	ISIC code	Moran I	p-value	Moran I	p-value	Moran I	p-value
Slaughtering, preparing and preserving meat	3111	0.0877	0.0002	-0.0061	0.5617	-0.0325	0.3841
Manufacture of dairy products	3112	0.0111	0.5822	0.0119	0.2038	0.0083	0.7029
Canning and preserving of fruits and vegetables	3113	0.0252	0.2373	0.0021	0.7801	-0.0129	0.777
Can., Preserv., and process of fish, crustacean	3114	0.0333	0.0336	0.0088	0.341	-0.0075	0.8979
Manufacture of vegs. and animal oils and fats	3115	-0.0068	0.6499	-0.0009	0.9422	0.0168	0.4542
Grain mill products	3116	-0.0092	0.6491	-0.0046	0.635	0.0151	0.5574
Manufacture of food products, N.E.C.	3121	0.0514	0.0218	-0.0031	0.7565	0.0545	0.0669
Manufacture of prepared animal feeds	3122	0.0884	0	0.0037	0.658	0.0455	0.1028
Distilling, rectifying and blending spirits	3131	0.0939	0	-0.0007	0.9612	0.0859	0.0009
Malt liquors and malt	3133	-0.0065	0.8142	-0.0008	0.9565	0.0825	0.0015
Soft drinks and carbonated waters industries	3134	-0.0191	0.4113	-0.0035	0.7205	-0.0197	0.6117
Tobacco manufactures	3140	-0.0084	0.7654	-0.0011	0.9266	-0.0099	0.7388
Spinning, weaving and finishing textiles	3211	0.2624	0	0.0048	0.5823	0.0026	0.8304
Manufacture made-up textile goods except wearing apparel	3212	0.0307	0.0596	0.004	0.6657	0.0205	0.0794
Knitting mills	3213	0.058	0	0.0022	0.1708	0.0763	0.0015
Manufacture of carpets and rugs	3214	0.2873	0	-0.002	0.8381	0.0108	0.6116
Manufacture of textiles, N.E.C.	3219	0.019	0.3227	-0.0016	0.8826	0.0364	0.2092
Manufacture of wearing apparel except footwear	3220	0.1238	0	-0.005	0.6345	0.0725	0.0243
Tanneries and leather finishing	3231	0.0549	0.0018	-0.0018	0.8592	-0.0116	0.6764
Manufacture prods. leather except footwear and apparel	3233	-0.0035	0.7667	-0.002	0.8485	-0.001	0.9307
Manufacture footwear except rubber or plastic	3240	0.0097	0.6119	-0.0004	0.9841	-0.0107	0.8169
Sawmills, planting and other wood mills	3311	0.1366	0	-0.004	0.6544	0.015	0.5871
Manufacture of wooden, cane containers, small cane ware	3312	0.0163	0.4181	-0.0009	0.9063	0.0287	0.3183
Manufacture wood and cork products N.E.C.	3319	-0.0067	0.8266	-0.0052	0.615	0.0035	0.4599
Manufacture furniture, fixtures except primarily mental	3320	0.2945	0	-0.0044	0.6573	-0.0012	0.9273
Manufacture of pulp, paper and paperboard	3411	-0.0198	0.3972	-0.0027	0.8032	0.0053	0.7791
Manufacture articles of pulp, paper, paperboardN.E.C.	3419	0.0505	0.0259	-0.0034	0.6139	0.0642	0.0358
Printing, publishing and allied industries	3420	0.1619	0	-0.0045	0.6678	0.0286	0.1963
Basic industrial chemicals except fertilizers	3511	0.0888	0	-0.0025	0.7832	0.1839	0
Fertilizers and pesticides	3512	0.029	0.1103	-0.0019	0.8393	0.0396	0.1178
Syn. resins, plastic mat. man-made fibers exc. glass	3513	0.0168	0.3717	-0.0004	0.9806	-0.0025	0.9712
Paints, varnishes and lacquers	3521	0.0323	0.1214	-0.001	0.943	-0.0087	0.8561
Drugs and medicines	3522	0.0186	0.3288	0.0187	0.0534	0.0569	0.0441
Soap, cleansing preparations, perfumes, cosmetics	3523	0.073	0.0012	-0.0036	0.7215	0.1492	0
Chemical products, N.E.C.	3529	0.2181	0	0.0114	0.2053	0.0284	0.3329
Misc. products of petroleum and coal	3540	-0.0027	0.8043	-0.0006	0.9681	-0.0038	0.985
Manufacture of rubber products N.E.C.	3559	0.0068	0.6887	-0.0037	0.7058	-0.002	0.9577
Plastic products N.E.C.	3560	0.0263	0.2354	0.0174	0.0756	0.086	0.0043
Pottery, china and earthware	3610	0.0072	0.6139	-0.0047	0.6314	0.0533	0.0765
Glass and glass products	3620	0.1538	0	-0.0015	0.8607	-0.0049	0.9439
Structural clay products	3691	0.0385	0.0698	-0.0036	0.7277	0.0413	0.1804
Cement, lime and plaster	3692	0.0224	0.3071	0.0013	0.8586	0.1011	0.0008
Non-metallic mineral products, N.E.C.	3699	0.0233	0.2483	-0.0028	0.7228	0.0801	0.0011
Iron and steel basic industries	3710	0.0186	0.3237	-0.0005	0.9524	-0.0199	0.6218
Non-ferrous metal basic industries	3720	0.0073	0.6743	-0.0031	0.7566	0.0398	0.1906
Cutlery, hand tools and general hardware	3811	0.024	0.0927	-0.0017	0.8833	0.1005	0.0019
Structural metal products	3813	0.1251	0	-0.0028	0.7999	0.1328	0
Fabricated metal products except machinery and equipment N.E.C.	3819	-0.0211	0.3588	-0.0022	0.8459	0.0275	0.3482
Agricultural machinery and equipment	3822	0.0135	0.2019	0.0048	0.6014	0.0033	0.8157
Spec. indus. machinery and equipment except 3823	3824	0.0268	0.1754	0.0061	0.4598	0.0999	0.0021
Office, computing and accounting machinery	3825	0.0236	0.208	0.0116	0.0883	-0.0059	0.9284
Electrical industrial machinery and apparatus	3831	0.0188	0.2782	0.0061	0.4304	0.0288	0.255
Radio, tele., communications equipment and apparatus	3832	-0.0035	0.9349	-0.0021	0.8475	-0.0037	0.999
Electrical appliances and housewares	3833	-0.0038	0.9244	-0.0013	0.8967	-0.0184	0.5827
Electrical apparatus and supplies, N.E.C.	3839	-0.0091	0.735	0.0014	0.8544	0.0978	0.0024
Shipbuilding and repairing	3841	0.0746	0	0.0149	0.0676	0.1388	0
Motor vehicles	3843	-0.0263	0.2414	0.0075	0.3994	0.0195	0.4778
Prof., scientific, measuring and control equipment	3851	0.0133	0.4888	-0.0046	0.6027	-0.0053	0.9415
Photographic and optical goods	3852	-0.0101	0.5917	-0.001	0.8596	-0.0219	0.5252
Jewelry and related articles	3901	0.0586	0	0.0055	0.2706	-0.0062	0.8743
Musical instruments	3902	0.017	0.409	-0.0012	0.9147	-0.0065	0.9065
Sporting and athletic goods	3903	0.0623	0.0016	-0.0013	0.8727	-0.013	0.7618
Manufacturing industries N.E.C.	3909	-0.0038	0.9198	0.0047	0.5369	0.0306	0.2957
E(I)		-0.0017		-0.0003		-0.0036	

Note: Moran indices are computed for first order contiguity matrices.

Table 4: EG index for Belgium

	ISIC code	E&G communes	E&G arrondissements	Rank E&G arr.
Misc. products of petroleum and coal	3540	0.4037*	0.3749*	1
Jewelry and related articles	3901	0.1342*	0.1784*	4
Pottery, china and earthware	3610	0.1136*	0.1398*	10
Knitting mills	3213	0.1103*	0.1656*	6
Can., Preserv., and process of fish, crustacean	3114	0.1065*	0.1585*	7
Shipbuilding and repairing	3841	0.0847*	0.1766*	5
Manufacture of vegs. and animal oils and fats	3115	0.0682*	0.1993*	3
Fertilizers and pesticides	3512	0.0525	0.0982	13
Basic industrial chemicals except fertilizers	3511	0.0436*	0.0502*	19
Manufacture of carpets and rugs	3214	0.037*	0.1575*	8
Spinning, weaving and finishing textiles	3211	0.033*	0.1368*	11
Manufacture of textiles, N.E.C.	3219	0.0301*	0.0565*	16
Canning and preserving of fruits and vegetables	3113	0.0287*	0.0361*	27
Cutlery, hand tools and general hardware	3811	0.0275*	0.027*	30
Drugs and medicines	3522	0.0273*	0.0991*	12
Agricultural machinery and equipment	3822	0.0239	0.0397	24
Musical instruments	3902	0.022*	0.0478*	21
Glass and glass products	3620	0.0184*	0.0436*	23
Manufacture footwear except rubber or plastic	3240	0.0161	0.0122	41
Sawmills, planting and other wood mills	3311	0.016*	0.0344*	28
Manufacture of prepared animal feeds	3122	0.0158*	0.0382*	25
Manufacture of dairy products	3112	0.0145*	0.0104	43
Structural clay products	3691	0.0144	0.0064	46
Photographic and optical goods	3852	0.0119	-0.0483	63
Tobacco manufactures	3140	0.0116	0.0244	31
Office, computing and accounting machinery	3825	0.0102	0.0535	17
Manufacture furniture, fixtures except primarily mental	3320	0.0099*	0.0137*	38
Paints, varnishes and lacquers	3521	0.0096	0.0514*	18
Manufacture made-up textile goods except wearing apparel	3212	0.0093	0.0372*	26
Sporting and athletic goods	3903	0.0088	0.0574	15
Cement, lime and plaster	3692	0.0087*	-0.0001	52
Manufacture prods. leather except footwear and apparel	3233	0.0086	0.0485	20
Non-metallic mineral products, N.E.C.	3699	0.0083*	0.0133*	39
Prof., scientific, measuring and control equipment	3851	0.0079	0.0188*	35
Tanneries and leather finishing	3231	0.0078	0.0796	14
Soap, cleansing preparations, perfumes, cosmetics	3523	0.0074	0.0144	37
Electrical appliances and housewares	3833	0.0074	0.0023	51
Manufacture of rubber products N.E.C.	3559	0.0071	0.0149	36
Slaughtering, preparing and preserving meat	3111	0.0068*	0.0055*	47
Manufacture of wearing apparel except footwear	3220	0.0064*	0.0209*	33
Distilling, rectifying and blending spirits	3131	0.0062	0.2159*	2
Manufacturing industries N.E.C.	3909	0.0061	-0.0056	56
Manufacture wood and cork products N.E.C.	3319	0.0051	0.0028	50
Printing, publishing and allied industries	3420	0.0051*	0.0228*	32
Plastic products N.E.C.	3560	0.0051*	0.0117*	42
Manufacture of food products, N.E.C.	3121	0.0045*	0.0055*	47
Manufacture of wooden, cane containers, small cane ware	3312	0.0035	0.0046	49
Manufacture articles of pulp, paper, paperboardN.E.C.	3419	0.0032	0.0098	44
Electrical apparatus and supplies, N.E.C.	3839	0.003	-0.0063	57
Structural metal products	3813	0.0023*	0.0093*	45
Non-ferrous metal basic industries	3720	0.0014	0.0123	40
Malt liquors and malt	3133	0.0013	0.0272	29
Manufacture of pulp, paper and paperboard	3411	0.001	0.0206	34
Fabricated metal products except machinery and equipment N.E.C.	3819	-0.0041	-0.0029	53
Spec. indus. machinery and equipment except 3823	3824	-0.0049	-0.0036	54
Electrical industrial machinery and apparatus	3831	-0.0072	-0.0053	55
Grain mill products	3116	-0.009	-0.0162	58
Iron and steel basic industries	3710	-0.0091	0.0447	22
Soft drinks and carbonated waters industries	3134	-0.0144	-0.0284	60
Chemical products, N.E.C.	3529	-0.0154	0.1496*	9
Syn. resins, plastic mat. man-made fibers exc. glass	3513	-0.0175	-0.018	59
Radio, tele., communications equipment and apparatus	3832	-0.0202*	-0.0301	61
Motor vehicles	3843	-0.0272	-0.0373	62

N

Table 5: EG index for Ireland

	ISIC code	E&G township	E&G county	Rank E&G county
Photographic and optical goods	3852	0.488*	0.2957*	1
Iron and steel basic industries	3710	0.1342*	0.0432	25
Manufacture of wooden, cane containers, small cane ware	3312	0.0949	-0.1267	63
Electrical appliances and housewares	3833	0.0922	0.0752	14
Malt liquors and malt	3133	0.0863	-0.0441	61
Can., Preserv., and process of fish, crustacean	3114	0.0793*	0.1147*	9
Syn. resins, plastic mat. man-made fibers exc. glass	3513	0.0734	0.1774	3
Motor vehicles	3843	0.072*	0.0297	30
Manufacture of vegs. and animal oils and fats	3115	0.0683	0.065	17
Manufacture of prepared animal feeds	3122	0.0483*	0.046*	23
Manufacture of carpets and rugs	3214	0.0438	0.0747	16
Misc. products of petroleum and coal	3540	0.0432	0.0104	39
Musical instruments	3902	0.0399	-0.073	62
Manufacture articles of pulp, paper, paperboardN.E.C.	3419	0.0393	0.0543	18
Glass and glass products	3620	0.038	0.1297*	6
Jewelry and related articles	3901	0.0363*	0.01	41
Office, computing and accounting machinery	3825	0.036	0.0025	46
Chemical products, N.E.C.	3529	0.0319	0.0204	34
Prof., scientific, measuring and control equipment	3851	0.0272*	0.0373*	27
Structural clay products	3691	0.0251	0.0303	29
Soft drinks and carbonated waters industries	3134	0.02	-0.0289	56
Slaughtering, preparing and preserving meat	3111	0.0173*	0.0411*	26
Canning and preserving of fruits and vegetables	3113	0.0168	0.0448	24
Manufacture of pulp, paper and paperboard	3411	0.0159	0.2171*	2
Drugs and medicines	3522	0.0156*	0.0213*	33
Manufacture wood and cork products N.E.C.	3319	0.015	0.0011	49
Manufacture furniture, fixtures except primarily mental	3320	0.0135*	0.0507*	20
Manufacture of wearing apparel except footwear	3220	0.0131*	0.0515*	19
Sawmills, planting and other wood mills	3311	0.013	0.0359*	28
Electrical apparatus and supplies, N.E.C.	3839	0.0111	0.0058	43
Radio, tele., communications equipment and apparatus	3832	0.0108	-0.0215	53
Plastic products N.E.C.	3560	0.0103*	0.0039	44
Basic industrial chemicals except fertilizers	3511	0.01	-0.0396	59
Manufacture of dairy products	3112	0.0079	0.0752*	15
Manufacture made-up textile goods except wearing apparel	3212	0.007	-0.0072	52
Manufacture of rubber products N.E.C.	3559	0.0052	0.0137	37
Cement, lime and plaster	3692	0.0037	0.0103	40
Soap, cleansing preparations, perfumes, cosmetics	3523	0.0029	-0.0242	54
Cutlery, hand tools and general hardware	3811	0.0027	0.015	36
Spinning, weaving and finishing textiles	3211	0.0015	0.1178*	8
Printing, publishing and allied industries	3420	0.0014	0.1671*	5
Structural metal products	3813	0.001	0.0011	48
Agricultural machinery and equipment	3822	-0.0008	0.1005*	11
Manufacture of food products, N.E.C.	3121	-0.0009	0.0199*	35
Non-ferrous metal basic industries	3720	-0.0009	0.0034	45
Fertilizers and pesticides	3512	-0.0016	-0.0302	58
Fabricated metal products except machinery and equipment N.E.C.	3819	-0.0016	0.0013	47
Spec. indus. machinery and equipment except 3823	3824	-0.0028	0.0134	38
Paints, varnishes and lacquers	3521	-0.0036	0.0465	22
Manufacturing industries N.E.C.	3909	-0.0044	-0.0005	50
Manufacture of textiles, N.E.C.	3219	-0.0056	0.0078	42
Knitting mills	3213	-0.0097	0.1753	4
Pottery, china and earthware	3610	-0.0111	0.0229	32
Non-metallic mineral products, N.E.C.	3699	-0.0131	-0.0039	51
Tobacco manufactures	3140	-0.0133	-0.029	57
Distilling, rectifying and blending spirits	3131	-0.0136	0.0763	13
Manufacture prods. leather except footwear and apparel	3233	-0.0144	-0.0411	60
Tanneries and leather finishing	3231	-0.016	0.1082	10
Shipbuilding and repairing	3841	-0.0175	0.0502	21
Grain mill products	3116	-0.0194	0.0243	31
Electrical industrial machinery and apparatus	3831	-0.0368	-0.025	55
Manufacture footwear except rubber or plastic	3240	-0.0514	0.0809	12
Sporting and athletic goods	3903	-0.0529	0.1185	7

Note: results were computed for 1998; stars stand for statistical significance according to the two standard deviation rule; sectors are ranked according to the local-level E&G index ranking; *townships* and *counties* correspond to the local respectively the regional geographic breakdown.

Table 6: EG index for Portugal

	ISIC code	E&G concelho	E&G distrito	Rank E&G dist.
Tanneries and leather finishing	3231	0.3941*	0.417*	4
Manufacture wood and cork products N.E.C.	3319	0.3272*	0.3781*	6
Office, computing and accounting machinery	3825	0.3134*	0.0766	33
Jewelry and related articles	3901	0.2859*	0.3038*	10
Glass and glass products	3620	0.2085*	0.305*	8
Misc. products of petroleum and coal	3540	0.2032*	0.6313*	1
Manufacture made-up textile goods except wearing apparel	3212	0.1655*	0.2034*	12
Prof., scientific, measuring and control equipment	3851	0.0845*	0.1248*	27
Fertilizers and pesticides	3512	0.0824*	0.1799*	17
Spinning, weaving and finishing textiles	3211	0.0796*	0.1801*	16
Manufacture furniture, fixtures except primarily mental	3320	0.0776*	0.138*	24
Manufacture footwear except rubber or plastic	3240	0.0756*	0.1254*	26
Drugs and medicines	3522	0.0747*	0.5357*	2
Printing, publishing and allied industries	3420	0.0739*	0.1634*	18
Manufacture prods. leather except footwear and apparel	3233	0.069*	0.0349*	46
Manufacture of dairy products	3112	0.0657	0.0258	50
Distilling, rectifying and blending spirits	3131	0.0651*	0.0268	49
Can., Preserv., and process of fish, crustacean	3114	0.0583*	0.0325*	48
Knitting mills	3213	0.0549*	0.2042*	11
Soap, cleansing preparations, perfumes, cosmetics	3523	0.0539*	0.483*	3
Paints, varnishes and lacquers	3521	0.0505*	0.0705*	35
Electrical industrial machinery and apparatus	3831	0.0494	-0.0301	62
Iron and steel basic industries	3710	0.0492*	0.0496	42
Electrical appliances and housewares	3833	0.0471	-0.024	61
Shipbuilding and repairing	3841	0.0461*	0.4065*	5
Manufacture of carpets and rugs	3214	0.0452*	0.1344*	25
Pottery, china and earthware	3610	0.0429*	0.2006*	13
Syn. resins, plastic mat. man-made fibers exc. glass	3513	0.0354*	0.1391*	22
Manufacture of vegs. and animal oils and fats	3115	0.0334	0.1385*	23
Manufacture of food products, N.E.C.	3121	0.0332*	0.1503*	21
Manufacture of prepared animal feeds	3122	0.0332*	0.0948*	30
Manufacture of pulp, paper and paperboard	3411	0.0314*	0.1163*	28
Basic industrial chemicals except fertilizers	3511	0.0263*	0.1839*	14
Structural clay products	3691	0.0248*	0.1522*	20
Agricultural machinery and equipment	3822	0.0241*	0.0821*	31
Motor vehicles	3843	0.0217*	0.063*	38
Cement, lime and plaster	3692	0.0214	0.1816*	15
Plastic products N.E.C.	3560	0.0212*	0.0577*	40
Non-metallic mineral products, N.E.C.	3699	0.0178*	0.0483*	43
Non-ferrous metal basic industries	3720	0.0167*	0.0185	53
Soft drinks and carbonated waters industries	3134	0.0164*	0.0695*	36
Manufacture of wooden, cane containers, small cane ware	3312	0.014*	0.0019	58
Fabricated metal products except machinery and equipment N.E.C.	3819	0.0137*	0.0222*	52
Manufacturing industries N.E.C.	3909	0.0136*	0.0137*	54
Cutlery, hand tools and general hardware	3811	0.0129*	0.0124*	55
Structural metal products	3813	0.0113*	0.08*	32
Manufacture of wearing apparel except footwear	3220	0.0112*	0.0625*	39
Slaughtering, preparing and preserving meat	3111	0.0111*	0.0685*	37
Manufacture articles of pulp, paper, paperboardN.E.C.	3419	0.0111*	0.0347*	47
Chemical products, N.E.C.	3529	0.0102	0.0432	44
Manufacture of rubber products N.E.C.	3559	0.0095*	-0.0056	59
Sawmills, planting and other wood mills	3311	0.009*	0.0373*	45
Spec. indus. machinery and equipment except 3823	3824	0.0067*	0.0101	56
Electrical apparatus and supplies, N.E.C.	3839	0.0054	0.0575*	41
Canning and preserving of fruits and vegetables	3113	0.0031	0.1566*	19
Grain mill products	3116	0.0031	0.0741*	34
Radio, tele., communications equipment and apparatus	3832	-0.0019*	0.023*	51
Musical instruments	3902	-0.0051	0.3684	7
Manufacture of textiles, N.E.C.	3219	-0.0114*	0.1087*	29
Sporting and athletic goods	3903	-0.026	0.0061	57
Malt liquors and malt	3133	-0.0306	-0.1542	63
Photographic and optical goods	3852	-0.0483	-0.0138	60
Tobacco manufactures	3140	-0.4349	0.3044	9

Note: results were computed for 1998; stars stand for statistical significance according to the two standard deviation rule; sectors are ranked according to the local-level E&G index ranking; *concelhos* and *distritos* correspond to the local respectively the regional geographic breakdown.

Table 7: Rank correlation of EG indices between countries

	Belgium (arrondissements)	Ireland (counties)	Portugal (distritos)
Belgium (arrondissements)	*1*	-	-
Ireland (counties)	*0.196 (0.123)*	*1*	-
Portugal (distritos)	*0.416 (0.000)*	*0.057 (0.656)*	*1*

(p-values in parenthesis)

Table 8: OLS estimations (Belgium, Ireland, Portugal)

	OLS		
	Belgium	Ireland	Portugal
	(1)	(2)	(3)
Total input purchases	0.153**	0.046	1.088**
	(0.063)	(0.183)	(0.511)
Share of higher education	-0.154	-0.409	0.987**
	(0.164)	(0.461)	(0.433)
Gross inv. in tang. capital goods	5.384	3.269	9.308
	(8.184)	(3.755)	(31.862)
Gross inv. in machines	-6.182	-6.871	-15.676
	(10.156)	(5.706)	(31.855)
Purchase of energy products	2.547	4.663	0.305
	(2.194)	(6.603)	(9.773)
R&D expenditure	7.578	11.923	134.645*
	(23.570)	(16.510)	(72.484)
Average plant size	-0.170	0.012	0.077
	(0.194)	(0.009)	(0.116)
Constant	0.009	0.012	-0.049
	(0.061)	(0.194)	(0.107)
2-digit ISIC dum.	Yes	Yes	Yes
Observations	63	55	61
Adjusted R-squared	0.24	0.03	0.25

Note : Standard errors in parentheses. ***, **, and * signify 1, 5, and 10 per cent significance levels. Data source is Eurostat. R&D expenditure is not studentized. All specifications performed using OLS estimators.

Table 9: Oaxaca Decomposition of Ellison and Glaeser index

Country i	Country j	$EG_i - EG_j$	$(\beta_i - \beta_j)X_i$	$\beta_j (X_i - X_j)$
Portugal	*Ireland*	0.084	0.043	0.041
Portugal	*Belgium*	0.078	-0.015	0.093
Belgium	*Ireland*	0.006	-0.010	0.016

[1] See, for instance, Ellison and Glaeser (1997), Maurel and Sédillot (1999), Rosenthal and Strange (2001), Duranton and Overman (2005). A notable exception is Devereux et al. (2004), which deals (although with some limitations) with cross-country comparison of agglomeration patterns.
[2] See Barrios and Strobl (2004), Brulhart and Traeger (2005), Midelfart-Knarvik et al. (2000), Amiti (1999), among others Some studies have also provided evidence for the existence of agglomeration economies leading to productivity gains at the city or region-level as, for example, Sveinkauskas (1975) Tabuchi (1986), Moomaw (1981), Rauch (1993), Glaeser et al. (1992), Henderson et al. (1995), Ciccone and Hall (1996) and Ciccone (2002).
[3] See, for instance, Puga (1998) for a theoretical analysis and Midelfart-Knarvik et al. (2000) for empirical evidence.
[4] See, in particular, Audretsch and Feldman (1996).
[5] See for instance, Crozet (2004).
[6] It would be thus interesting to assess what portion of our results can be attributed to the different size and internal geographical of the countries under scrutiny. However, this is beyond the scope of this study, but will be an important topic for further research.

[7] See for instance Openshaw and Taylor (1979) and Morphet (1997).
[8] Note that Duranton and Overman (2002) and Marcon and Puech (2003) circumvent this issue by treating space continuously rather than using an arbitrary collection of geographical units. Although appealing, a major drawback of their distance-based localization index stems from the need of having data on the geographic coordinates for each plant, respectively zip codes of plants.
[9] http://europa.eu.int/comm/eurostat/ramon/
[10] Final conversion tables that were used to perform a unified data set are available from the authors upon request.
[11] The current NUTS nomenclature subdivides the territory of the European Community into 78 NUTS1 regions, 211 NUTS2 regions and 1093 NUTS3 regions. At the local level, the NUTS4 level is defined only for the following countries: Finland, Greece, Ireland, Luxembourg, Portugal and the United Kingdom. The NUTS 5 level consists of 98433 townships or their equivalent.
[12] As an exception for Ireland we used NUTS5 (3445 spatial units) to compute the Moran index because we only had information about the contiguity matrix at this geographical level.
[13] Descriptive statistics on the spatial units are provided in Tables 1a and 1b.
[14] It should be noted that the EG index is computed at the country-level taking the overall employment distribution of common sectors as a benchmark.
[15] Considering the column for Ireland in Table 2, only four sectors do highlight positive spatial autocorrelation. This result is essentially driven by our choice of spatial unit to compute the Moran index, namely DEDs rather than townships.
[16] These measures concern the EG indices computed at the regional level of aggregation. When going to the local level, the same ranking is found among countries but amplitudes are smaller. Note also that the median value of the EG index for Portugal is 0.080, to be contrasted with 0.023 and 0.023 for Ireland and Belgium, as well as 0.023 for the US (Ellison and Glaeser (1997)).
[17] Definition of high-tech sectors stems from Hatzichronoglou (1997). In our data base, seven hi-tech sectors are available: Drugs and medicines (3522), Spec. indus. machinery and equipment except 3823 (3824), Office, computing and accounting machinery (3825), Electrical industrial machinery and apparatus (3831), Radio, tele., communications equipment and apparatus (3832), Prof., scientific, measuring and control equipment (3851) and Photographic and optical goods (3852).
[18] This latter explanation is indeed supported by Bertinelli and Decrop (2002), where it has been shown for Belgium that several high-tech sectors are ranked in the top 20 among a 237-sector classification. This result is consistent with Maurel and Sédillot (1999) and Teixeira (2002). Furthermore, note that by dropping some sectors across countries for the sake of consistency, two high-tech sectors, that were highly ranked, have been deleted for some countries: Aircraft (3845) and Watches and clocks (3853).
[19] These percentages are 19, 46 and 78 respectively when considering the local level.
[20] Results for Italy have been made available by Giordano Mion.
[21] Data description heavily rely on definitions provided by Eurostat (http://epp.eurostat.ec.europa.eu/). Further details are provided in the data appendix.
[22] One should note that some of the 2-digit industry dummies were significant.