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Dynamics of rural areas: an assessment of clusters of employment in Sweden

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Abstract

There are numerous examples in the empirically based literature, which argue in favour of the importance of firms' agglomeration in space as a way of creating and sustaining economic competitive advantages. One way to identify the degree of agglomeration of economic activity is through identification of the trends in clustering patterns relating to employment. The objective of this paper is thus to investigate patterns of clustering in both traditional and modern branches of the economy for two Swedish rural study regions (two leading areas and two lagging ones), assessing their location in relation to national economic dynamics. Standardised Employment Rates (SERs) are calculated and mapped using Geographic Information Systems (GIS) for thirty-seven economic branches. The Getis–Ord statistic is used to identify clusters of employment. The findings show that the study areas are to different degrees included in most of the clusters of the traditional branches, but not in a uniform way. Well performing areas often tend to be included in clusters composed of traditional private businesses, whilst lagging areas tend to be part of clusters in which the public sector is responsible for employment, this is particularly so in the sparsely populated areas of North Sweden. Most of the robust clusters relating to the modern branches of the economy are concentrated in the larger urban areas of Sweden, though in some cases, also in other larger regional urban centres. The most surprising result was perhaps that clusters of employment within such modern branches are relatively over-represented in certain parts of some lagging areas, a fact that may reflect the effects of regional policy measures on the decentralisation of R&D and post secondary education. Maps showing SERs and patterns of employment using clustering analysis often reflect the boundaries of functional regions, the degree of economic specialisation, and the dynamism of a region in a national context, all of which suggests that such a methodology can be utilised in the new toolbox designed to help aid the process of regional policy programme evaluations.

1. Introduction

Many countries are at the present time undergoing a number of concurrent and rather fundamental economic, social and spatial transformations reflecting what is often called the shift from modernity to late modernity (Giddens, 1990, 1991) or the emergence of what is often labelled the informational society (Castells, 1989). In Europe, certain regions are now emerging as important foci of industrial success through their *stocks* of specialised know-how, intellectual infrastructure and technological capabilities (Brown, 2000) whilst others are becoming increasingly marginalised. In Sweden, it is claimed that these structural changes are increasing regional economical differences, between the rural, low-density populated areas, mostly in the North, and the large and prosperous urban areas. Rural policies in many EU and other OECD countries are already reflecting such shifts (see, for instance, Bryden, 2000; Freshwater, 2000; Schrader, 2000) though there are surprisingly few empirical studies addressing the impact of these macro changes on the differential economic performance of the regions.

It is thus now timely to investigate patterns of differential economic performance across the regions for two reasons. The first reason concerns the importance given by the European Union to the understanding of differential performance at the local and regional levels, as a key element in devising practical strategies and programmes for sustainable rural and regional development in different contexts (see, for instance, the Single Programming Documents under Objective 1 of the Structural Funds, and the Business Plans under the LEADER Community Initiative). For a territorial approach on this issue, see RUREMPLO, and other projects, such as, Terluin and Post (2000). In Sweden, the instigation of new approaches aimed at the

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promotion of a higher degree of autonomous economic growth at the regional level demand new ways of assessing the regions' position in relation to national economic dynamics. The growth agreements, or *Tillväxt Avtal*, that each county has recently concluded with Swedish central government, constitute such an example of this type of approach.

The second reason relates to the advent of new technologies in data analysis. The advent of computerised mapping systems has led to the creation of operational systems for visualising growing amounts of data. The emergence of approaches such as that used in Geographic information systems (GIS) potentially makes the geographical analyses of data a much more penetrating and incisive tool than it was hitherto. GIS facilitates the integration of many types of data onto a common spatial framework and opens up the possibility of fine-gained spatial analysis. The value of GIS in analysing spatial patterns becomes even greater when it is enhanced with spatial statistical techniques (Anselin, 1995; Haining et al., 1996; Unwin, 1996; Bivand, 1998; Haining et al., 1998).

The contribution made by this paper is to the investigation of clustering patterns in both traditional and modern economic branches for two rural study regions in Sweden, assessing their location in relation to national economic dynamics. In so doing, we want to demonstrate the application of spatial statistics to problems of assessing differential performance at the regional level.

The point of departure for this analysis comes from the assumption that clusters or agglomerations of employment can be found where the degree of employment concentration in space is beyond that which may be observed where firms had chosen their location completely at random. It is already known that employment does not follow a random pattern in space, especially as firms/institutions pay particular attention to the many advantages[1] of being located close together. Thus, the occurrence of clusters of employment is assumed here to indicate not only a degree of regional economic specialisation, but also dynamism as compared to the surrounding regions.

It is worth noting that the rural areas selected for this analysis have all been subject to the vagaries of national regional and rural policy for a considerable period of time, and that they have been eligible for help via the EU's Structural Fund policy since the mid 1990s. The Southeast Sweden region was an Objective 5b area during the period 1995–1999, thereafter it fell into the new Objective 2 status category, which by definition means that it is already defined as a cluster within the traditional industries area, being based on agriculture and forestry. The second region looked at here, that of Northern Sweden, was initially in Objective 6, and is currently in Objective 1, which is also defined as depending on traditional manufacturing industries, and is thus deemed to be suffering from numerous deglomeration and accessibility problems.

The problems related to the achievement of a critical mass of specific economic activity in these sparsely population could be seen as an obstacle to clustering and to the pursuit of economies of scale. The locations of these traditional clusters are often rooted in history, and invariably linked with the discovery of natural resources. In addition, the long-term public sector involvement in maintaining local services in places with ageing population problems has meant that lagging areas concentrated a great share of branches related to public service production.

The programmes for Objectives 5b/2 Southeast Sweden and 6/1 Northern Sweden explicitly aim at the renewal of the industrial structure of these regions. Measures frequently used in this regard relate to enhanced competence and the re-training of the labour force, as well as incentives to start-up firms in new industrial branches, networking between firms in order to overcome the problems created by long distances. Such measures constitute clear elements in a conscious strategy to develop new clusters of industries in these areas. The links, or partnerships, between leading centres within the so-called *new economy* and the rural hinterland are clearly stressed in these policy programmes. It is in this light then that this paper seeks to outline and forward strong policy-oriented arguments for analysing (1) which traditional clusters continue to dominate in different regions and (2) which modern, *new economy* clusters emerge in—or close to—these rural areas. The first type of analysis should help us to describe the extension, geographically delimit and prioritise where the need is for further offensive programmes aimed at the renewal of the industrial structure. The second type of analysis will help us to evaluate the spatial outcome of policy measures designed both to re-locate modern industrial branches in rural areas, and to expand upon what intrinsic growth has already occurred. The analysis of such clusters is likely to reveal the position and strength of the obstacles to the extension of such clusters into these non-traditional *industrial* centres. We suggest and anticipate, that the methodology used in this cluster assessment of employment can be utilised in the new toolbox designed to help aid the process of regional policy programme evaluation.

The structure of this paper is as follows. In Section 2 the factors and processes that are believed to impact on the geography of individual firms' location choice and, by extension on employment levels generated, are briefly reviewed. In Section 3 the hypotheses of study are

[1] See, for instance, Maskell (1998) for an extensive discussion of these advantages.

presented followed by a description of the study areas (Section 4) and the methodology (Section 5) that assumes clusters (through measures of spatial association) as an indicator of proximity, economic specialisation and dynamism. In Section 6 clustering patterns of employment within traditional and modern branches of the economy are assessed using four study areas as the basis of analysis. The last section, 7, presents a broad set of final considerations as well as directions for future work.

2. Clusters in space: does proximity matter to economic dynamism?

There are many examples in the literature of supporters of the notion of the importance of firms' agglomeration in space—or proximity—as a way to create and sustain economic dynamism. More recently, it has also been argued that the role of localised learning is of strategic importance in the promotion of endogenous regional development. The importance of proximity in explaining performance is intimately tied to the development of the concept itself. According to Scott (1997) although the concepts that underpin clustering draw upon the already well established Marshallian theories of agglomeration, it is only through the recent work of economic geographers, regional scientists and sociologists that linkages between industrial performance and geography are now being closely explored.

Moreover, according to Kirat and Lung (1999), proximity can be related to several different notions. It can entail *physical proximity*, which represents the outcome of the development path of natural constraints/resources. The term can also be conceived in consideration of a given configuration of the existing economic relationships among agents, which indicates the positioning of agents within a spatial framework. Another perspective relating to notions of *proximity* deals with association with the set of interdependencies (mostly technologically based ones) between various activities within the scope of production, which can be linked to other sectors (e.g., R&D) or to other similar sectors. The current authors propose however to utilise two further notions of *proximity*. The first is called *organisational proximity* and is deployed within an organisation, relating to (inter)dependence between organisations within a network, for instance. The second notion is that of an *institutional proximity* that indicates the assembly of agents as parties of a common space composed of representations, models and rules being applied to thought and action (p. 30). This form of proximity is tied to the interactions between agents, who can base a territory on a collective learning process, which may imply a certain geographic proximity among agents, a condition of the exchange of information that is unable to be transported spatially by technical means.

Regardless of the concept of proximity considered here, we can assume that the advantages of being geographically concentrated range from traditional factors of production for which the costs differ significantly between locations, to more subtle factors related to information and technological diffusion. Maskell (1998) lists the most visible advantages of geographical agglomeration that can be found in the literature as the following:

(a) Cost reduction that may be experienced by easier access to specialised supply of complementary products or services.

(b) Infrastructure advantages are predetermined by the demand of agglomerated firms that require an improved supply of infrastructure such as, transport systems and educational facilities.

(c) Labour-market advantages are the result of the process of specialisation within the agglomeration that leads to the formation of a labour force with qualifications suited to the needs of local firms.

(d) Technological spillovers and the maintenance of an atmosphere for information interchange (already alluded to Marshall, in the 1920s) over products, processes, markets and regulation effects.

(e) Local cultural identity can be a result of the closeness of the relationships in a geographical agglomeration of related firms—the existence of a special local system of codes, which supports and stimulates its internal economic activity and offers credible protection against imitation.

(f) The ability to create a non-tradable advantage: the local climate of shared trust is an advantage that not all agglomerations succeed in having in relation to outer regions. Once the trust element exists, it becomes part of the local business culture and thus one of its most important advantages.

Both Maskell (1998), and Kirat and Lung (1999) however point out that geographic proximity should be considered as a necessary, though in itself not a sufficient precondition for the existence of a territorially innovative system. This means that the business environment of a geographical agglomeration does not necessarily lend itself to cooperation and interaction, and thus neither to an innovation system. On the contrary, *differences in relations between firms within an existing local or regional milieu may range from rapprochement to detachment, indifference or uncompromising rivalry* (Maskell, 1998, p. 110). Only in a few circumstances would agents be willing to cooperate and produce a climate of shared trust, creating a kind of *territorial innovation network* (Kirat and Lung, 1999, p. 31), a process that takes time to develop and constitutes the product of a collective dynamic in which learning processes play a central role.

Santos' contribution (Santos, 2000) is in agreement with several other sources of empirical evidence in suggesting that proximity matters in the perpetuation of competitive advantages, though the author reminds us that what is more important is the level of organisational proximity, as this contributes to the upgrading of the competitive edge of localised production systems and aids in resource creation. Santos thus argues in favour of the combination of geographical proximity with knowledge transmission and collective learning as a way to achieve competitive advantages.

Maskell and Malmberg (1999) investigated the impact of geographical location on the ability of firms to create and sustain competitiveness under globalisation. They thus raise three fundamental questions in this context. The first question is related to what competition is actually about in today's world economy, and how the performance of firms and industries is related to both space and place. The second is concerned with why geographical areas tend to specialise in particular types of economic activity, and why patterns of specialisation are durable. The third question concerns how high-cost regions can sustain competitiveness and prosperity in an increasingly integrated world economy. The answers to all of these questions relates to *how knowledge creation emerges* and to the development of the *localised capabilities* that promote such learning processes (p. 20). Maskell and Malmberg point out, for instance, that empirical evidence from Europe suggests that some types of interfirm knowledge creation and other operations take place within confined territories because technology leaders are present in these areas, or because local authorities are skilled in promoting learning among local firms.

In the specific case of furniture industry in Denmark, Maskell (1998) argues that spatial proximity between related firms can create certain competitive advantages. These advantages are however not simply related to the possibility of utilising the geographical concentration of suppliers or customers, but rather to the relative ease of access to knowledge acquired by firms in the proximity—this is only possible through the existence of certain bonds of trust. The locational pattern of the furniture industry is in full accordance with theories of trade and endogenous growth—territorially confined and industry-specific capabilities and competencies are built over time through processes of *learning-by-experience*. This finding, whilst not unique in the literature, is however suggestive of a different geography of employment that is highly influenced by historical aspects of development.

Dependence on geographical proximity or on a network of links to local business seems to be much less significant for branches of economy, such as, R&D (Diez, 2000). Though this is also applicable to certain branches of the traditional industrial economy, such as the Swedish machinery industry (Larsson and Malmberg, 1999). Diez (2000), investigated the importance of research institutes in supporting business innovation activities in three metropolitan areas (Stockholm, Barcelona and Vienna) as fundamental impacting factors on the regional economy. Findings show that research institutes do not however cooperate exclusively with local business. On the contrary, cooperation partners are located both at the national or the international levels. In Stockholm, as such foreign manufacturers are often more important as cooperation partners than local firms. According to Diez, these findings shed light on the actual significance of research institutions in the support of firms' innovation processes — ⊖ which are in fact smaller than that suggested by concepts such as innovative networks, innovative milieu or learning regions. Moreover, Cornish (1997) suggests that proximity between producers and markets plays a limited role in effective product innovation.

The Swedish experience may differ from that of other countries, though bearing in mind the general case concerning the provision of professional business services, their geographical concentration in large urban centres is consistent with the experience of most other comparable countries, as it was generally accepted that proximity to ones client base demands a central physical position in the marketplace. This notwithstanding however, Hermelin (1998) produces arguments for several other factors based on a study of five Swedish municipalities: Stockholm, Uppsala, Eskilstuna, Västerås and Nyköping. Other factors such as professional labour, localisation and urbanisation economies, and the circumstances surrounding the establishment of firms, as well as their subsequent history, she concludes, can also play a role in the geographical distribution of such activities. Hermelin also points out that between 1985 and 1993, the locational pattern of the professional business services sector changed slightly, due to the number of suburban municipalities and regional centres that experienced major gains in employment during this period, thus she suggests, one can see definite signs of an ongoing process of decentralisation occurring. However, she concludes by noting that in Sweden, *the concentration of service producers* (in terms of the number of employees in urban areas) remains an indisputable fact (p. 265).

Regardless of how conflicting the international findings are on the impact of the location of economic activity, the need for more information on Swedish conditions is evident. Given certain trends at the international level, it is already understood that knowledge-based branches are likely to be located in the larger urban centres whilst others, often of a more traditional nature, historically developed in other parts of the country, including rural areas. Thus, this paper attempts to contribute to the knowledge base concerning the use of spatial patterns of employment as a way of tracing

differential economic dynamism in rural areas. As such, particular attention will be paid to differences in clustering patterns between two pairs of leading and lagging areas.

3. Hypothesis of study

The identification of clustering patterns of employment is carried out in this paper in order to assess the importance of firms/institutions' agglomeration in space as an indicator of differential economic dynamism in rural areas. The objective is to investigate patterns of clustering in both traditional and modern branches of the economy across two Swedish rural regions (two leading areas and two lagging ones) and assesses their location in relation to patterns of national economic dynamics. The definition of a *leading* (or well performing) area and a *lagging* (or less well performing) area is based on a pre-assessment of Swedish rural areas that exhibit medium to long-term differences in economic performance in accordance with several factors, including GDP per head, status of policy programmes and the degree of rurality according to OECD criteria. These areas are chosen as study areas for the DORA project in Sweden. DORA stands for *Dynamics of Rural Areas*.[2]

Hypothesis 1. Rural areas that are lagging are often outside clusters of industrial activity whilst the more dynamic areas are often part of clusters that characterised the national dynamic in the late 1990s.

Hypothesis 2. Leading rural areas tend to be part of few clusters of activities that characterise the modern economy, that is, composed of knowledge-based branches, while lagging areas remain in few clusters of more traditional branches, often publicly financed activities.

Hypothesis 3. Rural areas located in more densely populated areas, which have a relatively better communications network, and are located more strategically in relation to central power structures, both nationally and at the European level, tend to be included more often in clusters of employment. As all the previously mentioned factors can be seen as advantages with regard to spatial agglomeration as pointed in the literature, we should thus expect that rural areas in Southeast Sweden are more likely to be part of such clusters than those in Northern Norrland.

Hypothesis 4. The modern 'knowledge-based' industrial branches are still at the beginning of their product cycles[3] and thus in Sweden no clusters outside the main core areas (Stockholm, Gothenburg and Malmö) can yet be identified.

Hypothesis 5. Cluster analysis can be a useful tool indicating the degree of proximity of economic activities in space and, in so doing, one can argue in favour of the advantages of the proximity of economic activities for the regional economic dynamic in the regional context.

4. Economic dynamism in rural areas: the DORA case study

The empirical work contained in this paper is based on the analysis of the so-called DORA case studies. These cases are composed of four groups of municipalities located in two distinct rural regions in Sweden: Southeast Sweden and Northern Sweden. DORA—Dynamics of Rural Areas, is a two-year international comparative research project carried out at Nordregio (Sweden) in co-operation with the Arkleton Center for Rural Development (Scotland), the Agricultural University of Athens (Greece) and FAL (Germany). The projects' main goal is to contribute to the understanding of differential economic performance in rural areas. This paper deals with only one factor of analysis (out of ten) regarding the economic structure of the areas.[4]

Within each of these two DORA regions, two study areas have been selected (giving a total of four study areas) which exhibit medium to long-term differences in

[2] DORA is funded by the European Commission under the Fourth Framework Programme for Research and Technology Development, FAIR6-CT98-4162. For more information, see http://nordregio.se/dora.htm.

[3] The term 'product cycle' borrows its meaning partially from the usage of 'product cycle' to be found in, e.g., Johansson (1993), p. 136–137, though in this specific case the term is more akin to the idea of product diffusion. Firstly, the product is introduced to the market (eliminating concurrent products), it spreads over the territory, starting from the central clusters of production, slowing down towards the periphery and, in the later stages, its production became more effective or is superseded by a new product and thus the cluster production disappears, both centrally and in the more peripheral areas.

[4] In recognition of the inter-disciplinary nature of the DORA project, and of the research teams involved, quantitative and qualitative research methods have been employed. A list of ten factors worked as a guide to comprehensive research, five were tangible factors and five, less tangible factors. Tangible factors deal with the objective, formal, measurable and well-established characteristics of economic performance. Tangible variables are primarily based on quantitative, statistical data. Less tangible variables refer mainly to informal relations and activities. Even though all countries agreed on a common methodology, the way each factor was assessed was not the same in each country, which made a comparison factor-by-factor across countries a dificult task. Of course, a comparison between the findings of this paper and those of other partner-countries would be needed to support or refute the hypothesis stated here, though, as yet, this type of analysis of clusters of employment for other countries was not available.

economic performance in accordance with several criteria, including GDP per head, status of policy programmes and degree of rurality according to OECD criteria. A study area set is composed of a well performing area and a lagging area (Table 1). Southeast Sweden region is divided into two groups of municipalities in relation to their economic performance. The leading or Well Performing Southeast—WPSE, Ödeshög, Ydre, Kinda, Boxholm and Aneby compose a group of municipalities that can be considered as having the characteristics of a *dynamic region* compared with other municipalities in the same region. The municipalities of Hultsfred and Vetlanda were taken as examples of less dynamic areas in the region and thus were labelled the Less Well Performing Southeast—LWPSE, or lagging area. The study area itself is part of a larger region called Southeast Sweden, or *Sydöstra Sverige*. The main potentialities of Southeast Sweden are its possession of natural resources (wood, watercourses and lakes), its location and culture.

The region belongs to the Southeast highland, which is rich in lakes and watercourses. Its proximity to nature with a large area of forest and well-preserved historic environments make the region an attractive place to live. The diversified landscape with alternating cultural traditions, the lakes and forest, is unique in a European perspective and is clearly attractive especially in terms of international tourism. Comparatively speaking, the region is closer to the locations of the main Swedish urban centres, to the Baltic countries and indeed to the European continent as a whole, than several other regions of Sweden. The size of the region is measured at 17000 km^2, which roughly equates to an area covering two-thirds of Belgium. In terms of infrastructure, the Southeast region has a relatively well-constructed road network, which means that one may reach Stockholm region in 3–5 h and Malmö–Copenhagen region in 4–5 h. By train, the travel time to these areas is 3–6 h and 4–6 h, respectively. There are however few daily flight connections to Stockholm and Copenhagen from cities close to the region. The region also has several important port connections. Such characteristics are associated with the *Smålandsk way of life*, which basically stands for the people's resistance, independence and perseverance, which it is said, brings a unique strength to the region. The region does however suffer from barriers that work against its strengths. The ageing, sparse and decreasing population associated with the low formal educational levels of the population constitutes its main constraints. The region is also known for its traditional and poorly diversified industrial sectors, based on the wood industry, agriculture and manufacturing, activities that have an underdeveloped export potential and that, in terms of labour market, fail to address the demands of female members of the labour force, and have only a limited ability to assuage demand in the skilled labour force.

Storuman, Sorsele and Lycksele form a group of municipalities in Northern Sweden regarded as a dynamic region when compared to other municipalities in the same region, the so-called WPN—Well Performing Norra Norrland. The Less Well Performing Norra Norrland area—LWPN, is composed of three municipalities, namely Överkalix, Pajala and Gällivare located in Norrbotten County. The study area is part of the so-called Northern Sweden region—Norra Norrland. The potentialities of the Northern Sweden region cannot be limited to its location and the uniqueness of its environment. The region maintains a strong potential for tourism (*Europe's last wild land*—is the current slogan), whilst it has a strategic location in relation to other Nordic countries. The landscape of this huge area is widely varied. It extends from the mountains in the west, along the great rivers and through the vast forests and farming areas. Many natural reserves and protected rivers are found in this region, including that at Kebnekaise, Sweden's highest mountain. Besides the natural resources, this region also displays other singularities, for instance, it is a multicultural area. It is the only region in Sweden that has boundaries with two other countries (Norway and Finland). Northern Sweden is part of the so-called Barents Euro Arctic Region, (which also includes Finland, Norway and Russia). The region is also characterised by its long tradition of mining (e.g., iron) and forestry, both of which are still important exporting sectors in Sweden.

These traditional industrial sectors, combined with the exploitation of watercourses (hydropower) are crucial to the health of the regional economy. Working against these potentialities are several important constraints such as relative remoteness and size. The region is located both on the periphery of Europe and also on the periphery of Sweden itself, though it is relatively close to Finland, Norway and Russia. The total area is 165 000 km^2, which corresponds to that of almost 40 percent of Sweden's area and 5 per cent of the EU's

Table 1
The DORA regions and study areas in Sweden

Regions	*Norra Norrland* *North Sweden*	*Sydöstra Sverige* *Southeast Sweden*
"Well performing" *Leading*	Storuman, Lycksele and Sorsele	Ödeshög, Ydre, Kinda, Aneby and Boxholm
"Less well performing" *Lagging*	Överkalix, Pajala and Gällivare	Vetlanda and Hultsfred

area. The region is the EU's largest NUTS II-region, as large as the whole of Austria, The Netherlands and Denmark combined. The region is also known for its decreasing, sparse and ageing population. Such development in terms of population structure has created regional imbalances in education and consequently, in the labour market over the last few decades, especially between the coastal and inland areas. The mining and forestry industries often thought of, as *male based industries* do not contribute to an already highly segregated labour market, in which women are often limited to activities within the public sector. All these tangible barriers are certainly accentuated by a weak and diffuse regional identity (despite the strong rural communities movement during the 1980–1990s—*landsbygdsrörelse*) and the historical paternalistic attitude towards the State (which previously was the sole owner of all natural resources in the region) and, more recently, to EU organizations.

5. The methodology

In order to validate the hypothesis, two sets of branches were chosen from the employment database (5-digits) for 1997 across the whole of Sweden (from SCB—Statistiska Centralbyrån, *Statistics Sweden*). The first set exemplifies the traditional industrial branches while the second set of branches indicates the modern or knowledge-based economy. The choice of traditional branches was carried out based on a pre-evaluation of the most common economic activities in our study areas from a list of approximately one-hundred branches from SCB:s Firms records—*Företagsregister* (SCB, 1998). The classification of branches as traditional and modern can be target for criticism since the decision to place them as a modern or traditional was subjective. Perhaps, the branch of wooden furniture should be seen as modern since it may depend upon design-knowledge-based activities. The same could be also said of the aluminium industry. However, based on the historical economic traditions of the regions of study, it was decided that such branches should be classified as *traditional*.

This selection was not only based on the total number of employees (at least 30) but also on how common they appeared to be in other municipalities of the region. The main idea of starting from the most important local branches was to verify empirically to what extent the DORA study areas could be placed in a national context in terms of their degree of specialisation. This approach was more bottom-up than that used for the selection of modern branches as it started from each municipalities' employment composition. The selection process for choosing the modern branches was carried out through the identification of activities that can generally be equated with the *new economy*, without actually having any information on the employment settings of these branches in DORA study areas. Table 2 lists the two set of industrial branches used in this analysis.

Among the traditional branches, twenty-one were selected based on their representativeness in terms of employment in the DORA study areas. In general terms, these branches can be divided in three groups. The first group is composed of branches involving mining activities, agriculture and animal husbandry (including reindeer and other similar animals). The second group incorporates manufacturing branches, such as, sawmills, iron ore and the steel and metal working industry. The third group is mostly composed of activities that are publicly financed, for instance, primary school and home-help services. Employment in religious associations was also an important sector in three municipalities of the study and, in this case, was included in the traditional branch.

Those branches regarded as modern numbered sixteen in total, and can be further divided in three groups. Those branches related to computer and consulting activities comprise the first group, Research and Development—R&D, constitutes the second group and, the third group, is composed of branches related to post-secondary education, universities and educational institutions in several areas of knowledge.

5.1. Obtaining reliable maps of employment distribution using SER—Standardised Employment Rate

In order to have a measure of employment distribution for each of the 289 Swedish municipalities, a Standardised Employment Rate (SER) has been calculated using arithmetic functions in *MapInfo*.[5] This type of standardisation is a useful way of representing data for a set of areas where the areas differ in size (absolute values would tend to over-emphasise large areal units) and where it is necessary to allow for differences in population characteristics between areas (Haining, 1990). The SER for municipality (i) is given by (1):

$$SER_{(i)} = (O_{(i)})/E(i)_{(i)})\times 100 \quad (i = 1, 2, \ldots, N), \tag{1}$$

where $O(i)$ is the observed number of employment in a given branch and $E_{(i)}$ is the expected number of employment in given branch.

With sufficiently disaggregated employment data, the calculation of the expected count could be undertaken in a similar way to that used for example in the calculation of standardised mortality rates in disease mapping where it is usual to control for the confounding effects of age and sex in estimating area specific relative risk rates. In this case, an average rate is obtained by

[5] MapInfo Professional Version 5.0, Copyright © 1985–1998 MapInfo Corporation. It should be noted that virtually any of the other available Desktop mapping systems could have been used.

Table 2
The dataset

Traditional branches	Modern branches
01300 Agriculture diverse	72100 Consulting in hardware
13100 Iron ore quarrying	72201 Data consulting
20101 Sawmills	72202 Software producers
20202 Particle board industry	72300 Data service offices
27100 Iron and steelworks industry	72400 Database hosts and similar
27420 Aluminium industry	72500 Service firms for computer and office machines
28520 Manufacturing and metal industry	73101 Natural Sciences, R&D institutions
36110 Furniture/chairs industry	73102 Technology, R&D institutions
36140 Furniture-diverse industry	73103 Medicine, R&D institutions
45211 Housing construction industry	73104 Agriculture, R&D institutions
52112 Supermarkets	73105 Multidisciplinary R&D institutions
60240 Road carriers	80301 University/technological institutes
75111 State/municipal organisations	80302 University/economy, administration and social issues
85311 Housing for the elderly	80303 University/teaching
85312 Housing and care for the psychologically handicapped	80304 University/health care
85120 Health care ambulatory	80305 University/culture and information
85323 Home service and similar	
85321 Pre-school	
80100 Primary school	
80210 High school	
91310 Religious associations	

dividing the total number of those employed in a given branch by the total employment in the area. For each municipality (i), this average rate is multiplied by the employment of (i). As a consequence the SER is simply a rate $(O_{(i)})/(n_{(i)})$ where $n_{(i)}$ is the chosen denominator, multiplied by a constant which includes the inverse of the average rate for the area as a whole. The Standardised Employment Rate – SER of 200, for example, indicates that municipality has twice higher share of employment in a given branch than could be expected, given the total number of those employed in that municipality.

5.2. Creating clusters of employment using spatial association measures

A measure of spatial association has been used as an indication of the degree of proximity of economic activities over the whole country—a measure that is assumed here to be able to indicate economic dynamism. The main objective here was to identify robust clusters of employment that illustrate the region's economic specialisation and provide indications that these economic activities are taking advantage of their geographically proximity as pointed in the literature. The main reason for using spatial statistics in this analysis relates to the importance of the spatial information content. For instance, similarity in location (proximity) and in attribute (total employment in branch x) of a certain zone (municipality) in relation to its neighbouring zones provides a robust basis for identifying clusters of economic activities.

The Getis–Ord statistic, or simply (G_i), has a number of attributes that make it attractive for measuring association in a spatially distributed variable. The Getis–Ord statistic can be described as the ratio of the sum of values in a neighbourhood of an area to the sum of all values in the sample. According to Getis and Ord (1992), G_i statistics are useful to detect local pockets of dependence that may not show up using global statistics. The global statistics Morans I, in Goodchild (1986), was initially applied under the randomisation assumption to trace patterns of autocorrelation. The scores are found in Appendix B SpaceStat (see Anselin, 1992) was used to calculate the global and local Moran's I. The local Getis–Ord statistic provides a criterion for identifying clusters of high or low values, indicating the presence of significant local spatial clusters. When the model provides a measure of spatial clustering that includes the observation $j = i$ under consideration, the model is called G_i^*. The local Getis–Ord statistic, $G_{(i)}^*$, is given by the following formula (2):

$$G_i^* = \sum_j w_{ij}(d)x_j / \sum_k x_k \tag{2}$$

Where $w_{ij}(d)$ are the elements of the contiguity matrix for distance d, in this case, a binary spatial matrix was used to incorporate the spatial information entailed in the map of Swedish municipalities. A simple 0/1 matrix where 1 indicates that the municipalities have a common border and 0, otherwise.

The standard normal deviation (z-value) was used to indicate significant differences in values. The significance of the z-value of each local indicator can be computed

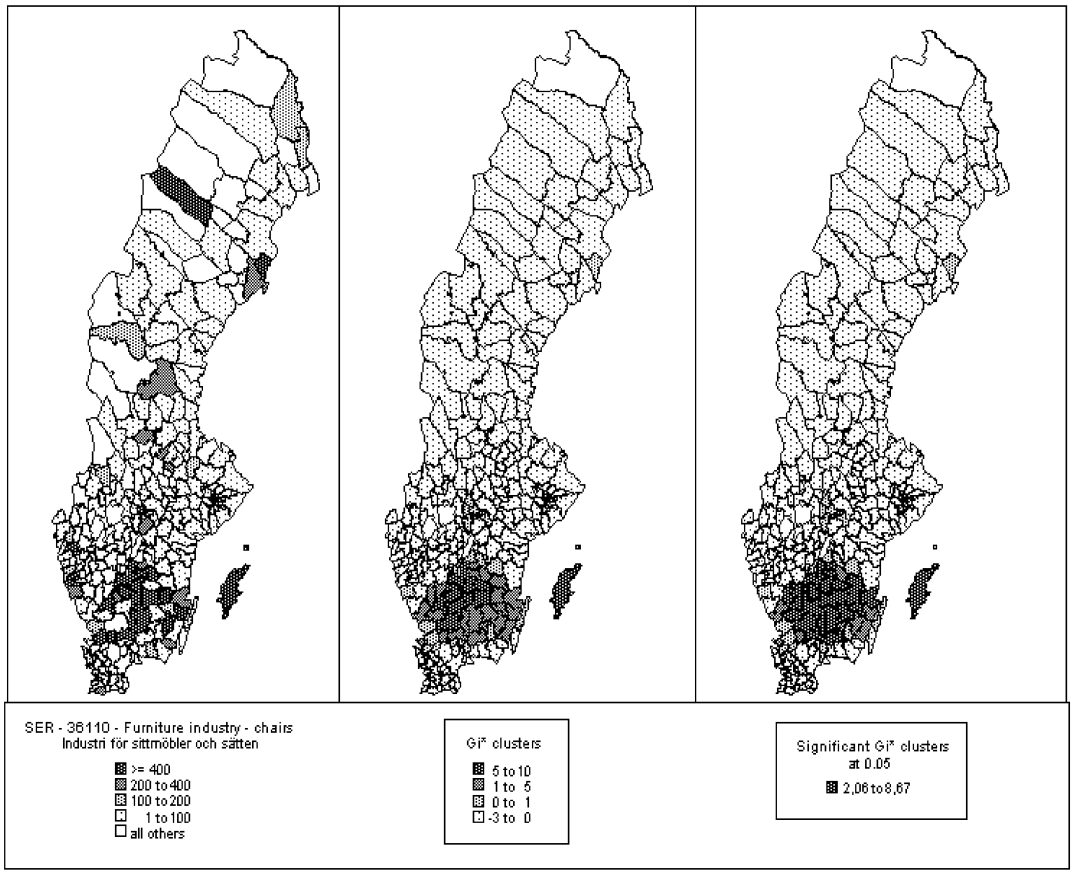

Fig. 1. SER and Gi* clusters: furniture/chairs industry.

under the assumption that attribute values are distributed at random across the area. A positive and significant z-value indicates spatial clustering of high values, whereas a negative z-value indicates spatial clustering of low values. Finally, maps were created showing areas with concentrations of employment in a given branch, statistically significant at $p \leqslant 0.05$ for the whole of Sweden. The resulting clusters are discussed below.

The following discussion of the results has two levels of analysis. The first level refers to results on the spatial variation in the SER (Eq. (1)). The second level refers to results based on the Getis–Ord test (Eq. (2)) which describes larger scale patterns in the data, namely geographical clusters of areas with high and low SERs.

6. Assesment of clusters: the DORA study areas in a national context

Results indicate that the combination of SERs and spatial association measures can be used as an indicator of employment distribution, economic specialisation and clustering of economic activities through employment data at the municipal level. The SER maps provide a robust basis for identifying cluster of employment by using G_i^* statistics (Figs. 1–4 and Table 5 illustrate a selection of the results). The maps of G_i^* clusters illustrate the tendency for clustering of employment (hot spots) and also areas that have less employment in a given branch than the 'overall avarage' (cold spots). The maps of significant clusters show the strength of the different clusters in the national context. These results are pretty conservative because they often restraint the size of the clusters to small number of municipalities (the cluster's core). Since we are interested in having an overview of the trends for clustering patterns of employment, the maps were more often used as a general basis for the analysis than focusing only on significant clusters.

It is however important to bear in mind that clusters or conglomerates of employment are concentrated where the degree of employment concentration in space is beyond that which may have been observed if firms simply chosen their location completely at random. Not surprisingly, maps showing patterns of cluster of employment often reflect the boundaries of functional

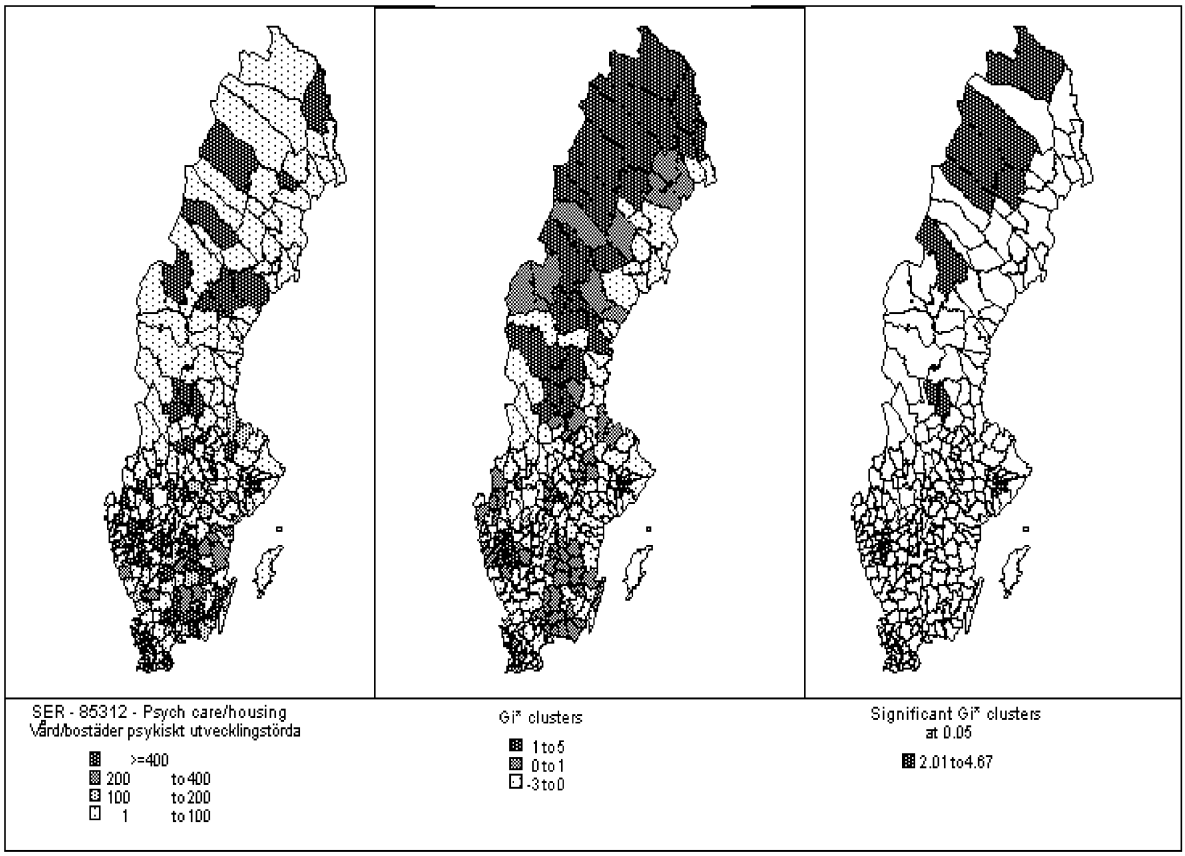

Fig. 2. SER and Gi* clusters: housing and care for the psychologically handicapped.

regions, the so-called Local Labour Market areas;[6] the degree of economic specialisation of the regions, and therefore, their degree of dynamism in a national context.

6.1. The traditional branches

The findings show that the DORA study areas are to different degrees included in most of the clusters of traditional branches found using spatial association measures—though not in a uniform fashion. Table 3 show the results for the selected branches, the star (*) indicates strong patterns of clustering.

Well performing areas tend often to be included in clusters composed of traditional private businesses, especially Southeast Sweden, whilst lagging areas tend to be part of clusters in which the public sector (State, County or municipality) is responsible for most local employment, this is true particularly for Northern Sweden. In areas such as Northern Sweden, characterised by low population density, the level of service employment per capita is high as such areas constitute a small market, and thus have an unbalanced demography. Such aspects are, however, not captured by the method used in this study. In general terms, one can argue that the relatively better performance of Southeast Sweden can be corroborated by Hypothesis 3 that suggests that the region would perform better than Northern Sweden. This is because the region is located more strategically in relation to central power structures and in relation to Europe and also because the region displays previously mentioned factors that lead to the advantages with spatial agglomeration, something which was pointed out by Maskell (1998).

These results lend weight to the argument (even though only partially) that lagging areas would be more dependent on the public sector than the leading ones as indeed was suggested in Hypothesis 2. Of the ten private traditional industrial branches, seven included clusters of municipalities from well performing areas (partially or totally). Seven out of nine public financed branches were composed of clusters of municipalities regarded as less well performing and depopulating areas.

From a national perspective, the degree of economic specialisation of the DORA study regions is clear

[6] Local Labour Market (LLM) areas can be understood as synonymous of *place of production*. Thus, LLM areas indicate the extension of the area in which businesses use to recruit labour force but also, and most importantly, they reflect the regional production environment that differ widely within Sweden, a kind of *economic footprint* Sweden can be divided in approximately one hundred local labour market areas.

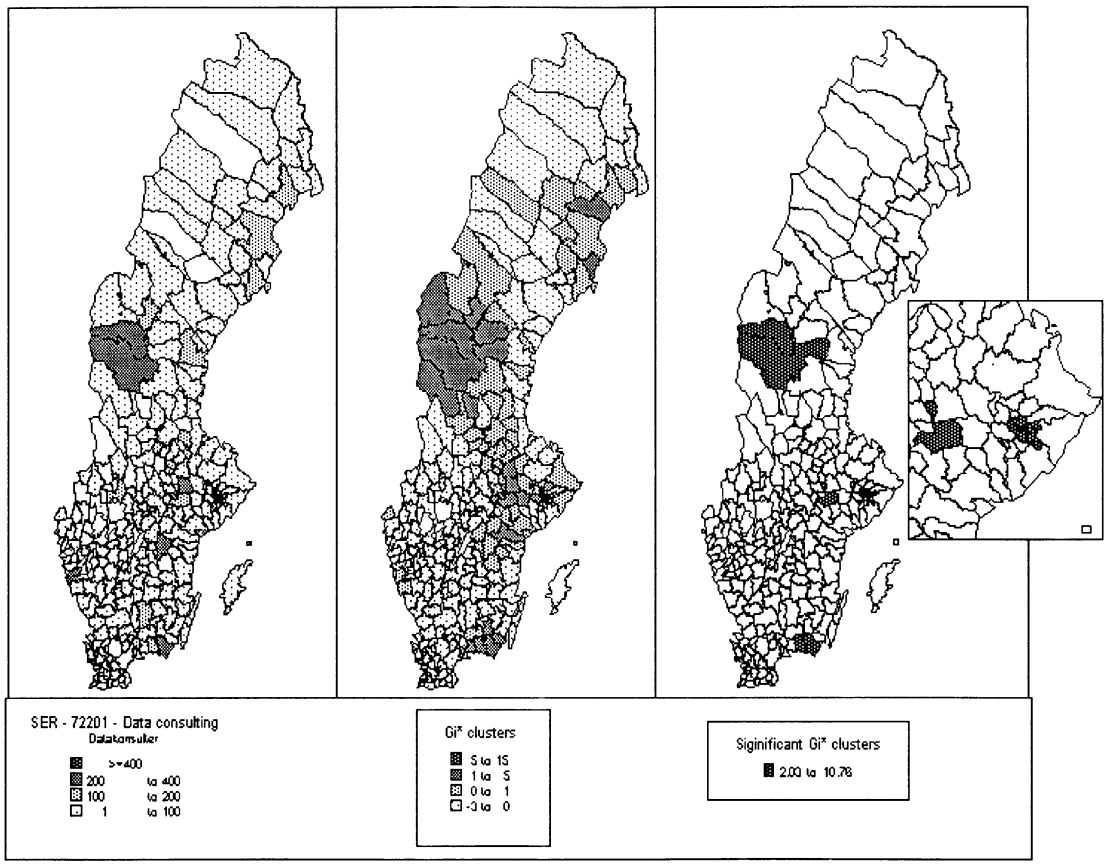

Fig. 3. SER and Gi* clusters: data consulting.

looking at the patterns of clustering for several branches. Among the traditional branches, the production of chairs (36110), sawmills (20101), particle board (20202), housing construction (45211) and, surprisingly, municipal/state organs (75111), housing and care for the psychologically handicapped (85312) and Secondary schools (80210) are all heavily concentrated in the South eastern region. In Northern Sweden the predominant branches are, iron ore quarrying (13100), Primary schools (80100), health care (85120), homes for the elderly (85311), housing and care for psychologically handicapped (85312). Figs. 1 and 2 illustrate the clustering patterns for selected branches.

It is however worth noting how far such clusters of traditional branches are located in relation to the main Swedish urban centres (especially Stockholm), mostly the private ones. This constitutes a clear indication of the late stage of the production cycle for such branches, though also that the initial pattern of clustering for these activities depended historically on particularly favourable *natural* conditions existent in that given location, which gave the specific region a competitive advantage over a certain period of time.

Several traditional branches tend to be clustered either over the leading areas or the lagging ones, suggesting a clear pattern of specialisation at study area's level. Typical examples are the branches of religious association (91310), iron and steel works (27100) and furniture-diverse industry (36140) in WPSE, aluminium industry (27420), manufacturing and metal industry (28520) in LWPSE, health care (85120) and iron ore quarrying (13100) in LWPN, manufacturing and metal industry (28520) in WPN.

6.2. The modern branches

The modern knowledge-based branches are still at the beginning of their product cycles and, thus, most of the robust clusters remain concentrated in the main core urban areas of Sweden (Stockholm, Gothenburg and Malmö) though, in several cases, they can also be found in other larger urban areas.

Eight modern branches out of sixteen partially include the DORA study areas (Table 4). Four different types of clusters of employment partially incorporate South eastern Sweden and five parts Northern Sweden. They are as follows, consulting in hardware (72100), data service offices (72300), service firms for computers and office machines (72500), natural sciences R&D (73101), universities/institutions with post secondary courses in economy, administration and social issues (80301), health care (80304) and teaching (80302).

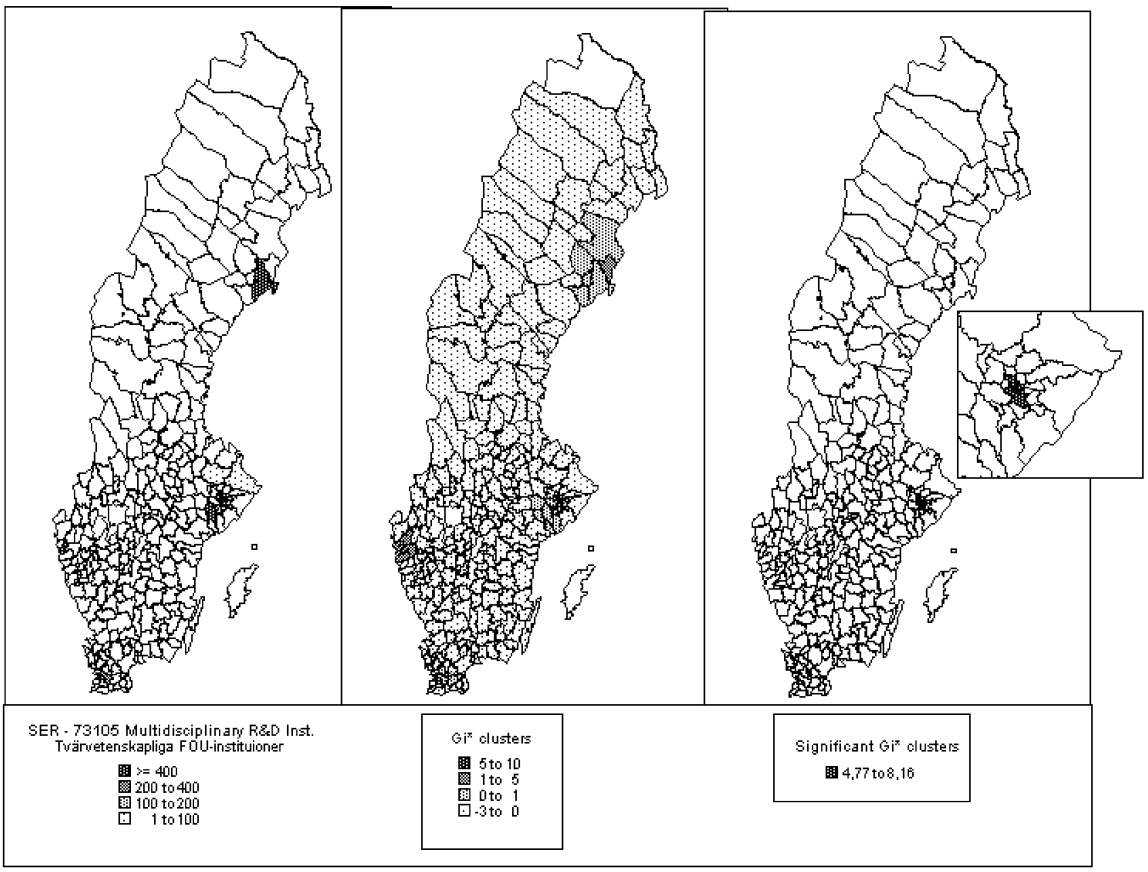

Fig. 4. SER and Gi* clusters: multidisciplinary R&D institutions .

Surprisingly, six out of the eight clusters of modern branches partially include lagging areas (Figs. 3 and 4). In other words, the hypothesis (number 2) that suggested that leading rural areas tend to be part of clusters of activities that characterise the modern economy, whilst lagging areas remain in clusters of the more traditional branches of industry and in public financed activities, has been shown to be false in several cases. However, in lagging areas, five out of the eight clusters originate from public financed activities, such as, universities and R&D, rather than from the private sector per se. Of course, we may envisage spill-over from these public financed activities locally though, for the time being, it is worth remembering that the share of the employed labour force in IT related branches for Northern Sweden is only half that of the figure for the country as a whole. In the case of Northern Sweden, the regional universities, especially Umeå University and Luleå University of Technology, are expected to be the driving forces of this process.[7] New technologies growing with the help of public research and development include opto-electronics, computer technology, hyper pressure technology, software engineering, data communications, signal processing, space research and cartography (Norrbotten County, 1999; Västerbotten County, 2000).

One interpretation of this specific pattern could be that these lagging municipalities are more attractive than the smaller leading municipalities, also referred to in this study. These lagging municipalities are relatively close to the regional centres, they are large in terms of total population (e.g., Hultsfred, Gällivare), have a relatively good urban infrastructure and are, therefore, more attractive targets for regional policy measures targeted at the decentralisation of university education and research in Sweden.

Most of the lagging areas do not have universities in their municipalities, though they often import courses at post-secondary level from the regional universities. This common practice among lagging municipalities can also be used to explain the engagement of a portion of the labour force in teaching and R&D locally. Hultsfred and Lycksele are good examples of this practice.

The existence of clusters of modern branches in leading areas is believed to be related to the regions own capacity to adapt their economic structure to the demands of internationalisation and globalisation through modernisation of their traditional industrial

[7] Samlat Program Dokument, Mål 1, Norra Norrland (2000).

Table 3
Clusters of employment, traditional branches, 1997

Traditional branches	Clusters are present in DORA areas
01300 Agriculture diverse	Partially WPSE & WPN
13100 Iron ore quarrying	Whole LWPN
20101 Sawmills	WPSE*, LWPSE* and partially WPN*
20202 Particle board industry	WPSE but mostly LWPSE
27100 Iron and stellworks industry	WPSE and partially LWPN
27420 Aluminium industry	LWPSE*
28520 Manufacturing and metal industry	WPSE
36110 Furniture/chairs industry	WPSE* & LWPSE*
36140 Furniture-diverse industry	WPSE and partially LWPN
45211 Housing construction industry	Partially WPSE & LWPSE
52112 Supermarkets	None in the study regions
60240 Road carriers	WPN & LWPN, partially WPSE
85311 Housing for the elderly	Partially SE, WPN*
85312 Housing and care for the psychologically handicapped	LWPSE, WPN* & LWPN*
85120 Health care ambulatory	LWPN*
85323 Home service and similar	LWPN*
85321 Pre-school	LWPSE, LWPN
80100 Primary school	WPN, LWPN partially WPSE and LWPSE
80210 High school	LWPSE and partially WPSE
91310 Religious associations	WPSE*

Table 4
Clusters of employment, modern branches, 1997

Modern branches	Clusters are present in DORA areas
72100 Consulting in hardware	LWPN*
72201 Data consulting	None of the study areas
72202 Software producers	None of the study areas
72300 Data service offices	Partially WPSE and partially N (weak)
72400 Database hosts and similar	None of the study areas
72500 Service firms for computer and office machines	Partially SE, partially LWPN (weak)
73101 Natural Sciences, R&D institutions	Partially LWPN
73102 Technology, R&D institutions	None of the study areas
73103 Medicine, R&D institutions	None of the study areas
73104 Agriculture, R&D institutions	None of the study areas
73105 Multidisciplinary R&D institutions	None of the study areas
80301 University/technological institutes	None of the study areas
80302 University/economy, administration and social issues	LWPSE
80303 University/teaching	Partially WPSE
80304 University/health care	Partially LWPSE
80305 University/culture and information	LWPN (weak)

composition—a more endogenous process than that found in lagging areas. Evidence of this is suggested by the fact that most of the clusters of these modern branches in leading areas are composed of activities often owned by the private firms.

7. Final considerations

On the basis of the evidence thus gathered, a number of final considerations can be drawn, in the national context, on clustering patterns of employment in two sets of economic branches in the highlighted study areas. The findings show that the study areas are, to different degrees, part of most of the employment clusters found in the traditional branches, though this is not so in a uniform way. In general terms, well performing areas tend often to be included in clusters composed of traditional private businesses, whilst lagging areas tend to be part of clusters in which the public sector is responsible for employment, this is true especially for Northern Sweden. In these areas, service employment per capita is high as they constitute a small market and have an unbalanced demographic base, aspects that are not captured by this method. No significant differences between the Southeastern and Northern Sweden areas

Table 5
Moran's I for traditional and modern branches

Traditional branches	I	Modern branches	I
01300 Agriculture diverse	0.068[a]	72100 Consulting in hardware	0.013
13100 Iron ore quarrying	0.326[a]	72201 Data consulting	0.347[a]
20101 Sawmills	0.001	72202 Software producers	0.056
20202 Particle board industry	0.142[a]	72300 Data service offices	0.032
27100 Iron and stellworks industry	0.015	72400 Database hosts and similar	0.002
27420 Aluminium industry	−0.000	72500 Service firms for computer and office machines	0.032
28520 Manufacturing and metal industry	−0.012	73101 Natural Sciences, R&D institutions	0.043
36110 Furniture/chairs industry	0.221[a]	73102 Technology, R&D institutions	0.007
36140 Furniture-diverse industry	0.052	73103 Medicine, R&D institutions	0.006
45211 Housing construction industry	0.049[a]	73104 Agriculture, R&D institutions	0.013
52112 Supermarkets	0.101[a]	73105 Multidisciplinary R&D institutions	0.002
60240 Road carriers	0.038[a]	80301 University/technological institutes	0.194[a]
75111 State/municipal organisations	−0.020	80302 University/economy, administration and social issues	−0.004
85311 Housing for the elderly	0.078[a]	80303 University/teaching	−0.022
85312 Housing and care for the psychologically handicapped	−0.037	80304 University/health care	−0.006
85120 Health care ambulatory	0.034	80305 University/culture and information	0.004
85323 Home service and similar	0.035		
85321 Pre-school	0.065[a]		
80100 Primary school	0.062[a]		
80210 High school	0.029		
91310 Religious associations	0.043		

[a] Significant at 0.05 level. It is important to note that the inference theory for the local Getis–Ord test is only strictly valid if there is no global tendency to spatial concentration or autocorrelation. Results for the Moran's I statistic show that this assumption does not hold for certain branches. The effect of global clustering on the performance of the Getis–Ord statistic has been noted and whilst it does not invalidate the technique, the results reported here should be interpreted with caution.

were however found with regard to the clusters of employment for the modern branches of economic activities.

Most of the robust clusters for the modern branches are concentrated in the main core-urban areas of Sweden, though in several cases, they can also be found in other large regional urban centres. The most surprising result uncovered in the course of the study was that clusters of employment within the modern branches are relatively over-represented in parts of the lagging areas, a fact that may reflect the effects of the regional policy measures towards decentralisation of R&D and post secondary education over the last two decades. This finding gives legitimacy to the importance of having oriented policy measures that foster localised learning in peripheral rural areas. This also draws attention to the need for having long-term policy strategies that enhance competitiveness, and promote linkages between private firms and the public sector (e.g., R&D institutions), thus providing room for experimentation. For an extensive discussion of the principles of a localised learning policy, see Maskell (2001).

Maps showing SERs and patterns of employment using clustering analysis often reflect the boundaries of functional regions, the degree of economic specialisation and dynamism of a region in its national context. Thus, as was initially suggested, the methodology used here can be utilised in the new toolbox designed to help the process of regional policy programme evaluation. For future studies, it is expected that the geographical location (coordinates) of each firm will be used, rather than zonal data of employment at the municipal level, as this will provide a better picture of the degree of proximity as an indication of economic dynamism. The forecast is that a rapid development will occur in the field of spatial statistics not only in the identification of clusters of employment, but also in the explanation of economic processes that take the geographical configuration into account. In this context it is important to be able to report on the positive experience gained by using spatial data analysis through a combination of spatial statistics and GIS, as was done in the current paper.

The combination of a quantitative approach to employment using clustering analysis could, in future studies, be combined with qualitative analysis. This could certainly help to better explain the dynamics of clusters by taking factors influencing the organisational and spatial embeddeness of networks into consideration. A combined approach could also incorporate factors that are *less tangible* but that do influence the cluster formation (see, for instance, Oerlemans et al., 2001; Danielzk and Wood, 2001), such as, the role of institutions (autonomy, co-operation and responsiveness), the long term impact of regional policies on cluster formation and the importance of people's values, beliefs and attitudes for fostering social learning.

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