Regional Studies

ISSN: 0034-3404 (Print) 1360-0591 (Online) Journal homepage: https://www.tandfonline.com/loi/cres20

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To cite this article: Dan O'Donoghue & Bill Gleave (2004) A Note on Methods for Measuring Industrial Agglomeration, Regional Studies, 38:4, 419-427, DOI: 10.1080/03434002000213932

To link to this article: https://doi.org/10.1080/03434002000213932

Published online: 23 Jan 2007.

Regional Studies, Vol. 38.4, pp. 419–427, June 2004

Carfax Publishing
Taylor & Francis Group

A Note on Methods for Measuring Industrial Agglomeration

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(Received December 2002: in revised form September 2003)

O'Donoghue D. and Gleave B. (2004) A note on methods for measuring industrial agglomeration, *Reg. Studies* **38**, 419–427. A range of quantitative techniques have been employed by researchers in economic geography and other social science disciplines for the purpose of measuring and spatially delimiting agglomerations of industrial activity. However, these techniques appear to have been applied with little consistency within the literature, particularly with regard to the use of arbitrary cut-off values for determining what level of industrial specialization defines an agglomeration. This paper proposes a new measure, the 'standardized location quotient', which recognizes agglomerations as being comprised of locations with statistically significant (rather then arbitrarily defined) location quotient values for the industry/activity under analysis. The use of the measure in delimiting spatial agglomerations within the UK business services sector, using recent employment and workplace data, is demonstrated.

Industrial clusters Industrial agglomeration Statistical significance Business services

O'Donoghue D. et Gleave B. (2004). Des façons de mesurer le taux d'agglomération industrielle: une note, *Reg. Studies* **38**, 419–427. Les chercheurs dans le domaine de la géographie économique et dans d'autres disciplines des sciences sociales se sont servis de toute une série de techniques afin de mesurer et de délimiter des agglomérations d'activité industrielle. Cependant, la documentation laisse voir que ces techniques ont été appliquées avec peu de cohérence, surtout quant à l'emploi de valeurs limites arbitraires pour déterminer le niveau de spécialisation industrielle nécessaire à la délimitation d'une agglomération. Cet article cherche à proposer une mesure nouvelle, à savoir le 'Quotient de Localisation Standardisé', qui considère les agglomérations comme des emplacements dont les valeurs des quotients de localisation pour l'industrie ou l'activité en question sont statistiquement importantes (plutôt que arbitrairement définies). A partir des données récentes sur l'emploi et le lieu de travail, on démontre comment se servir de cette mesure pour délimiter des agglomérations géographiques au sein du secteur des services aux entreprises au R-U.

Regroupements industriels Agglomération industrielle Importance statistique Services aux enterprises

O'Donoghue D. und Gleave B. (2004). Bemerkung über Methoden zur Messung industrieller Ballung, *Reg. Studies* **38**, 419–427. Zum Zwecke der Messung und räumlichen Abgrenzung von Ballungen industrieller Unternehmen sind von Forschern der Wirtschaftsgeographie und anderen Disziplinen der Sozialwissenschaften eine ganze Reihe quantitativer Techniken eingesetzt worden, doch in der Literatur scheinen diese Techniken miteinander unvereinbar zu sein, besonders im Hinblick auf die Anwendung von willkürlichen Trenungswerten zur Definition der Höhe industrieller Spezialisierung, welche Ballung bestimmt. Dieser Aufsatz schlägt ein neues Maß vor, den "standardisierten Standortquotient", der Ballungen als Gebilde definiert, die aus Standorten mit statistisch signifikanten (statt willkürlich bestimmten) Standortquotientenwerten für die zu analysierende Industrie/Tätigkeit bestehen. Die Anwendung des Maßes bei der Begrenzung räumlicher Ballungen im Sektor der geschäftlichen Dienstleistungen Großbritanniens wird mittels kürzlich erhaltener Daten bezüglich Erwerbstätigkeit und Arbeitsplätzen demonstriert.

Industriecluster Industrieballung Statistische Bedeutung Geschäftliche Dienstleistungen

O'Donoghue D. y Gleave B. (2004) Una comentario acerca de métodos destinados a medir la aglomeración industrial, *Reg. Studies* **38**, 419–427. Investigadores de la geografía económica y otras disciplinas de las ciencias sociales han empleado una variedad de técnicas cuantitativas con el propósito de medir y delimitar espacialmente aglomeraciones de actividades de carácter industrial. Sin embargo, estos métodos se han aplicado poco consistentemente dentro de la literatura, particularmente en lo que respecta al uso de valores de corte arbitrario para determinar qué nivel de especialización industrial define una aglomeración. Este artículo propone una nueva medida, el 'Cociente de Localización Estándar' (*Standardized Location Quotient*), el cual define las aglomeraciones como aquellas que comprenden localizaciones con valores de cocientes de localización estadísticamente significativos (en vez de arbitrariamente definidos) para la industria/actividad objeto de análisis. El uso de este método a la hora

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http://www.regional-studies-assoc.ac.uk

de delimitar aglomeraciones espaciales en el sector de servicos a empresas en el Reino Unido, mediante la utilización de datos recientes de empleo y lugar de trabajo, está demostrado.

Clusters industriales Aglomeración industrial Significación estadística Servicios a empresas

JEL classifications: C0, C10, R00, R12

INTRODUCTION

The 'industrial cluster' concept has gained widespread popularity, particularly since the work of PORTER, 1990, and many of his ideas have become mainstream in the past decade. Various aspects of clusters have been examined by KRUGMAN, 1991a; JACOBS and DE MAN, 1996; COE and TOWNSEND, 1996; FESER, 1998; and GORDON and MCCANN, 2000; to name just a few. Despite the interest generated amongst academics, practitioners and politicians alike, the concept of clusters remains problematic, even though it has ascended rapidly to the status of orthodoxy (MARTIN and SUNLEY, 2003). The concept has been left poorly defined by researchers who have tended to explore different aspects of 'clusters' and 'clustering' according to their own specific needs and interests (JACOBS and DE MAN, 1996). In consequence, basic empirical questions concerning what level of industrial agglomeration should be taken to indicate the possible existence of a cluster have remained largely unanswered. It is argued here that defining such a critical level of agglomeration should be considered as axiomatic if clusters are to be identified in a consistent and meaningful way.

A range of techniques have been used to measure and spatially delimit agglomerations of industrial activity. However, there appears to be no consistency in the literature when it comes to theoretically determined cut-off points for including/excluding areal units in/from the agglomeration in question. These are usually defined arbitrarily, as demonstrated by MILLER *et al.*, 2001, with their use of the location quotient. It would seem timely therefore if an approach for defining agglomerations could be developed which was empirically satisfactory, while at the same time underpinned by theoretical considerations. Such an approach is proposed in this paper and used to delimit a regional agglomeration of business service activity in South East England. The sections which outline and demonstrate this new approach follow a brief review of the cluster concept, and some of the measures utilized to delimit clusters in the past.

INDUSTRIAL AGGLOMERATION AND THE CLUSTER CONCEPT

As MARTIN and SUNLEY, 2003, point out, Porter's definition of the industrial cluster consists of two core elements. The first is aspatial and can be construed as being related to the *functional* dimension of a cluster. This states that clusters are comprised of interconnected companies and associated institutions linked by commonalities and complementarities. The second element of Porter's definition is related to the concept of industrial agglomeration. This stresses the role of *geographical proximity* in facilitating the formation and maintenance of vertical and horizontal linkages between companies within a cluster. From an empirical standpoint, the identification of clusters requires both of these elements to be considered. This paper is uniquely concerned with measuring industrial agglomeration, or the spatial (rather then functional) dimension of clusters. It seeks to develop a method for defining what degree of spatial agglomeration should be demanded before an industry or set of activities can be regarded as being 'spatially clustered'.

When exploring the cluster concept, it is important to consider FESER's, 1998, assertion that there is no theory of clusters *per se*, rather an eclectic range of theories and ideas that constitute the logic of clusters. Most researchers would broadly recognize a cluster as a 'geographically proximate group of inter-connected companies and associated institutions in a particular field, linked by commonalities and complementarities' (PORTER, 1998, p. 199). However, there is currently considerable debate as to whether the forces which underlie cluster growth and development, relate predominantly to pecuniary mechanisms that enhance firm efficiency (KRUGMAN, 1991a), or information spillover effects that facilitate technological learning and innovation (GLAESER *et al.*, 1992). Furthermore, there is no clear agreement as to the geographical limits of these forces. This issue is of particular relevance in light of the relatively spatially diffuse, 'regionalized' patterns of clustering identified by COE and TOWNSEND, 1996, in producer service industries within South East England, and SCOTT, 2001, in relation to 'the rise of city-regions'. It is argued in this paper that the different scales over which clustering is manifest, and the lack of clear geographical cluster boundaries in general, has enhanced the need to derive an objective and conceptually satisfactory method for spatially delimiting agglomerations of industry.

The logic of clustering is often explained in terms of the concept of external economies, or the benefits that lie outside the control of the individual firm

but within the economic system in which the firm participates (Scott, 1998; Staber, 2001). The presence of external economies, which are usually classified as being either pecuniary or technological in nature (Phelps *et al.*, 2001), is held to be enhanced when an industry develops within an area. Pecuniary, or market related, external economies are transmitted via inter-firm supply and demand linkages, and arise when the investments made by a firm have 'dynamic impacts on the possibilities for enhanced profitability, and therefore expansion, by other firms' (Harrison, 1992, p. 472). Technological external economies are transmitted outside the market system and occur when business ideas and knowledge, crucial for enhancing a firm's innovative potential and productivity, circulate between firms often via personal exchanges in the labour market (Schall, 1971; Glaeser *et al.*, 1992). The relative importance of these two types of external economies in the development and operation of clusters is an issue contested amongst researchers from economic geography and other social science disciplines.

Martin, 1999, and Phelps *et al.*, 2001, point out that pecuniary and technological external economies operate at different geographical scales. The input–output linkages associated with pecuniary external economies tend to operate over wide geographic areas, such as whole continents, and to some extent promote the geographical dispersion of industry, particularly manufacturing (Krugman, 1998). Technological external economies on the other hand, associated with the transmission of information and ideas often via face-to-face communications, are held to create highly localized patterns of clustering, particularly within knowledge intensive industries such as business or financial services. The geographical scale at which clusters are conceptualized therefore depends upon which side of this pecuniary/technological divide is emphasized, and whether service or manufacturing activities are considered. For example, while Krugman, 1991a, argues that pecuniary external economies are responsible for creating broad intranational core–periphery patterns in US manufacturing, Gordon and McCann, 2000, p. 523, argue that 'classic milieux effects' (manifested as interaction and cooperation between firms) operate among local service clusters within London in areas such as 'Soho, Covent Garden, or the White City'. There is thus a degree of confusion within the literature when it comes to empirically defining cluster boundaries. A possible starting point in overcoming this ambiguity is to develop a non-arbitrary technique for identifying agglomerations of industrial activity.

Before a technique for measuring industrial agglomeration is proposed in this paper, it is necessary to review the measures that have been used previously by other researchers in the cluster literature. It is argued that a major drawback of using these measures to identify agglomerations is that they fail to determine whether or not a location has an *exceptional* concentration of employment engaged in a particular type of economic activity or industry.

PREVIOUS CLUSTER/ AGGLOMERATION DELIMITATION

Perhaps the most popular measure used to spatially delimit agglomerations is the location quotient (LQ). The LQ typically measures the ratio between the local and national percentage of employment, attributable to a particular industrial sector. When the percentage of people employed within a particular industry, in a local area, is equal to the national (average) percentage of people employed in that industry, an LQ of 1 is derived. An industry is said to be 'over-represented' within an area if it has an LQ of over 1, and 'under-represented' if it has an LQ of less than 1. Areas with high levels of 'over-represented' industries are often held to constitute clusters because they have an above average concentration of employment in that industry. The question remains, however, regarding how large an LQ should be before one considers it to be indicative of clustering. Therefore the main limitation of using the LQ for this purpose is that there is no commonly agreed or theoretical LQ cut-off values for defining a cluster (Martin and Sunley, 2003). These tend to be defined arbitrarily as demonstrated by Miller *et al.*, 2001, who used a cut-off value of 1·25 to identify clusters within a range of UK industries, and Isaksen, 1996, in Malmberg and Maskell, 2002, who defined an industrial agglomeration as a local labour market area with an LQ larger than 3. The measure of agglomeration proposed in this paper is based on the LQ, but rather than using an arbitrary cut-off point it seeks to embed the decision in the concept of statistical significance.

A further drawback of using the LQ to delimit clusters is that the measure does not provide information on the absolute size of local industries. It is possible therefore to obtain high LQ values for industries that have small workforces in absolute terms. In an attempt to overcome this limitation, Fingleton *et al.*, 2002, devised a technique based on the LQ called the measure of 'horizontal clustering' (HC). This is calculated as the number of jobs in a local industry that exceeds the number expected for that industry. The expected number is defined by the number of jobs in the industry that would respond to the area having the national average share of that industry, and therefore produce an LQ value of 1. The HC measure therefore takes into account both the relative local concentration of an industry within an area, and the size of the industry in absolute terms. In the sense that it captures the number of excess workers in a sector, the HC measure is reminiscent of the 'Florence index'. A key problem with such a measure is its capacity to possess very high absolute values when the proportional representation of the sector in question is only slightly above the national

average employment in that sector. The measure clearly fails therefore to identify clusters as places that are somewhat exceptional. Irrespective of its success in delimiting clusters, the HC measure, like the LQ, suffers from the fact that there is no common or accepted critical value cut-off point for defining a cluster.

Although used within economic geography predominantly to measure employment diversity in local labour market areas (O'Donoghue, 1999, 2000), the Gini-coefficient of specialization has also been utilized to delimit agglomerations of industrial activity. Krugman, 1991b, in Malmberg, 1996, used the measure to describe the spatial distribution of 106 US industries, concluding that many industries are highly concentrated at the state level. Like the LQ and the HC measure, however, there is no theoretical Gini cut-off value for identifying a cluster. Also, the Gini-coefficient can be used only to calculate specialization within a range of different economic sectors, rather than within one specific sector of interest. For this reason it has not been used very often for the purpose of measuring agglomeration.

Within the realm of input–output analysis, clusters have also been delimited functionally on the basis of pecuniary buyer–supplier linkages. Such analyses have attempted to identify the different types of associated industries and activities that make up a specific functional cluster. Indeed Feser and Bergman, 2000, p. 12, state that input–output analysis provides 'the best uniform means of identifying which firms and industries are most likely to interact through a myriad of formal and informal channels'. Furthermore, they argue that 'crude measures' such as the LQ are typically justified on the grounds that systematic input–output data are often unavailable at the local or regional level (Martin and Sunley, 2003). Because of the difficulties associated with obtaining input–output data at such a fine level of geographical aggregation, it is not always possible to place accurate spatial boundaries around functionally linked groups of firms or industries. Also, there are no commonly agreed linkage strength cut-off values for conceptualizing such groups as clusters. Therefore while conceptually satisfactory for examining the functional aspects of clusters, due to constraints of data access, this approach has tended to be applied at a relatively wide spatial scale (e.g. Feser and Bergman, 2000).

Duranton and Overman, 2002, tested for clustering, or what they describe as localization, using a *k*-density function and point data on the geographical location of UK manufacturing establishments. An important aspect of this study is the author's recognition that most cluster measures are indices that do not report levels of statistical significance. They stressed the importance of statistical significance as a prerequisite for any measure of the clustering of activities. It is this emphasis on statistical significance that becomes the focus of the following section.

THE STANDARDIZED LOCATION QUOTIENT

As discussed above, most researchers agree that clusters are manifest spatially as industrial agglomerations and this explains in part why the LQ is used so extensively in empirical work on the topic. Its ease of use, the accessibility of data, and its applicability at different geographical scales suggest that the LQ should continue to be used for the purpose of measuring agglomeration. However, its usage needs to be standardized. The technique for spatially delimiting agglomerations proposed in this paper was devised in response to there being no conceptually satisfactory LQ cut-off value for defining an agglomeration. Central to this rationale was the notion that agglomerations should be comprised of exceptional or distinct locations that have statistically significant (rather then arbitrarily defined) LQ values for the industry/activity under analysis. The proposed measure is based on aggregate data and identifies those locations that have exceptional concentrations of activity as represented by statistically significant residuals (outliers) at the 5% confidence level. On the simplest level, it is calculated in three steps as follows:

1. Calculate LQ values for the industry or activity under analysis, at the desired level of spatial and sectoral aggregation.
2. Check that the LQ values are normally distributed at the 5% confidence level using the Kolmogorov-Smirnov test for normality (readily available on software such as SPSS). The distribution of LQs will tend to be skewed positively, i.e. if 1 is considered the national average, it is possible to have values greater than 2 but no less than 0. If such asymmetry is severe (if the distribution does not approximate normality), it is recommended that LQ values should be transformed logarithmically. The hypothesis that a set of sampled LQ values will conform to a normal distribution, and therefore the stability of the SLQ approach, can be evaluated using a Monte Carlo method (e.g. SPSS Exact Tests) to simulate the actual LQ distribution based on a series of data replications.
3. Convert the LQs (or logarithmically transformed LQs) into z-values. Identify those locations, which have *exceptional* concentrations, or agglomerations, of activity by examining residual values that lie beyond 1·96 standard deviations from the mean. This cut-off is not arbitrary as it represents the 5% level of statistical significance so commonly used by researchers in the social sciences. Alternatively, due to the asymmetric nature of LQ distributions some might feel that a one-tailed approach might be more appropriate. In that event, locations with *z*-values beyond 1·65 should be considered as outliers.

Because of the way in which it is calculated, the resultant measures (the value of the *z*-score for each

location) can be named as the '*standardized location quotient*' (SLQ). It is now appropriate to highlight the main limitations of this approach. This discussion is followed by an example of how the technique might be used to identify spatial agglomerations within the UK business service sector.

LIMITATIONS OF THE SLQ APPROACH

The initial or transformed LQ values, from which the SLQ values are calculated, are required to be normally distributed. However, the probability that a set of LQ values will conform to a normal distribution even after logarithmic transformation is largely dependent upon how the raw employment data is aggregated, both spatially and sectorally. Using a more complex statistical procedure, ELLISON and GLAESER, 1997, develop an index of industry localization which controls for differences in the size of the geographic units for which data are available. However, rather then compromise the flexibility and simplicity of the technique proposed here, perhaps by specifying the characteristics of the data set in terms of industrial classification and type of areal unit, it is recommended that the SLQ cannot be calculated in cases where a non-normal LQ distribution is found.

A further limitation of the SLQ is that it does not take into account differences in the size distribution of firms between geographic units. It therefore cannot discriminate between those areas which have a large number of small and medium sized interlinked firms, and those which have a large single firm employing the same number of workers (MARTIN and SUNLEY, 2003). In a functional context, this is a key consideration since many researchers have observed that industries which are comprised of clusters of small firms tend to be more highly innovative than industries comprised mainly of large firms (MCCANN, 2001). In order to control, therefore, for the contribution of large firms to an area's overall workforce, the following adjusted form of the LQ may be used in the calculation of the SLQ:

$$AdjLQ_i = \frac{e_{Sfi}/e_t}{E_{Sfi}/E_t}$$

where: Sf = small and medium sized firms; i = industry; e = regional employment; and E = national employment. An adequate estimation of the total number of workers employed in small and medium sized firms (i.e. firms with fewer than 200 employees) within industry i can be derived from the Annual Business Enquiry workplace analysis data which can be disaggregated by employment size-band and is available from the National Online Manpower Information System (NOMIS).[1] The adjusted LQ can be used quickly and easily to confirm whether an agglomeration of many small and medium sized firms is being represented by a high location quotient.

A BUSINESS SERVICE CLUSTER IN SOUTH EAST ENGLAND?

Business services are those activities that satisfy an intermediate demand by supplying expertise and services to other organizations (O'FARRELL and MOFFAT, 1995). They constitute an important part of value added in the production process (O'FARRELL *et al.*, 1992). Since the late 1970s, the UK business service sector has been characterized by a spatially uneven, 'distinctly regionalized mode of economic growth' (ALLEN, 1992, p. 298). In 1996, for example, the South East (including London) accounted for 1,267,000 business service jobs, 45% of the UK total (COE and TOWNSEND, 1996). This paper employs a sectoral definition of business services that corresponds with those used already by other researchers. The sector is held to be comprised of the following six types of economic activity, each identified by its 1992 SIC classifier: accounting/bookkeeping activities (1992 SIC 7412), advertising (7440), computer and related activities (72) business/management consultancy (7414), labour recruitment activities (7450) and legal activities (7411). Collectively, for the purposes of this example, these six activities will be aggregated and called business services.

The following analyses were all conducted using 1998 Travel-to-Work-Area (TTWA) boundaries. It was felt that TTWAs were the most appropriate areal units to use as these reflect, as closely as possible, the commuting fields of what can be considered local economies. Using such a functionally meaningful unit of spatial analysis could also potentially highlight the polycentric urban structure of any business service clusters made up of contiguous TTWAs. Since industrial clustering is a phenomenon associated with urban localities, it was decided that only those TTWAs which make up the British urban system should be analysed. These were identified using O'DONOGHUE's, 1999, criteria, which requires TTWAs to have a workforce of greater than 30,000 in 2000, with less than 5% of the workforce employed in 1992 SIC groups 1 and 2: agriculture, hunting and forestry, and fishing. Of 297 TTWAs, 145 satisfied these criteria and these accounted for 92·3% of the employed British workforce (excluding the self-employed). Employment data for 2000 were used as these were the most recent Annual Employment Survey data available from NOMIS.

The results of the analysis provide useful insights into the level and nature of agglomeration within the UK business service sector. Each of the six SIC classes were examined in turn along with the data aggregated to represent total business services. Figs. 1 and 2 demonstrate how the technique was used in our example. Fig. 1 illustrates the distribution of LQs across the urban areas of the UK for aggregate business

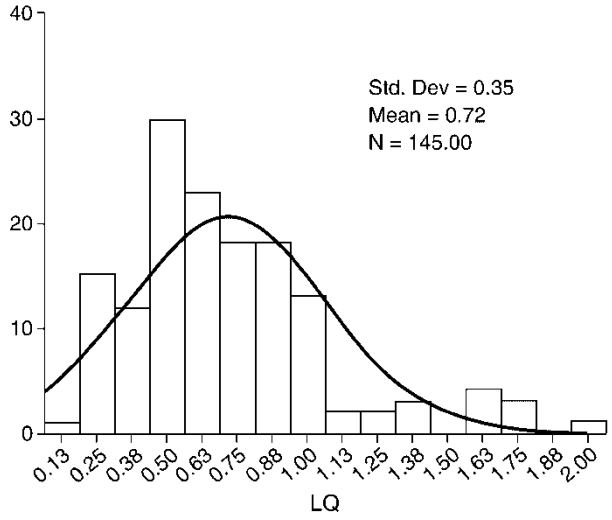

Fig. 1. *Distribution of LQs for aggregate business services*

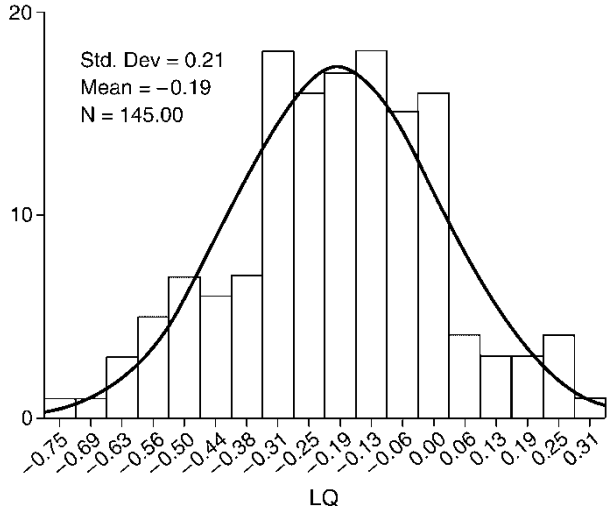

Fig. 2. *Distribution of LQs for aggregate business services after logarithmic transformation*

services, while Fig. 2 is the distribution after logarithmic transformation. It is clear from these histograms that some places are indeed quite distinct from the remainder of the distribution. The technique was applied to each of the six SIC classes described above as well as for the aggregated business service sector. The results of this analysis, and the identification of TTWAs that were found to have statistically significant residuals at the 5% confidence level, can be found in Table 1 and the accompanying map (Fig. 3), which clearly delimits a spatially contiguous business service agglomeration in the South-East of England. An examination of the different SIC classes that make up the business service sector reveals that the individual sub-sectors do not share identical locational attributes (the large-city, non-regional foci of legal services particularly stands out). Instead a variety of spatial specializations exist within the sub-sectors. In the interest of brevity however, these internal differences and spatial patterns of variation will not be discussed in depth, but

Table 1. *Standardized location quotients (SLQ) after logarithmic transformation for aggregate business services and SIC sub-sectors*

		1992 SIC sub-sectors					
TTWA	Aggregate business services	72 Computer and related activities	7411 Legal activities	7412 Accounting/ book-keeping activities, etc.	7414 Business/ management consultancy activities	7440 Advertising	7450 Labour recruitment, etc.
Reading	*2·34*	*2·77*	0·20	1·71	1·92	1·28	0·95
Aylesbury & Wycombe	*2·04*	*2·13*	0·15	1·23	*2·54*	*2·67*	0·29
Slough & Woking	*2·03*	*2·29*	0·64	0·74	1·54	1·87	1·17
Guildford & Aldershot	*2·02*	*2·34*	0·43	1·30	*2·07*	1·15	0·92
London	*2·00*	1·30	3·38	*2·83*	1·81	1·81	1·16
Banbury	1·95	0·35	0·20	0·16	1·64	0·74	*2·05*
Milton Keynes	1·91	1·79	0·03	1·40	*2·65*	1·08	1·08
Northampton	1·89	0·39	0·86	0·37	0·79	−0·16	*2·09*
Newbury	1·56	*2·06*	0·81	*2·37*	0·90	0·54	0·66
Basingstoke	1·55	*2·10*	1·76	0·76	1·35	0·10	0·98
Stevenage	1·54	1·83	1·77	0·08	*2·16*	0·17	0·94
Leeds	1·03	0·43	*2·67*	1·25	0·11	0·92	0·90
Brighton	0·96	0·40	0·45	0·02	1·26	*2·10*	0·71
Worthing	0·95	0·54	0·09	1·47	0·03	*2·19*	0·69
Manchester	0·81	0·64	1·98	1·15	0·17	1·20	0·55
Edinburgh	0·76	0·60	*2·78*	0·80	−0·10	1·32	0·35
Salisbury	0·70	0·15	1·28	1·27	*2·63*	−0·38	0·47
Taunton	0·42	−0·43	1·06	*2·95*	0·06	−0·55	0·26
Liverpool	0·01	0·38	*2·12*	0·14	−0·52	0·29	0·38

Note: Values in italics are outliers.

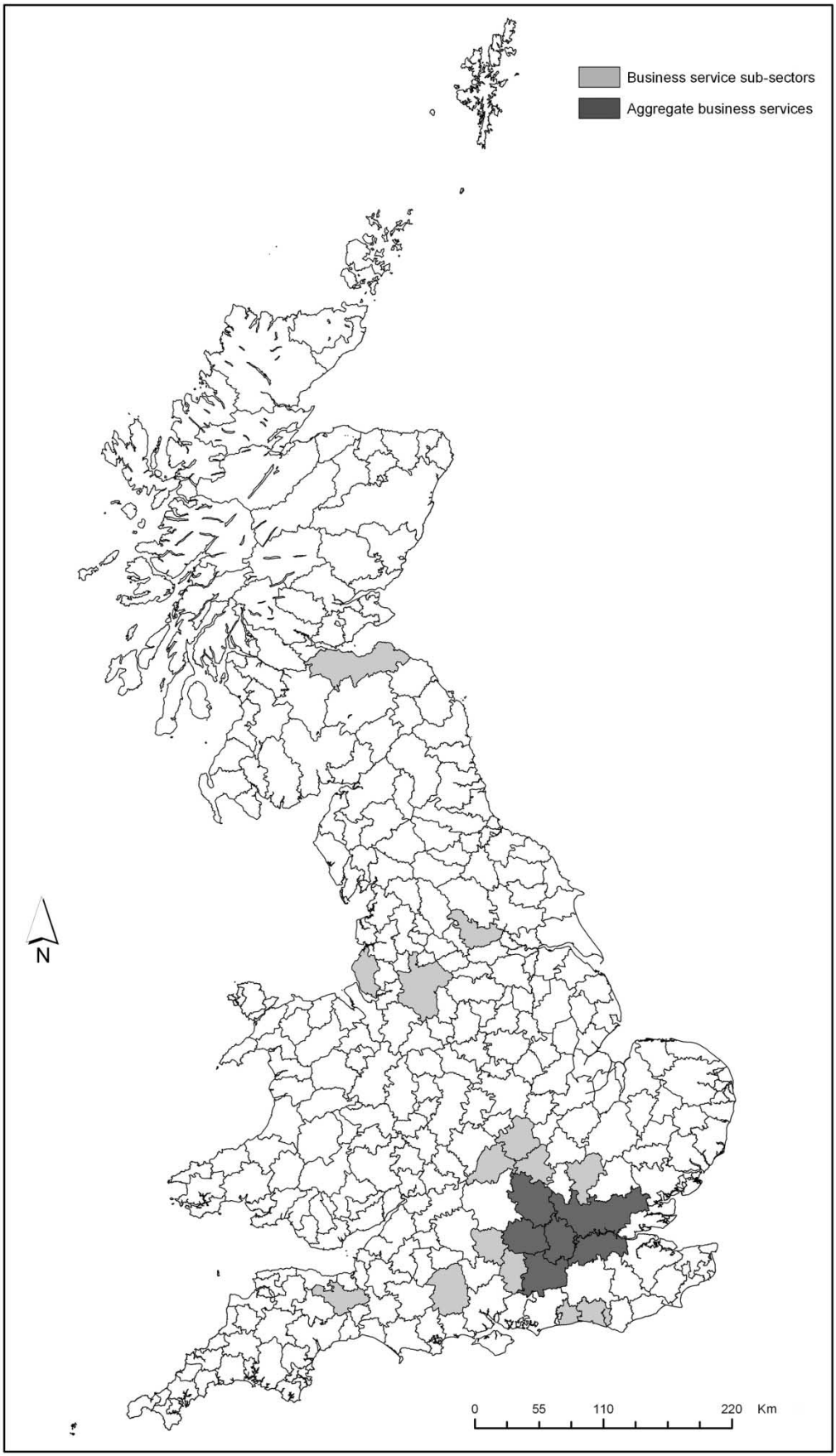

Fig. 3. Business service agglomerations, 2000: TTWAs with statistically significant SLQs

described in light of an evaluation of the proposed technique.

The TTWAs identified in Table 1 have been ranked on the basis of their SLQ score for the aggregated business service sector. The individual sub-sectors are also included so that internal variations and specializations can be noted. Fig. 3 clearly indicates the spatial extent of the business service agglomeration in the South East of England. The five TTWAs with the highest SLQs are contiguous and represent a core geographic region extending westwards from London – a result not unexpected given the 'M4 Corridor' phenomenon. A further analysis using the adjusted LQ (to control for the contribution of workplaces with over 200 employees to each TTWA's total workforce) highlighted Newbury as another statistically significant business service agglomeration, and London as not being statistically significant, possibly because of the presence of large headquarters and corporate service suppliers (MARSHALL, 1994).

In addition to the five core TTWAs, there are a number of TTWAs which, while not having high enough SLQs for business services, do have exceptional SLQ scores for the sub-sectors. It is clear from Fig. 3 that most of these areas, with the exception of legal services, are, if not contiguous, geographically proximate to the five TTWAs which constitute the business service agglomeration. Perhaps these areas should be viewed as serving an ancillary function to the agglomeration. Legal service clustering appears to be a large city phenomenon linked to the traditional interpretation of services as non-basic, city serving activities. Also, these services may be regarded as consumer services whose spatial distribution throughout the urban system closely matches that of the resident population. As mentioned above however, it is not the authors' intention at this stage to uncover or investigate the extent of multi-faceted variations within the wider business service sector; it is to demonstrate that it is possible to use a statistically objective measure, the SLQ, to identify spatial agglomerations.

CONCLUSION

After a brief review of the cluster concept and previous attempts to examine the spatial and functional dimensions of clusters, a new technique has been suggested which is simple to calculate, can be applied consistently, and is robust in its ability to deal with data at various levels of spatial and sectoral aggregation. An analysis of recent UK employment data clearly demonstrates the success of the technique in the delimitation of a business service agglomeration in South East England. This analysis using the SLQ provides us with a starting point for conducting enquires into the functional nature of the agglomeration, perhaps using more conventional survey techniques to elicit firm level information on linkage patterns and other types of inter-firm relationships and forms of cooperation. It has been argued that previous approaches to delimit clusters have not been applied consistently, leading to a certain degree of confusion within the literature. The technique proposed in this paper is by no means a panacea. It is extremely simple in conception and execution. However, even if not widely accepted or adopted by other researchers, we hope it stimulates thought surrounding the concept of clusters and how they might be delimited in a rigorous and meaningful fashion.

NOTE

1. The ABI workplace analysis provides an estimation of the total number of workplace sites within the UK for each year from 1998. This data can be disaggregated sectorally to the four-digit SIC code level, spatially to the level of electoral wards and by employment size-band. Workplaces do not always represent legally separate companies. Although single site companies that are not part of a chain are comprised of just one workplace, multi-site firms are made up of a number of individual workplaces, e.g. a head office, branch offices, etc.

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