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Abstract

In the contemporary debate on the spatial organisation of urban regions much emphasis is put on the development of polycentric urban patterns on a variety of spatial scales. Polycentric development at the intra-urban scale of the polycentric city implies an unfolding of a spatial division of labour between the centres. This article analyses whether also on the inter-urban scale of polycentric urban regions such a trend towards complementarity can be found. Opposing trends occur, however, as the division of labour in service sector activities between the main cities of some prime examples of polycentric urban regions is diminishing.

Key words: Polycentricity, Complementarity, Service sector, Urban networks, Polycentric Urban Regions, Correspondence analysis.

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1 Introduction

In the contemporary debate on the changing spatial organisation of urban regions much emphasis is put on the development of polycentric urban patterns. The concept of polycentricity basically means little more than the co-existence of a number of centres within a certain area and so can be applied to a wide variety of spatial scales. Polycentric urban patterns have been identified and conceptualised at the intra-urban scale and at the inter-urban scale (KLOOSTERMAN and MUSTERD, 2001a; DAVOUDI, 2003). An intra-urban polycentric urban pattern arises from the development of centres alongside the traditional inner city or central business district within a city region (a city and its smaller suburban satellites) and is labelled a 'polycentric city'. Nowadays, it is widely acknowledged that all post-industrial cities are in fact polycentric.[i] By polycentric urban patterns at the inter-urban scale, reference is made to regions in which a number of cities cluster together. These are often called polycentric urban regions: systems of historically distinct and administratively and politically independent cities located in close proximity and lacking a dominating city in political, economic, cultural and other aspects (KLOOSTERMAN and

LAMBREGTS, 2001). Though 'polycentric urban region' seems to have become one of the more common concepts for urban regions with these characteristics, a wide variety of more or less similar concepts is in circulation. Recent examples include 'city networks' (CAMAGNI and SALONE, 1993), 'multicore city-regions' (WESTIN and ÖSTHOL, 1994), 'network cities' (BATTEN, 1995), or 'polynucleated metropolitan regions' (DIELEMAN and FALUDI, 1998a). Several authors have suggested that the meaning of the concept of polycentricity differs between the intra-urban and inter-urban scale (KLOOSTERMAN and MUSTERD, 2001a; DAVOUDI, 2003). KLOOSTERMAN and MUSTERD (2001a) see four dimensions along which inter-urban polycentricity may be qualitatively different from intra-urban polycentricity: physical form, political entity; functional relationships and the economic dimension. In this paper, differences in functional relationships between the intra-urban level of the 'Polycentric city' and the inter-urban level of 'polycentric urban regions' are explored.

In terms of functional relationships, KLOOSTERMAN and MUSTERD (2001a:627) argue that on the intra-urban scale '[t]he shift towards polycentricity in the context of one individual city implies an unfolding of a spatial division of labour where 'new' locations are being developed'. The balancing of agglomerative and dispersive forces by economic activities and urban functions has led to a more spatially specialised metropolitan layout incorporating many different types of centres (ROBERTS et al., 1999, HALL, 2001). As each of them has some specific locational advantages, for instance relating to accessibility, rental prices, room for expansion etc., they together cater for the diversity in locational needs of these activities and functions. Though many of these centres are often labelled as *sub*centres, they are often the main centre in the region for the specific activities and functions found there. So, while a hierarchy remains, it is more appropriate to speak about

a hierarchy between different locations in connection with a specific urban function or economic activity, rather than with a centre in general. This is a manifestation of a disconnection between the size and function of centres. The many different urban functions and economic activities each have their own hierarchy, which is reflected in different settlement patterns, the main centres of which often do not overlap, but rather tend to be spread over the variety of centres. Consequently a certain division of labour between the centres has developed (HALBERT, 2004), leading to complementarity (ROBERTS et al., 1999). On the higher scale of polycentric urban regions, KLOOSTERMAN and MUSTERD see two possible outcomes of further polycentric development. On the one hand, they speculate that a development similar to the development at the intra-urban level will take place, i.e. functional differentiation may be strengthened as cities specialise in specific urban functions, which they then provide for the entire region. On the other hand, the functional differentiation between the cities making up the polycentric urban region may erode, as the whole region becomes more of a homogeneous economic environment characterised as one large labour market or location for business. The first explanation has been accepted as the most likely outcome, for instance HALL (2001) suggests that within increasingly polycentric urban structures there is increasing specialisation, citing as an example the functional division of labour between the main cities of the Pearl River Delta region in China. So, as regards the dimension of functional relationships, the key issue is whether or not a division of labour is developing between centres or cities so that they increasingly complement each other.

Polycentric development processes at the intra-urban scale have been widely documented, for a recent analysis see for instance HALBERT (2004). However, less is known about these processes at the inter-urban level. This paper explores whether we see a further division of

labour also developing on the scale of polycentric urban regions. This question will be framed in a wider theoretical debate on the spatial organisation of polycentric urban regions, and in particular on the nature of the relationships between cities (section 2). In section 3 we present our analysis of these relationships on the inter-urban scale of polycentric urban regions. This includes details on methodology and data, as well as an introduction to our three case study regions, which are all prime examples of polycentric urban regions: the Randstad in the Netherlands, the Flemish Diamond in Belgium and the RheinRuhr Area in Germany. The results of the comparative analysis of the division of labour between the major cities of these regions are presented in section 4. In the final section we compare our findings at the inter-urban level with polycentric urban development patterns at the intra-urban level.

2 Complementary Relationships

In the contemporary debate on the spatial organisation of urban regions much emphasis is put on the nature of the functional relationships between the centres of urban regions. It is debated whether or not we are witnessing a transformation in spatial structure that can be labelled 'from hierarchy to network'. The pattern of centres within a city would then be increasingly less characterised by a hierarchy with the traditional downtown centre at the top and a number of subcentres. Often it is questionable whether subcentres are really that 'sub'. On a higher spatial scale, polycentric urban regions also seem to be at odds with the traditional Christallerian urban pattern emphasising hierarchical relationships (CAMAGNI, 1993; CAPELLO, 2000). The clustering of more or less similar-sized cities close together and the lack of a clear hierarchy between them seems to provide a completely different urban pattern. It has been suggested that this pattern is following a 'network model', which

conflicts with the central place model (BATTEN, 1995; VAN DER KNAAP, 2002). The unfolding of a division of labour between centres or cities in a region could be considered as a manifestation of the development of complementary relationships between them. Such complementary relationships are a key characteristic of this 'network model' of spatial organisation, the others being the overlapping of the functional hinterlands of cities resulting in functional integration and size neutrality, that is a relative disconnection between size and function of a city. The latter means that the population number of a city no longer determines its basis for activities and functions. Higher order functions can thus be found in cities that are lower-ranked in terms of size, and the other way around, a city may host a set of functions and activities that are of less significance than one would expect from its size. Together, these network characteristics lead to a diffused criss-cross pattern of spatial interactions. So, our question of whether a division of labour is developing is in part similar to the question of whether polycentric urban regions are characterised by a network model of spatial organisation, as has been assumed by CAMAGNI and SALONE (1993) and VAN DER KNAAP (1994), who point to the Randstad as an example. Policy-makers also assume the presence of such a network model, as can be seen from the labelling of polycentric urban regions in strategic regional development policies, for instance in Belgium ('urban networks'), Estonia ('urban networks'), France ('réseaux de villes'), Germany ('Städtenetze'), Italy ('reti di città'), the Netherlands ('urban networks') and Switzerland ('vernetzte Städtesystem').

From a theoretical standpoint, however, a polycentric urban region is not necessarily an urban network. It makes sense to distinguish between both concepts. A polycentric urban region can be identified more or less by structural characteristics such as the location of its cities relative to each other and their size distribution (see KLOOSTERMAN and

LAMBREGTS, 2001; PARR, 2004). Urban networks could be considered an advanced sort of polycentric urban region. Polycentric urban regions also qualify for the label urban network when relational characteristics as described by the network model of spatial organisation have developed. So, to theoretically justify the label urban network, there should be a certain minimum extent of functional integration, of a relative disconnection between size and function as well as of complementarity.

Though some previous work on conceptualising 'complementarity' has been done (ULLMANN, 1956; LAMBOOY, 1969; CAMAGNI and SALONE, 1993), it has remained a rather vague concept despite its increasingly frequent, but often casual appearance in both academic writings and policy documents. Here, we define complementarity as a result of supply and demand. For centres or cities to be complementary, they need to satisfy two important preconditions:

1.) There must be differentiation between the centres or cities in terms of urban functions or activities taking place in the centre or city.[ii]

2.) The geographical markets of demand for these urban functions/activities or places must at least partly overlap. This means that mere differentiation does not suffice. The urban functions/activities in one centre or city should provide services to business or households also making use of functions/activities in other centres. Or, at the city level, activities in one city should provide their services also to businesses or citizens located in the other city.

To a certain extent both preconditions are linked, as interaction is likely to result from differentiation, which then leads to complementarity (Ullmann, 1956; Batten, 1995). However, not all differentiation leads to interaction because of intervening opportunities

(intervening sources of supply) and the costs of interaction (Ullmann, 1956). Moreover, the scale on which the interaction takes place varies according to the multiple scales on which economic activities or urban functions operate.

The benefits of complementarity are linked to what ALONSO (1973) referred to as 'borrowed size'. When two cities complement each other, then the citizens and companies in one place can take advantage of the consumer and business services the other city has to offer. These functions can then be more specialised, as the demand market on which they build is larger given the overlapping of hinterlands. In other words, complementarity is linked to agglomeration economies, though, given the physical separation of the urban centres and of the firms involved, such advantages are more appropriately described as 'regional externalities' (PARR, 2004).

3 The analysis of complementarity

Our analysis of complementary relationships focuses on service sector activities of the main cities within three polycentric urban regions. This includes business services as well as public services. In 1999, 66% of all jobs were in the service sector in the RheinRuhr Area, while this number was 80.8% for the Randstad and 70.5% and 78.4% for the Antwerp and Brussels functional urban regions respectively (IAURIF, 2001). It could be hypothesised that such services, e.g. financial services, transportation and logistical services, education facilities etc., in one place may have a function for businesses and households in other places as well. This is less evident for the primary (agriculture, fishing etc.) and in particular secondary (manufacturing) sectors, as, in general, these are often relatively more connected to national or international markets rather than regional markets.

Furthermore, our analysis focuses on the first criterion for cities to be complementary, namely differentiation on the supply side. Given the strong link between differentiation and interaction, this may also indirectly reveal more about the second criterion of overlapping demand markets, even though this second criterion is not further explored here. Data is also not available to establish the extent to which each and every service sector examined functions on a regional scale indeed. However, analyses for the producer services sector in one of our case study regions, the Randstad, revealed an intricate web of relationships spanning the whole Randstad area (MEIJERS, 1999) and beyond, as polycentric urban regions can by no means be defined as single, closed functional units. Rather they should be considered as open and multi-layered complexes of nodes, networks, flows and interactions at global, regional and local scales (ALBRECHTS, 2001). So, even when differentiation results in spatial interaction, this does not necessarily mean that this interaction takes place on the regional level of polycentric urban regions. However, our choice to focus on the service sector was also prompted by the assumption that these may operate relatively more on this regional scale than other sectors. Still, it may be more appropriate to speak of an analysis of *potential* complementarity, as we do not know the extent to which it has materialized in reality.

Case study regions

The Randstad, Flemish Diamond and RheinRuhr Area (see Figure 1) are all often cited as archetypical examples of polycentric urban regions and have therefore been selected as case study regions. They probably do not need much introduction given their currency in the literature.[iii] It is exactly the comparison of these three regions that may put findings for individual regions into the right perspective.

The three regions have all been conceptualised as relevant functional entities by their respective governments, for strategic policies trying to enhance national and regional competitiveness. With nearly 12 million inhabitants and a population density of slightly more than 1000 inhabitants/km^2, the RheinRuhr Area in Germany is the largest and most densely populated conurbation, followed by the Randstad in the Netherlands (nearly 7 million inhabitants, a density of almost 1000 inhabitants/km^2), while the Flemish Diamond in Belgium has over 5 million inhabitants but a considerably lower density of nearly 600 inhabitants/km^2 (IAURIF, 2002, and own calculations).

<Figure 1>

Data

In order to analyse the division of labour in commercial and public services between the main cities making up the Randstad, Flemish Diamond and RheinRuhr Area respectively, use was made of databases registering all the establishments and the number of people working in them. This also includes government and non-commercial organisations. An establishment is defined as a location of a firm, organisation, institution or independent profession in or from which an economic activity or independent liberal profession is being practiced by at least one employed person. Multi-establishment firms have separate recordings for each establishment. The economic activities are coded according to the European Union wide NACE Rev. 1 classification (Nomenclature statistique des Activités économiques dans la Communauté Européenne). Use was made of datasets presenting the economic activities of establishments at the two-digit level of detail. This includes 29 different economic activities in the commercial and public services sector.[iv] Each establishment was given a weighting based on the number of people employed in it.

For the Randstad, a dataset presenting data on the municipal level was derived from the National Information System on Employment (LISA) database for the years 1996 and 2002. The dataset for the Flemish Diamond was provided by the National Office for Social Security in Brussels (NOSS). This semi-governmental body is responsible for the financing of social security for employees. The data covers the municipal level for the years 1996 and 2002. The dataset for the RheinRuhr Area region was provided by an institution also involved in social security, the Institut für Arbeitsmarkt- und Berufsforschung and produced by its Regionaldirektion NRW der Bundesagentur für Arbeit. Data was available at the level of 'Kreisfreie Städte' for the five years 1998-2002. Due to divergent delimitations of functional urban areas, or the absence thereof (Flemish Diamond), our data concerns solely the central cities.

Method

Correspondence analysis was used to analyse the differentiation in the service sector profiles of the cities within a polycentric urban region. Correspondence analysis is a technique to analyse the association between rows and columns of a table or matrix by representing the rows and columns as points in a low-dimensional Euclidean space (in practice often a two-dimensional plot). Categories with similar distributions are represented as points that are close in space, and categories that have very dissimilar distributions are positioned far apart. For an extensive discussion of correspondence analysis see GREENACRE (1993) and CLAUSEN (1998). Though often used as a tool to enable the graphic interpretation of complex data, correspondence analysis also provides a single statistic that describes the extent of differentiation in the service sector profiles of a group of cities. This statistic is called the total inertia. Total inertia is a measure of the

extent to which the profile points are spread around a centroid, which represents the average profile. The larger the distance of the category points to the centroid, the higher the inertia. The highest attainable inertia is equal to the dimensionality of the problem (in our case the number of cities – 1). This maximum would be reached if all the cities host completely different service activities, whereas zero inertia is attained when they all have exactly the same commercial and public services within their boundaries. In reality, values will be far from the maximum, as reaching the maximum value would imply, for example, that all schools are located in one city, all supermarkets in another one, and all banks in yet another one. In other words, cities have a large component of employment in non-tradeable economic activities.

Provided that the contingency tables for the Randstad, Flemish Diamond and RheinRuhr Area have a similar format (the same number of cities in the rows and the same categories of service sector activities in the columns), the total inertia-statistic of the three regions provides for a comparable measure of differentiation. This implies that the same number of cities for these three regions had to be selected. Being the smallest region in terms of the number of cities included, the Flemish Diamond sets the maximum. Using a threshold value of 80,000 inhabitants in 2000, this region includes four cities, which also happen to be the corners of the 'diamond': Brussels, Ghent, Antwerp, Leuven. This also matches well with the Randstad region, where it is very common to identify four main cities (Amsterdam, Rotterdam, The Hague and Utrecht), which are distinctively larger than the others. We could have used a lower threshold for the Flemish Diamond to include two or three remaining smaller cities, but this would make the selection in the Randstad region quite arbitrary, as there is a much larger number of similar-sized cities in the league below the four main cities. Though identifying four main cities in the RheinRuhr Area is less

obvious, for reasons of comparison a selection can also be made of four cities that have the most inhabitants and are characterised by the highest centrality: Cologne, Düsseldorf, Essen and Dortmund.

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A comparison in time of the total inertia statistic, presenting the extent to which the cities differ from each other in terms of service sector activities, leads to some remarkable conclusions.[v] Figure 2 presents the development of differentiation and thus the potential complementarity for the three regions.

<Figure 2>

The first conclusion is that the extent of existing and/or potential complementarity in the Randstad and Flemish Diamond is considerably higher than in the RheinRuhr Area. So, as regards service sector activities, the cities in the RheinRuhr Area are much more similar to each other than those in the Randstad and Flemish Diamond. The latter two seem to be characterised by cities that are more specialised in certain types of service activities. Perhaps this can be partly explained by the historical development of the three regions. The polycentric pattern in the Randstad and Flemish Diamond has basically been inherited from the past, as fragmented political and administrative structures prevailed for centuries in the Low Countries, thus preventing the rise of one powerful city that dominated the others (see also DIELEMAN and FALUDI, 1998c). As a result all cities were able to develop

specialised urban functions according to their competencies or local competitive advantages. Though this also holds for the RheinRuhr Area to a certain extent, this area later witnessed a rapid and overwhelming process of urbanisation and industrialisation linked to such natural resources as deposits of coal and iron ore. Consequently, the main economic base for each city turned out to be manufacturing, which dominated over other types of economic activities for a long time.[vi]

However, at the same time, our second conclusion is that the overall extent of complementarity in the Randstad and Flemish Diamond has declined considerably in the period from 1996-2002. This decrease was 12.8% in the Randstad and even 18% in the Flemish Diamond. Interestingly, over the same period the cities in the RheinRuhr Area became more different from each other as regards their service sector activities. The sudden upward change between 2001 and 2002 in the RheinRuhr Area is largely due to Dortmund becoming relatively more specialised in adult education. The truth, however, is that from 2002 on workers of mostly large firms who had become redundant were not simply dismissed but employed in a "Personalentwicklungs-Agentur", a personal development centre where they are retrained for other jobs. So, they are not actually involved in teaching adults. Without this bias the extent of differentiation in the RheinRuhr Area would show a slight increase by some 3 %.

Detailed regional analysis

In the remainder of this section, each polycentric urban region featuring as a case study will be presented individually. This allows a more detailed analysis of how the total inertia for each region has come about. It will tell us which cities and which service-sector activities contribute to the extent of complementarity (and which do not). One of the main

advantages of correspondence analysis is that it graphically displays associations, thus enabling an easier interpretation of the associations between cities and service sector activities. These two-dimensional plots are analysed here (Figures 3, 4 and 5). However, they first require some guidance for correct interpretation.

The title of the Figures 3, 4 and 5 also presents the 'percentage of total inertia explained' by the plot. The method diminishes the number of dimensions (3 in our case) to just 2, in order to be able to present them in a two-dimensional plot. Though this is done in the most accurate way, it inevitably leads to a loss of information. This percentage of explained inertia indicates how accurate the two-dimensional plot still is. The percentages found for the three regions are all satisfying, even very high in the cases of RheinRuhr Area and Flemish Diamond.

In each plot, two axes together indicate the origin (0,0), which resembles the average profile of the four cities. The further a city is away from the origin, the more it contributes to the extent of complementarity. If two cities lie close together, then their economic profiles are more or less similar. The same condition applies to the economic activities. Economic activities lying close together are more or less similarly distributed between the cities. The distance between cities and economic activities is more complicated, since these are not defined as chi-square distances. All cities influence the location of an economic activity, and conversely, all economic activities contribute to the location of a city. In general, cities and activities will be close to each other when the observed value for this pair of points in the table is larger than expected, and the distance will be large when the observed value is less than the expected value. For reasons of clarity, out of the 29 economic service activities included in the analysis, only those activities contributing at

least 0.001 to the extent of complementarity are depicted. Service activities that do not meet this threshold value are either insignificant in terms of the number of jobs, or because the distribution of jobs in this activity over the four cities is similar to the distribution of all jobs over these cities. Obviously, this is for instance the case with retail trade, where the expected number of jobs in the four cities is more or less equal to the observed number. In addition, the numbers in the figures that mark the location of a certain economic activity are displayed in three sizes. The largest size contributes at least 0.01 to the total inertia, the middle size between 0.005 and 0.01 and the smallest size between 0.001 and 0.005.

<Figure 3>

Randstad

In 2002, the three largest Randstad cities - Amsterdam, Rotterdam and The Hague - had relatively distinct profiles in commercial and public services. Utrecht had a more general and average profile and is, therefore, located closer to the origin (Figure 3). The Hague and Rotterdam contribute most to the total inertia (i.e. are most specialised) as they are located furthest from the origin. The Hague, which is the seat of the Dutch government, is very much associated with public administration and relatively more extra-territorial organisations and bodies are present there. Given the fact that Rotterdam's harbour is one of the largest in the world, it is not surprising to find that Rotterdam holds a strong position in water transport and supporting and auxiliary transport activities. Other specialisations include sewage and refuse disposal and construction. Amsterdam has a relatively dominant position in the commercial services sector, in particular in financial intermediation, computers and related activities and publishing and printing. Moreover,

leisure seems to be more important for Amsterdam given the strong presence of the hotels and restaurants and recreation, culture and sports sectors. Utrecht's profile in service activities resembles Amsterdam's the most. Moreover, trade and business activities as well as education are activities strongly present in this city. In general, it seems that the three largest cities in the Randstad have different roles in providing services to companies and citizens, each of them specialising in either commercial services (Amsterdam), transportation (Rotterdam), or public administration (The Hague).

Flemish Diamond

As Figure 4 displays, out of the four main Flemish Diamond cities, the smallest one, Leuven, is the most specialised, namely in research and development. Together with Ghent, another old university town, it holds a strong position in education and healthcare and social work. Antwerp has - like Rotterdam - an important port within its boundaries, resulting in the strong presence of water transport and supporting and auxiliary transport activities. Also construction and business activities are relatively more common in Antwerp than in the other cities. Brussels, the main seat of government of the European Union, the Belgian state as well as the Flanders and Brussels Capital Region, is consequently strongly specialised in public administration and defence (for example NATO), and related activities of membership organisations and extra-territorial organisations and bodies. Moreover, it holds a strong position in commercial services activities, including financial intermediation, insurance and pension funding as well as in post and telecommunications. Like the Randstad, the Flemish Diamond seems to be characterised by a quite distinct division of labour between the cities.

<Figure 4>

RheinRuhr Area

Figure 5 presents Dortmund and Essen, the main cities of the Ruhr area, relatively close on the right of the plot, while Cologne and Düsseldorf, the main cities of the Rheinschiene are on the left, but more distant from each other. The activities most exclusively linked to one city (thus contributing most to the inertia), which are insurance and pension funding and recreation, culture and sports, are both linked to the city of Cologne. Air transport also has a strong presence, while Cologne's strong position in land transport and post and telecommunications is shared with Dortmund. Public services such as education, health and social work are relatively more common in Dortmund. The same holds for construction. Düsseldorf holds a strong position in a number of commercial services, such as financial intermediation, activities auxiliary to financial intermediation, real estate, activities that support transport activities and other business activities. It shares a strong position in wholesale trade with Cologne. At this level of analysis, Essen does not seem to offer anything the other cities do not already provide themselves. In general, the main groups of service activities seem to be more evenly spread over the region.

<Figure 5>

Closing remark

Looking at the three regions individually, it is apparent that main groups of economic service activities can be much more exclusively attributed to one city in the Randstad and Flemish Diamond than in the RheinRuhr Area. For instance, clusters of government-related activities can quite exclusively be found in The Hague and Brussels, commercial financial services in Amsterdam and Brussels, transport services in Rotterdam and

Antwerp, leisure activities in Amsterdam, research and education in Ghent and Leuven. In the RheinRuhr Area, the activities making up these main groups of service activities are all much more spread over the whole region.

5 Conclusion

One could argue that polycentric urban regions are not necessarily urban networks. The first term primarily relates to the morphology of the regional urban system, 'the image on the map', the latter implies the presence of the characteristics of what is labelled the 'network model' of spatial organisation. According to the network model of spatial organisation, a key relationship between the centres is complementarity. In this paper, the analysis focused on the division of labour in service sector activities between the main cities of three prime examples of polycentric urban regions: the Randstad, the Flemish Diamond and the RheinRuhr Area. The objective was to examine whether or not these cities complement each other, or, to be exact, have the potential to do so, as for complementarity to develop not only a division of labour in service sector activities on the supply side is important, but also a geographical overlapping of demand markets for these activities. It has been assumed that a division of labour also implies strong spatial interaction, but this link requires further analysis. It was found that the division of labour between the main cities of the Randstad and Flemish Diamond is much stronger than in the RheinRuhr Area, thus indicating that the existing and potential complementarity is much higher in these regions. As far as the aspect of complementary relationships is concerned, the Randstad and Flemish Diamond seem to bear more features of the network model of spatial organisation than does the RheinRuhr Area nowadays. Comparatively, as far as the aspect of complementarity is concerned, the 'urban network'

label is more applicable to the Randstad and the Flemish Diamond than to the RheinRuhr Area. Some explanation for this is likely to be found in the different urban development pathways of the regions. The polycentric layout in the Randstad and Flemish Diamond has been shaped over the past centuries as fragmented political and administrative structures and rivalry have prevented the rise of one continuously dominant city. Major urban development in the RheinRuhr area took place much later, when because of the presence of natural resources such as coal and iron ore the area witnessed rapid industrialisation and urbanisation.

The extent of existing and potential complementarity in the Randstad and Flemish Diamond is, however, declining at a relatively fast pace. This empirical evidence supports the idea that further polycentric development at the inter-urban scale eventually leads to a more homogeneous economic environment. This means either that the range of different business milieus and specialised clusters of service activities diminishes, or that local competitive advantages are becoming increasingly regionalised. Analysing business start-ups in the Randstad, KLOOSTERMAN and LAMBREGTS (2001) found that cluster formation is indeed taking place at a supralocal level.

As regards the dimension of functional relationships, the meaning of polycentric development differs between the intra-urban and inter-urban scale. Our explorative analysis at the macro-level suggests that opposing trends occur. A division of labour seems to develop at the intra-urban level, whereas at the inter-urban level this division of labour is diminishing. Perhaps an explanation can come from the differences in the genesis of polycentric urban patterns at both scales. Contrary to the intra-urban scale where new centres develop next to an existing main centre, polycentric urban patterns at the regional

scale start from existing centres (cities) and derive their significance from the alleged development of functional relationships between them. Obviously, further research, for instance including the micro-level (individual sectors of activities), is needed to confirm these opposite trends.

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Figure 1. The Randstad, Flemish Diamond and RheinRuhr Area.

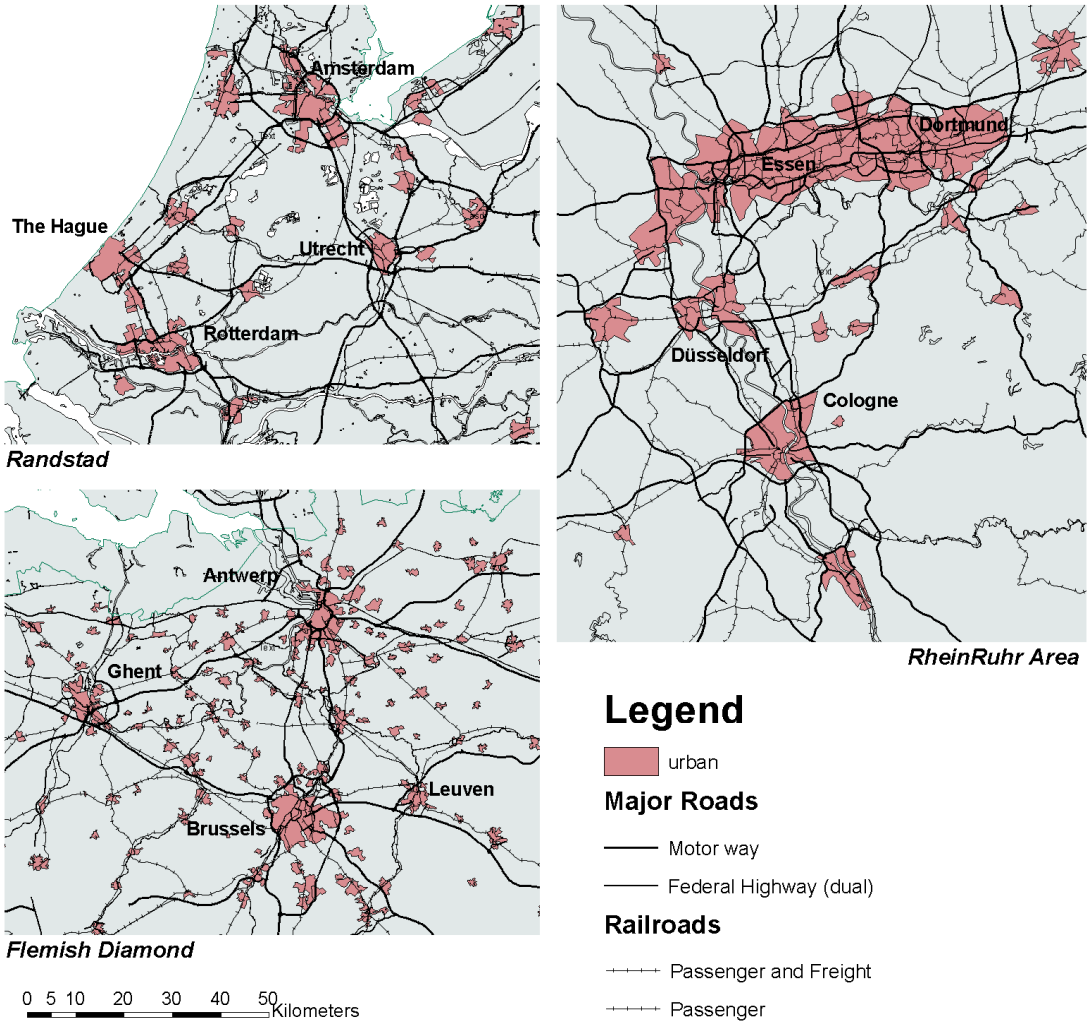


Figure 2. Development of the extent of (potential) complementarity in the Randstad, Flemish Diamond and RheinRuhr Area, 1996-2002.

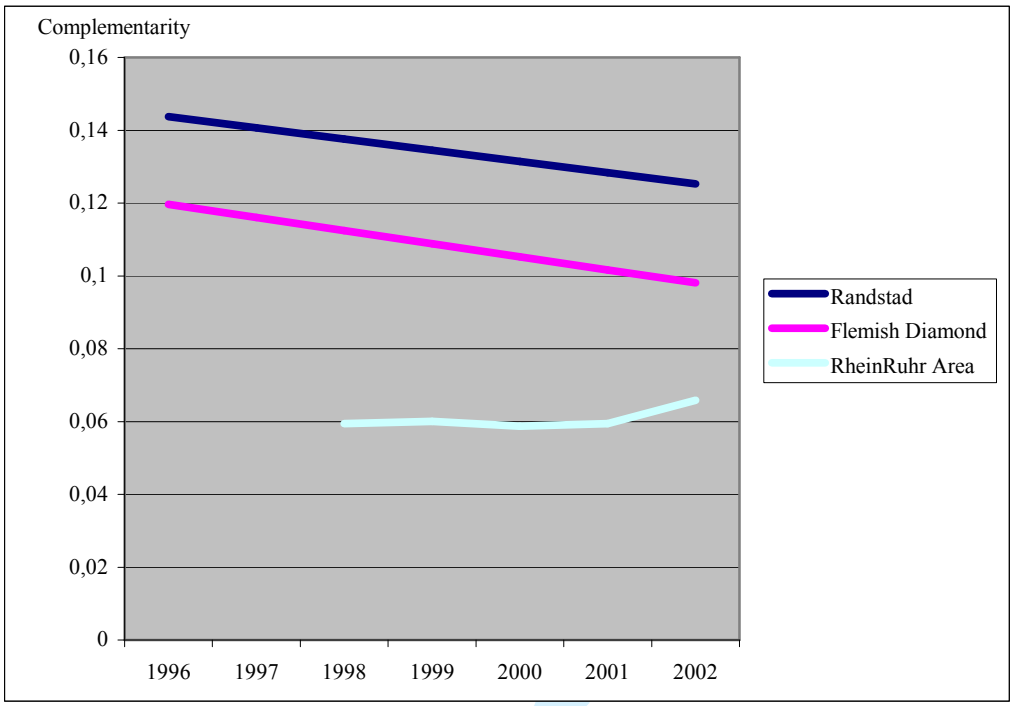
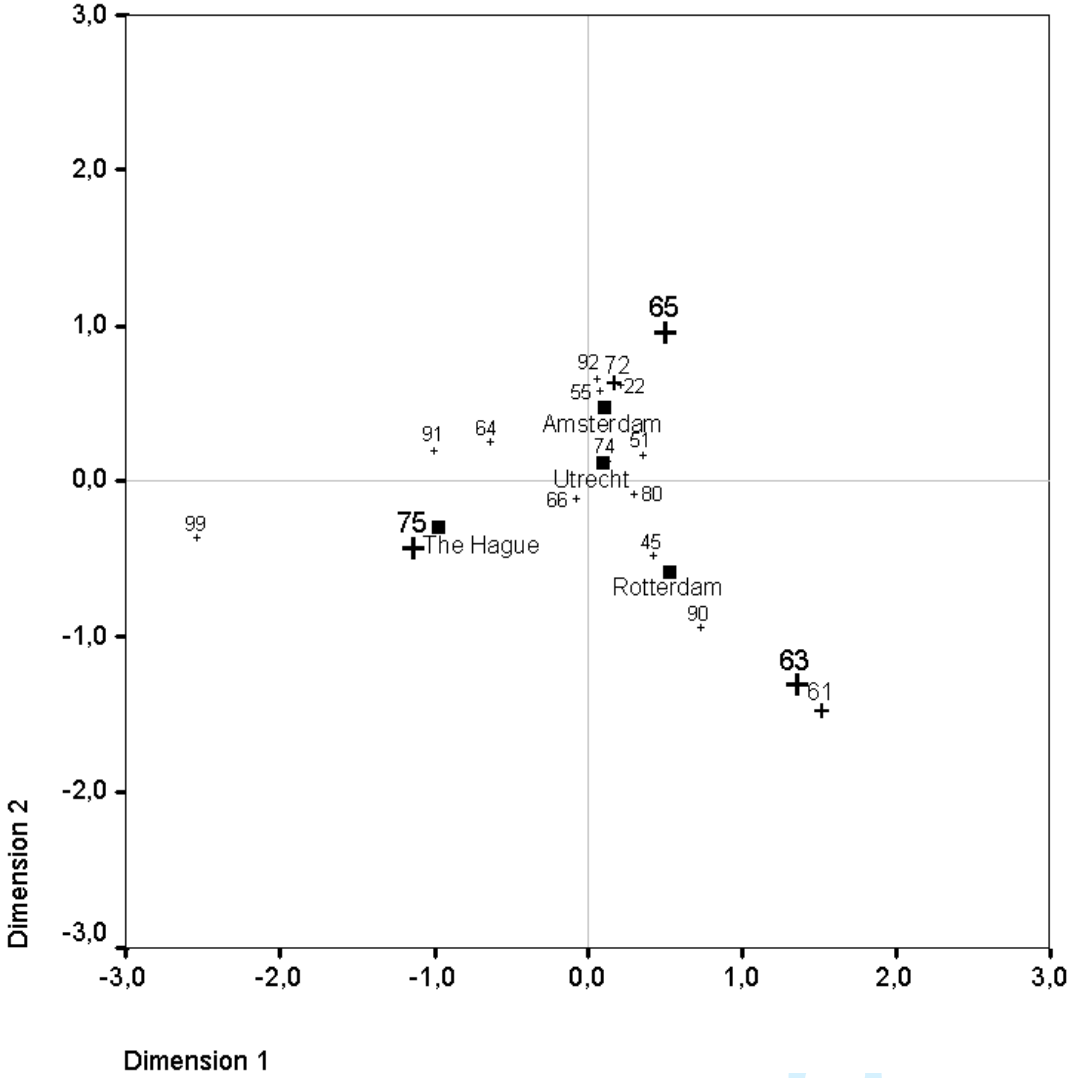
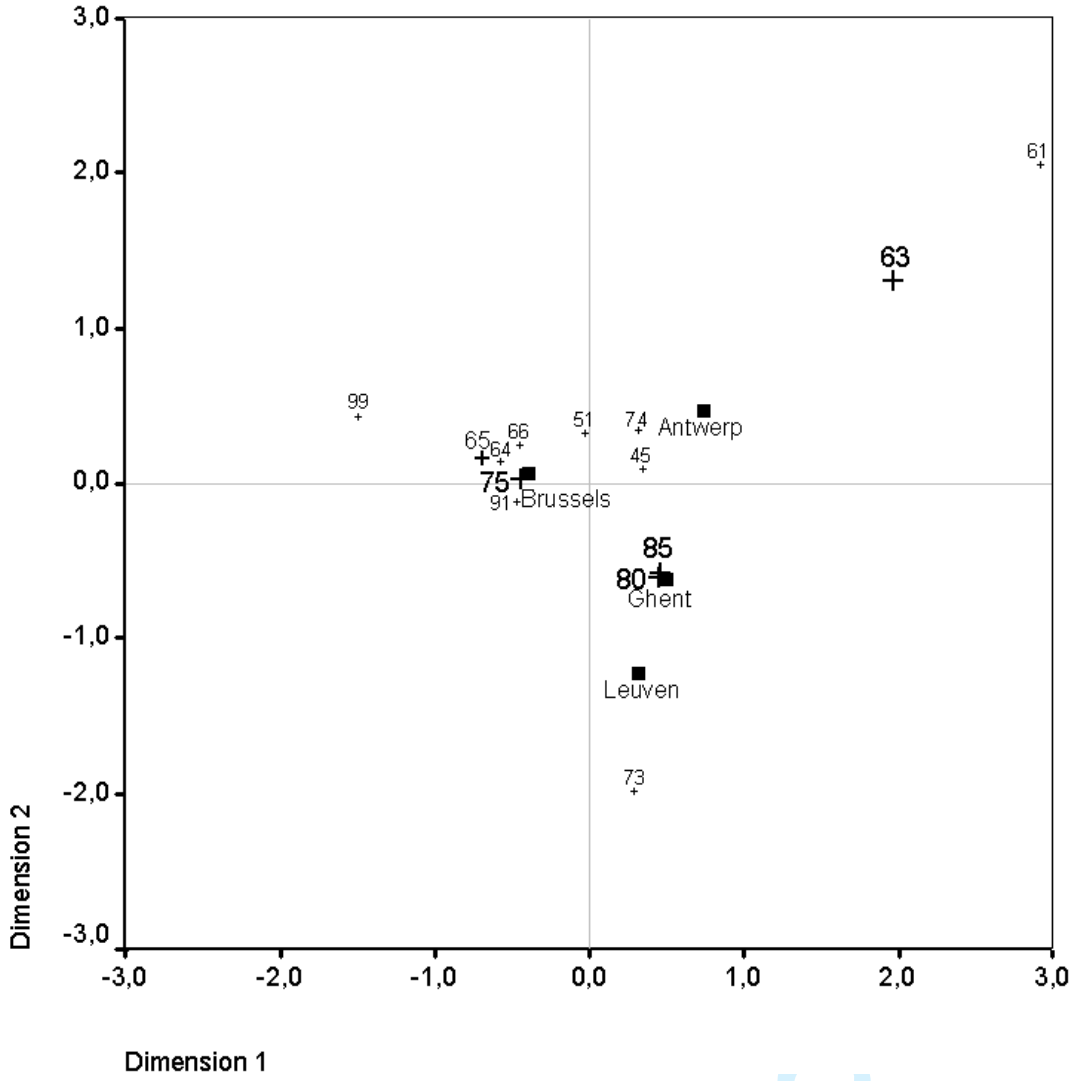


Figure 3. Differentiation in the spread of service sector activities over the main Randstad cities, 2002 (percentage of total inertia explained: 83,8%).



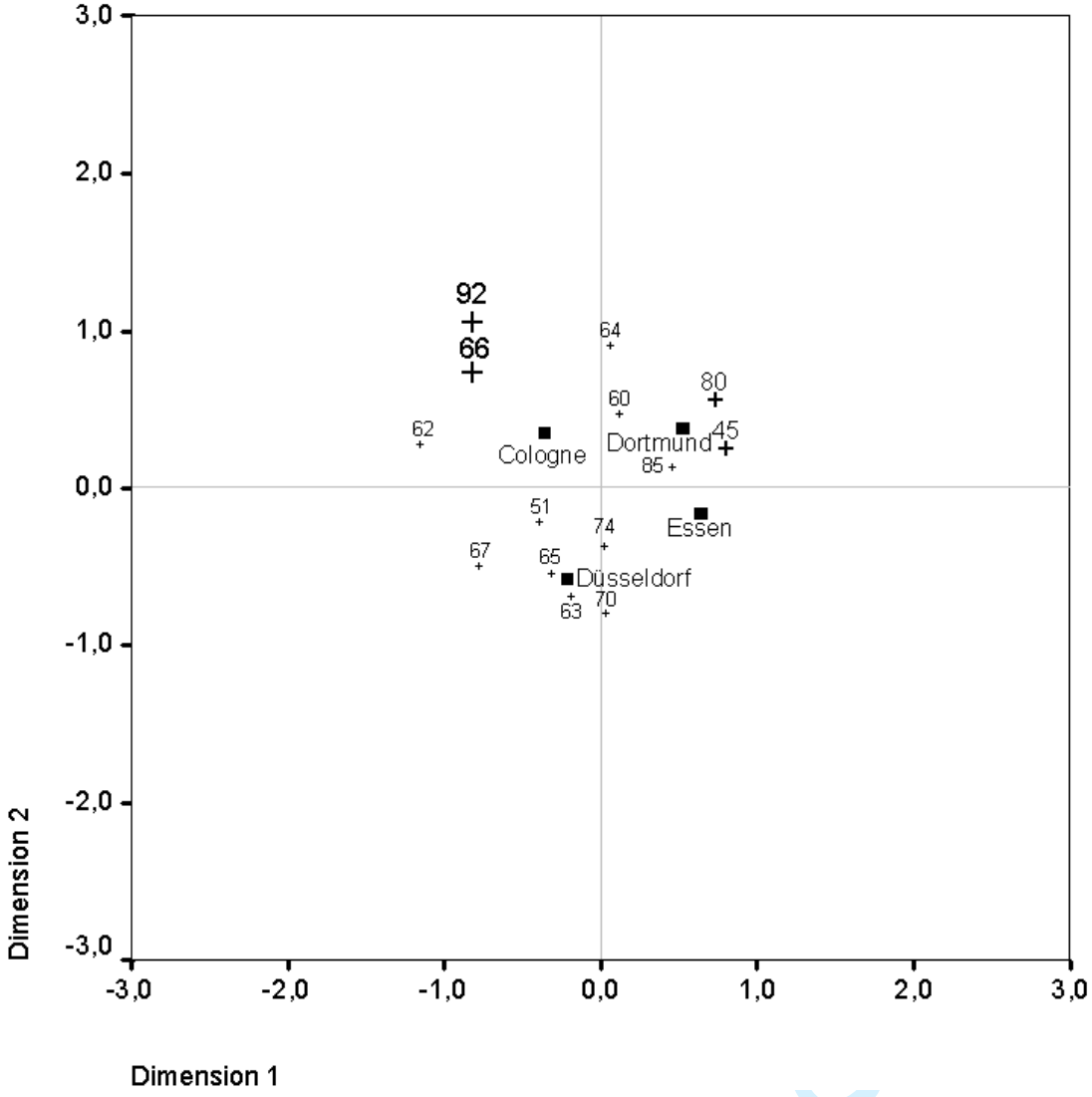
22	Publishing, printing and reproduction	64	Post and telecommunications	80	Education
45	Construction	65	Financial intermediation	90	Sewage and refuse disposal, sanitation
51	Wholesale trade	66	Insurance and pension funding	91	Activities of membership organisations
55	Hotels and restaurants	72	Computers and related activities	92	Recreational, cultural and sporting activities
61	Water transport	74	Other business activities	99	Extra-territorial organisations and bodies
63	Supporting and auxiliary transport activities	75	Public administration and defence		

Figure 4. Differentiation in the spread of service sector activities over the main Flemish Diamond cities, 2002 (percentage of total inertia explained: 96,1%).



45	Construction	65	Financial intermediation	80	Education
51	Wholesale trade	66	Insurance and pension funding	85	Health and social work
61	Water transport			91	Activities of membership organisations
63	Supporting and auxiliary transport activities	73	Research and development	99	Extra-territorial organisations and bodies
64	Post and telecommunications	74	Other business activities		
		75	Public administration and defence		

Figure 5. Differentiation in the spread of service sector activities over the main RheinRuhr Area cities, 2002 (percentage of total inertia explained: 92,2%).



45	Construction	64	Post and telecommunications	74	Other business activities
51	Wholesale trade	65	Financial intermediation	80	Education
60	Land transport	66	Insurance and pension funding	85	Health and social work
62	Air transport	67	Activities auxiliary to financial intermediation	92	Recreational, cultural and sporting activities
63	Supporting and auxiliary transport activities	70	Real estate activities		

Notes

[i] Questions have been raised over whether the dominant form of the deconcentration of employment and urban functions indeed results in a clustering in centres, as some have found evidence, particularly in the US, for a dispersal over the urban territory in a non-centred way (GORDON and RICHARDSON, 1996; LANG and LEFURGY, 2003). However, evidence for metropolitan areas in North West Europe justifies the term 'Polycentric City' as a process of 'concentrated deconcentration' rather than dispersal resulting in a polycentric structure (HALBERT, 2004; BOGAERTS et al., 2005).

[ii] Another source of differentiation that we do not elaborate on in this paper relates to differences in places, e.g. the working environment or living environment the centre or city provides (see also MUSTERD and VAN ZELM, 2001).

[iii] The reader is referred to special issues of: European Planning Studies by DIELEMAN and FALUDI, 1998b, 6 (4); Urban Studies by KLOOSTERMAN and MUSTERD, 2001b, 38 (4); European Planning Studies by PRIEMUS, ZONNEVELD and FALUDI, 2004, 12 (3), as well as a collection edited by MEIJERS et al., 2003.

[iv] Code 22 'Publishing, printing and reproduction of recorded media', officially part of the manufacturing sector, is also included.

[v] In order to test for the robustness of the analysis presented here, we ran the same correspondence analyses using more cities (fourteen) and a more detailed level of breakdown (3-digit) for the Randstad and RheinRuhr Area (similar data for the Flemish Diamond was not available), which repeatedly confirmed our main conclusions. A further analysis for all three regions, taking all 2-digit NACE-sectors into account confirms our main conclusions. Only the total inertia statistic for the RheinRuhr Area presents a

somewhat more ambiguous picture, as in stead of being rather stable, the other analyses show a decline.

[vi] Note that manufacturing activities are not included in the analysis.