Chapter 14
Interlocking Firm Networks and Emerging Mega-City Regions in the Knowledge Economy

Alain Thierstein and Stefan Lüthi

Abstract The main objective of this contribution lies in the exploration of a new metropolitan form in the context of the knowledge economy: polycentric Mega-City Regions. In the first part, we focus on the theoretical building blocks of Mega-City Regions by considering these polycentric urban structures as an emerging spatial phenomenon based on re-scaling processes of agglomeration economies as well as network economies. By using the two inter-related concepts, we secondly analyse large-scale interlocking networks and functional urban hierarchies in nine Mega-City Regions in North West Europe: Munich, Northern Switzerland, the Dutch Randstad Region, South East England, Rhine-Ruhr, Rhine-Main, the Paris Region, Central Belgium and Greater Dublin. The main conclusion of the paper is that polycentric Mega-City Regions are becoming a more general phenomenon in advanced economies. The inter-urban functional linkages are found to be extending and intensifying while, at the same time, global functions are clustering and centralising. These apparently contradictory processes are intersecting on the Mega-City Region scale, which emerges as a new strategic location for activities of the knowledge economy.

Keywords Mega-city region • Knowledge economy • Interlocking firm networks • Advanced producer services firms • Agglomeration economies • North Western Europe

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J. Klaesson et al. (eds.), *Metropolitan Regions*, Advances in Spatial Science,
DOI 10.1007/978-3-642-32141-2_14,

1 Introduction

Globalisation has entailed a reorganisation of spatial development processes on a global, European, national and regional scale. New forms of hierarchical and network development and functional differentiation between cities can be observed (Friedmann 1986; Sassen 2001). Scott (2001) and, recently, Hall and Pain (2006) argue that cities cannot be separated from their regional hinterlands as they often compose a functional division of labour in terms of different kinds of services and value chains among firms (Hall and Pain 2006; Scott 2001). Hence, the traditional hierarchical model of a core city dominating its urban hinterland is becoming increasingly obsolete. Instead, a process of selective decentralisation of particular urban functions, and the simultaneous re-concentration of others, has led to the emergence of polycentric Mega-City Regions (Kloosterman and Musterd 2001; Thierstein et al. 2008; Lüthi et al. 2008). This emerging urban form is spread out over a large area containing a number of cities more or less within commuting distance, and one or more international airports that link the region with other parts of the world (Hoyler et al. 2008b). Different attempts have been made to handle these extended urban regions analytically, and a variety of research projects and publications concerned with polycentricity on a city-regional scale has been produced (ESPON 2004; Hall and Pain 2006; Thierstein et al. 2006; Built Environment, 32.2, 2006; Regional Studies, 42.8, 2008). Furthermore, a number of labels have been used to denote the identified new metropolitan form (Hoyler et al. 2008b): for instance, polycentric urban regions (Kloosterman and Musterd 2001), global city-regions (Scott 2001) or Mega-City Regions (Hall and Pain 2006). The main objective of this contribution lies in the exploration of the Mega-City Region hypothesis. It is structured in four main sections. The first section focuses on the theoretical building blocks of the Mega-City Region concept. Based on these findings, the second section explains the Mega-City Region hypothesis that identifies polycentric Mega-City Regions as an emerging spatial phenomenon based on re-scaling processes of agglomeration and network economies. In the third section, we are looking at several Mega-City Regions in North West Europe by referring to two recent empirical research projects: the INTERREG IIIB study POLYNET (Hall and Pain 2006) and a case study about the emerging Mega-City Region of Munich Thierstein et al. (2007). The fourth section concludes by synthesising the main findings and putting them into the theoretical context.

2 Theoretical Background

In this section, the theoretical building blocks of the Mega-City Region hypothesis are discussed. Generally speaking, they can be divided into two bodies of literature stemming from different approaches to interpret global trends in spatial development: agglomeration economies and network economies.

2.1 Agglomeration Economies

'Agglomeration economies' is a generic concept, referring to a number of different theories: Traditional Agglomeration Models, New Industrial Geographies and Innovation Systems. The following section provides an overview of these theoretical concepts.

2.1.1 Traditional Agglomeration Models

Early theories on agglomeration economies are strongly inspired by Joseph Schumpeter (1926) and Alfred Marshall (1920). Schumpeter (1926) initially focused on the roles of entrepreneurs and their small companies in recognizing the importance of particular inventions and assembling the resources needed to turn them into marketable products (Schumpeter 1926). This process is well known as the Schumpeter I model. Alfred Marshall (1920), on the other hand, argued that spatial concentration could confer external economies on firms as they concentrated in particular cities. These external economies mainly take the form of increasing returns to scale as firms are able to take advantage of large pools of skilled labour, local markets and the easy transmission of new ideas (Marshall 1920). Marshall's concept has been taken up by Edgar M. Hoover (1937, 1948), who grouped the sources of agglomeration advantages into internal returns of scale, localisation and urbanisation economies. Localisation economies, on the one hand, arise as a particular industry concentrates in a given location leading to the development of local expertise, special skills and advantages that are specifically related to the industry in question. Urbanisation economies, on the other hand, arise from the diversity and the more general characteristics of a city; for instance the multiplicity of specialised business services, infrastructure and cultural and leisure functions that may be used by any firm in the city rather than only a single economic sector (Hoover 1937, 1948).

2.1.2 New Industrial Geographies

Based on these early agglomeration theories, a second wave of agglomeration models was developed in the 1980s onwards to explain why local space was still important for newly-developing forms of production. The most influential among these theories was Michel J. Piore's and Charles F. Sable's concept of flexible specialisation, which identified the breakdown and deverticalisation of large firms as a key characteristic in modern economies (Piore and Sable 1984). In the face of international competition and changing customer demands, this process is driven by the need for firms to be both more specialised and more flexible in the ways in which they organise their production. The result is a networked form of production that leads to a reconnection of economic activities to local space because of the

need for proximity between the numerous specialists involved in any given value chain (Simmie 2005).

The flexible specialisation thesis inspired several new concepts dealing with innovation, knowledge and regional development. Influential among these were the Innovative Milieus and the New Industrial Districts and the New Industrial Spaces approach.

In the approach of the Innovative Milieu developed by the GREMI (Groupe de Recherche Européen sur les Milieux Innovateurs), firms are seen as part of a milieu with an innovative capacity. These milieus include a set of collective and dynamic processes incorporating many actors within a given region that lead to networks of synergy producing interrelationships and learning (Bramanti and Maggioni 1997; Maillat et al. 1993). In addition, the authors of the GREMI underline not only the importance of links within but also with the world outside the milieu. This is a critical extension to the local supply-side-focused networks of the traditional industrial districts approach (Simmie 2005).

The theory of the New Industrial District, first identified by Giacomo Becattini in the so-called Third Italy, emphasises the innovative capacity of small and medium-sized enterprises (SMEs) belonging to the same industry and local space. Commonly, industrial districts are defined as localised production systems, based on a strong local division of labour between small and specialised firms, which are integrated in the production and value chain of an industrial sector (Becattini 1989). Newer approaches, however, highlight that such networks also connect large firms and their suppliers and enable the introduction of flexible specialisation by facilitating subcontracting. As a consequence, the manufacturing depth of large companies is reduced and a smooth diffusion of innovation throughout the whole regional economy is facilitated (Grabher 1991).

A third influential approach inspired by the flexible specialisation thesis is the concept of New Industrial Spaces. Especially, the Californian School, led by Allen J. Scott, launched the notion of New Industrial Spaces by combining insights from different literatures such as industrial districts, flexible production systems, transaction economies and others (Storper and Walker 1988; Scott 1985). The authors argue that in flexible production systems, the tendency to agglomeration was reinforced not only by externalisation but also by intensified re-transacting, just-in-time processing, variable forms of inter-unit transacting and the proliferation of many small-scale linkages with low unit costs. Scott argues that the economic process of vertical disintegration into extended and specialised divisions of labour is leading to spatial forces that encourage small firms to concentrate in space (Scott 1985).

2.1.3 Innovation Systems

The multi-faceted character of agglomeration economies has also been discussed quite openly in evolutionary economics (Edquist and Johnson 1997). The key concepts of contemporary evolutionary theory stem from the Schumpeter II model (1942). In contrast to the Schumpeter I model, the Schumpeter II model

recognises the significance of Research and Development (R&D) within large firms, where increased R&D activities are setting up a self-reinforcing circle leading to renewed impulses and finally to increased market concentrations. From a spatial point of view, this argument is interesting in regards to the establishment and persistence of R&D activities in particular Mega-City Regions. Schumpeter's ideas were taken up and further developed, for example by Richard Nelson and Sidney Winter in their work on the evolutionary theory of economic change (Nelson and Winter 1982). According to modern evolutionary theory, intra-firm networks of large multinational corporations (MNCs) are important driving forces in the global knowledge economy, concentrating and centralising their power in their headquarters that are often located in core metropolitan areas. The decisions of these MNCs about where they conduct their activities along the value chain play a major role in where innovation and knowledge are located. They can split its activities into units and localise and disperse these units in the most favourable places in terms of local knowledge resources and industrial culture (Massey 1985).

In the last 20 years, the literature on spatial innovation systems has shifted from the national (Edquist 1997; Nelson 1993; Lundvall 1988, 1992) to the regional (Asheim and Isaksen 1997; Cooke et al. 1998) and local dimension (Muscio 2006; Carrincazeaux et al. 2008). National Innovation Systems (NIS) can be defined as the elements and relationships which interact in the production, diffusion and use of new knowledge and are located within the borders of a nation state (Lundvall 1992). According to the Regional Innovation System (RIS) theory, on the other hand, it is the region that plays a central role in economic coordination, especially with respect to innovation, evolving into a "nexus of learning processes" (Cooke et al. 1998). RISs are complex systems with strong interactions between regional actors systematically engaged in interactive learning (Morgan 1997). The relevance of the local dimension of governance has finally led to the creation of a new strand of research in regional studies, stressing how local policies can play a key role in fostering learning processes. Accordingly, Local Innovation Systems (LIS) are based on the generation of localised learning systems where some local innovation policies are activated to transfer technologies, to enforce technological cooperation and to provide support and incentives to innovative networks. The strategic response of local actors to the challenge of increasing competition is the mechanism through which structural change and the economic dynamics at the local level are stimulated (Muscio 2006).

The interdependence between agglomeration and evolutionary economics are of great importance for the understanding of spatial development processes and the dynamics of polycentric Mega-City Regions. Morgan (1997) as well as Moulaert and Sekia (2003) refer especially to Michael Storper's work as the fullest attempt to marry these two disciplines (Morgan 1997; Moulaert and Sekia 2003). Michael Storper (1995) recognizes the principal dilemma of economic geography between the resurgence of regional economics and globalisation (Storper 1995). By combining insights from institutional, agglomeration and evolutionary economics, he explains this phenomenon by the association between organisational and technological

learning within agglomerations, based on traded (input–output relations) and untraded interdependencies (regional conventions, norms and values, public institutions etc.).

An intermediate position between agglomeration economies and network economies is taken up by the French School of Proximity Dynamics, which made key contributions to the literature on Mega-City Regions in the 1990s, proposing that proximity covers a number of different dimensions (Torre and Rallet 2005). Therein a distinction is made between the relational and local aspects of proximity. Local proximity is defined as spatial distance between actors. Relational proximity, on the other hand, is associated with the closeness of actors in organizational terms, meaning that actors share the same relational space, for example the way interaction and coordination between actors is organized (Boschma 2005). However, as Boschma and Iammarino (2009) show, regional growth is not affected by simply being well connected to the outside world or having a high variety of knowledge flowing into the region. Rather they found evidence for the 'related variety concept': the highest learning opportunities are present when cognitive proximity between the extra-regional knowledge and the knowledge base of a region is neither too small nor too large (Boschma and Iammarino 2009).

2.2 Network Economies

Most observations on how external economies influence spatial development have focused on agglomeration economies. However, many of these investigations have failed to consider the contribution of global network economies. As argued by Cabus and Vanhaverbeke (2006), network economies need to be acknowledged as complementary to agglomeration economies (Cabus and Vanhaverbeke 2006). Simmie (2003) for example has observed that most innovative firms operate from rather than within localities (Simmie 2003). Therefore, in the following section, we will discuss some of the most important approaches relating to urban network economies. Generally speaking, they can be divided into two groups: World City Network models and Value Chain models.

2.2.1 World City Network Models

Much of world city research has been related to the emergence of a globally networked knowledge economy in which Advanced Producer Services (APS) firms play a predominant role. In this respect, Saskia Sassen's global city approach is an important contribution (Sassen 2001). It discovers a new geography of centrality in which the city centres or the central business districts form the heart of the global urban network. The functional centrality of these global cities leads to an increasing disconnection of the city centres from their broader hinterlands or adjacent metropolitan region. The reason for this disconnecting process lies, according to Sassen, in the location strategies of Advanced Producer Services (APS) firms as spearheads

of the rising global knowledge economy. These enterprises are increasingly located just within the city centres of economic regions and connect these places directly with other city centres in the world (Sassen 2001).

In contrast to Saskia Sassen's global city approach, John Friedmann's world city concept argues that the territorial basis of world cities comprises not only the central city but also the whole economic space of the surrounding region. Therefore, world cities are often polycentric urban regions containing a number of historically distinct cities that are located in more or less close proximity. Furthermore, John Friedmann describes the rise of a transnational urban network, referring to a major geographical transformation of the capitalist world economy whose production systems are increasingly internationalised. This reconfiguration results in a new international division of labour whose main agents are multinational enterprises with complex spatial organisational structures. It is the presence of these multinational enterprises that makes world cities into geographical places of great economic power (Friedmann 1986).

Another heuristic framework about network cities is provided by Manuel Castells' highly influential concept of a space of flows (Castells 2000). He argues that the new spatial logic is determined by the pre-eminence of the space of flows over the space of places. By space of flows he refers to the system of exchange of information, capital and power that structures the basic processes of societies, economies and states between different localities, regardless of localisation. Furthermore, Castells (1989) argues that the "space of flows" and the creation of "multinuclear spatial structures" is not an undifferentiated process. Rather, it follows a hierarchical and functional logic. Higher-level functions tend to be concentrated in certain privileged locations, while assembly functions are scattered over more and varied locations. He argues that the more information-based an industry is, the clearer is the trend toward a hierarchical pattern of segmented location (Castells 1989).

While Friedmann (1986) and Castells (2000) offer a heuristic and theoretical framework as to why globalisation requires a networked conception of cities, Peter Taylor (2004) provides with his world city network approach an empirical instrument for analysing inter-city relations in terms of the organisational structure of the global economy (Taylor 2004). With his team – the Globalisation and World Cities Study Group (GaWC) at Loughborough University – he analyses the inter-city relations using a specific methodology, in which relationships between cities are not measured directly. Instead, the method uses a proxy by analysing the internal structures of large APS firms and revealing the relationships between head offices and other branches located all over the world.

2.2.2 Value Chain Models

Another starting point for understanding the changing nature of international trade and industrial organisation is contained in the notion of a value-added chain, as developed by international business scholars who have focused on the strategies of firms in the global economy. In its most basic form, a value-added chain is "...the

process by which technology is combined with material and labour inputs, and then processed inputs are assembled, marketed, and distributed. A single firm may consist of only one link in this process, or it may be extensively vertically integrated. . .” (Kogut 1985:15). The key questions in this literature are which activities and technologies a firm keeps in-house and which should be outsourced to other firms, and where the various activities should be located Gereffi et al. (2005).

A rich literature has evolved in order to explain how global industries are organised and governed Coe et al. (2008). Three sets of terminology have become especially prominent. An early but still very active body of research exists on Global Commodity Chains (GCC), a term popularised by Gary Gereffi in a large number of publications since 1994. The GCC framework pays particular attention to the powerful role that large retailers and highly successful branded merchandisers have come to play in the governance of global production and distribution.

In the last decade, however, transnational giants have changed quite dramatically, outsourcing many activities and developing strategic alliances with competitors. They have become less vertically integrated and more network-orientated (Wildemann 2003). As a consequence of these structural changes, researchers at the Institute of Development Studies in Sussex have developed a second approach: the Global Value Chain (GVC) framework. In contrast to the GCC framework, the GVC approach attempts to delineate the varying governance structures both within and between different sectors (Coe et al. 2008:267). Thereby, the value chain is understood as providing the full range of activities that firms and workers engage in to bring a product or a service from its conception to its end-use and even beyond Gereffi et al. (2005).

Finally, the third approach is the Global Production Network (GPN) framework, initially developed by researchers in Manchester (Henderson et al. 2002). GPNs can be defined as the globally organised nexus of interconnected functions and operations through which goods and services are produced, distributed and consumed (Coe et al. 2004). Thereby, the process of embeddedness, both territorially and within business networks, is of great importance. Henderson et al. (2002) argue that the mode of territorial embeddedness or the degree of a GPN firm’s commitment to a particular location is an important factor for value creation, enhancement and capture (Henderson et al. 2002).

3 The Mega-City Region Hypothesis

At the intersection of agglomeration economies, world city networks and global value chains, a new metropolitan form – so called polycentric Mega-City Regions – is emerging in advanced economies. However, Mega-City regions are not a completely new phenomenon. Jean Gottmann originally made similar observations as long ago as 1961 in his pioneering study “Megalopolis: The Urbanized Northeastern Seaboard of the United States” (Gottmann 1961). Few years later, Peter Hall (1966) observed that next to the traditional “highly centralised giant city” there

exists a "polycentric type of metropolis". This polycentric metropolis consists of "a number of smaller, specialised, closely-related centres" and should be understood as "a perfectly natural form, which has evolved over a period of history quite as long as the single metropolitan centre" (Hall 1966). However, the most recent rediscovery of the concept has been in Eastern Asia, in areas like the Pearl River Delta and Yangtze River Delta regions in China, the Tokaido (Tokyo-Osaka) corridor in Japan, and Greater Jakarta (Hall 1999; Scott 2001).

Lately, Peter Hall and Kathy Pain (2006) emphasise its large-scale nature and developing polycentric structure by defining Mega-City Regions as "...a series of anything between 10 and 50 cities and towns physically separated but functionally networked, clustered around one or more larger central cities, and drawing enormous economic strength from a new functional division of labour. These places exist both as separate entities, in which most residents work locally and most workers are local residents, and as parts of a wider functional urban region connected by dense flows of people and information carried along motorways, high-speed rail lines and telecommunications cables" (Hall and Pain 2006:3). The key point of this definition is that Mega-City Regions are not solely characterised by simple attributes such as demographic size or physical settlement structures but as socio-economic relational processes linking regions to other cities and towns on different geographical scales. Thus, Mega-City Regions are defined by their linkages among its constituent functional parts and without any predefined territorial boundaries.

Referring to the Mega-City Region definition as suggested by Peter Hall and Kathy Pain (2006), we argue that the emergence of polycentric Mega-City Regions is the result of two interdependent processes: agglomeration economies as well as network economies. Agglomeration economies result from the clustering of knowledge-intensive firms in certain areas enabling them to benefit from spatial proximity and local knowledge spillovers. By local knowledge spillovers we understand both, intended flows of knowledge, such as input–output relations along the value chain, and unintended flows of knowledge, based on regional conventions, norms and values. Network economies, however, result from global sourcing strategies of knowledge-intensive firms leading to relational proximity and international knowledge exchange. Based on this functional logic, we argue that polycentric Mega-City Regions are the outcome of a spatial up-scaling of agglomeration economies and a spatial re-concentration process of network economies. Figure 14.1 depicts schematically the inter-relationships between the knowledge economy that basically follows a functional logic and the emergence of Mega-City Regions, which basically are the effect of spatial logic at work.

On the one hand, the up-scaling process of agglomeration economies is determined by the achievements realised in transportation and telecommunications technologies. The costs of several modes of transport and communication have drastically declined and, in some cases, speed and reliability have significantly improved. As a consequence, polycentric Mega-City Regions are increasingly enabled to achieve agglomeration economies of comparable magnitude to those of large mono-centric cities.

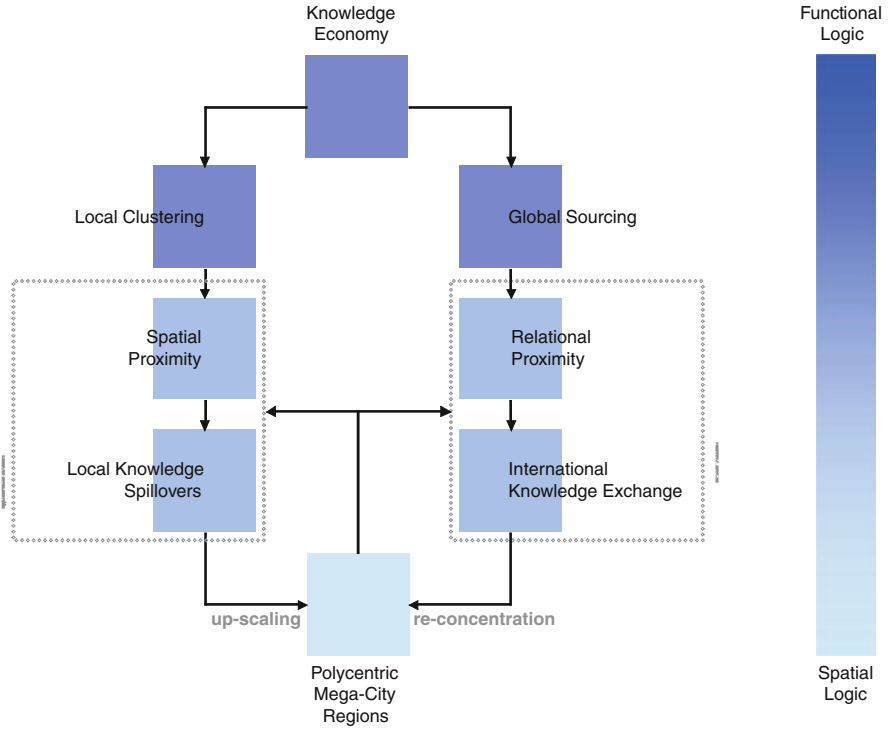

Fig. 14.1 Agglomeration and network economies in the context of Mega-City Region development (own illustration)

On the other hand, the spatial re-concentration of network economies is determined by the location behaviour of the knowledge economy. In order to improve their added value, knowledge-intensive firms need several local business conditions such as proximity to international gateway infrastructures like airports and high-speed train nodes. Many international knowledge-intensive enterprises have already recognised the advantage of being located around airports and within the corridors between the airport and the city. Furthermore, knowledge-intensive firms are looking for high quality infrastructures such as universities with a good reputation or large settlements of leading global companies, as well as for the availability of specialised knowledge, the presence of competitors, business partners and customers as well as qualified manpower.

All in all, the interplay between the up-scaling process of agglomeration economies and the re-concentration of network-economies is strongly subject to increasing returns leading to polycentric Mega-City Regions as essential spatial nodes and engines of today's global economy. In a similar way, but with regard to new information technologies, Manuel Castells (1989) argues that ". . .alongside the centralisation and metropolitanisation of information industries, there is also a process of decentralisation of service activities over regions, urban areas and locations within the major metropolitan areas; and this decentralisation is being

helped, and sometimes even stimulated, by new information technologies" (Castells 1989:151). It is this two-fold process of simultaneous re-concentration and decentralisation, both elements associated with the same dynamics of the knowledge economy, which explains the complexity of Mega-City Region development.

4 Emerging Mega-City Regions in North West Europe

Different attempts have been made until now to analyse the polycentric structure of emerging Mega-City Regions in Europe (Hall and Pain 2006; Thierstein et al. 2007; and others). One of the most recent empirical research activities is the INTERREG IIIB Study POLYNET – Sustainable Management of European Polycentric Mega-City Regions (a comprehensive illustration of the POLYNET results is provided by Hall and Pain 2006). POLYNET aimed to investigate the polycentricity of eight Mega-City Regions in North West Europe and their current state of functional division of labour: South East England, the Paris Region, Central Belgium, the Dutch Randstad, Rhine-Main, Rhine-Ruhr, Northern Switzerland and Greater Dublin (Hall 2007). Based on the methodology of POLYNET, a second attempt to handle the Mega-City Region hypothesis analytically is the case study of Thierstein et al. (2007) about the emerging Mega-City Region of Munich Thierstein et al. (2007). This section presents the methodology and some empirical results of both research projects.

4.1 The Interlocking Network Model

With its seminal research, POLYNET introduced a new way of looking at polycentric urban structures and hierarchies, adopting Peter Taylor's world city network approach on the Mega-City Region scale (Taylor et al. 2008). Both Thierstein et al. (2007) as well as the POLYNET study started from the premise that intra-firm networks of Advanced Producer Services (APS) firms offer a strategic lens to examine intercity relations within and beyond larger urban regions, building theoretically on Saskia Sassen's (2001) identification of Advanced Producer Services (APS) as crucial actors and outcomes of globalisation and localisation processes and Manuel Castell's (2000) notion of a "space of flows". Thereby, the following business lines are considered: accounting, insurance, banking and finance, management- and IT-consulting, law, third- and fourth-party logistics, design and architecture as well as advertising and media. The analysis of the intra-firm networks of these business lines is based on the methodology of the Globalisation and World Cities Study Group (GaWC) (Taylor et al. 2008). This approach estimates city connectivities from the office networks of multi-location multi-branch enterprises. The basic premise of this method is that the more important the office, the greater its flow of information will be to other office locations. Thereby, the empirical work comprises two steps.

In a first step, a so-called 'service activity matrix' is developed. This matrix is defined by cities in the lines and knowledge-intensive firms in the columns. Each cell in the matrix shows a service value (v) that indicates the importance of a city to a firm. The importance is defined by the size of an office location and its function. By analysing the firms' websites, all office locations are rated on a scale of 0 to 3. The standard value for a cell in the matrix is 0 (no presence) or 2 (presence). If there is a clear indication that a location has a special relevance within the firm's network (e.g. headquarters, supra-office functions), its value is upgraded to 3. If the overall importance of a location in the firm's network is very low (e.g. small agency), the value is downgraded to 1.

In the second step, the interlocking network model established by Peter Taylor (2004) is used to estimate connectivities between cities within and beyond emerging Mega-City Regions (Taylor 2004). The primary outputs of this interlocking network analysis are network connectivities, a measure that estimates how well-connected a city is within the overall intra-firm network of knowledge-intensive enterprises.

There are different kinds of connectivity values that are calculated. The connectivity between two cities (a, b) of a certain firm (j) is analysed by multiplying their service values (v) representing the so-called *elemental interlock* (r_{abj}) between two cities for one firm:

$$r_{abj} = v_{aj} * v_{bj} \tag{14.1}$$

To calculate the total connectivity between two cities, one has to summarise the elemental interlocks for all firms located in these two cities. This leads to the so-called *city interlock* (r_{ab}):

$$r_{ab} = \sum r_{abj} \tag{14.2}$$

Aggregating the city interlocks for a single city produces the *interlock connectivity* (N_a). This measure describes the importance of a city within the intra-firm network of all knowledge-intensive enterprises that have been analysed.

$$N_a = \sum r_{ai} \qquad (a \neq i) \tag{14.3}$$

Finally, if we relate the interlock connectivity for a given city to the city with the highest interlock connectivity, we gain an idea of its relative importance in respect to all other cities that have been considered.

The main limitation of this model is that it does not consider extra-firm networks in its conceptualisation. However both, intra-firm and extra-firm networks are important in analysing the patterns of the changing value chain of the knowledge economy. Intra-firm networks are of interest because of the growing prevalence of multinational and multi-location firms providing important vehicles for transferring results of research and development as well as knowledge. Extra-firm networks in addition are interesting because they generate possibilities for increased economies of scale through flexible, networked production complexes.

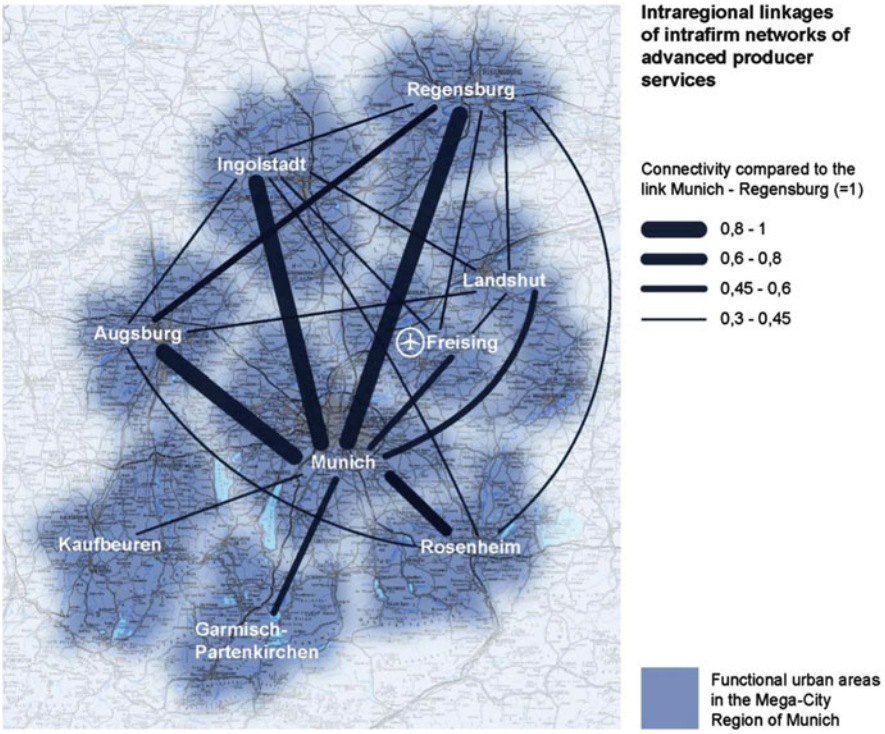

Fig. 14.2 Intra-firm connectivity between APS firms at regional level (Source: own calculation)

4.2 The Wider Munich Area as a Hierarchically Organized Mega-City Region

Based on the calculations of the interlocking network model, Thierstein et al. (2007) show that the wider Munich area can be regarded as an emerging functional region where sub-centres have different functional and hierarchical roles. In Fig. 14.2, they show the spatial patterns of the intra-firm connectivity between Advanced Producer Services (APS) firms in the wider Munich area. The analytical building blocks are built by nine Functional Urban Areas (FUAs): München, Kaufbeuren, Garmisch-Partenkirchen, Rosenheim, Landshut, Freising, Regensburg, Ingolstadt and Augsburg. All of them can be reached within a 1 h car journey from the city centre of Munich. Furthermore, they are defined as having an urban core of at least 15,000 inhabitants and over 50,000 in total population. The thickness of the lines illustrates the total connectivity between two FUAs. These connectivity values are related to the highest interlock connectivity of the study area, which is the connection between Munich and Regensburg. This high value is due to the fact that many Advanced Producer Services (APS) firms have relatively important and therefore highly-rated locations in both cities. The most important finding of this figure is that

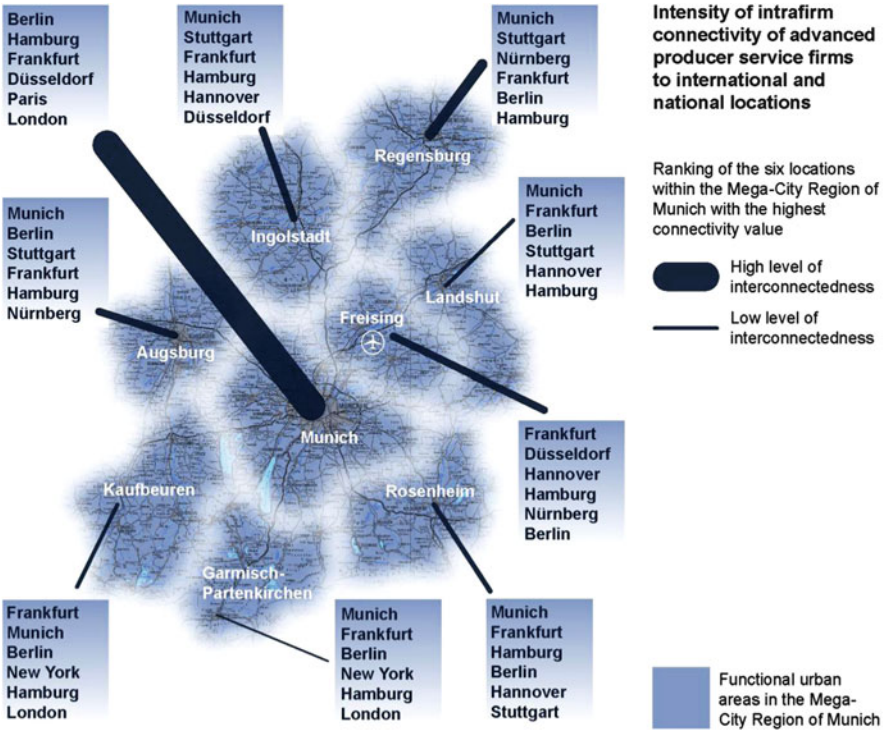

Fig. 14.3 Intensity and ranking of connectivity values created by intra-firm networks of APS companies (Source: own calculation)

the predominant part of intra-firm networks is located within the wider Munich area, defining it as a functionally polycentric Mega-City Region. In other words, since the FUAs within the study area are more closely linked with each other than with outlying FUAs, they begin to form a conglomerate of functionally linked cities that merits being labelled as an emerging Mega-City Region Thierstein et al. (2007).

In their case study, Thierstein et al. (2007) do not only identify the wider Munich area as a highly interconnected space of flows, but they also identify it as a hierarchically organized urban system. They show that there is a distinct functional urban hierarchy within the Mega-City Region, with Munich as primary city especially in respect to international intra-firm connectivity. Figure 14.3 shows this fact for international intra-firm networks of Advanced Producer Services (APS) firms. For each FUA, the six mostly connected locations are listed. The thickness of the lines reflects the total international connectivity for each FUA. The Figure shows that Munich is most strongly linked with four big national cities (Berlin, Hamburg, Frankfurt and Düsseldorf) followed by Paris and London as the first European destinations. This is a surprising finding because it could be assumed that – in an increasingly globalised world – international linkages would be more important for the APS sector in Munich. Another interesting feature concerns the connectivities

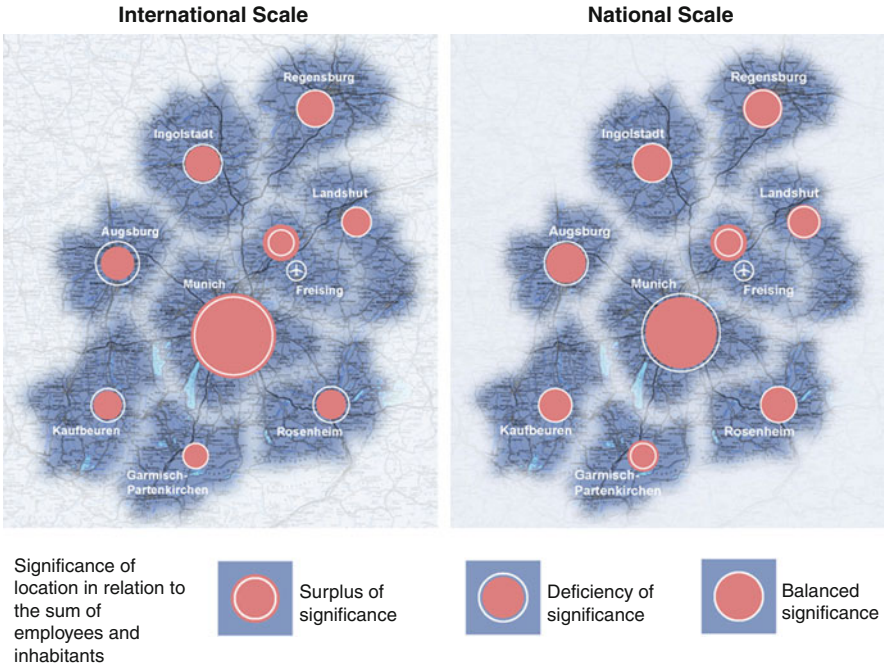

Fig. 14.4 Significance of Functional Urban Areas (FUAs) in the Mega-City Region of Munich for APS firms (Source: own calculation)

in the secondary cities around Munich. Most of them are primarily connected to Munich, generally followed by further German locations. This means that APS firms in these locations mainly have offices in Munich or other national urban centres, whereas offices in European or even international locations are quite rare. Hence, in the case of APS interlocking networks, medium-sized and small urban centres in the wider Munich area are not directly integrated into international networks of knowledge-intensive economic activities. Instead, they are well-integrated into large-scale regional networks of knowledge exchange. The city of Munich, however, is a central node and international gateway for smaller centres in the emerging Mega-City Region and acts as an important international knowledge-hub Thierstein et al. (2007).

In order to show the relative significance of the FUAs within the wider Munich area, Thierstein et al. (2007) put the interlock connectivity for each FUA in relation to the sum of its inhabitants and jobs. In Fig. 14.4, this relative significance is illustrated in the following way: the pink circle illustrates the connectivity value for the FUA and the white ring shows its sum total of inhabitants and jobs. Hence, an outer pink ring indicates a higher connectivity as expected in terms of inhabitants and jobs. This represents a surplus of significance. A smaller pink circle, in contrast, indicates a lower connectivity than expected, which represents a deficiency of significance. If one compares international and national connectivity values in this way, an interesting spatial pattern is revealed. Figure 14.4 confirms

that Munich acts as an important hub for international connectivities, whereas the surrounding FUAs are particularly of national importance. The latter seem to have a crucial role as regional centres, supplying regional markets with services and products. In this sense, smaller FUAs have to be viewed as complementary centres taking over functions which cannot be provided by Munich itself. A special case within the study area is Freising, a small town that is quite close to Munich and immediately next to the international hub-airport. Freising shows a clear surplus of significance for both national and international connectivities. Obviously, despite its small size, Freising seems to benefit from a dense network of global companies owning branch offices in several international locations. As a consequence, Thierstein et al. (2007) conclude that Freising and Munich are not complementary but substitutive locations within the emerging Mega-City Region of Munich, which means that international firms hardly choose an office location at both sites.

4.3 Looking at Eight Emerging Mega-City Regions in North West Europe

In order to compare the functional polycentricity of different Mega-City Regions in North West Europe and the relative significance of its cities and towns, Thierstein et al. (2006) related the interlock connectivities for all FUAs in the POLYNET study to the sum of its inhabitants and jobs (Thierstein et al. 2006). In this section, we will take you on an analytical tour of the eight Mega-City Regions that have been under investigation in the POLYNET project.

4.3.1 The Mega-City Region of Northern Switzerland

A first case study of POLYNET is the European Metropolitan Region (EMR) of Northern Switzerland, an incipient Mega-City Region extending in discontinuous linear pattern from Zurich and its region westwards towards Basel. Figure 14.5 shows the significance of the most important FUAs in the Mega-City Region of Northern Switzerland for national and international connectivities. For international connectivities Zurich shows a quite balanced significance level. Important reasons for this international significance are Zurich's special role among top-ranking financial firms with international presence and its gateway function because of its international airport and the universities with their reputation, in particular the Swiss Federal Institute of Technology (ETH) (Thierstein et al. 2008). For national connectivities, however, Zurich's position seems to turn into a deficiency of significance, whereas other secondary centres gain in importance. A rather interesting example is Zug, a small agglomeration with about 95,000 inhabitants. From a relative perspective, it has comparatively strong connections with national and international locations.

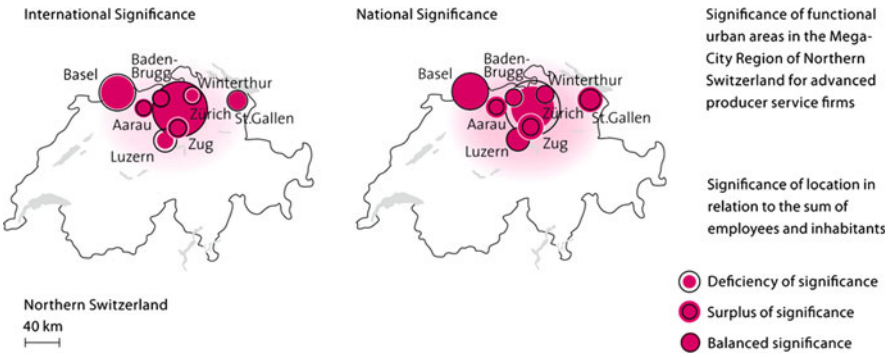

Fig. 14.5 Significance of Functional Urban Areas in the Mega-City Region of Northern Switzerland for APS firms (Thierstein et al. 2006)

The reason for Zug's relative importance lies, on the one hand, in its proximity to the international hub of Zurich and, on the other hand, in its attractive tax policy. Despite its small size, Zug seems to benefit from a dense network of global companies owning branch offices in several national and international locations giving it a special position within the emerging Mega-City Region of Northern Switzerland. It seems that the internationalisation of companies in a specific location has a greater effect on the degree of connectivity than the mere size of an agglomeration or a core city (Thierstein et al. 2008).

4.3.2 The Randstad Region

A second POLYNET case study is the Randstad in the Netherlands, encompassing the cities of Amsterdam, The Hague, Rotterdam and Utrecht, but now extending outwards to include cities such as Arnhem, Amersfoort and Breda. The area measures about 70 by 75 km and contains about 6.6 million people. They live in a large number of mainly medium-sized cities and in an even larger number of smaller towns and villages. This co-presence of many individual smaller and larger cities in a relatively small area gives the Randstad its archetypical polycentric appearance (Lambregts 2008). As Fig. 14.6 shows, for international APS enterprises, Amsterdam with its international airport is by far the most important location within the entire Mega-City Region. On the national scale, however, the other agglomerations such as Utrecht and Breda clearly gain in importance.

4.3.3 The Mega-City Region of South East England

A particularly interesting case within the POLYNET study is the Mega-City Region of South East England, where London is the centre of a system of some 30–40 cities and towns within a 150 km radius (Hall 2007). Ironically, although South East England appears relatively monocentric in terms of the size and distribution of its

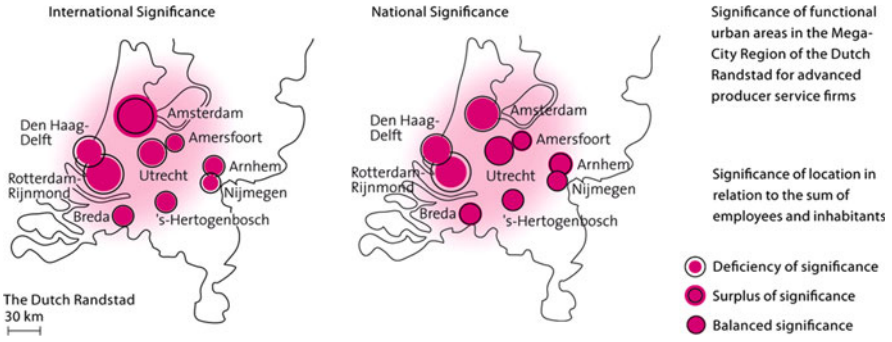

Fig. 14.6 Significance of Functional Urban Areas in the Mega-City Region of the Randstad Holland for APS firms (Thierstein et al. 2006)

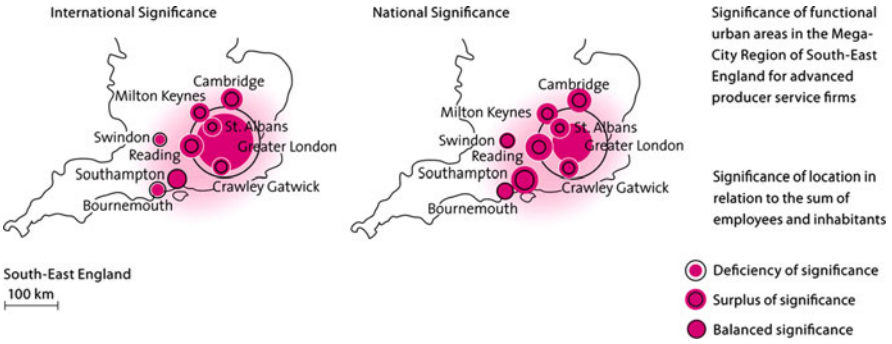

Fig. 14.7 Significance of Functional Urban Areas in the Mega-City Region of South East England for APS firms (Thierstein et al. 2006)

towns and cities, it proves the most functionally polycentric region in the POLYNET study (Pain 2008). Figure 14.7 shows clearly that the mere size of an agglomeration such as London does not automatically increase its functional significance. In absolute terms, London is clearly the most important location for international APS firms within the Mega-City Region of South East England. In relative terms, however, the smaller agglomerations such as Reading and Cambridge show relatively high international connectivities.

According to Pain (2008) the eight APS centres outside London do not show a notable sectoral specialisation. Financial services are well represented in Bournemouth and logistics in Milton Keynes, Reading and Crawley are seen as important emerging service clusters for accountancy and law, whereas Cambridge has a large representation of design and information technology firms. But in general, a wide variety of other sectors is also represented in these centres providing a great potential for urbanisation economies. Interestingly, this finding is in contrast to the results for more morphologically polycentric Mega-City Regions, such as the Randstad and the Rhine-Ruhr, which have a stronger sectoral specialisation between different agglomerations (Pain 2008).

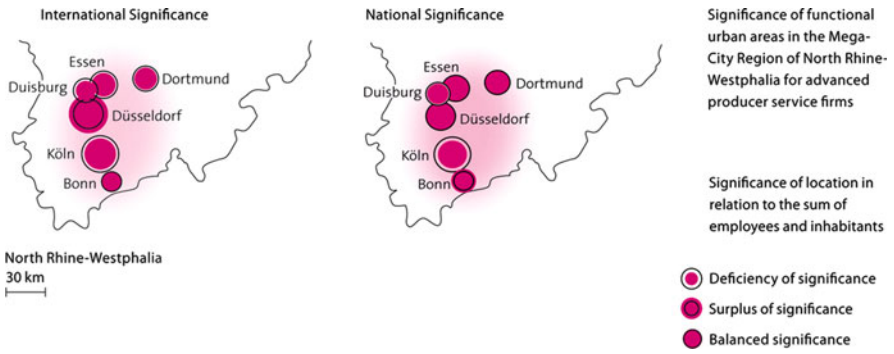

Fig. 14.8 Significance of Functional Urban Areas in the Mega-City Region of Rhine-Ruhr for APS firms (Thierstein et al. 2006)

4.3.4 The Rhine-Ruhr Region

A fourth POLYNET case study is Rhine-Ruhr, one of the world's largest polycentric Mega-City Regions, embracing 30–40 towns and cities with a total population of some 10 million people, and with no obvious 'core city'. Although the Rhine-Ruhr still has a relatively strong industrial base, de-industrialisation is taking place all across the region. However, some cities have been able to offset job losses in the Ruhr's industrial sector with new jobs in the tertiary sector. Due to several agglomeration advantages, the cities of Düsseldorf and Bonn have done much better in this respect. In the second half of the twentieth century, Düsseldorf profited enormously from the tertiary sector. Today it is one of the leading centres of the German advertising and fashion industry (Knapp and Schmitt 2008). The relative importance of both Düsseldorf and Bonn can also be seen in Fig. 14.8. On the national scale, the metropolitan cores of Rhine-Ruhr have – with the exception of Köln – quite balanced connectivity patterns. This means that these regional centres are interconnected almost to the same extent by nationally-orientated APS firms. On the international scale, however, the relative importance of Düsseldorf within Rhine-Ruhr increases, which underlines its important function as an international knowledge gateway connecting the Mega-City Region to a wider space of flows. In contrast to Düsseldorf and Bonn, the agglomeration of Köln – the fourth biggest city in Germany – is clearly less integrated in national and international APS networks. This shows, as with many other POLYNET case studies, that the mere size of an FUA does not automatically correlate with its significance in terms of international connectivity.

4.3.5 The Rhine-Main Region

The second German case study within the POLYNET project analyses the multi-scalar polycentricity in the Mega-City Region of Rhine-Main, which encompasses the cities of Frankfurt am Main, Wiesbaden and Mainz, but extending widely outwards as

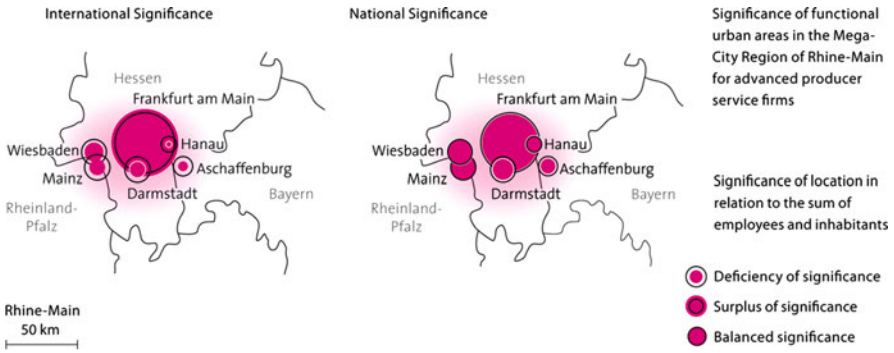

Fig. 14.9 Significance of Functional Urban Areas in the Mega-City Region of Rhine-Main for APS firms (Thierstein et al. 2006)

far as Hanau and Aschaffenburg in the east and Darmstadt in the south. Rhine-Main, Germany's second biggest metropolitan region after Rhine-Ruhr, has long been identified as the country's most globalised urban agglomeration, not least due to its core city Frankfurt am Main, Germany's undisputed financial centre (Grote 2004) and leading international logistics hub (Schamp 2001).

The analysis of network connectivities confirms Frankfurt's dominant position as the major hub of knowledge-intensive business services on both national and international scales (see Fig. 14.9). Note, however, that the relative significance of Frankfurt increases with geographical scale. On the national scale, Frankfurt is part of the 'urban circuit' of those German cities (Frankfurt, Hamburg, Munich, Düsseldorf, Berlin, Stuttgart and Cologne) that have long constituted the apex of a polycentric national configuration of cities and metropolitan regions, characterised by complementary functional and sectoral specialisation (Blotevogel 2000). Wiesbaden and Mainz, respective capitals of the states of Hessen and Rhineland-Palatinate, also show quite balanced interlock connectivities on the national scale. The national linkages of Darmstadt (a city with a strong information technology sector and technical university) as well as Aschaffenburg and Hanau (two smaller FUAs in eastern Rhine-Main that have retained a higher percentage of their industrial workforce) are clearly smaller than expected in terms of their inhabitant- and employment-size. This finding is even more pronounced on the international scale. Frankfurt clearly acts as 'first city' for internationally-orientated APS firms and therefore constitutes a key gateway to the other major cities and towns in Germany and the world (Hoyler et al. 2008a).

4.3.6 The Paris Region

The Paris region is an interesting POLYNET case study for testing the emergence of a polycentric Mega-City Region for two reasons. On the one hand, the Paris FUA is highly affected by globalisation processes, being with London one of the most

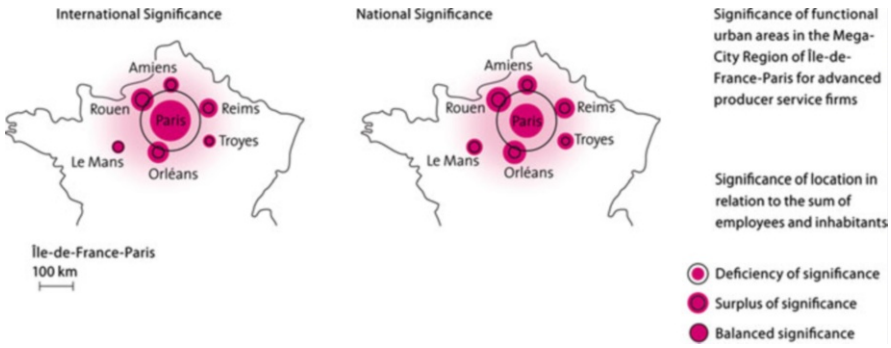

Fig. 14.10 Significance of Functional Urban Areas in the Paris Region for APS firms (Thierstein et al. 2006)

prominent global metropolises in Europe. On the other hand, the natural geological basin that surrounds the Paris region (Bassin parisien) contains a series of medium and small cities and towns of reasonable size constituting a demographic reserve almost equivalent to the Ile-de-France region's own population. From a morphological point of view, the urban structure in the Bassin parisien follows a relatively polycentric pattern. A series of middle-sized cities circle Paris linked by what is known as the Route of Cathedrals (Orléans, Rouen, Amiens, Reims) organising the Bassin parisien's demographic pattern (Halbert 2008).

In absolute terms, APS firms are still predominantly concentrated in the Paris FUA; more specifically, in the central part of its agglomeration, known as the 'Golden Triangle' linked by the city's western arrondissements, La Défense and the suburbs of Boulogne-Billancourt and Issy-les-Moulineux. However, when putting the connectivity value of the different FUAs in relation to inhabitants and employment, the secondary centres around Paris are clearly more networked on both national and the international scales (see Fig. 14.10). The FUA of Paris, on the other hand, does not achieve the degree of connectivity as expected in terms of its inhabitants and employment figures. One explanation for this astonishing finding is the pronounced functional division of labour within the Bassin parisien's urban system (Halbert 2004) giving the secondary cities more socio-economic weight in relative terms. Whereas Paris is specialised in research and development, management consulting, marketing, culture and the arts, secondary cities are focused on public services and some basic production activities such as manufacturing or logistics. As a consequence, spillovers from the Paris agglomeration affect positively these secondary cities that benefit from hosting deconcentrated functions which, in turn, develop local service economies and generate new revenues spent locally. Some of these secondary cities have been more successful than others, like Orléans for instance, which has found sectoral and functional specialisation that complements the economic profile of the whole Paris region (Halbert 2008).

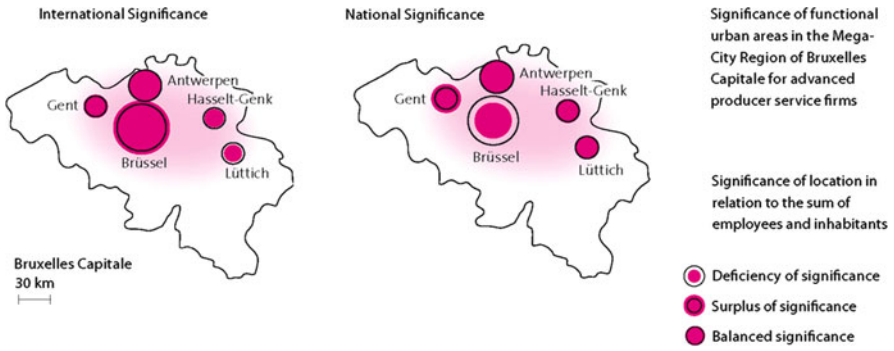

Fig. 14.11 Significance of Functional Urban Areas in the Mega-City Region of Central Belgium for APS firms (Thierstein et al. 2006)

4.3.7 Central Belgium

A seventh POLYNET case study is Central Belgium, comprising Brussels and a surrounding ring of large- and medium-sized cities, with a high degree of interdependence and a total population of ca. seven million (Hall 2007). The Belgian urban system is dominated by Brussels with almost twice as many inhabitants as Antwerp and six times more than Ghent (Vandermotten et al. 2006a). In terms of international APS connectivities, Fig. 14.11 shows for Brussels a clear surplus of significance. This position is intrinsically related to the location of European institutions in the city and to the resulting presence of international consulting, lawyers and other lobbyist offices (Vandermotten et al. 2006b). In addition to the presence of 'classic' subsidiaries of numerous multi-national companies (MNCs) Brussels is sometimes chosen by the latter for their European headquarters, while Belgian firms of international scope mostly choose Brussels as their decision-making centre (e.g. Dexia Group). Many internationally-orientated APS firms setting up in Belgium – especially advertising or law firms offering specialised services to international organisations and knowledge intensive logistics enterprises based around Brussels airport – opt for a location in Brussels itself without trying to establish subsidiaries in other Belgian cities. Due to the small size of Belgium, these firms have no difficulty in serving the whole of the national market from their Brussels base (Vandermotten et al. 2006a).

4.3.8 Greater Dublin

The last POLYNET case study is concerned with the functioning of Greater Dublin, an emerging Mega-City Region within a 50–60 km radius around the city of Dublin, developing particularly northwards along the Dublin-Belfast corridor. For the purpose of the POLYNET study, the Greater Dublin region is defined as a functional urban region comprising the Dublin metropolitan area and four surrounding

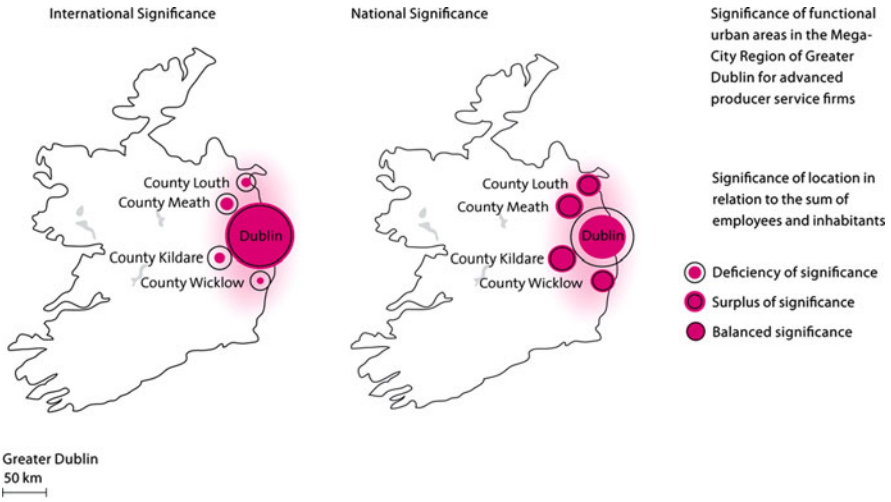

Fig. 14.12 Significance of Functional Urban Areas in Greater Dublin for APS firms (Thierstein et al. 2006)

local authorities in its hinterland: County Louth, County Meath, County Kildare and County Wicklow. In its urban settlement and employment structure, Greater Dublin is the most distinctive of all the eight POLYNET Mega-City Regions: it is completely dominated by the city of Dublin and its suburbs. However, while still relatively small, the major urban centres outside Dublin city have experienced dramatic population growth in the last decade Sokol et al. (2008). Figure 14.12 confirms this tendency where the four secondary centres possess a slight surplus of significance at the national level. In terms of international knowledge-intensive business services, however, the city of Dublin clearly acts as first city and therefore constitutes a key gateway for the entire Mega-City Region. One reason for this is the fact that for large international financial services players, the city of Dublin itself is a 'decentralised' location within a much larger corporate network. In other words, Dublin is often chosen as the off-shoring location of multi-national companies (MNCs) that relocate certain business functions from other, even higher cost locations such as London or Paris Sokol et al. (2008).

5 Conclusion

Comparing the different case studies presented above, three groups of FUAs stand out.

A first group is characterised by a strong deficiency of significance of the primary FUA on both scales, national and international. Surprisingly, Paris and London are the two only FUAs belonging to this group. In absolute terms, both cities are clearly the most important locations for international APS firms within their Mega-City

Regions. In relative terms, however, they do not achieve the degree of connectivity as expected in terms of their inhabitant and employment figures. This clearly shows that the mere size of an agglomeration does not automatically increase its functional significance. The interpretation of this finding in relation to the Mega-City Region hypothesis in Fig. 14.1 is that the up-scaling process of agglomeration economies is also present in big cities such as London and Paris, leading to distinct positive spillovers from the primary to the secondary FUAs. Hence, although South East England and the Paris region appear to be relatively mono-centric in physical terms, they prove the most functionally polycentric regions of all case studies.

A second group of FUAs is characterised by a strong surplus of significance of secondary FUA on both scales, national and international. The most typical examples of this group are the secondary cities around London and Paris, such as Cambridge and Reading or Rouen and Orléans respectively. In fact, this group seems to belong to the winners of spatial restructuring processes going on in London and Paris. These cities benefit from the up-scaling process of agglomeration economies by hosting deconcentrated functions, which develop local service economies and generate new revenues spent locally.

And finally, a third group of FUAs is characterised by a slight surplus of significance on the international scale. For Dublin, Brussels and to some extent Zurich, the differences between the international and the national scale are remarkably high. This means that many internationally oriented APS firms setting up in these cities hardly try to establish subsidiaries in the wider region. Hence, these primary cities can be interpreted as central nodes and international gateways with a high concentration of global network economies. The secondary cities in these emerging Mega-City Regions are not directly integrated into international networks of knowledge-intensive economic activities. Instead, they are well integrated into large-scale regional networks based on the increasing up-scaling process of agglomeration economies. For Amsterdam, Düsseldorf and Frankfurt, the differences between the international and the national scale are less pronounced. Especially for the Mega-City Regions of Amsterdam and Düsseldorf, this may be the consequence of their archetypical polycentric structure, leading to a fast intra-regional diffusion of international knowledge thanks to well-established agglomeration economies.

Over the last decades, Europe has experienced the reorganisation of functional-territorial division of labour in the knowledge economy. The increasing importance of network economies has introduced new thinking about space, place and scale that interprets regions as unbounded, relational spaces. From a relational point of view, regions can be defined by their linkages and relations within and beyond their territorial boundaries (Pike 2007). The increasing complexity of network economies leads to a kind of paradox associated with the emergence of Mega-City Regions. The inter-urban functional linkages are found to be extending and intensifying while, at the same time, global functions are clustering and centralising. Evidence from Thierstein et al. (2007) as well as POLYNET suggests that these apparently contradictory processes are intersecting on the Mega-City Region scale. While specialised global functions are concentrating in ‘first cities’, proximate regional centres are gaining complementary service functions across a wide geographical area. Because of the various requirements for competing in the

world economy, it is not possible for a first city to act without the smaller agglomerations in its vicinity. Smaller cities fulfil an important role as complementary economic spaces. Interlocking networks of knowledge-intensive firms link these different agglomerations together, thus defining emerging Mega-City Regions as physically separated but functionally networked socio-economic spaces. As POLYNET shows, the clearest example of this phenomenon is South East England where secondary towns and cities around London are found to have synergistic roles with each other as well as with London itself – a phenomenon referred to in the POLYNET study as "functional polycentricity", which is caused by an extension of APS network relations through a Mega-City Region process (Hall and Pain 2006). The main conclusion of this paper is that polycentric Mega-City Regions emerge as a scale-dependent phenomenon based on the coming together of various interlocking firm networks of different organizational structures and scalar reach. Mega-City Regions are becoming a more general phenomenon in advanced economies based on re-scaling processes of agglomeration and network economies.

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