Interlocking Firm Networks and Emerging Mega-City Regions

A Framework to Analyze the Hidden Geography of the Knowledge Economy in Germany

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Abstract

Globalization has entailed a reorganisation of spatial development processes on the global, European, national and regional scales. New forms of hierarchical and network development and functional differentiation between cities can be observed. In this context, the knowledge economy has been highlighted as a central issue in economic geography and innovation studies over the past decade. With the aim of identifying emerging spatial patterns of the knowledge economy, this paper applies a relational research concept to assess knowledge flows and polycentric Mega-City Region development in Germany. More than a pure locational perspective, this relational research design makes it possible to highlight how Functional Urban Areas (FUAs) within and beyond Mega-City Regions are interlocked with each other. We start from a conceptual background that brings together location behaviour of internationalized firms with a value chain approach. First, we look at how multi-branch multi-location firms in the knowledge economy develop their intra-firm networks on various spatial scales. Second, we identify the partners whom these firms have working relationships with along individual chains of value, and where these extra-firm linkages are located. We analyse the two main pillars of the knowledge economy – Advanced Producer Services (APS) and High-Tech firms. The analytical building blocks of that research approach are 337 Functional Urban Areas in Germany, including adjacent agglomerations in Germany's neighbouring countries. This makes it possible to identify and contextualize large-scale and cross-border urban geographies of knowledge intensive firms and their emerging spatial hierarchies.

Keywords: Mega-city Region, knowledge economy, value chain, Advanced Producer Services firms, High-Tech firms, interlocking firm networks

1. Introduction

Globalization has entailed a reorganization of spatial development processes on the global, European, national and regional scales. New forms of hierarchical and network development and functional differentiation between cities can be observed (Friedmann, 1986, Sassen, 2001). Scott (2001) and, lately, 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 decentralization 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*., 2008).

Spatial development policy in Germany felt a need to establish metropolitan regions much earlier. In 1995, the German Ministers for Spatial Planning designated six Mega-City Regions – Berlin, Hamburg, Munich, Rhine-Main, RhineRuhr, and Stuttgart – as the "engines of societal, economic, social and cultural development" (BMBAU, 1995, 27-29). They are defined as high-performance locations whose outstanding functions transcend national boundaries and thus have impacts on the international scale. The urban agglomeration around Halle, Leipzig and Dresden (the so-called Saxony Triangle) joined this new league of urban-regions in 1997. And finally, in 2005, another four – Rhine-Neckar, Bremen/Oldenburg, Nuremberg, and the city-triangle Hanover-Braunschweig-Göttingen – joined this exclusive club (BMVBW, 2005). From an analytical point of view, however, such strategic spatial articulations are not very convincing as they are hardly based on resilient analytical findings. They can instead be interpreted as embodying the hope to have 'set in motion' a kind of self-fulfilling prophecy based on Article 72 of the German Constitution, which requires "uniformity of living conditions" throughout the national territory (Knapp and Schmitt, 2008).

From a scientific point of view, different attempts have been made to handle these extended urban regions analytically, and a variety of research projects and publications concerned with polycentricity at the city-regional scale has been realised (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*., 2008); for instance polycentric urban regions (Kloosterman and Musterd, 2001), global city-regions (Scott, 2001) or Mega-City Regions (Hall and Pain, 2006). In this paper the notion of 'emerging Mega-City Regions' is in use for two reasons: first, because we understand Mega-City Regions as unbounded, relational spaces characterised by dynamic socio-economic processes linking regions to other cities and towns on different spatial scales. Second, because we would like to set apart our analytical framework from the politically inspired Mega-City Region concept in Germany.

The main objective of this paper lies in the exploration of the Mega-City Region hypothesis. The paper is structured in three main sections. The first section focuses on the concept of Mega-City Regions by discussing its two generic processes: agglomeration economies and network economies. In the second section we suggest a research concept in order to reveal these two processes. And finally, in the third section,

we conclude by synthesising the main findings and putting them into the context of some European policy discussions.

2. Theoretical background

In this section, the theoretical building blocks of the Mega-City Region hypothesis are discussed. First, we explain the two main processes of Mega-City Region development: agglomeration economies and network economies. Based on these findings, we then explain 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.

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 chapter provides an overview of these theoretical concepts.

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). Ever since, regional economists have generally agreed that agglomeration economies arising from firm concentrations in particular places confer economic advantages. However, the debate on the appropriate content for the notion of agglomeration economies is far from finished. Various viewpoints exist today between the original Weberian formulation in terms of minimum transportation costs and industrial organization, the Marshallian external economies and the Hooverian reformulation in terms of localization and urbanization economies (Moulaert and Sekia, 2003). 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, Hoover, 1948). Few years later, Raymond Vernon developed his highly influential '*product life cycle theory'* (Vernon, 1966). He argued that during the first innovative stage in a product's live cycle, firms are most likely to be found in large metropolitan agglomerations. The main reason for this is that the introduction of new innovative products is highly dependent on

communication and external economies. In this sense, Vernon (1966) makes a counter-argument against the traditional Weberian 'transport-cost paradigm' based on the analysis of firms shipping well-defined standard goods between regular points in space (Simmie, 2005).

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 organize 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 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. This cooperative learning is brought about primarily through the mobility of employees, interrelationships between regional suppliers and purchasers, and face-to-face contacts that are all facilitated by spatial proximity (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 outside world of 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).

The concept of embeddedness is a key feature that distinguishes both the Innovative Milieu and the New Industrial District approach from neo-classical agglomeration theory (Simmie, 2005). With the *New Economic Sociology* concept, Granovetter (1985) and others argue that far from being a separate, detached activity, economic activity is also a social phenomenon (Granovetter, 1985). Among the social characteristics of economic activity are habits, conventions and norms of behaviour, which may be developed by the social interactions of actors 'embedded' within a

regional context.

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).

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 centralizing 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 is located. They can split its activities into units and localize and disperse these units in the most favourable places in terms of local knowledge resources and industrial culture (Massey, 1985).

In order to show the inter-relationship between agglomeration and evolutionary economics, we pick up three ongoing debates in modern evolutionary theory.

The first debate issues the nature of the innovation process and recognises that innovation is no one-way diffusion process but an entire system of innovation (Moulaert and Sekia, 2003). According to this idea, innovation is based on the systemic interaction between economic agents, companies, research institutions and the public sector. These interactions are built up by frequent personal interchanges, facilitated by geographical proximity and leading to local knowledge spillovers and agglomeration economies.

The second debate deals with the nature of spatial innovation systems and especially with the way institutional dynamics are interpreted. In the last 20 years, the literature on spatial innovation systems has shifted from the national (Edquist, 1997, Nelson, 1993, Lundvall, 1988, Lundvall, 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 boarders of a nation state (Lundvall, 1992). According to the *Regional Innovation System (RIS)* theory, on the other hand, it is the region that play 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 engage in interactive learning (Morgan, 1997). The relevance of the local dimension of governance, finally, has 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 on the local level are stimulated (Muscio, 2006).

The third debate showing the connections between agglomeration and evolutionary economics, finally, argues that the development of technologies is a path dependent process building up technological trajectories over time. Evolutionary economists argue that these trajectories would be concentrated in space, especially where innovative activities are heavily based on tacit knowledge and frequent face-to-face contacts. These in turn are made easier by both relational and geographical proximity leading to the agglomeration of knowledge-intensive firms in particular Mega-City Regions.

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 globalization (Storper, 1995). By combining insights from institutional, agglomeration and evolutionary economics, he explains this phenomenon by the association between organizational and technological learning within agglomerations, based on traded (input-output relations) and *untraded interdependencies* (regional conventions, norms and values, public institutions etc.). A certain counter position to Storper's (1995) 'qualitative calibration' of the agglomeration concept is given by Michael Porter (1996) who argues that it is time to shed 'agglomeration economies' and to concentrate on the nature of the network externalities (Porter, 1996, Moulaert and Sekia, 2003) (Figure 1).

2.2. Network economies

Most observations on how external economies influence spatial development have focussed 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.

World city network models

Much of world city research has been related with 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).

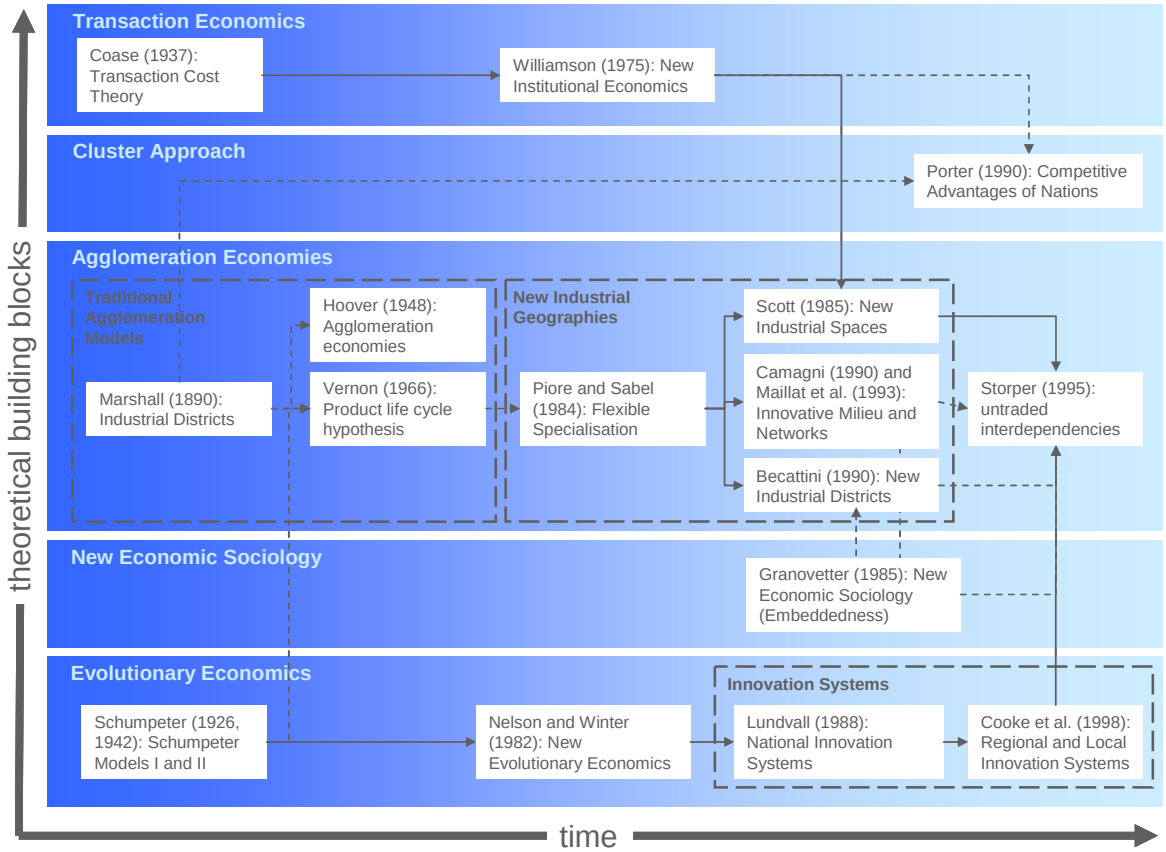

Figure 1: Theoretical roots and building blocks of Agglomeration Economies (Own illustration).

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. This fundamental difference between John Friedmann's world cities and Saskia Sassen's global cities are well described by Derudder (2006): "Sassen's focus on centrality leads her to conceptualising 'global cities' as focal points that operate separately from their hinterlands. Friedmann's focus on the relative concentration of power, in contrast, implies that a 'world city' may consist of multiple cities and their hinterlands that may themselves be subject to urbanisation

processes" (Derudder, 2006:2034). 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).

Manuel Castells' highly influential concept of a *space of flows* (Castells, 2000) contributes another heuristic framework about network cities. 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. He argues that "our society is constructed around flows: flows of capital, flows of information, flows of technology, flows of organizational interaction, flows of images, sounds, and symbols. Flows are not just one element of the social organization: they are the expression of processes dominating our economic, political, and symbolic life (...)" (Castells, 2000:442). Thus, Castells (2000) proposes the idea that there is a new spatial form characteristic of social practices that dominate and shape the network society: the space of flows. 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 (1996) offer a heuristic and theoretical framework as to why globalization 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 organizational 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 (see also section 3.4 in this paper).

Value chain models

Another starting point for understanding the changing nature of international trade and industrial organization 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, which was popularised by Gary Gereffi in a large number of publications since 1994. The GCC framework pay particular attention on 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 do to bring a product or a service from its conception to its end use and even beyond (Gereffi *et al.,* 2005).

The third approach, finally, 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).

2.3. Emerging mega-city regions

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 of "Megalopolis: The Urbanized Northeastern Seaboard of the United States" (Gottmann, 1961). Few years later, Sir 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) emphasize its large-scale nature and developing polycentric structure by defining Mega-City Regions as "…a series of anything between ten 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.

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 and 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. Network economies, however, result from global sourcing strategies of knowledge-intensive firms leading to relational proximity and international knowledge spillovers. 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 2 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.

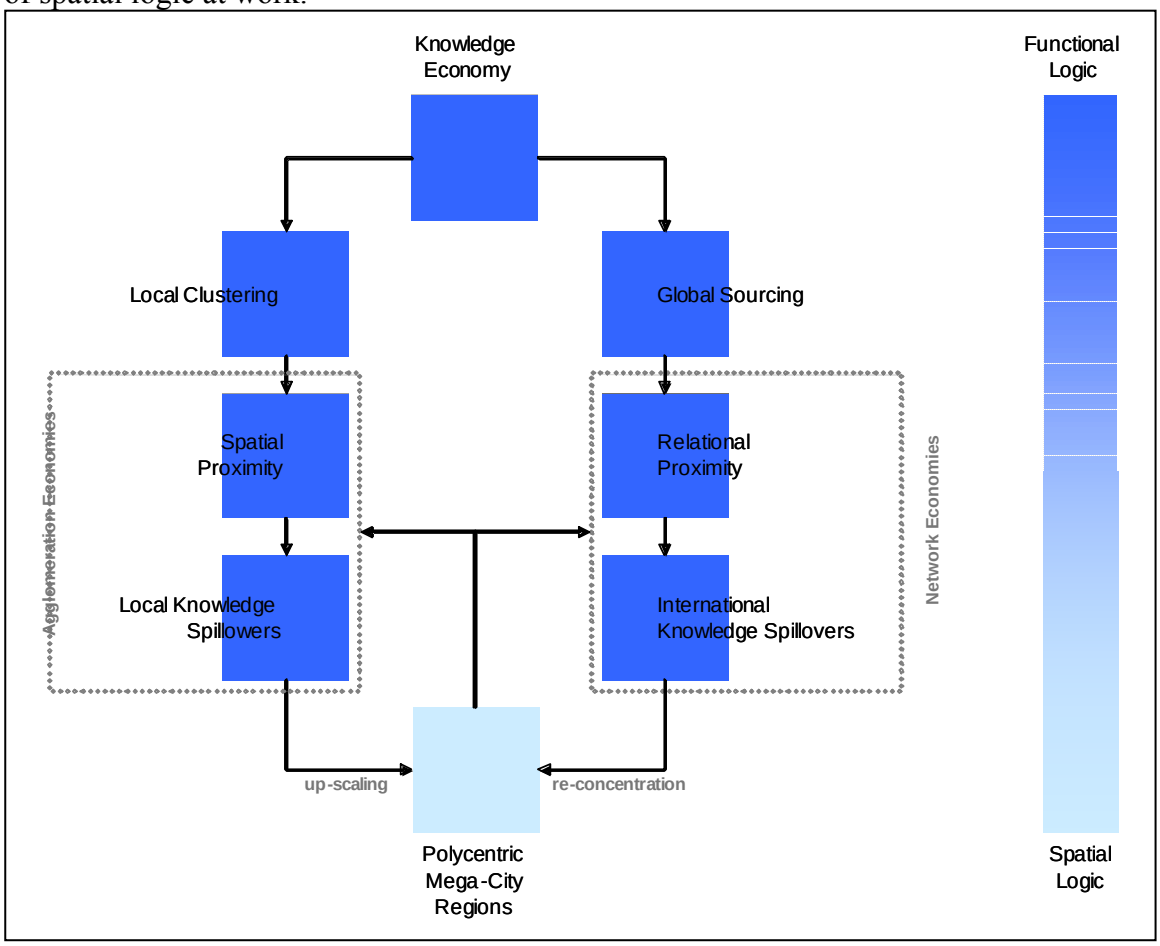

Figure 2: Agglomeration and Network Economies in the context of Mega-City Region development (Own illustration).

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.

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 recognized 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 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 centralization and metropolitanization 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 decentralization 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 decentralization, both elements associated with the same dynamics of the knowledge economy, which explains the complexity of Mega-City Region development.

Different attempts have been made until now to analyse the polycentric structure of emerging Mega-City Regions in Europe and Germany (Krätke and Brandt, 2009, Krätke, 2007, Kujath, 2005, Kujath and Schmidt, 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 the following 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, RhineRuhr, Northern Switzerland, and Greater Dublin (Hall, 2007). With its seminal research project, 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). The 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 as crucial actors and outcomes of globalization and localization processes, Manuel Castell's (1996) notion of a "space of flows" and Peter Taylor's (2004) concept of a "world city network" (Hoyler et al., 2008). All in all, the POLYNET study moved essentially forward the theoretical debate on large polycentric urban regions on the basis of new empirical evidence from North Western Europe. The main conclusion of the POLYNET findings is that polycentricity emerges as a scale-dependent phenomenon based on the coming together of various business service networks of different organizational architectures and scalar reach (Hoyler et al., 2006). The Mega-City Region, in its various guises, is becoming a more general phenomenon in advanced economies (Hoyler *et al*., 2008).

Based on the methodology of the POLYNET study – especially on the case study of the Mega-City Region of Northern Switzerland (Thierstein *et al*., 2008) – a second attempt to handle the Mega-City Region hypothesis analytically is the case study of Thierstein, Goebel and Lüthi (2007) about the emerging Mega-City Region of Munich (Thierstein *et al*., 2007). By analysing the two main pillars of the knowledge economy – Advanced Producer Services (APS) and High-Tech firms – they do not only look at the intra-firm networks of multi-location firms, but also on the value chain relations between different enterprises and sectors. The main finding of this study is that the wider Munich area can be regarded simultaneously as a hierarchically organized polycentric Mega-City Region and as a high-grade localized system of value chains. Within this emerging Mega-City Region, Thierstein, Goebel and Lüthi (2007) found evidence that Munich plays an important role for all other cities and towns in the Mega-City Region, particularly in relation to its international gateway-function for knowledge-intensive businesses. However, the city of Munich, which has around 2.2 million inhabitants, is too small to concentrate all of the major functions of the Mega-City Region in its own location. It is the complementary combination of Munich and the supplemental centres in its hinterland that elevates the emerging Mega-City Region of Munich to a competitive level in the context of the global economy.

3. A framework to analyze the hidden geography of the knowledge economy in Germany

Based on these previous attempts to handle the Mega-City Region hypothesis analytically, we now present the design of our ongoing research project aiming to reveal the hidden geography of the knowledge economy in Germany. Referring to the theoretical discussion above and to the argumentation of Thierstein et al. (2008) concerning the combination of the world city network with a value chain model, we extend the POLYNET approach by three important dimensions.

First, we investigate not only APS enterprises but also High-Tech firms, which form another important pillar of the knowledge economy, not only in Germany. In order to understand the geographies of globalization processes in the knowledge economy, one has to account simultaneously for both the APS and the High-Tech sectors because both of them are integral parts of Mega-City Region development. Krätke (2007) for example argues that in both the APS and the High-Tech sectors, which constitute the key sectors of an increasingly knowledge-based and innovation-driven economy, an ongoing process of selective spatial concentration in urban agglomerations and metropolitan regions leads to the development of strong cluster potentials, which raise the productivity and innovation capacity of these regional economic centres and contribute to an increase of workplaces particularly in these branches of industry (Krätke, 2007).

Second, we extend the analysis by also looking at extra-firm networks of knowledge intensive enterprises along their individual value added chains. 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 multisite firms providing important vehicles for transferring research and knowledge. Extra-firm networks, in contrast, are interesting because they generate possibilities for increased economies of scale through flexible, networked production complexes.

And third, we expand the scale of analysis from regional to national; more precisely, we analyse the German space economy including its adjacent agglomerations in Germany's neighbouring countries. This makes it possible to identify and contextualize large-scale urban structures and hierarchies as well as the role of small and medium sized cities and towns within the German space economy.

3.1. Main hypotheses

In the centre of our research project, there are two main hypotheses analysing two dimensions of the German space economy: a regional and a hierarchical dimension; the former results in the Mega-City Region hypothesis, the latter in the so called hierarchy hypothesis.

The mega-city region hypothesis

The increasing importance of network economies have 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 its 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. The evidence form 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). On the basis of these findings, but adapted to our extended research design, we suggest the following hypothesis with respect to the German space economy:

> *A multiplicity of high-grade APS- and High-Tech locations create interlinkages between cities and towns at a city region scale, leading to a new spatial phenomenon in Germany: polycentric Mega-City Regions.*

In this hypothesis, we refer to the Mega-City Region definition as suggested by Peter Hall and Kathy Pain (2006), which means that Mega-City Regions are defined by their linkages within, and without any predefined territorial boundaries. In other words, the Mega-City Region's boundaries are defined by the knowledge flows within and between knowledge intensive firms that interlocks spatially proximate cities and towns in the German space economy. On this way, we are able to avoid an 'a priori' identification of Mega-City Regions and to start with firms and their functional logic driven by the knowledge economy.

The hierarchy hypothesis

From the seminal work of Peter Hall (1966) about the characteristics of world cities to the pioneering work of Sakia Sassen (2001) about the global city, the central facet of the world city literature has been to rank cities according to their disproportionate geo-economic power in the world-system (Beaverstock *et al*., 1999). In this context, Richard Florida (2005) hypothesize that – despite the flatting' impacts of Information and Communication Technologies (ICT) – the world is still very a ‚spiky place', with only a very limited number of truly global players. Florida emphasize that the growing importance of the knowledge economy – and its requirements for talented and creative people, high-quality urban locations and organizational networking – produces a counter-force that brings about a (re-)concentration of added value and innovation to only a very few truly global urban areas. In a similar way, Manuel Castells (1989) argues that the 'space of flows' and the creation of 'multinuclear spatial structures' is not an undifferentiated process (Castells, 1989). Rather, it follows a hierarchical and functional logic (Sokol *et al*., 2008). Referring these arguments, the second central question of our analysis is about the extent to which the functional urban hierarchy within and between Mega-City Regions in Germany is associated with different spatial scales and sectors of knowledge-intensive activities. We hypothesise that:

> *(Intra-firm) networks of APS- and High-Tech firms create a steep functional urban hierarchy within the German space economy in which only few agglomerations establish substantial international connectivities. In terms of regional connectivities, this functional urban hierarchy is less pronounced.*

3.2. The definition of the study area

POLYNET aimed to analyse and compare the polycentricity of eight Mega-City Regions in form of different case studies. By defining these case study areas, there is a significant element of circularity. Since the objective of POLYNET was to study functional polycentricity and to identify Mega-City Regions as physically separated but functionally networked socioeconomic spaces, POLYNET could only seek to define Mega-City Regions when it had already completed the research. That means that POLYNET had to start with a working definition that delimits the different Mega-City Regions in a pragmatic way.

In our research design, we expand the scale of analysis from the Mega-City Region to the national scale, including adjacent agglomerations in Germany's neighbouring countries (Figure 3). The analytical building blocks are built by 337 Functional Urban Areas as defined by the ESPON research project 111 – Potentials for polycentric development in Europe (ESPON, 2004). They are defined as having an urban core of at least 15,000 inhabitants and over 50,000 in total population; the definition of the rings is based on 45-minute isochrones. Further details about the FUA delineation can be seen in the Annex Report D of the ESPON Project 111 (Schürmann, 2004).

This up-scaling of the study area has – in comparison to POLYNET – several advantages. First, in order to identify polycentric Mega-City Regions in the German space economy as functionally networked urban configurations, we do not have to start with an 'a priori' working definition that delimits Mega-City Regions in a approximate way. Based on the results of the interlocking network model, we can directly start to analyse the spatial connectivity patterns, what from we may identify polycentric Mega-City Regions as defined by Peter Hall and Kathy Pain (2006). Second, the fine grained

covering of the study area with a multiplicity of FUAs makes it possible to identify the role of small and medium sized cities and towns that are located at the peripheries or between polycentric Mega-City Regions. The third advantage concerns the inclusion of adjacent FUAs up to 50 km distance from the German borderline, which makes it possible to identify and contextualize large-scale urban structures and hierarchies of cross border agglomerations and Mega-City Regions.

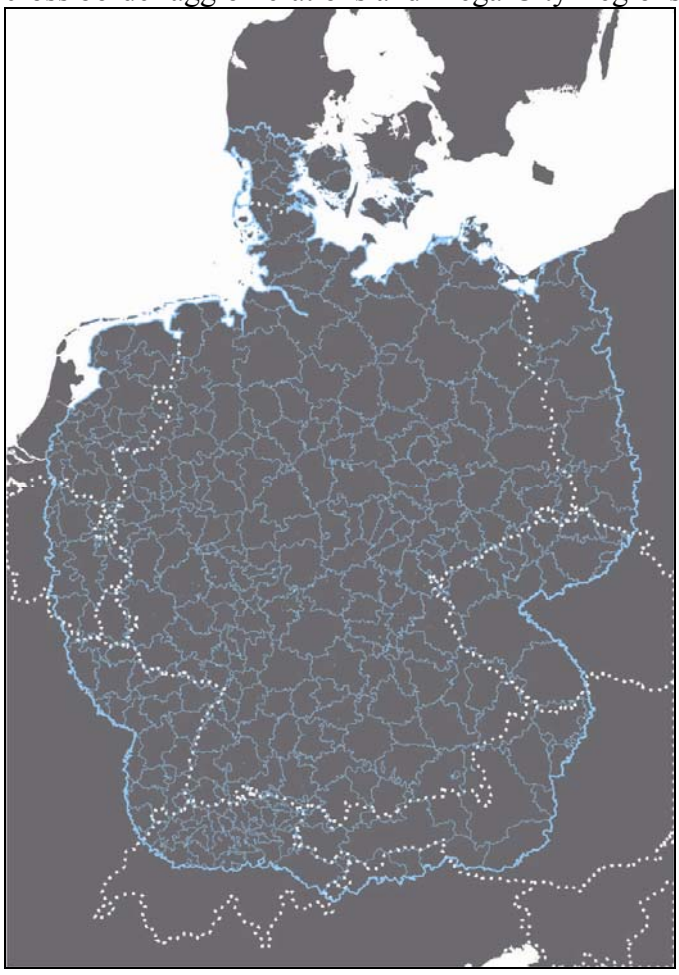

Figure 3: Study Area: 337 Functional Urban Areas in Germany and its neighbouring countries (Own illustration).

3.3. Sampling strategy

In this research project, we analyse the location behaviour of knowledge-intensive firms focussing particularly on APS- and High-Tech firms. The sampling strategy follows a top-down approach in two steps. In the first step, the APS- and High-Tech sectors are operationalised on the basis of the international NACE (Nomeclature générale des activités économiques) classification at a four-digit level (Table 1). Thereby, we refer to the classification proposed by Legler and Frietsch (2006). According to these authors, an economic sector can generally be defined as knowledge intensive, if its share in university graduates, engineers and scientists as well as research and development activities (R&D) are higher-than-average (Legler and Frietsch, 2006). For the High-Tech sector, Legler and Frietsch (2006) start their classification on the basis of the Oslo manual of the OECD (OECD, 2005). In order to account for the specific characteristic of the German High-Tech industry, however, they refine the classification to a four-digit

level using special European and German data that is not available on OECD level, such as the European and German R&D cost structure survey or patent investigations. For the APS sector, they use the share of highly qualified manpower (university graduates) as a proxy for knowledge intensive services. Thereby, the EU labour force survey provides data at a two-digit level. However, for a more detailed analysis of national and regional distinctions in Germany, Legler and Frietsch (2006) consider additional data using the German Social Insurance Statistics as well as up-to-date micro census data (Legler and Frietsch, 2006).

Table 1: Studied sectors, NACE Codes in brackets (Own compilation).

High-Tech	Advanced Producer Services (APS)
Chemistry & pharma 2330, 2413, 2414, 2416, 2417, 2420, 2441, 2442, 2451, 2461, 2463, 2464, 2466, 2511, 2513, 2615	*Banking & finance* 6511, 6512, 6521, 6522, 6523, 6711, 6712, 6713, 7011, 7012
Machinery 2911, 2912, 2913, 2914, 2924, 2931, 2932, 2941, 2942, 2943, 2952, 2953, 2954, 2955, 2956, 2960	*Insurance* 6601, 6602, 6603
Electronics 3110, 3120, 3140, 3150, 3161, 3162, 3210, 3320, 3330	*Information and communication services* 6430, 7221, 7230, 7240, 7250, 7260
Computer-Hardware 3001, 3002	*Advertising & media* 7440, 2211, 2212, 2213, 2214, 2215, 9211, 9220, 9240
Telecommunication 3220, 3230	*Logistics (3p & 4p)* 6030, 6110, 6220, 6230, 6340
Medical & optical instruments 3310, 3340	*Management- und IT-Consulting* 7210, 7222, 7413, 7414, 7415
Vehicle construction 3410, 3430, 3511, 3520, 3530	*Design, architecture & engineering* 7420, 7430
	Law 7411
	Accounting 7412

In the second step, the sample of knowledge intensive firms whose intra-firm and extra-firm networks are analysed is defined. Thereby, the firms have to meet four criteria: first, they have to belong to a knowledge intensive economic sector as defined by Legler and Frietsch (2006). Second, they have to belong to the largest knowledge intensive firms in Germany, measured my means of employment size. Third, they have to be multi-branch enterprises with at least one office location in the study area. Having met these conditions, firms are finally selected on the basis of the availability of information on their office networks.

The research sample is based on different information sources. In the first place, the data set of the commercial data provider Hoppenstedt is used. Hoppenstedt is one of the largest business data providers in Germany. Its database includes over 245,000 profiles of German companies, their branches and the major industrial associations in Germany. In the second place, the database of Hoppenstedt is supplemented by several rankings showing the top firms in different sectors, such as Forbes' Global 2000,

Fortune's Global 500, the 2007 EU Industrial R&D Investment Scoreboard and all in the prime standard of the Deutsche Börse AG listed firms (reference date: 29. July 2008).

3.4. The interlocking network model

The analysis of intra-firm networks is based on the methodology of the Globalisation and World Cities Study Group (GaWC). 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. The empirical work comprises three stages.

Once the relevant knowledge-intensive firms have been identified, the first stage is to examine the geographical extent of the linkages that they have and to evaluate how intensive these linkages are. The prime sources of information are web sites. It is necessary to scavenge all possible relevant available information from these sites supplemented by material from any other sources available such as annual reports. For each firm, two types of information are gathered. First, information about the size of a firm's presence in a city is searched for. Ideally, information on the number of professional practitioners listed as working in the firm's office in a given city is needed. Such information is widely available for law firms but is relatively uncommon in other sectors. Here, other information has to be used, for instance the number of offices the firm has in a city. Second, the extra-locational functions of a firm's office in a city are recorded. Headquarter functions are the obvious example, but other features like subsidiary Headquarters and regional offices are also recorded. Any information that informs these two features of a firm's presence in a city is collected in this scavenger method of information gathering (Taylor *et al.,* 2002).

In a second stage, this information is transformed into a manageable dataset. In conversion from information to data, there is always a tension between keeping as much of the original material as possible and creating a credible ordering that accommodates all degrees of information across cases. In this exercise, there is very detailed information for some firms and much less for others. This tension is resolved by devising a relatively simple scoring system to accommodate the multifarious information gathered. By analysing the firms' websites, all office locations are rated at a scale of 0 to 5. The standard values for a cell in the matrix are 0 (no presence), 5 (company headquarters) or 2 (normal presence). If there is a clear indication that a location has a special relevance within the firm network (e.g. exceptionally large offices with many practitioners, regional headquarter) its value is upgraded to 3 or even to 4. If the overall importance of a location in the firm-network is very low (e.g. small agency) the value is downgraded to 1. The end result from this scoring process is a so-called '*service activity matrix'*. This matrix is defined by many 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. This 'service activity matrix' builds the basic dataset to analyse the intra-firm networks by running the interlocking network model.

In the third stage, finally, we use the interlocking network model established by Taylor (2004) to estimate connectivities between FUAs in the German space economy (Taylor, 2004). The primary outputs of the interlocking network analysis are network connectivities, a measure that estimates of how well connected a city is within the overall intra-firm network of knowledge intensive enterprises.

There are different kinds of connectivity values. The connectivity between two FUAs (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 FUAs for one firm:

$$r_{abj} = v_{aj} * v_{bj} \quad (1)$$

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

$$r_{ab} = \sum r_{abj} \quad (2)$$

Aggregating the city interlocks for a single FUA produces the *interlock connectivity (N_a)*. This describes the importance of a FUA within the overall intra-firm network.

$$N_a = \sum r_{ai} \qquad (a \neq i) \quad (3)$$

If we relate the interlock connectivity for a given FUA to the FUA with the highest interlock connectivity, we gain an idea of its relative importance in respect to the other FUAs that have been considered. The resulting values of relative connectivity score somewhere between 0 and 1.

3.5. The value chain approach

Knowledge exchange and business activities do not only arise through branch office networks, but primarily from the division of labour between companies. In many cases, outsourcing strategies in respect of single activities are more efficient and lead to a higher quality of products and services. Many firms concentrate on their key competencies, which are produced in-house, while activities that do not belong to the core business are outsourced to other companies. Even networks between competitors open the opportunity for formal and informal knowledge exchange within the same field of business. We assume that these networks are strongly anchored within Mega-City Regions due to the quality of infrastructures like airports, universities with a good reputation or large settlements of leading global companies, as well as the availability of specific knowledge (Thierstein *et al*., 2006). Under these conditions, there is a high potential for developing new products and services needing upstream and downstream inputs and costumers, which represents the different elements of the value chain in the knowledge economy.

By means of a web survey that combines relational data on firm locations with the degree and importance of working interrelationships along individual firms' chain of value we want to shed some light on the value added process of APS- and High-Tech firms from a spatial perspective. By overlaying a multiplicity of different value chains we aim to identify patterns of spatial division of labour and localised value chain systems. How do APS- and High-Tech firms organize their value added chains spatially? What role does geographical proximity play? Where are upstream and downstream inputs come from? In order to answer these and other questions, the web survey comprises three sections. In a first section, information is gathered about the firm's business location and the spatial range where they source inputs for their products from. In the second section, the firms are asked to localize and assess the importance of their extra-firm relations to other APS and High-Tech firms. And finally, in order to relate the extra-firm relationships to a stylised value chain, the responding firms have to localise their business activities along the individual value chain elements of 'financing', 'research & development', 'processing', 'marketing', 'sales & distribution' and 'customers'. All in

all, this procedure gives a comprehensive picture about the spatial value chain patterns of APS- and High-Tech firms on the global, European, national and regional scale.

3.6. The qualitative network analysis

In addition to the quantitative network analysis, our research design includes a series of in-depth face-to-face interviews with senior business practitioners and organisations. The interview method provides qualitative evidence complementing our quantitative data gathered by the other empirical research. Whereas quantitative analyses provide harder, more easily measurable evidence across large data bases, the in-depth face-to-face interviews elicit softer case study evidence on the subtle and strategic processes underlying the quantitative results. This produces an extensive and rich data source on the actual changes and issues relevant to the study that could not be elicited by alternative means. Furthermore, it helps to understand better the interplay between location strategies of knowledge-intensive enterprises, geographical proximity and the development of polycentric Mega-City Regions.

The semi-structured questionnaire is designed to allow interviewers to reveal information about the pattern, volume and quality of connectivities and flows related to everyday experience of business operations. Common open-ended questions form the basis for the interviews to ensure that first responses were a true reflection of issues deemed important by the responding persons themselves. The standardised question framework focuses on four aspects: first, the firm's organisational strategy; second, the firm's regional, national and international networking activities; third, personal networks, interactions and communication habits of the interviewee; and fourth, the role of the institutional framework including the role of geographical and relational proximity. The discussions are tape-recorded and transcribed wherever possible so that specific quotations can be used to illustrate the reported results as appropriate. The transcript is analysed by means of a computer based qualitative content analysis, a methodology originally developed for social sciences in order to analyse unstructured qualitative data.

The sample size of the interviews is not intended to allow a statistical analysis of the results. The data collected are qualitative and the findings are consequently suggestive rather than providing precise facts. However, a target is set at 25 interviews with senior executives representing the major economic areas in Germany as well as both the APS- and the High-Tech sectors. Although the findings do not provide precise statistical measures of causes and effects, they do offer an understanding of polycentric Mega-City Regions in globalisation as experienced and practiced by knowledge-based business decision-makers. The summary of results shall identify similarities and differences between individual cases and attempts to isolate qualitative causal relationships underlying the Mega-City Region as well as the hierarchy hypotheses. The principal variables of the analysis are business sectors, geographical scope and location, but a variety of regional specificities will also taken into account in interpreting the results.

4. Conclusion

Over the last decades, Europe has experienced the reorganisation of functional-territorial division of labour in the knowledge economy. As a consequence, there is a mismatch between the political objectives and strategies for a sustainable spatial development and

actual development tendencies. Whereas planning principles rest on a normative and territorial logic, actual spatial development follows a functional logic, largely driven by market forces (Gabi *et al.,* 2006:168). The European policy discussion is faced with an overarching dilemma between territorial cohesion and economic competitiveness. On the one hand, the Lisbon Agenda, adopted by the European Council, seeks to make Europe the world's most competitive and dynamic knowledge economy by the year 2010 (European Council, 2000). On the other hand both the European Spatial Development Perspective (ESDP) as well as the later Gothenburg Agenda promote a more balanced and sustainable pattern of urban development across Europe, reducing the weight of the central urban zone of North West Europe (the London-Paris-Milan-Munich-Hamburg-Pentagon) (European Commission, 1999). An Informal Ministerial conference was held in Leipzig on 24 and 25 May 2007 within the framework of the German EU (European Union) Council Presidency. On the occasion of this conference, ministers responsible for Spatial Development in EU Member States agreed on the "Territorial Agenda of the European Union", which supports the implementation of both the Lisbon and the Gothenburg Strategies through an integrated territorial development policy (EU, 2007). Unfortunately, this Territorial Agenda hardly addresses the importance of the knowledge economy and the functional division of knowledge-intensive businesses in a spatial perspective. Furthermore, it evokes a kind of polycentricism – a belief that there are benefits to be gained from polycentric development. Such benefits are thought to include increased competitiveness, cohesion and regional balance, parity of access to infrastructure and knowledge, and sustainable development. In this sense, polycentricism is an abstract idea, a way of looking at reality and seeing what Europe's spatial planning policy makers want to see (Hague and Kirk, 2003).

Prior to launch of new political strategies boosting polycentric spatial development, there is a need for a deeper understanding of the interrelationships between polycentric spatial development and economic competitiveness. The key aim of the research concept suggested in this paper is therefore to empirically investigate the functional polycentric patterns and interlocking networks of APS and High-Tech firms on different special scales. With our analytical approach, we are able to shed some light on at least two dimensions of the German space economy. On a spatial dimension, the increasing complexity of network economies and its spatial articulation on different geographical scales can be revealed by analysing the connectivity patterns between cities and towns. Based on these findings, we are able to assess the politically designated Mega-City Regions in Germany in terms of their intra- and extra-regional functional linkages. In other words, we are able to assess the Mega-City Region hypothesis for the German space economy and to relate it to the new theoretical debate in economic geography that interprets regions as unbounded, relational space (Pike, 2007). On a hierarchical dimension, we are able to analyse to which extent the functional urban hierarchy within the German space economy is associated with different special scales and economic sectors. By analysing the interlock connectivity of the German Functional Urban Areas (FUAs), we are able to estimate how well connected these areas are on a regional, national, European and global scale. In other words, we are able to reveal the hierarchical positions of the politically designated Mega-City Regions in Germany and to assess their function as engines for socio-economic development having impacts on the international scale, as German policy makers claim it. Raising awareness of this nascent spatial scale by analytical evidence is a prerequisite to the establishment of large-scale metropolitan governance.

References

Asheim, B. & Isaksen, A. (1997), Location, Agglomeration and Innovation: Towards Regional Innovation Norway? *European Planning Studies*. V.5, (3): 299-310.

Beaverstock, J. V., Smith, R. & Taylor, P. J. (1999), A Roster of World Cities. *Cities*. V.16, (6): 445-458.

Becattini, G. (1989), "Sectors and/or districts: some remarks on the conceptual foundations of industrial economics", in Goodman, E. & Bamford, J. (eds.) *Small firms and industrial districts in Italy.* Routledge, London.

BMBAU (1995), *Raumordnungspolitischer Handlungsrahmen*. Beschluss der Ministerkonferenz für Raumordnung in Düsseldorf am 8. März 1995. Bundesministerium für Raumordnung Bauwesen und Städtebau, Bonn.

BMVBW (2005), *Weichen zur Mobilisierung von Wachstumspotenzialen in den Metropolregionen sind gestellt - Länder unterstützen Stolpes Initiative für weitere deutsche Metropolregionen*. Pressemitteilung des BMVBW. V.136.

Bramanti, A. & Maggioni, M. A. (eds.) (1997), *The Dynamics of Milieux: The Network Analysis Approach,* Ashgate, Aldershot.

Cabus, P. & Vanhaverbeke, W. (2006), The territoriality of the network economy and urban networks: evidence from flanders. *Entrepreneurship & Regional Development*. V.18, 25-53.

Carrincazeaux, C., Lung, Y. & Vicente, J. (2008), The Scientific Trajectory of the French School of Proximity: Interaction- and Institution-based Approaches to Regional Innovation Systems. *European Planning Studies*. V.16, (5): 617-628.

Castells, M. (1989), *The Informational City. Information Technology, Economic Restructuring, Urban-Regional Process*, Blackwell Publishers, Oxford.

Castells, M. (2000), *The rise of the Network Society. The Information Age: Economy, Society and Culture,* Blackwell Publishers, Malden.

Coe, N., *et al*. (2004), '*Globalizing' regional development: a global production networks perspective.* Transactions of the Institute of British Geographers. V.29, (4): 468-484.

Coe, N. M., Dicken, P. & Hess, M. (2008), Introduction: global production networks—debates and challenges*. Journal of Economic Geography*. V.8, 267-269.

Cooke, P., Uranga, M. G. & Etxebarria, G. (1998), Regional systems of innovation: an evolutionary perspective. *Environment and Planning* A. V.30, 1563 - 1584.

Derudder, B. (2006), On Conceptual Confusion in Empirical Analyses of a Transnational Urban Network. *Urban Studies*. V.43, (11): 2027-2046.

Edquist, C. (1997), "Systems of Innovation Approaches - Their Emergence and Characteristics", in Edquist, C. (ed.) *Systems of Innovation: Technologies, Institutions and Organizations*. Pinter, London, Washington.

Edquist, C. & Johnson, B. (eds.) (1997), *Institutions and Organizations in Systems of Innovation,* Edward Elgar Publishing, Cheltenham.

ESPON (2004), *ESPON Project 1.1.1. Potentials for polycentric development in Europe*. Project Report. European Spatial Planning Observation Network ESPON, Luxembourg.

EU (2007), *Territoriale Agenda der Europäischen Union. Für ein wettbwerbsfähiges nachhaltiges Europa der vielfältigen Regionen. Angenommen anlässlich des Informellen Ministertreffens zur Stadtentwicklung und zum territorialen Zusammenhalt in Leipzig* am 24. / 25. Mai 2007. Europäische Union, Leipzig.

European Commission (1999), *ESDP: European Spatial Development Perspective: Towards Balanced and Sustainable Development of the Territory of the European Union*. Brussels.

European Council (2000), *Presidency Conclusions* - Lisbon European Council, 23 and 24 March. Lisbon.

Friedmann, J. (1986), The world city hypothesis. *Development and Change*. V.17, 69-83.

Gabi, S. *et al*.,(2006), Governance Strategies for the Zürich-Basel Metropolitan Region in Switzerland. *Built Environment*. V.32, (2): 157-171.

Gereffi, G., Humphrey, J. & Sturgeon, T. (2005), The governance of global value chains. *Review of International Political Economy*. V.12, (1): 78-104.

Gottmann, J. (1961), *Megalopolis. The Urbanized Northeastern Seaboard of the United States,* Twentieth Century Fund, New York.
Grabher, G. (1991), *The Embedded Firm: The Socio-Economics of Industrial Networks*, Routledge, London.
Granovetter, M. (1985), Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*. V.91, (3): 481-510.
Hague, C. & Kirk, K. (2003), *Polycentricity Scoping Study*. School of the Built Environment. Heriot-Watt University, Edinburgh.
Hall, P. (1966), *The world cities*, Weidenfeld and Nicolson, London.
Hall, P. (1999), "Planning for the Mega-City: A new Eastern Asian Urban Form?" in Brotchie *et al*., J. F. (ed.) *East West Perspecitves on 21st Century Urban Development: Sustainable Eastern and Western Cities in the New Millennium*. Ashgate, Aldershot.
Hall, P. (2007), "Delineating urban territories. Is this a relevant issue?" in Cattan, N. (ed.) *Cities and networks in Europe. A critical approach of polycentrism*. John Libbey Eurotext, Paris.
Hall, P. & Pain, K. (2006), *The Polycentric Metropolis. Learning from Mega-City Regions in Europe*, Earthscan, London.
Henderson, J., *et al.* (2002), Global production networks and the analysis of economic development. *Review of International Political Economy.* V.9, (3): 436-464.
Hoover, E. M. (1937), *Location Theory and the Shoe and Leather Industries*, Harvard University Press, Cambridge, MA.
Hoover, E. M. (1948), *The Location of Economic Activity*, McGraw-Hill, New York.
Hoyler, M., Freytag, T. & Mager, C. (2006), Advantageous Fragmentation? Reimagining Metropolitan Governance and Spatial Planning in Rhine-Main. *Built Environment*. V.32, (2): 124-136.
Hoyler, M., Kloosterman, R. C. & Sokol, M. (2008), Polycentric Puzzles - Emerging Mega-City Regions Seen through the Lens of Advanced Producer Services. *Regional Studies*. V.42, (8): 1055–1064.
Kloosterman, R. C. & Musterd, S. (2001), The Polycentric Urban Region: Towards a Research Agenda. *Urban Studies*. V.38, (4): 623-633.
Knapp, W. & Schmitt, P. (2008), Discourse on 'Metropolitan Driving Forces' and 'Uneven Development': Germany and the RhineRuhr Conurbation. *Regional Studies*. V.42, (8): 1187–1204.
Kogut, B. (1985), Designing global Strategies: Comparative and Competitive Value-Added Chains. *Sloan Management Review*. V.26, (4): 15-28.
Krätke, S. (2007), Metropolisation of the European Economic Territory as a Consequence of Increasing Specialisation of Urban Agglomerations in the Knowledge Economy. *European Planning Studie*s. V.15, (1): 1-27.
Krätke, S. & Brandt, A. (2009), Knowledge Networks as a Regional Development Resource: A Network Analysis of the Interlinks between Scientific Institutions and Regional Firms in the Metropolitan region of Hanover, Germany. *European Planning Studies*. V.17, (1): 43 - 63.
Kujath, H.-J. H. (ed.) (2005), *Knoten im Netz*, Lit Verlag, Münster.
Kujath, H. J. & Schmidt, S. (2007), *Wissensökonomie und die Entwicklung von Städtesystemen. Leibnitz Institut für Regionalentwicklung und Strukturplanung*, Erkner b. Berlin.
Legler, H. & Frietsch, R. (2006), Neuabgrenzung der Wissenswirtschaft - forschungsintensive Industrien und wissensintensive Dienstleistungen (NIW/ISI-Listen 2006), *Studien zum deutschen Innovationssystem.* Niedersächsisches Institut für Wirtschaftsforschung, Fraunhofer-Institut für System- und Innovationsforschung, Hannover, Karlsruhe.
Lundvall, B.-Å. (ed.) (1988), *Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation,* Edward Elgar Publishing, Cheltenham.
Lundvall, B.-Å. (ed.) (1992), *Introduction in: National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Edward Elgar Publishing, Cheltenham.
Lüthi, S., Thierstein, A. & Goebel, V. (2008), *Intra-firm and extra-firm linkages of the knowledge economy - the case of the Mega-City Region of Munich,* Paper presented at the annual Meeting of the Association of American Geographers (AAG). Boston.

Maillat, D., Quévit, M. & Senn, L. (1993), *Réseaux d'innovation et milieux innovateurs: un pari pour le développement régional*. EDES, Neuchâtel.
Marshall, A. (1920), *Principles of Economics, Chapter 10 - Industrial Organization, Continued. The Concentration of Specialized Industries in Particular Localities*, Macmillian and Co., London.
Massey, D. (1985), *Spatial Divisions of Labour. Social Structures and the Geography of Production* (reprint), MacMillan, London.
Morgan, K. (1997), The Learning Region: Institutions, Innovation and Regional Renewal *Regional Studies*. V.31, (5): 491-503.
Moulaert, F. & Sekia, F. (2003), Territorial Innovation Models: A Critical Survey. *Regional Studies*. V.37, (3): 289-302.
Muscio, A. (2006), From Regional Innovation Systems to Local Innovation Systems: Evidence from Italian Industrial Districts. *European Planning Studies*. V.14, (6): 773-789.
Nelson, R. (1993), *National Innovation Systems*, Oxford University Press, Oxford.
Nelson, R. & Winter, S. (1982), *An evolutionary theory of economic change*, The Belknap Press of Harvard University Press, Cambridge/London.
OECD (2005), *Oslo Manual - Guidelines for collecting and interpreting innovation data*. Third edition. Paris.
Pike, A. (2007), Editorial: Whither Regional Studies? *Regional Studies*. V.41, (9): 1143-1148.
Piore, M. J. & Sable, C. F. (1984), *The second industrial divide: Possibilities for Prosperity*, Basic, New York.
Porter, M. E. (1996), Competitive advantage, agglomeration economies and regional policy. *International Regional Science Review*. V.19, 85-94.
Sassen, S. (2001), *The Global City: New York, London, Tokyo*, Princeton University Press, Oxford.
Schumpeter, J. A. (1926), *Theorie der wirtschaftlichen Entwicklung*, *2. Aufl*, Duncker&Humblot, München/Leipzig.
Schürmann, C. (2004), *Morphological Analysis of Urban Areas Based on* 45-minute Isochrones. Annex Report D to ESPON Project 1.1.1 Potentials for Polycentric Development in Europe. ESPON Monitoring Committee, Luxembourg.
Scott, A. J. (1985), Location processes, urbanisation and territorial development: an exploratory essay. *Environment and Planning A*. V.17, 479-501.
Scott, A. J. (2001), *Global City-Regions: Trends, Theory, Policy*, Oxford University Press, Oxford.
Simmie, J. (2003), Innovation and Urban Regions as National and International Nodes for the Transfer and Sharing of Knowledge. *Regional Studies*. V.37, (6): 607-620.
Simmie, J. (2005), Innovation and Space: A Critical Review of the Literature. *Regional Studies*. V.39, (6): 789–804.
Sokol, M., van Egeraat, C. & Williams, B. (2008), Revisiting the 'Informational City': Space of Flows, Polycentricity and the Geography of Knowledge-Intensive Business Services in the Emerging Global City-Region of Dublin. *Regional Studies*. V.42, (8): 1133–1146.
Storper, M. (1995), The Resurgence of Regional Economies, Ten Years Later: The Region as a Nexus of Untraded Interdependencies. *European urban & regional studies*. 119-221.
Storper, M. & Walker, R. (1988), *The geographical foundations and social regulations of flexible production complexes*, London.
Taylor, P. J. (2004), *World City Network: A Global Urban Analysis*, Routledge, London.
Taylor, P. J., Catalano, G. & Walker, R. (2002), *Measurement of the World City Network,* GaWC Research Bulletin. Globalization and World Cities Study Group, GaWC.
Taylor, P. J., Evans, D. M. & Pain, K. (2008), Application of the Interlocking Network Model to Mega-City-Regions: Measuring Polycentricity Within and Beyond City-Regions. *Regional Studies.* V.42, (8): 1079-1093.
Thierstein, A., Goebel, V. & Lüthi, S. (2007), *Standortverflechtungen der Metropolregion München. Über Konnektivität in der Wissensökonomi*e. Lehrstuhl für Raumentwicklung, TU München, München.

Thierstein, A. *et al.(*2006), *Raumentwicklung im Verborgenen. Untersuchungen und Handlungsfelder für die Entwicklung der Metropolregion* Nordschweiz, NZZ Buchverlag, Zürich.

Thierstein, A. *et al.* (2008), Changing value chain of the knowledge economy. Spatial impact of intra-firm and inter-firm networks within the emerging Mega-City Region of Northern Switzerland. *Regional Studies*. V.42, (8): 1113-1131.

Vernon, R. (1966), International Investment and International Trade in the Product Cycle. *The quarterly journal of economics*. V.LXXX, (2): 190-207.

Wildemann, H. (2003), *Supply Chain Management. Effizienzsteigerung in der unternehmensübergreifenden Wertschöpfungskette,* TCW Transfer-Centrum, München.