

Germany's Polycentric Metropolitan Regions in the World City Network

Angelika Münter

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Abstract On a regional scale, two types of polycentricity can be observed. The first involves polycentric metropolitan regions that have evolved in the course of post-suburban development around a previously monocentric city, whereas the second type involves neighbouring metropolises evolving into a multi-core polycentric metropolitan region due to an increase in the functional interaction between each other. The German urban system is characterised by both types of polycentricity. In this paper I examine the role of these two types of polycentricity within the context of globalisation. I address the question of whether individual metropolitan cores and metropolitan cores and their associated post-suburban areas share the global functions of a metropolitan region or whether such functions are concentrated in a single city within the metropolitan region. To this end, I analyse the locations of leading global advanced producer service firms in Germany in their role as sub-nodes of the world city network. Finally, I discuss the empirical findings in the context of modelling the world city network.

Keywords Polycentricity · Metropolitan regions · World city network · Germany

Die polyzentrischen deutschen Metropolräume im World City Network

Zusammenfassung Auf der regionalen Maßstabsebene lassen sich zwei Typen von Polyzentralität beobachten.

Dies sind zum einen polyzentrische Metropolräume, die im Zuge post-suburbaner Entwicklungen im Umland ehemals monozentrischer Kernstädte entstanden sind, und zum anderen polyzentrische Städtereionen, die sich aus einer zunehmenden funktionalen Verflechtung mehrerer Kernstädte in räumlicher Nähe entwickelt haben. Das deutsche Städte-system ist durch beide Typen von Polyzentralität geprägt. In diesem Beitrag wird die Rolle dieser beiden Typen vor dem Hintergrund der Globalisierung diskutiert. Es wird analysiert, ob die einzelnen metropolitanen Kerne sowie der metropolitane Kern bzw. die metropolitanen Kerne und ihr jeweiliges post-suburbanes Umland sich die globalen Funktionen eines Metropolraumes teilen oder ob sich diese globalen Funktionen in einer einzelnen Stadt innerhalb des Metropolraumes konzentrieren. Hierzu werden die Standorte der global führenden wissensintensiven unternehmensbezogenen Dienstleistungsunternehmen in Deutschland in ihrer Rolle als Knoten im world city network analysiert. Abschließend werden die empirischen Forschungsergebnisse vor dem Hintergrund der Modellierung des world city networks diskutiert.

Schlagwörter Polyzentralität · Metropolräume · World city network · Deutschland

1 Introduction

The German urban system is characterised by two types of polycentricity on a regional scale: post-suburban polycentric regions and multi-core polycentric regions. In this paper I examine the role of these two types of polycentricity in the context of globalisation.

To this end, I apply the world city network (WCN) model built by Peter J. Taylor and the GaWC (Globalization and

A. Münter (✉)
ILS – Institut für Landes- und Stadtentwicklungsforschung,
Brüderweg 22-24, 44135 Dortmund, Germany
e-mail: angelika.muenter@ils-forschung.de

World Cities) research group. The world city network model is an empirical instrument for analysing inter-city relations in terms of the organisational structure of the global economy. It is built as an interlocking network model for measuring relations between world cities indirectly, using the office location strategies of leading global advanced producer service (APS) firms as an archetypal proxy for world city network activities (Taylor 2004, p. 60 ff.). In the past decade major analyses of the integration of global economic centres into the world city network have been conducted. However, additional research into the integration of polycentric metropolitan regions is needed. This paper aims to encourage discussion on the integration of such regions into the world city network using German metropolitan regions as an example. In particular, I examine whether the two types of polycentricity observable on a regional scale differ in this respect. In the analyses I apply the world city network model in two different manners, focusing on the one hand on individual cities within metropolitan regions to show intra-regional differences with respect to the world city network integration, and on the other hand on the external relations of metropolitan regions within the world city network.

This paper is organised in four sections. I start by providing an overview of the literature on the regionalisation of metropolises and their evolution into polycentric urban configurations as well as on empirical studies applying Taylor's world city network model and addressing aspects of polycentricity on a regional scale (Sect. 2). This is followed by a short introduction to the data and methodology of my empirical research (Sect. 3). I then present my findings about how Germany's metropolitan regions are integrated into the world city network (Sect. 4), before discussing these empirical findings in the context of modelling the world city network and indicating certain needs for further research (Sect. 5).

2 Polycentric Metropolitan Regions in the World City Network

The spatial rescaling of cities observed over the last few decades is the result of a regionalisation and a metropolitanisation of cities, with today's metropolises seldom limited to the administrative boundaries of the core city. Functions important to a metropolis's economic viability are part and parcel of such sprawl, involving not only such land-consuming metropolitan infrastructures as airports, but also increasingly functions and business sectors once predominantly located in metropolitan cores. This is explainable by the fact that certain hinterland areas provide advantages regarding accessibility and proximity similar to those found in the metropolitan core (Läpple/Soyka 2007, p. 67 ff., 96 ff.; Blotevogel/Danielzyk 2009, p. 22 f.). Debates about the future

course of globalisation "will almost certainly revolve in part around the question of city-regions and their deepening role as points at which globalization processes crystallize out on the geographic landscape." (Scott 2001, p. 7).

The regionalisation of metropolises and their evolution into polycentric urban configurations can be observed in all metropolitan regions. But polycentricity is far from being a consistently used term. Many different labels have been used to denote and conceptualise polycentric urban configurations when analysing them at a regional scale, such as global city-region (Scott 2001), polycentric urban regions (Kloosterman/Musterd 2001; Meijers 2007b) or mega-city region (Hall/Pain 2006). All of these conceptualisations characterise polycentric regions as regions with multiple cities and business centres within commuting distance and at least one international airport linking the region with other parts of the world, though they diverge in detail (Hoyler/Kloosterman/Sokol 2008, p. 1055).¹ In this paper I focus on two types of polycentric regions at a regional scale that differ from one another according to the way they have developed over time (post-suburban polycentric regions and multi-core polycentric regions, see Sect. 1 and Blotevogel/Danielzyk 2009, p. 23 f.).

Post-suburban polycentric regions: As a result of urban sprawl, today's cities are characterised by functional connections and relationships with their hinterland that are based on a division of labour and overlapping network structures and space-time-configurations. These lead to the emergence of functional "city regions" or "metropolitan regions".² The contemporary metropolitan region is diametrically opposed to traditional radial and concentric urban structures, with the former suburban hinterland increasingly gaining independence from the traditional centre. New centres and nodes of activity accrue, and are characterised by different functions. Though a region's traditional centre will maintain its functional predominance, it will no longer dominate the region in all central functions. Compared to the traditional centre, new centres are more functional and sectorally specialised with regard to their economic functions. New business centres in the hinterland are often located close to airports, high-speed train stations or important motorway junctions. Cheaper and improved transportation and information and technology applications (ICT) now allow for the formation

¹ In addition to this analytical conceptualisation of polycentricity at the regional scale, the term is used as a normative planning strategy (e.g. European Commission 1999; Davoudi 2003) and on all spatial scales from the intra-urban to the global (e.g., Hoyler/Kloosterman/Sokol 2008; Burger/Meijers 2010).

² The difference between a "city region" and a "metropolitan region" becomes manifest in the importance of the core city or region: Each core city is part of a "city region" and if the core city or a region, respectively, has a metropolitan character, it can be described as a "metropolitan region". In this paper I will focus on metropolitan regions.

of extended city hinterlands. On the one hand improved accessibility leads to the regionalisation of people's potential action radius (daily commuting to work, shopping trips, etc.), while on the other hand businesses can profit from the advantages of proximity and knowledge spill-overs generated in the region without experiencing the disadvantages of the core city (Brake 2005, p. 13 ff.). Thus a metropolitan region may in toto be characterised as a single labour market or economic entity. In summary, specialisation and the division of labour within a metropolitan region is often discussed under the term "post-suburbanisation" (e.g., Phelps/Parsons/Ballas et al. 2006). For this reason in this paper I will be referring to this type of polycentricity in metropolitan regions, i.e., an omnipresent phenomenon in the hinterland of all post-industrial cities (Meijers 2007a, p. 890), as "post-suburban polycentricity".

Multi-core polycentric regions: The second type of polycentricity in city and metropolitan regions, the multi-core polycentric region, is much less common. It evolves from an increase in functional connections between several neighbouring metropolises as the hinterlands of the individual metropolises becoming increasingly overlapped. Kloosterman and Musterd define these regions as having the following characteristics: They consist of historically distinct cores that were independent political entities up to now, which are in more or less close proximity (within commuting distance). None of the core cities within these regions is clearly predominant from a political, economic or cultural perspective. In addition, such regions may contain several smaller cities (Kloosterman/Musterd 2001, p. 828). The ways such regions have evolved historically are multifaceted, but in numerous cases the region offered a locational advantage that led to an economic boom during a specific economic period. Such regions may, for example, be former industrial areas in which the core cities emerged in a period of rapid industrialisation based on deposits of natural resources such as coal or iron ore (e.g., the Ruhr Valley). They may also be an agglomeration of seaports, such as the core cities of the Dutch Randstad, which experienced a boom in the 17th century, or the cities of the Pearl River Delta in China, which have grown rapidly in the last decades due to their "special economic zone" status. Within multi-core polycentric metropolitan regions the cities historically either performed different functions (e.g., in the Randstad with Amsterdam as the financial centre and Rotterdam as the main seaport) or the same kind of functions (e.g., in the Ruhr Valley) (Kloosterman/Musterd 2001, p. 627).³

³ With regard to content, the two types of polycentricity at the regional scale described in this paper have major similarities with the smaller scale intraurban and larger scale interurban polycentricity described by Kloosterman/Musterd (2001). There is, however, one important difference. Kloosterman/Musterd refer to intraurban polycentric developments that take place within a single administrative and political

Globalisation is also leading to new forms of hierarchical and network developments and to functional differentiation between cities all over the world (Friedmann 1986; Sassen 2001). Metropolises have a strategic importance in economic activities and dynamics. In the course of the ongoing process of globalisation they are increasingly becoming integrated in complex economic networks, becoming the nodes through which the commodity, information and migration flows linking up the global economy run (Castells 1996). Whereas Friedmann's world city hypothesis (1986, p. 70) states that the territory of a metropolis is comprised not only of the core city itself, but also of its surrounding economic hinterland, and that, therefore, metropolises are often de facto polycentric regions, Sassen's initial global city approach reveals a new geography of centrality where the city centres of global cities have become the epicentres of the global urban network, and yet where they are becoming increasingly disconnected from their hinterlands (Sassen 2001, p. 21).⁴ Following Derudder's description, "Sassen's focus on centrality leads her to conceptualizing '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 hinterland that may themselves be subject to urbanization processes" (Derudder 2006, p. 2034; see also Thierstein/Lüthi/Kruse 2008, p. 1118).

Building on Sassen's (2001) initial global city approach and her identification of the fact that an advanced producer service sector (high value-added professional, creative and financial services) plays a key role in globalisation outcomes, as well as on Castells' (1996) notion of a "space of flows", Taylor and the Globalization and World Cities Research Group (GaWC) developed the model of a world city network (WCN), an empirical instrument for analysing inter-city relations in terms of the organisational structure of the global economy (Taylor 2004). The highly specialised economic sector of advanced producer service (APS) firms, which facilitate production and distribution across the global economy, is notably reliant on the urbanisation economics (Jacobs 1970) the metropolises generate. To retain their major clients, APS firms have themselves globalised,

entity as well as to spatial units that also comprise administratively independent suburbs. In this paper I focus solely on polycentric regions that comprise several administratively independent municipalities (see Sect. 2). Kloosterman and Musterd's definition of polycentricity also alludes to the idea that the two types of polycentricity at the regional level differ in scale and size. Multi-core polycentric regions are much larger than post-suburban polycentric regions. Multi-core polycentric regions comprise several core cities, each with their own post-suburban hinterland that overlaps the hinterland of other core cities in the region. Thus, in multi-core polycentric regions both types of polycentricity at the regional scale occur.

⁴ Sassen now similarly recognises that regions may be linked to "global circuits" (Sassen 2002, p. 13).

and now have branches in cities throughout the world. Their “globality” is part of their identity, and they recruit both new clients and highly-skilled professionals in this spirit (Sassen 2001, p. 21; Taylor 2004, p. 57). Communication flows in the global economic network do not run between cities, but between the APS firms located therein. And thus, the world city network model is an interlocking network model that measures the relations between world cities indirectly, using the office location strategies of leading global APS firms as an archetypal proxy for world city network activities (Taylor 2004, p. 60 ff.). Major analyses on the integration of global economic centres in the world city network have been conducted during the past decade. The world city network can be understood as a basic methodological framework that allows researchers to extend the model in order to address specific research issues (see Globalization and World Cities Research Network 2010a; Growe/Blotevogel, Hoyler and Lüthi/Thierstein/Bentlage in this special issue).

Following Sassen’s (2001) initial conceptualisation of global cities as focal points that operate separately from their hinterlands and ignoring Castells’ notion (1989, p. 167) that the “space of flows” may be associated with the formation of “multifunctional, multinuclear spatial structures”, Taylor’s approach focuses on the role of individual cities in the global knowledge economy (Hoyler/Kloosterman/Sokol 2008, p. 1534). Indeed, up to now, most analyses of the world city network have been based on individual cities rather than on cities and their wider regional context. Aspects of polycentricity at the regional scale in the world city network have only been addressed in a handful of still seminal empirical attempts.

Regional-scale polycentricity aspects in the world city network were comprehensively addressed for the first time in “POLYNET—Sustainable Management of European Polycentric Mega-City Regions” (see Hall/Pain 2006), an EU-funded international research programme for eight European mega-city regions (South East England, the Randstad, Central Belgium, Rhine-Ruhr, Rhine-Main, Northern Switzerland, the Paris Region and Greater Dublin). The focus of POLYNET was to extend the scope of the world city network model to describe and compare inter-city relations within mega-city regions and the connectivity of cities in mega-city regions on different geographical scales (regional, national, European and global). The results show the scale-dependent functional polycentricity of mega-city regions, the importance of which, in general, is declining the more the scale is shifted from the regional to the global perspective: the more global the businesses, the more concentrated global connectivity is within these regions. There are, however, remarkable differences between the regions considered. In the two regions found to be the most polycentric on all scales, the Rhine-Ruhr and the Randstad, the five best connected cities after the respective leading cities

Düsseldorf and Amsterdam show, on average, at least one third of Düsseldorf’s or Amsterdam’s connectivity at the global scale. In the Dublin region on the other hand, they only account for a negligible two percent (Taylor/Evans/Pain 2008, p. 1089).

Building on the POLYNET results, several further studies for other regions and countries have been conducted. Taylor/Evans/Hoyler et al. (2009) extended the POLYNET data and analysis from the South East England megacity region to the whole of the UK. The results not only show how well UK cities are linked into the national space economy but also identify two distinct regional scale polycentric processes in the UK: Firstly, a functionally “polycentric megacity regional process” out of London is creating new economic centres in South East England, and secondly, beyond this megacity region a “polycentric multi-city regional process” is occurring, which enhances the service capacity of traditional centres in the UK (Taylor/Evans/Hoyler et al. 2009, p. 700). Lüthi/Thierstein/Göbel (2010) extended the POLYNET approach by two dimensions in an additional case study for the Munich megacity region, investigating not only APS firms but also high-tech firms as another important sector of the knowledge economy. In addition to investigating intra-firm networks, they also looked at the extra-firm networks of these companies along their value chains. With regard to intra-firm networks (the focus in this paper) the Munich case study confirmed the POLYNET results, i.e., that the functional polycentricity of megacity regions shows a scale dependency for both APS and high-tech firms. In an ongoing research project the authors are analysing interlocking firm networks in 337 small-scale Functional Urban Areas (FUAs) throughout Germany, using a methodological approach similar to that used in the Munich region case study (Lüthi/Thierstein 2009, see Lüthi/Thierstein/Bentlage in this special issue for initial results).

With regard to regional scale polycentricity, the common feature of these research projects is that they measure polycentricity within polycentric metropolitan regions by analysing the connectivity generated by the inter-firm networks of APS firms between cities or small scale functional urban areas located within a larger metropolitan region. They also analyse to which extent each of these cities and functional urban areas respectively generates connectivity on different spatial scales. Additional research into polycentric metropolitan regions in total as potential business locations for leading global APS firms is needed, however. For this reason, in this paper the focus is on the external relations of such metropolitan regions and to what extent different parts of a metropolitan region (metropolitan core(s) and post-suburban zones) contribute to the region’s level of connectivity. This allows me to analyse the influence the two types of polycentricity at the regional scale described have on the

integration of polycentric metropolitan regions in the world city network. In particular, I investigate two hypotheses:

1. The post-suburban type of polycentricity tends to be of little significance with respect to the global connections of metropolitan regions. Within these metropolitan regions, network connectivity is mainly generated in the metropolitan core or cores.

I specifically formulated this hypothesis in this manner because, despite the regionalisation of urban configurations, the “metropolitan functions” of such regions remain predominantly concentrated in the core cities (Blotevogel/Schulze 2009, p. 42 ff).

2. The metropolitan cores of multi-core polycentric metropolitan regions share their global connections. From the perspective of leading global APS firms, in these regions several metropolitan cores are suitable for linking the metropolitan region with the rest of the world.

The direction this hypothesis takes is derived from the POLYNET results. These show that within multi-core polycentric metropolitan regions (in this case: the Rhine-Ruhr and Randstad), a number of core cities contribute significantly to the region's connectivity on all geographical scales (Taylor/Evans/Pain 2008, p. 1089).

Whether I accept or reject these hypotheses I gain an indication about how to interpret the role of polycentric regions in the world city network and how to improve world city network modelling in this respect. Should the first hypothesis be rejected, more attention needs to be paid to this subtype of polycentricity when modelling the world city network. With regard to the second hypothesis, acceptance would indicate a need for further research in this area.

3 Data and Methodology

I examined the hypotheses about the integration of polycentric metropolitan regions in the world city network using German metropolitan regions as examples. This is because the German urban system is—to a greater degree than other national urban systems—characterised by both types of polycentricity and is thus a suitable study area for addressing questions about polycentricity in the world city network. The German urban system is decentrally structured. In contrast to national urban systems dominated by a single city (such as London in the UK or Paris in France), Germany has a number of major cities, nearly all of which have the same importance within the urban system. The polycentric structure of the German urban system is the result of a long history of territorial fragmentation and the federal organisation of political power (Blotevogel 2002, p. 40 f.). With respect to the global importance of German cities, the

decentralised and polycentric structure of the German urban system is reflected inter alia by the decentralised distribution of metropolitan functions (see Blotevogel/Schulze 2009; Bundesinstitut für Bau-, Stadt- und Raumforschung 2010) and by the connectivity figures shown by German cities in the world city network (see Hoyler in this special issue).

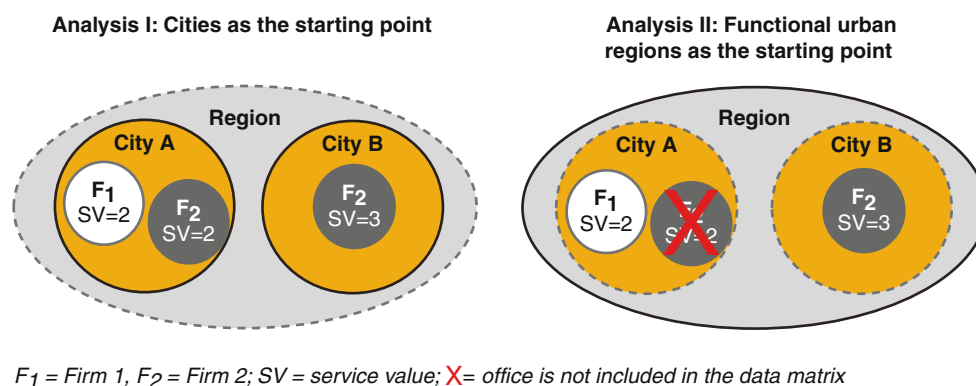
The world city network model built by Taylor and the Globalization and World Cities Research Network (GaWC) research group, which I apply during the examination of my hypotheses on Germany's polycentric metropolitan regions, is described as an interlocking network model. Networks usually consist of two layers (the “net level” and the “node level”), whereas an interlocking network is unusual in that it has three layers. In the case of the world city network, it consists of the network level of the global economy, the node level of cities (or in some exceptional cases, functional urban areas), and, most importantly, the additional sub-nodal level of APS firms (Taylor 2010b).

The latter are not just an additional level, they define the critical level: this is where the agents of network formation are found. In the global economy, it is firms who are the network makers, not the cities themselves. Thus for studying the world city network it is service firms that are investigated in order to understand the city network as the outcome. (Taylor 2010b, o. S.)

Globalised companies create the network via the workflows between company offices throughout the world. These workflows are measured indirectly using the office location strategies of such companies as a proxy for world city network activities (see Sect. 2). Information on all of a firm's offices is collected from its corporate website. Cities are then classified by their importance (“service value”) within the firm's worldwide office network on a scale ranging from 0 (no office in a particular city) to 5 (corporate headquarters). Based on the assumption that the more important an office is in the company's network, the more workflows it will generate, the potential workflows between two offices of a firm are calculated as the product of the service values of both offices. Next, the potential workflow between a firm's office in a specific city and all other offices of the same firm is aggregated. Aggregating these potential workflows again for all firms located in a city provides an estimate of the workflow relations between cities. Doing this for all cities provides an estimate for the entire world city network. And thus the analysis is not based on “actual working flows, but potential working flows, indirect measures derived from the data and the model assumptions” (Taylor 2010b, o. S.).⁵ It would seem that the world city network model is a rather

⁵ For further details on the methodology of measuring the world city network, see Hoyler in this special issue, Taylor (2004) or Taylor/Ni/Derudder et al. (2010).

Fig. 1 Data aggregation



rough proxy for relations between metropolitan regions due to the fact that there is a lack of suitable data sources in empirical world city research. Most of the data available is state-centric and dominated by attribute measurements, meaning that little transnational and network data is actually available (Derudder 2006, p. 2028 f.). Various researchers have tried to overcome this lack of suitable data by resorting to two basic approaches: An “infrastructure approach”, based on information on telecommunications or physical infrastructures, in which there is an emphasis on analyses based on airline data, and a “corporate organisation approach”, in which Taylor’s world city network model is a commonly accepted approximation of inter-city relations (Derudder 2006, p. 2029 f.).

To date three worldwide data collections and analyses have been made by the GaWC concerning the world city network. During the last data collection (2008) a matrix of 525 metropolises around the world and 175 leading global APS firms was developed. The firms considered were chosen by size and consisted of the top 75 financial service firms (banking and finance) and the top 25 firms in accountancy, advertising, law and management consultancy respectively (Taylor 2010b, o. S.).⁶ While researching the integration of polycentric German metropolitan regions in the world city network, I analyzed the locations of the leading global APS firms in Germany in an interlocking network model similar to the one used by the GaWC in 2008. In the case of the 175 firms considered, our interlocking network model is identical to the GaWC 2008 model, but the model applied in this paper does not cover cities throughout the world, but all locations of the 175 firms within Germany.⁷ Of the 175 original GaWC 2008 firms, 128 currently have at least one office in Germany and 192 German cities host at least one

office of one of the leading global APS firms. This means that my analyses are based on a 128×192 data matrix.⁸

My definition of “metropolitan regions” is based on the “functional urban regions” (FURs; in German: *Stadtregionen*) defined by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). Each functional urban region comprises one or more core cities with more than 100,000 inhabitants and the corresponding commuter zone defined by a share of at least 25% of a municipality’s commuters travelling into the core city/cities or the surrounding densely populated communities in 2008.⁹ However, in this paper I do not take all functional urban areas into account, but only those with the highest connectivity figures, i.e. those that are worthy of being characterised as metropolitan. These are referred to as “metropolitan regions” in this paper.¹⁰ A functional urban region consists of two spatial categories. On the one hand there is the “metropolitan core” (or cores), on the other hand the “commuter zone”, which, according to the theoretical findings on polycentric metropolitan regions (see Sect. 2), can also be described as the “post-suburban zone”.

I respectively analysed and aggregated the connectivity data in two different ways (see Fig. 1).

⁶ Further results of the 2008 data collection can be found, for example, in Taylor (2010b) and Taylor/Ni/Derudder et al. (2010).

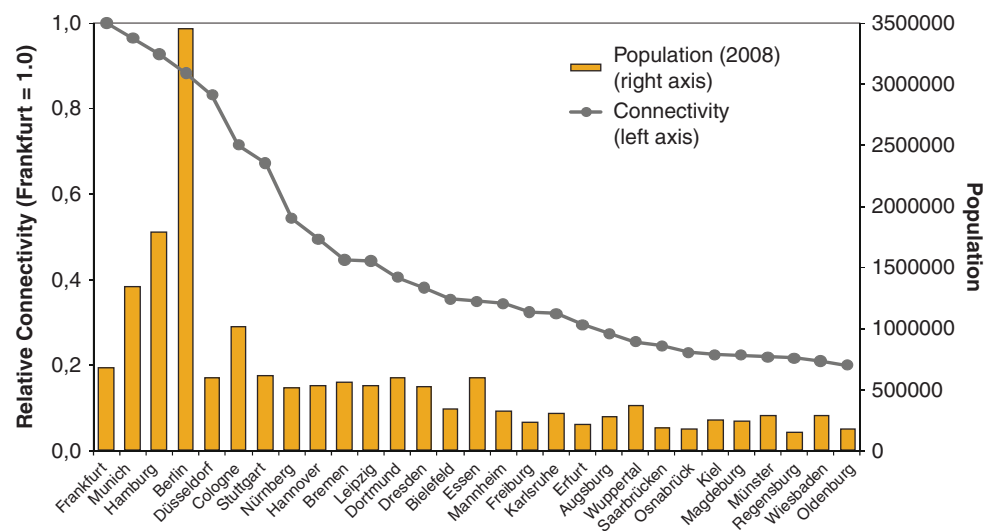
⁷ With regard to the two major German banks, the Deutsche Bank and the Commerzbank, only regional offices were included in the data matrix and not all private customer branches. Company locations were collected from the firms’ international and German websites and from the Hoppenstedt business database in early 2010.

⁸ Because I used other cities, my data is not directly comparable to the GaWC 2008 data. The methodology is exactly the same, however, and although we neglected the global connections of the firms’ German offices, the ranking (in terms of network connectivity of the ten best connected German cities) included in both datasets is nearly identical. My data was therefore deemed suitable for analysing Germany as a section of the world city network in my research.

⁹ When I conducted my analyses (spring 2010), the functional urban regions comprised the only nationally comparable demarcation of the functional hinterlands of core cities/metropolitan cores. In June 2010 the BBSR then published a functional demarcation of metropolitan regions valid throughout Europe for the first time (BBSR 2010). I have not yet been able to use this information in this paper, but I assumed there would only be negligible differences in the results, as similar metropolitan cores and hinterlands are covered by the two demarcations.

¹⁰ In the analyses I either refer to the 15 regions in which the major core city has a gross connectivity of at least 1500, or to the 8 regions in which the major core city has a gross connectivity of at least 2500 in analysis I.

Fig. 2 Relative connectivity (2010) and population figures (2008) of selected German cities. (Data source: Federal Statistical Office and author's own calculations)



Only cities that have a relative connectivity of at least > 0.2 compared to Frankfurt are illustrated

Analysis I “Cities as the starting point”: Here I look at the 192 cities that each host at least one leading global APS firm’s office as the starting point of the analysis. I add up the network connectivity of all cities located in a metropolitan region to calculate the region’s gross connectivity, i.e. the metropolitan region’s network connectivity is the accumulated network connectivity of the cities within this region. Analysis I adopts the city-centred perspective usually applied in analyses based on the GaWC model. This analysis is based on the assumption that, as every branch of an APS firm communicates directly with every other branch of the same firm, the level of communication flows is determined solely by the importance of an office within the firm’s overall office network (service value). This analysis is suitable for showing the intraregional differences of cities/spatial categories within a metropolitan region with respect to their integration into the world city network, using the connectivity generated by leading global APS firms within a metropolitan region.

Analysis II “Functional urban regions as the starting point”: This focuses on the external relations of a metropolitan region, i.e. excluding internal relations within a metropolitan region. In this analysis I assume that within a functional metropolitan region (demarcated by commuter flows as a proxy for intra-regional relations) there is a hierarchy between a firm’s offices: The firm’s most important office within a region (in terms of its service value) is the one communicating with offices in other regions, whereas subordinate offices within the region only communicate with each other and the region’s main office. Thus, all inter-regional communication flows only run through the firm’s most important office within a region and only this office is included in the analysis.¹¹ This

analysis is suitable for showing to what extent which cities/spatial categories within a metropolitan region are responsible for the region’s external relations.

Analyses I and II examine the integration of Germany’s polycentric metropolitan regions into the world city network from different perspectives. I examine the two hypotheses about the integration of post-suburban and multi-core polycentric metropolitan regions in the world city network with the help of both analyses. They complement each other in their validity, with each covering different facets of my research.¹²

4 Results

Before interpreting the data for the metropolitan regions in terms of the two hypotheses in the next sections, I draw attention to Fig. 2, with its focus on individual cities, to illustrate the flat hierarchies and polycentricity within the German urban system. Figure 2 displays the population and relative connectivity of all cities with a relative connectivity equivalent of at least 0.2 to that to Frankfurt (Germany’s best connected city): Seven cities achieve at least 0.5 of Frankfurt’s connectivity and 28 cities at least 0.2.¹³ Furthermore the chart shows that there is no direct correlation between

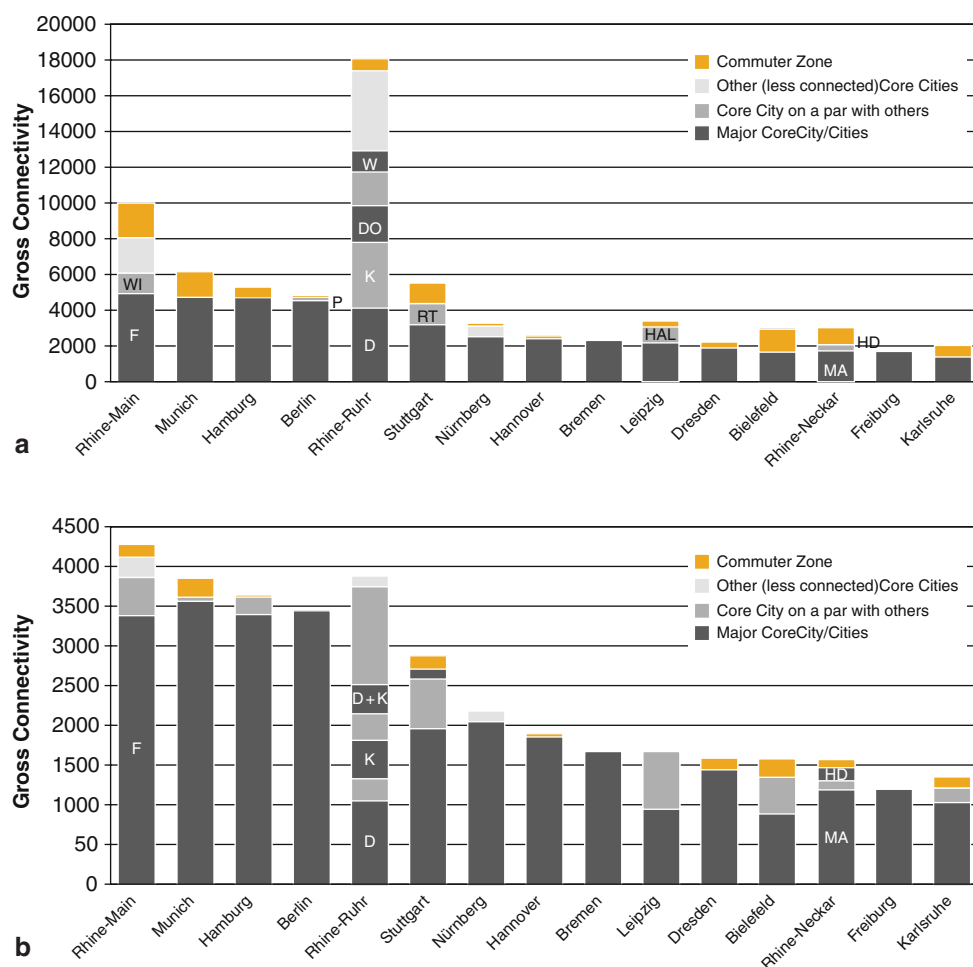
identified, as two or more offices are often equal. In such cases we do not allocate the most important office within a company in a functional urban region exactly to one specific city, but only to a spatial category (see Figs. 3b and 4b).

¹² In Analysis I the overall comparability of our data to the GaWC 2008 data only exists when analyses refer to individual cities, but not for the accumulated regional data.

¹³ Though the results of the data analyses are broadly comparable to the GaWC 2008 results (see footnote 8), the specific connectivity figures are not comparable. In the GaWC 2008 analysis London is the most integrated city in the world city network. Frankfurt is ranked 32nd, with a relative connectivity to London of 0.5 (Taylor 2010a, p. 24).

¹¹ As many branches are classified with a service value of 2 for a “standard or typical office of a firm” (Taylor 2010b, o. S.), in many cases no single most important office within a company in a region can be

Fig. 3 Gross connectivity of 15 German metropolitan regions. (a) Analysis I: Accumulated gross connectivity of cities within metropolitan regions, (b) Analysis II: Gross connectivity of metropolitan regions



* Core City on a par with others: This share of the connectivity of the region cannot conclusively be attributed to any one of the spatial categories, as there are two or more equal valued offices in different spatial categories within the region.

D: Düsseldorf; DO: Dortmund; E: Essen; F: Frankfurt; HAL: Halle; HD: Heidelberg; K: Cologne; MA: Mannheim; P: Potsdam; RT: Reutlingen; W: Wuppertal; WI: Wiesbaden;

ween connectivity and city size in terms of population, with Frankfurt, for example, being largely overrepresented with regard to connectivity, and Berlin largely underrepresented.

4.1 Post-suburban Polycentric Metropolitan Regions in the World City Network

Figure 2 also shows that all 29 German cities with a connectivity of at least 0.2 compared to Frankfurt are cities with at least 130,000 inhabitants (Regensburg is the smallest), and all 14 German cities with more than 500,000 inhabitants figure among the most connected cities. Generally speaking, within Germany the connectivity generated by leading global APS firms is highly concentrated in core cities with more than 100,000 inhabitants. In 2008 German core cities

comprised only 4% of the Germany's total area, 31% of its population and 40% of its employees¹⁴, but 81% of gross connectivity. These results already indicate that the first hypothesis, i.e. that the post-suburban type of polycentricism tends to be of little significance with respect to global connections of metropolitan regions, is applicable.

4.1.1 Analysis I: Individual Cities as the Starting Point

Within the 15 metropolitan regions, 88% of connectivity is, on average, assigned to the core cities, with commuter zones only accounting for 12%. However, although in general the connectivity of commuter zones is only minor, significant differences between functional urban regions can be observed. Figure 3a shows the accumulated gross connec-

Thus, the connectivity figures in this paper are on a much lower overall level than the GaWC 2008 figures.

¹⁴ Data from Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR).

tivity for the metropolitan regions, where a differentiation is made between a region's main core city/cities, other less connected core cities and the commuter zone. The analysis shows that there are quite a number of metropolitan regions that gain connectivity neither from the commuter zone nor from other core cities in the region (e.g., the Berlin, Hannover and Bremen regions) and can thus be characterised as monocentric in terms of connectivity generated by leading global APS firms. With respect to the post-suburban type of polycentricity, Fig. 3a shows that a number of regions gain additional connectivity from the commuter zone, such as the Rhine-Main, Munich, Stuttgart, Bielefeld and Rhine-Neckar regions. The influence of this type of polycentricity on the network is only minor, however, insofar as the affected regions can only marginally improve their ranking in the network through additional connectivity located in the commuter zone.

The pie charts in Fig. 4a give details of the eight major metropolitan regions. These charts show which role spatial categories (core city/cities and commuter zones) play in the connectivity of the metropolitan region as a whole. With regard to the post-suburban type of polycentricity, they primarily illustrate the significant regional differences between the metropolitan regions, with the Stuttgart, Munich and Rhine-Main regions gaining about one-fifth of their connectivity from the (post-) suburban commuter zone. For these regions there is no doubt that parts of their hinterland also show metropolitan location qualities.

4.1.2 Analysis II: Metropolitan Regions as the Starting Point

Analysis I, in which regions are modelled as the aggregate of individual cities, cannot, however, answer the question of whether the metropolitan core and the post-suburban zones actually share the region's global functions or whether firms only maintain additional branches within the region. The question about the share of connectivity generated by leading global APS firms within a metropolitan region is addressed in Analysis II, in which I treat the functional metropolitan region in toto as a potential location for an APS firm and only include the most important office of a company within a region in the analysis. Analysis II thereby shows a quite different pattern of connectivity than Analysis I, as can be seen in Fig. 3b. With regard to the post-suburban type of polycentricity, it can be clearly seen that there is a lower influence on the region's connectivity in Analysis II than in Analysis I, with the connectivity of all metropolitan regions only being affected marginally by this type of polycentricity. These results are confirmed when looking at the eight major metropolitan regions in detail in Fig. 4b. The Rhine-Main, Munich and Stuttgart regions, characterised as being post-suburban polycentric in the first

analysis, generally only have additional branches in the commuter zone, with the core cities dominant within these regions in terms of connectivity generated by leading global APS firms. When branches of the leading global APS firms do exist in the commuter zone, they are for the most part "back offices" of branches based in the metropolitan core(s).

4.2 Multi-core Polycentric Metropolitan Regions in the World City Network

4.2.1 Analysis I: Individual Cities as the Starting Point

While quite a number of metropolitan regions gain—although mostly only to a minor degree—additional connectivity from the commuter zone, few metropolitan regions gain connectivity from more than one core city (see Fig. 2a). These are primarily the Rhine-Main region, which gains connectivity not only from Frankfurt, but also from other core cities such as Wiesbaden or Mainz, and obviously the Rhine-Ruhr metropolitan region, which gains from the accumulation of connectivity from more than five high and medium connected core cities (Düsseldorf, Cologne, Dortmund, Essen, Wuppertal and others). The result of this calculation, in which the gross connectivity of individual cities is simply added together, is that the gross connectivity of the Rhine-Ruhr region is nearly twice as high as that of the second-placed region, the Rhine-Main region.

When we go into details in Fig. 4a, we see that in the Rhine-Main region core cities other than Frankfurt contribute nearly one third (30.2%) of the region's connectivity. It also becomes evident that the Rhine-Ruhr region is a prime example of a multi-core polycentric region, with Düsseldorf, the most connected city within the region, only accounting for 23% of the connectivity of the metropolitan region as a whole, and with four other core cities each contributing between 7% and 20% of the region's total connectivity.

We find that multi-core polycentric regions are very rare in Germany. Among the fifteen metropolitan regions only the Rhine-Ruhr region, the Rhine-Main region and, to a lesser degree, the Stuttgart region can be characterised as being multi-cored polycentric. Yet, when this type of polycentricity can be observed for a region, it has a remarkable influence on the region's gross connectivity, as shown by the prime example of the Rhine-Ruhr region.

4.2.2 Analysis II: Metropolitan Regions as the Starting Point

The fact that, similar to the post-suburban type of polycentricity, some of the additional connectivity of a metropolitan region is attributable to additional branches of a firm in a

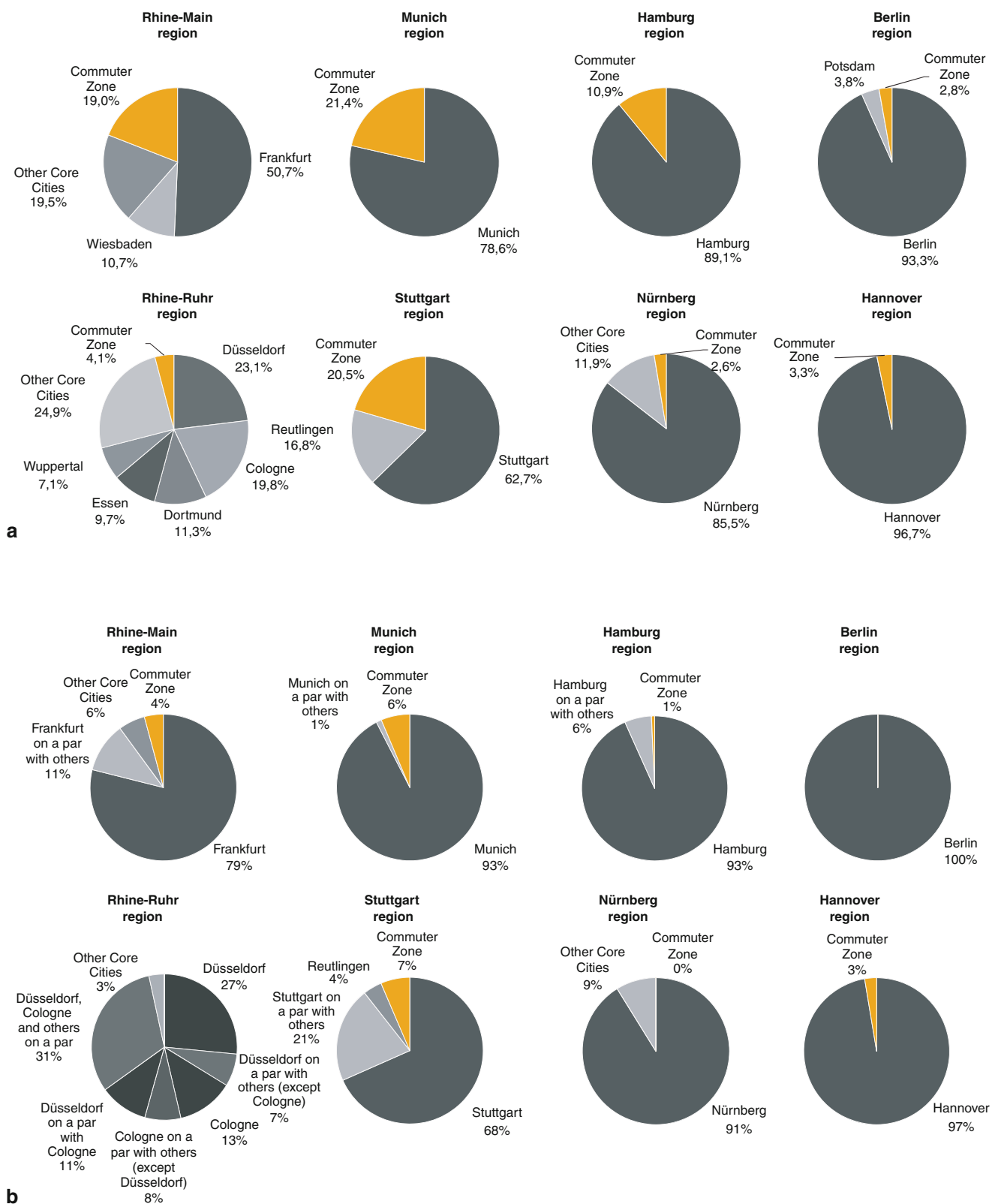


Fig. 4 Share of gross connectivity within eight major German metropolitan regions. **(a)** Analysis I: Share of accumulated gross connectivity within metropolitan regions, **(b)** Analysis II: Share of gross connectivity within metropolitan regions

region, can also be confirmed for the multi-core polycentric regions in Analysis II. The first evidence of this is the fact that a noticeable proportion of firms maintain more than one office in those metropolitan regions characterised as being polycentric in Analysis I. In the Rhine-Main region 16.5% and in the Rhine-Ruhr region more than half (51.2%) of all firms considered have branches in more than one city within the metropolitan region.

Figure 3b shows that the second type of polycentricity clearly has a smaller influence on a region's connectivity in Analysis II than in Analysis I. In Analysis II the connectivity of the Rhine-Ruhr region is still much higher than the connectivity of Düsseldorf itself, but only on a par with the second-placed Munich region and not as exceptionally high as in Analysis I. In all other regions no further core city makes any noticeable contribution to the region's connectivity.

These results are confirmed in Fig. 4b when looking at the eight major metropolitan regions in detail. In the Rhine-Main region characterised as being multi-core polycentric in Analysis I, for the most part only additional branches are located in core cities other than Frankfurt. This infers that Frankfurt plays a dominant role within this region in terms of connectivity generated by leading global APS firms. In Analysis II, only the Rhine-Ruhr region can be characterised as being multi-core polycentric in terms of connectivity. As the pie chart for the Rhine-Ruhr region in Fig. 4b shows, the Rhine-Ruhr region is not dominated by a single metropolitan core. In Analysis II, however, not five but just two core

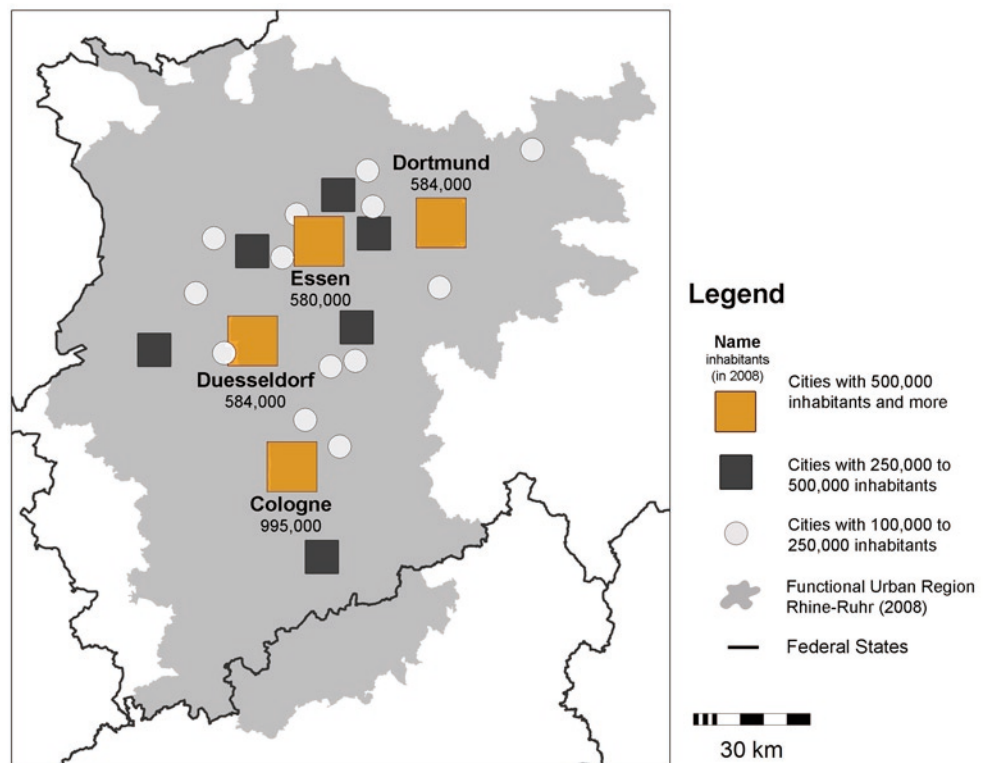
cities, Düsseldorf und Cologne, are found to make a substantial contribution to the region's connectivity, meaning that within the Rhine-Ruhr region Düsseldorf and Cologne are the dominant metropolitan cores. In the region's other core cities we mainly only find additional branches of leading global APS firms.

Thus, for the multi-core polycentric metropolitan regions the results are ambiguous, with our analyses showing two subtypes of multi-core polycentric regions. On the one hand there are multi-core polycentric regions with a dominant core. Within Germany there are two metropolitan regions, the Rhine-Main and the Stuttgart region, belonging to this subtype of polycentricity. In these regions polycentricity has only a minor impact on the region's connectivity as a whole (see also Hoyler/Freytag/Mager 2008). On the other hand there are multi-core polycentric regions with more than one dominant core. Within Germany there is just one metropolitan region of this subtype of polycentricity, the Rhine-Ruhr region. In this region polycentricity has a considerable affect on the region's connectivity. We will therefore take a closer look at this region in the next section.

4.3 A Closer Look at the Rhine-Ruhr Region

The Rhine-Ruhr region is the archetype of a multi-core polycentric metropolitan region without a dominant core, with Düsseldorf and Cologne partly sharing their global functions (see Fig. 5). Looking just at Düsseldorf, the best connected city within the Rhine-Ruhr region, we see that it accounts

Fig. 5 The Rhine-Ruhr metropolitan region. (Data source: Federal Statistical Office; author's own illustration)



for only 76%¹⁵ of the region's total connectivity, while in all other seven metropolitan regions shown in Fig. 4b the dominant core city accounts for between 89% (Stuttgart) and even 100% (Berlin) of the region's total connectivity. This indicates that Düsseldorf's (or more precisely the metropolitan Rhine-Ruhr region's) integration in the world city network is considerably underestimated. This is mainly due to the finding that the division of labour between Düsseldorf (ranked 81st in the GaWC 2008 analysis, Globalization and World Cities Research Network 2010b) and Cologne (ranked 171st in the GaWC 2008 analysis), two metropolises with their central business districts just 35 km apart (or 35 min by car or 21 min by high-speed train), is neglected in terms of their global functions when modelling the world city network. Findings for the Rhine-Ruhr region also indicate that even in this prime example of a multi-core polycentric metropolitan region comprising nine core cities that each have more than 250,000 inhabitants (see Fig. 4), the network connectivity generated by leading global APS firms is highly concentrated within the region, although in this case not in one but in two dominant core cities. Düsseldorf and Cologne together account for 98% of the Rhine-Ruhr region's total connectivity while all other core cities within the region and the commuter zones only account for 2%.

5 Conclusions

This paper aims to encourage discussion about the integration of polycentric metropolitan regions into the world city network by addressing this aspect exemplarily for German metropolitan regions. Looking at the results of the analyses, I conclude that the first hypothesis, i.e. that the post-suburban type of polycentricity within a functional metropolitan regions tends to be of little significance with respect to global connections of metropolitan regions, is confirmed by the two analyses. Even though the region's traditional centre(s) no longer dominate the region in all functions (Brake 2005, p. 13 ff.), they maintain their predominance as the preferred locations for highly specialized APS firms reliant on urbanisation economics. This especially applies to the law firms considered, which are concentrated entirely in the metropolitan cores within the eight major metropolitan regions. In the other four APS-branches considered (financial service firms, accountancy, advertising and management consultancy) the post-suburban zone accounts for 8 to 14% (Analysis I). The second hypothesis, however, which claims that the multiple metropolitan cores in multi-core polycentric metropolitan regions share their connectivity, cannot be

confirmed for multi-core polycentric regions in general, but only for such multi-core polycentric regions without a single dominant core (in terms of their integration into the network). The connectivity of multi-core polycentric metropolitan regions without a dominant core is underestimated in the world city network, which only looks at individual cities and neglects the share of network connectivity between the metropolitan cores in this subtype of polycentric metropolitan regions. It follows that more attention needs to be paid to this subtype of polycentricity when modelling the world city network. Though the Rhine-Ruhr region is an archetype of a multi-core polycentric urban region without a dominant core, with Düsseldorf and Cologne in particular sharing their connectivity, it is the only polycentric region of this type within Germany. It follows that further research is needed in order to investigate how common this subtype of polycentricity is throughout the world. It can be presumed that multi-core polycentric metropolitan regions with no dominant cores in terms of global connectivity are rather rare. Similar examples could be the Randstad in the Netherlands, the Pearl River Delta and Yangtze River Delta regions in China or the San Francisco Bay Area in the USA.

Further research is also needed to investigate how the division of labour between Düsseldorf and Cologne in the Rhine-Ruhr region (as well as between the metropolitan cores in other multi-core metropolitan regions without a single dominant core) can be characterised, i.e. which functional specialisation with regard to the Rhine-Ruhr region both cities show and why only two of the host of core cities in the Rhine-Ruhr region account for the dominant share of the region's connectivity. In general, questions pertain to the causes behind such observations and what impact the polycentric structure and the division of labour have on the region's spatial and economic development as well as on its visibility as a "global city (region)".

Although the analysis shows that the integration of multi-core polycentric metropolitan regions without a dominant core is underestimated in the world city network, the data is not sufficient to be able to ascertain these regions' actual rank within the world city network. This would require both a worldwide comparable demarcation of metropolitan regions and an extended data collection that not only covered individual cities but metropolitan regions as well. Such an analysis of a world city regions network would require a major amount of effort. As the bias in modelling the world city network can be assumed to only affect a small number of regions, and as the post-suburban type of polycentricity, to which the demarcation of the hinterland and the extended data collection would mainly apply, only plays a subordinate role, a pragmatic approach would probably be sufficient to better highlight the role of polycentric metropolitan regions in the world city network. This could be done by investigating which GaWC525-cities are, similar to Düssel-

¹⁵ 27% (Düsseldorf)+7% Düsseldorf on a par with others (except Cologne)+11% (Düsseldorf on a par with Cologne)+31% (Düsseldorf, Cologne and others on a par)=76%.

dorf and Cologne, characterised by an intraregional division of labour with regard to their global connectivity and therefore need to be considered in conjunction with each other in the world city network. Such an analysis would require neither a spatial demarcation of metropolitan regions nor an extended data collection.

One point of criticism regarding the Globalization and World Cities Research Network model is its focus on advanced producer services (APS) and the patterns of their inter-urban networks. This view has an Anglo-American bias which focuses too much on these advanced producer services while overlooking other types of companies for instance manufacturing companies that may have a global reach (see Robinson 2002). Looking at Germany, the current resilience and success of German small and medium-sized enterprises on global markets is evidently largely attributable to globalisation processes and could possibly display different patterns of transnational networks than those of APS firms. A closer look at German small and medium-sized enterprises and their networks could provide a new view on globalisation processes and give research on global or world city regions a new twist.

It is furthermore necessary to continue working on the fuzzy phenomenon of polycentricism. For Germany, and presumably all West European countries, the basic characteristics of polycentricism on a regional scale can be captured using the types of polycentricity described. Are these types of polycentricity applicable on a global scale, however? Post-suburban spatial structures such as "edge cities" (Garreau 1992) occur more often in such countries as the United States, and are at least in that country generally, as an alternative spatial concept to the central business district, significantly larger and more frequently shaped by producer service companies than new business centres on the fringes of German metropolises (Müller/Rohr-Zänker 2001). This would also imply that in these countries the post-suburban hinterland might play a significant role in a metropolitan region's global connectivity.

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