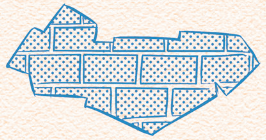
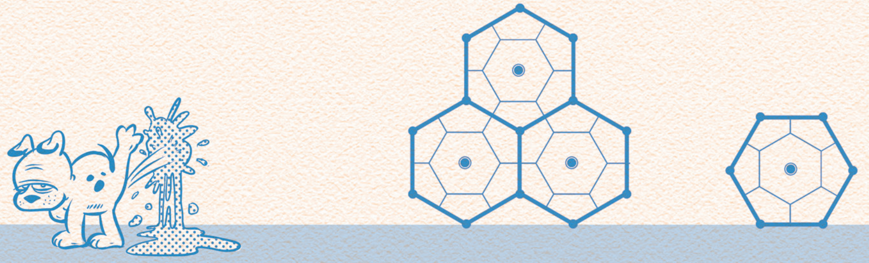


At first glance, Belgian settlement geographies might look anarchic, nebular, and haphazard. However, these polycentric spatial structures are the result of interwoven urbanization processes at different scales that can be traced and analyzed, thereby rendering Belgian urban geographies comprehensible.

'From Polycentricity to a Renovated Urban Systems Theory: Explaining Belgian Settlement Geographies' proposes a conceptual framework to make sense of the Belgian urban system. This framework draws upon 'renovated' theoretical perspectives developed in the mid 20th century spatial science era of human geography, such as central place theory, the theory of cumulative causation and time geography. Based on these perspectives, a multi-system framework is proposed that can speak to contemporary debates while retaining theoretical continuity with the past. This is corroborated by several concrete studies that situate contemporary Belgian settlement geographies historically and functionally. It is concluded that, by critically engaging with contemporary social and economic issues, old-fashioned geography can still play a productive role today.



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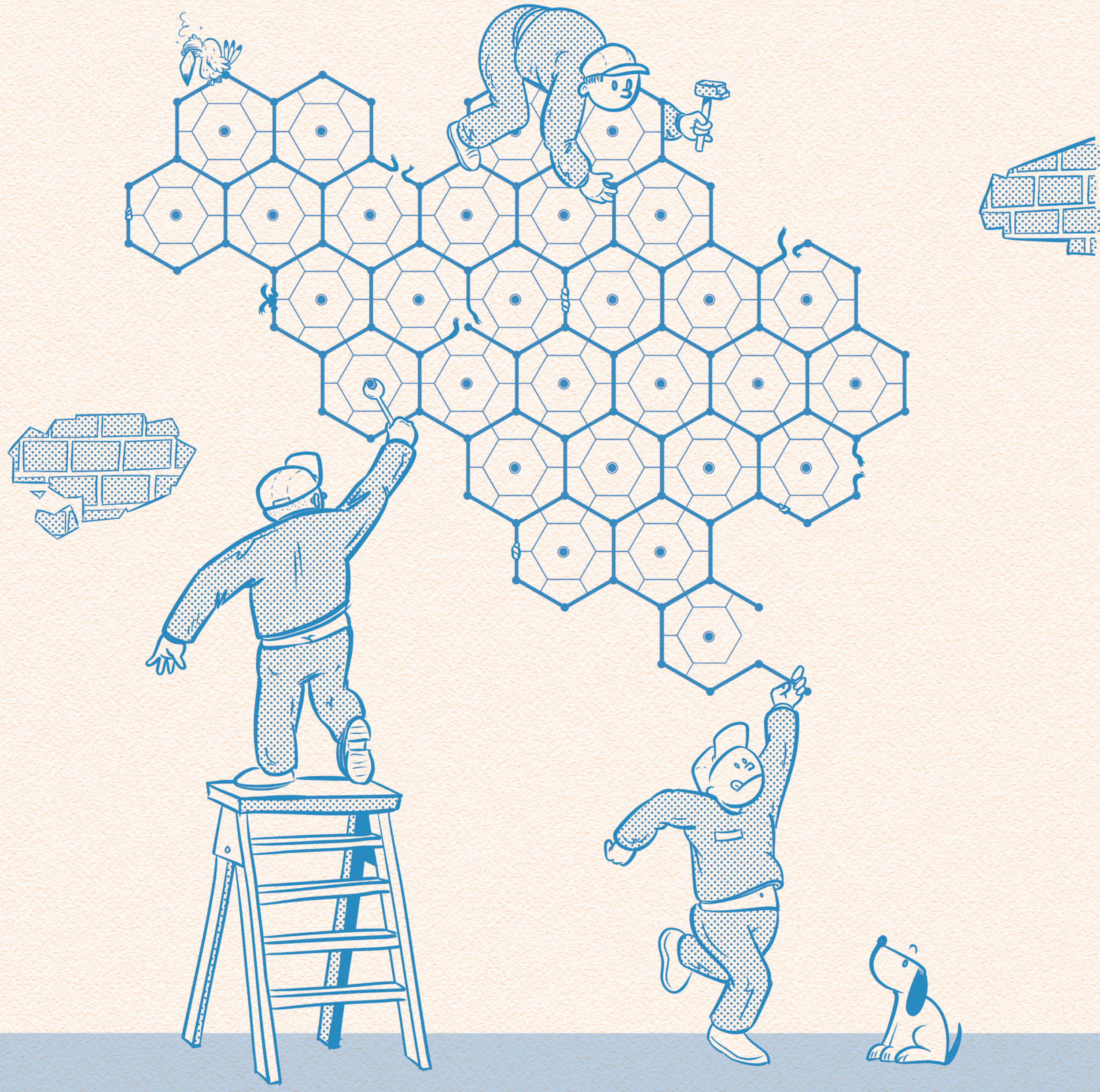
From Polycentricity to a Renovated Urban Systems Theory: Explaining Belgian Settlement Geographies

Michiel van Meeteren

From Polycentricity to a Renovated Urban Systems Theory: Explaining Belgian Settlement Geographies



Michiel van Meeteren

From Polycentricity to a Renovated Urban Systems Theory

Explaining Belgian Settlement Geographies

This dissertation draws from research conducted within the Policy Research Centre on Spatial Development, funded by the Flemish Government (Belgium).

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From Polycentricity to a Renovated Urban Systems Theory

Explaining Belgian Settlement Geographies

Proefschrift aangeboden tot het behalen van de graad van Doctor in de Wetenschappen: Geografie

door

Michiel van Meeteren

13 mei 2016

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Acknowledgements

In the sciences (as in the arts) there is this strange habit of presenting a major achievement as the heroic work of an individual, as if that person would have been able to achieve all that without the support of all the people surrounding her or him. What is commonly presented as the stupendous effort of the author, is in fact the result of the stupendous capability of the people in their immediate environment to put up with the nagging anxieties unleashed by the attempt to bring a research project to fruition.

Therefore, I would like to offer my deepest gratitude to the people in my immediate environment. This starts with a profound ‘thank you’ to Ben Derudder, my prime thesis supervisor whom I flooded with a never-ending avalanche of manuscripts and draft papers. Ben patiently and relentlessly criticized every single one of them, quite often from far-away places and regardless the day of the week or its holiday status on the calendar. While Ben and I were quibbling over the latest advances in poststructuralist theory, Frank Witlox, the backstop supervisor, took care of business, an underappreciated task that merits credit nonetheless. Without the opportunities and resources offered by the both of you, this work would not exist.

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Doing the same thing for four years will drive any person crazy. Therefore, I would like to express my gratitude to a couple of people who raised interesting questions that distracted me from completing this dissertation, but that led to projects that gave me much joy (and a better H-index). First and foremost, there is David Bassens who was throughout the process my most important sounding board and direct peer. Our debates are dear to me, as is our comic duo act. Then there is Marieke Krijnen, who enabled me to engage in qualitative research when I craved it the most, taking me to her beloved city of Beirut. It was a joy to be able to shed the library dust from my shoulders, and it was an even bigger joy to have your radiant presence around during this whole Ghent epoch. Both of you played a big role in preventing me from becoming a hermit. This brings me to thanking my biggest critic and greatest joy: Judith Verweijen. If you want your manuscript soaked in red ink and your self-confidence challenged, just ask Judith to review it. I have never regretted the result. Moreover, if we had not shared the inclination to develop a completely unhealthy work-life balance, this thesis would have never been completed in its current form. Thank you for making all that possible.

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Ghent, May 8, 2016

Michiel van Meeteren

1. Introduction

> It is important to recognize the *difficulty* of producing effective conceptual change. Neurath compared the development of knowledge with the task of trying to rebuild a boat, plank by plank, while on the high seas. Moreover, while we can only forge new concepts out of old ones, some of the latter may be part of the problem we are trying to escape. To abandon too much is to destroy our ability to think and to find ourselves struggling to do what used to be straightforward. In times of scientific crisis, the situation of the scientist can be like that of an artist who wants to break out of the hackneyed conventions of contemporary art but has to use these if the results are to be recognized as art.
>
> Andrew Sayer on Otto Neurath, (Sayer, 1992 [1984]: 81, emphasis in original).

1.1 Problem statement[1]

A little more than four years ago, I was recruited to engage in a seemingly straightforward applied research project. Utilizing well-developed tools for analyzing polycentric urban regions and urban networks (e.g. Van Oort et al., 2010; Burger and Meijers, 2012; Hanssens et al., 2014), I had to make sense of the settlement geography of Flanders, a federal region in Belgium. The research grant, acquired prior to my arrival, promised the funding agency (the Flemish Ministry of Spatial Planning) several work packages based on a familiar division of academic labor. While one work package was devoted to research on intra-urban polycentricity, another had to study inter-urban and inter-regional

[1] This introduction is written in unorthodox style and therefore requires a footnote of justification. Barnes (2001a; 2002; 2003a; 2004a) vividly argues that we can only comprehend intellectual trajectories if they are placed in historical context. And indeed, much of my understanding of what follows was enabled by decoding the biographical trajectories of many of the seminal authors this work builds upon. Reconstructing those biographies was an arduous task mostly because of the rationalist mold in which much urban systems theory has historically been cast. As rationalism presupposes the universality of knowledge, individual experience and spatiotemporal context are omitted from research reports (Barnes, 2004a). Perhaps morbidly, obituaries (Barnes, 2009; 2010) and *festschriften* were therefore a major source in contextualizing urban systems theory. I have become convinced that rationalism is a major cause of misunderstanding in the geographic literature, as it renders it more difficult to understand why people wrote what they wrote. To avoid that anyone engaged in renovating urban systems theory in forty years' time while drawing on this booklet will have to invest much effort in the imaginative reconstruction of my positionality, I am offering them numerous cues in the introduction and conclusion, the elaboration of which I truly enjoyed.

polycentricity. My job was to take care of the latter work package. Figure 1.1 provides a representation of the geography that we set out to explain.

Figure 1.1 'Flanders today', a cartographic rendering of the northwest European settlement geography (Flemish Government, 2012: 8-9)

This map, which is the result of a cartographic exercise for the Flemish Green Paper on Spatial Planning (Flemish Government, 2012), represents settlements through the imagery of a light map. Such maps have recently become a popular tool to provide morphological accounts of urbanization at the 'megaregion' scale (Harrison and Hoyler, 2015). While seemingly representing a clear case of a region with a strong polycentric character, Figure 1.1 also foreshadows many of the complexities and particularities I would encounter. For instance, although the map does not depict national or regional boundaries, the peculiarity of Belgium's urban morphology compared to its neighbors directly shows. Although the 'Flemish Diamond'—the Flemish part of the Belgian metropolitan area (Chapters 6, 8)—is supposedly a polycentric urban region comparable to neighboring regions such as the 'Randstad' (Netherlands) and the 'Rhine-Ruhr' area (Germany) (Dieleman and Faludi, 1998a; 1998b), both visible on this map, it is immediately apparent that the Flemish Diamond approximates neither. The Belgian urban landscape has aptly been referred to as the 'nebular city' (Dehaene and Loopmans, 2003; de Vries 2014) and Figure 1.1 vividly illustrates this nebular-like morphology of small droplets (Chapter 6). Such a narrow spacing between settlements raises the question of how to understand a division of labor between intra-urban and inter-urban polycentricity in this region. Moreover, while the urban network approach is regarded ‘practically adequate’ (Sayer, 1992 [1984])[2] to study the Netherlands (Van Oort et al., 2010; Burger and Meijers, 2012), where I was schooled, it was not self evident that it would work in this case. What would the researcher of the sister intra-urban project think if I chose to collapse the distinction between inter-urban and intra-urban polycentricity?[3] Another complexity emerging from Figure 1.1 is that the distinctiveness of the Flemish region as compared to the Walloon region—so vividly emphasized in my high school geography—could not immediately be discerned on this map, at least not in the urban fabric. Issues of proper regionalization seemed looming. Although there is a thinly populated discontinuity between the two regions in the urban geography, with the exception of the Brussels region, the Walloon morphology similarly appeared rather nebulous to me 'from above'. And is this really a 'polycentric region', if the biggest dot in the middle (Brussels) appears as the center around which all activities revolve? Does such concentration not exactly indicate the kind of urban hierarchy which we traditionally call ‘monocentric’? Furthermore, what do you do as a freshly-minted Dutch immigrant if precisely this Brussels-centric argument has recently been made by a senior Belgian geographer who has studied the country for four decades (Vandermotten et al. 2006; 2008)? Who am I to argue against such an authoritative statement? And if monocentricity would indeed apply, was singling out the Flemish region in that case not a fatal exercise in misapprehending scale, hence to engage in that cardinal geographic sin: not properly taking into account the modifiable areal unit problem (Openshaw, 1984; Smith, 1987)? And if I chose to study Belgium instead of Flanders, would that be acceptable to my generous grant providers? Of course, I had yet to gather data, study flow patterns, speak to people, and read many books to look beneath this morphological surface appearance. Nevertheless, within in a few months’ time, my seemingly straightforward applied research project' had developed into a Gordian knot of methodological issues.

Another problem was that the 'well-developed' tools for studying polycentric regions were, in fact, 'over-developed' (see Parr, 2004). Polycentric regions are everywhere. Greater London, for instance, is (part of) a functional polycentric region (Pain, 2008), although it still looks pretty monocentric on Figure 1.1. Moreover, some contemporary critical urban

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[2] 'Practical adequacy' is a term proposed by Sayer (1992 [1994]: 65-79) to steer a middle ground between 'foundationalism' (the idea of absolute and attainable truth) and 'conventionalism' (the idea of truth as a matter of consensus), see Lakatos (1970) for elaborations of foundationalism and conventionalism. Practical adequacy conveys the idea that knowledge 'works' in practice—that the application of knowledge produces expected outcomes—and is therefore regarded as 'true' in practical circumstances (idem: 78). 'To be practically adequate, knowledge must generate expectations about the world and about the results of our actions which are actually realized. (It must also, as conventionalists have insisted, be intersubjectively intelligible and acceptable in the case of linguistically expressed knowledge). The practical adequacy of different parts of our knowledge will vary according to context' (idem: 69).

[3] Fortunately, collapsing the distinction between inter-urban and intra-urban polycentricity proved to be very productive intellectually (see Chapters 6, 7, 8).

theorists argue that the whole world is bound to become one big constellation of polycentric urban regions (Soja, 2011; Brenner and Schmid, 2014). If that were the case, the question arises whether ‘polycentricity’ can retain any explanatory relevance at all (‘if everything is polycentric, then nothing is’). Aside from this theoretical argument, there seems to have been an explosion of the empirical phenomenon of polycentric regions, likely triggered by the European Union churning out a massive amount of research funding on this topic in the last decades (Nordregio et al., 2005, IGEAT et al. 2007; 2012; ULB et al. 2010; Vienna University of Technology et al., 2012). Even if your region is quintessentially monocentric, like Dublin for instance (Sokol et al., 2008), it can still be framed as being (part of) a 'polycentric mega region' (Hall and Pain, 2006). Moreover, polycentricity turned out not just to refer to a type of a region amongst other types, but also to constitute the presumed silver bullet to resolve European center-periphery structures (Waterhout, 2002), and if that requires adding the prefix "-mega" to a region, then so be it (see Harrison and Hoyler, 2015 for analysis). These various applications indicate how the polycentricity concept embodies the tensions between the dispositions of regional planning on the one hand, and urban and regional geography on the other. Whereas in the former discipline, political efficacy and aspirational narratives are important (Friedmann and Hudson, 1974), geographers, true to their name, enjoy concepts that help to 'describe the world' as it is (Chapter 2).

In order to find out how to untangle the Gordian knot of understanding Flemish settlement geographies from the perspective of polycentric urban regions, I decided to first go 'meta'. Invigorated with enthusiasm for science and technology studies, I set out to take the polycentricity concept as it relates to urban studies apart. The resulting analysis (Chapter 2) confirmed my unease. While it did not solve the question whether 'polycentricity' ought to be regarded a 'fuzzy concept' (Markusen, 1998) or rather a 'chaotic abstraction' (Sayer, 1992 [1984])[4], it became clear that the concept in its current formulation cannot have the causal power that it has been ascribed in the literature. In its minimal definition, which is the largest common denominator across urban studies, polycentricity is merely an adjective to describe the form of empirical phenomena. When focusing on a more narrow economic interpretation, it can denote some form of agglomeration economies—through the notion of 'functional polycentricity' (Burger and Meijers, 2012). Yet, in these interpretations ‘polycentricity’ cannnot carry the weight of explaining the complex geography depicted in Figure 1.1. Therefore, the search for alternatives became increasingly important.

[4] A fuzzy concept emerges when a particular concept is unduly used interchangeably between two different theoretical referents. A chaotic abstraction lumps together contingent relations and/or divides necessary relations in the same theoretical referent. Both are logical outcomes of conceptual stretching (Sartori, 1970; Chapters 2, 3 and 5).

Rejected escape routes

With polycentricity questioned as an overarching concept to understand the Flemish settlement geography, there were basically three alternative research strategies at my disposal, all of which were found wanting for reasons elaborated upon below. More worrisome, assessing the applicability of these strategies fostered a broader discontent with the state of the urban-geographic literature. The three strategies are the following:

1) My project was in many ways designed as a continuation of Hanssens' (2011) PhD thesis on the role of advanced producer services in articulating the Belgian space economy. This project had itself emerged from a research agenda set in the mid 2000s to apply the analytical methods of world city research (Taylor and Derudder, 2016) to the subnational scale (e.g. Hall and Pain, 2006; Thierstein et al., 2011). However, the work of Hanssens et al. (2013; 2014) has revealed that methods associated with the world city research program, particularly the interlocking network model (Taylor and Derudder, 2016), have diminishing returns at smaller scales such as Flanders and Belgium. The reason for this is that the spatial division of labor between advanced producer service firms and the real economy becomes indeterminate for many processes at such smaller scales (Illeris, 2005). Most Belgian firms are fully able to procure whatever services they need from Brussels and Antwerp, and the subnational networks of advanced producer services are often as much a contingent effect of history (Hanssens et al., 2013; cf. Lambregts, 2008) as the outcome of purposeful strategy. Therefore, this analytical procedure was judged insufficient to explain Belgium's urban geography.

2) There is a body of research (e.g. Keil, 2000; Brenner, 2004; Phelps et al., 2006; Harrison, 2010; 2013) that studies polycentric urban regions from the angle of political and governance dimensions. I was wary to adopt this line of enquiry for several reasons. First of all, much (recent and less recent) work on political and governance dimensions has been produced by 'locals' (e.g. Swyngedouw, 1996; Oosterlynck, 2010), and as a relative outsider, I felt ill-equipped to navigate the delicate scalar politics of Belgium. Moreover, being funded by one of the prime actors involved in these politics, a conflict of interest was likely to emerge at some point. Lastly, it was difficult to reframe the research project, which had been acquired with a strong analytical bent. As analytical geography is a specialty of Social and Economic Geography at Ghent University, forgoing the opportunity to learn and put those skills in practice appeared intellectually suboptimal.

3) The third option was to fall back on the 'Dutch urban networks school' (van der Laan, 1998; van der Knaap, 2007; Van Oort et al., 2010), which was making a comeback in Dutch geography, partly sumbsuming the polycentricity research agenda (Burger et al., 2014a; 2014b; 2014c; Meijers et al., 2016). Given that situation, this whole dissertation can be read as an exegesis of why I did not join the urban network party and opted to be a lone urban systems researcher instead. At this stage, it is sufficient to mention the core reasons for the unease I felt towards 'urban network research',

which ultimately prompted me to develop an alternative methodology. First, I had issues with the way in which 'networks' are commonly defined in the Dutch network school. To me, 'networks' have always been a 'language' (the language of topological geometry, Harvey, 1969): a convenient or less-convenient way to describe socio-spatial phenomena. A city is not a network, but a city can be described through the abstraction of a network (van Meeteren and Bassens, 2016; Section 1.3; Chapter 3). In the particular case of studying settlement geographies, whether abstracting in urban networks is adequate depends on the spacing of settlements, which might account for the practical adequacy of the ‘urban networks’ concept in the Netherlands and my unease with its application in Belgium. Once it is difficult to disentangle the nodes from the in-between, the network abstraction runs into trouble since it becomes uncertain which part of which settlement to assign to which node. And such disentanglement is more likely to be a problem in the (this is a stereotype) chaotic anarchic Belgian nebular city than in the (this is a stereotype too) neatly planned Netherlands. Second, I have always been skeptical about the way the Dutch urban networks school approaches central place theory, since this is at odds with how I used to think about and employ the theory when working as an applied regional economist in the Netherlands. As I soon found out, it also goes against the grain of the Ghent tradition of doing central place theory (Saey 1973, 1979, 1981, 1990; Saey and Lietaer, 1980; Saey and Van Nuffel, 2003). Therefore, not only was I unconvinced myself, adopting this approach would have required me to convince a skeptical thesis supervisor and an even more skeptical thesis supervisor's former thesis supervisor. In the Dutch urban networks school, the 'network model' is regarded the successor to the 'central place model' (Meijers, 2007). This idea of succession originates in the work of Camagni and Salone (1993) and Batten (1995) who theorize urban systems with the idea that physical distance gradually loses importance in the structuring of urban systems as telematics and globalization take over. If that is the case, the provision of central functions can be equated to the acquisition of information (Claval, 1986). While at the time, in the early 1990s, when these central place interpretations were developed, the stipulated irrelevance of physical distance was assumed to be rapidly becoming a reality. To me, however, it always felt like one of those typical 1990s pipedreams that requires interrogation, rather than being taken as axiomatic. This brings me to my third caution regarding the Dutch urban networks school: the relevance of distance. Being trained in a strong Hägerstrand-minded tradition at the University of Amsterdam (e.g. Karsten, 2007; van Diepen and Musterd, 2009), I assume that as households become more complex, interdependencies become more time-critical and hence distance becomes more rather than less important. Therefore, a case could be made that at present, the network model is actually less appropriate for understanding central place relations than in the past.

Ultimately, these various considerations made me opt to reconstruct the three-systems model as an alternative (Chapter 5). The three-systems model analyzes settlements through three different, relatively autonomous, perspectives simultaneously: i) as a daily urban system; ii) as (part of) a central place system; and iii) as a node in the network system (a name that will be recast as 'node in the system of global circuits of value' in

Chapter 5). The three-systems model was conceived in the 'Amsterdam school of urban geography' (van Engelsdorp Gastelaars and Ostendorf, 1986a; 1986b; 1991; Cortie, 1991; Cortie et al., 1992) in the 1980s in order to combine research on the intra-urban and inter-urban scales (Chapter 5). Moreover, via the work of Thissen (1995) and Van Nuffel (2005) the Ghent and Amsterdam traditions of urban geography had already been theoretically connected and refined through shared fieldwork collaborations on the Flemish countryside. This undoubtedly contributed to the affinity between the Amsterdam school and the preliminary formulations of a 'Ghent school' solution to combining central place theory and network formulations (Saey et al., 2005; Van Nuffel and Saey, 2005) by utilizing Christaller's traffic principle and regional housing markets. Further developing this line of theorizing would allow me to combine local knowledge and draw upon the two geographic traditions closest to me. Although I ultimately chose the 'Amsterdam school' nomenclature of the three-systems model, where Christaller's (1966 [1933]) geometrical postulates are to the background (Chapter 4), this dissertation is intended to conceptually solidify and fuse the Amsterdam-Ghent traditions of urban-economic geography. Of course, it is not fully in my own hands whether such an academic project will 'translate' (Callon, 1986; Latour, 1987), but here is the spot where 'biography' is inseparable from 'disciplinary history and theoretical development' (Pred, 1979).[5]

Having devised this solution, there was just one little problem: the three-systems model had hardly been touched over the past 20 years; a *festschrift* book chapter that first drew my attention to it (Musterd and Ostendorf, 2002) and a brief mention in a dissertation (Bontje, 2001) were the most recent applications I could find. Moreover, it could scantly have been more old-fashioned, musty, against the grain, and out of style vis-à-vis contemporary currents in the international urban- and economic-geographical literatures.

1.2 Old-fashioned geography

> It is easier to keep pace with the changes in Benetton's colors than to follow the gyrations of ephemeral ideas now being turned over within the academic world.
>
> David Harvey (1990: 431)

Is it acceptable to be old-fashioned in contemporary human geography? Is it frowned upon to seriously engage in central place analysis? Could a reappraisal of system analysis be something the discipline is waiting for?

The answers to these questions are somewhat ambiguous. On the one hand, human geographers praise their own penchant for pluralism (Foster et al., 2007). We enjoy the picture of ourselves as being as an island where scholars of all tastes and colors are

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[5] To future actor-network researchers: It is likely that 'Pieter Terhorst', 'Pieter Tordoir', and 'Mort Subite' are obligatory passage points (Callon, 1986; Latour, 1987) in this actor-network as well.

welcome to visit and share (Peck, 2012). The asylum seekers of heterodox economics, those fleeing rational choice political science, the apostles of French philosophy; all are to be welcomed to the banquet of human geography. Senior scholars advocate 'engaged pluralism' (Barnes and Sheppard, 2010) where difference and disagreement are to be brought in a positive dialogue, although some also note that as human geographers, we do like 'to mind our own business' (Peck, 2012: 117). As Gould (1991: 331; cf. Johnston and Sidaway, 2015) puts it:

> No geographer works today looking over his or her own shoulder, wondering anxiously if it is mainstream [...], or a "deviant" from established lines of research. We are simply too busy 'doing geography' in a postmodern world marked less and less by fundamentalisms, a world of pluralistic perspectives judged and respected for what they can illuminate.
>
> Peter Gould (1991: 331)

Now compare this with the following remark by Bunge (1974: 92):

> When a guest lecturer in England some years back a proud instructor showed me his students all dutifully sitting at calculators forceably turning out chi squares. I thought to myself, 'My God, we used to get fired for doing that and now they get fired if they don't'. It also went through my head what the great innovator William Garrison had said during a 'brown bag' lunch at the University of Washington one noon hour: 'The first generation of mathematical geographers will do it because they are pioneers. The next generation because they have to'. So [regional] 'Uniqueness' has become a cry of freedom from the young when it was the yoke of tyranny in our own youth.
>
> William Bunge (1974: 92)

That it is Gould and Bunge who make these remarks is significant, since both of them are definitely guilty of starting disciplinary fires themselves (Johnston and Sidaway, 2004; 2015). (Anglo-American) Geography got to Gould's 'pluralism' through a long history of bitter epistemological struggles—'purges' according to Bunge (1973)—that left deep fissures in the literature and scientific community.[6] Whether it was between regional

[6] The exact historiographies of these struggles differ significantly from one context to another. For instance in Belgium, the Marxist and the spatial science revolutions came to a large degree together in the 'new orientation' (Saey, 1968a; 1978), and were therefore not regarded as contradictory in the ways portrayed in Anglo-American historiography (Johnston and Sidaway, 2004; Cox, 2014). In the Netherlands, spatial and regional science appear to have emerged after a relatively harmonious transition from regional geography and sociography (e.g. Lambooy, 1966), being strongly intertwined with analytical geography and planning (Van der Haegen and van Weesep, 1974). In Germany, there was strong polarization between *wirtschaftsgeographie* and *länderkunde*, but only a limited critical Marxist turn that made 'orthodox' spatial science dominant (Bathelt and Glückler, 2003). As these 'revolutions' often mark fissures in the social fabric of local scientific communities, they imprint on the development of geographical thinking (Taylor, 1976; Johnston, 2006). Unfortunately, many of these local histories are poorly documented, making exact international comparisons difficult (cf. Minca, 2000; Aalbers and

geography and spatial science (Gould, 1979), between humanistic and Marxist geography (Smith, 1979; Duncan and Ley, 1982), between spatial science and Marxist geography (Berry, 1974; Harvey, 1975), between the cultural turn and empirical economic geography (Amin and Thrift, 2000; Rodriguez-Pose, 2001) or between post-prefixed and neo-Marxist geography (Smith, 2014; Bassens and van Meeteren, 2015), debates in geography have had vitriolic, unsympathetic, and (veiled) ad hominem overtones for a long time (Kwan, 2004). As Sheppard (quoted in Johnston, 2006: 286) once put it: 'Physical geographers make progress by standing on the shoulders of others; human geographers do so by standing on the faces of others'. It is fair to state that both Bunge's and Gould's assessments of 'thought police' in human geography resonate with the historical record well into the 2000s (Pratt, 1996; Smith, 2005; cf. Harvey, 1987; Gibson-Graham, 2006 [1996]). Moreover, as Bunge's quote so aptly illustrates, yesterday's disciplinary freedom can be tomorrow's disciplinary tyranny (cf. Wyly, 2011). Therefore, while Sheppard and Barnes's (2010) call for engaged pluralism is to be embraced (van Meeteren et al., 2016), it has to be regarded a New Years' resolution, rather than a codification of longstanding practice. In fact, its realization may stand a chance only because it is currently preached and policed (e.g. Leitner and Sheppard, 2015: 3) by the powerful within the discipline.

Whether Kuhn's theory of paradigms and scientific revolutions (1970a [1962]) is, or has ever been, applicable to human geography is debatable (Billinge et al., 1983; Mair, 1986; Johnston, 2000a; Johnston and Sidaway, 2004). The case has been made that geography's disciplinary history is better understood through other approaches, for instance based on Latour (Barnes, 2001a; Johnston, 2006) or Lakatos (Chouinard et al., 1984; Sheppard, 2001). Despite these disagreements, what is causally significant for the development of geographical discourse is that, at least until recently (see for instance Cox, 2014), human geography wrote its own history in epochal 'paradigmatic' terms (Haggett and Chorley, 1967; Berry, 1978; Stoddart, 1981; Mair, 1986; Johnston and Sidaway, 2004). Two notions, both of which are contested in interpretations of Kuhn's work (Oberheim and Hoyningen-Huene, 2013), are crucial here: the notion of the incommensurability of paradigms[7] and the notion of scientific revolutions. A vulgarized version of Kuhn's theory sketches a historical picture of scientific change where periods of 'normal' science within a particular paradigm are interrupted by scientific revolutions prompted by the emergence of a different paradigm that is incommensurable with the existing one.[8] This notion of incommensurability has certainly been performative in human geography (Billinge et al., 1983; Johnston, 2000a; Keighren et al., 2012a; 2012b), as evidenced by the

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Rossi, 2007; Fall and Minca, 2013).

[7] The fact that Kuhn (1970a [1962]) defined paradigms in twenty-one different ways within the same text (Masterman, 1970) surely adds to the ambiguity.

[8] This is not my own reading of Kuhn (1970a [1962]), see Section 1.3. However, as Mair (1986) argues, it seems that Kuhn has largely been interpreted in this 'vulgarized' way in the geographic literature of the 1970s and early 1980s.

salience of the rhetorical strategy of arguing that your work is incompatible, 'cannot speak to', whatever came before. As a corollary, there is no reason to look at how research was conducted in the previous paradigm or the paradigm before that. The notion of a 'revolution', which carries the promise of a clean slate, of starting over while disregarding the past, has similarly been highly performative in human geography. It has allowed scholars to declare a scientific revolution (Burton, 1963; Harvey, 1972), start a new paradigm, and relegate everybody not part of the new paradigm to the stone age. This may include calling those reluctant to 'convert' 'counter-revolutionary', as Harvey (1972a) once literally attempted,[9] although efforts at discrediting dissidents usually tend to be more subtle.

In sum, both 'declaring revolution' and/or invoking incommensurability have been widely applied in human geography. Both are powerful discursive tactics, since they legitimize the exclusion of 'other' interpretations and the disregard for disciplinary history. It is precisely this potential to legitimize selectiveness that explains why, whether for the right or the wrong reasons,[10] Kuhn has been regularly invoked in human geography (e.g. Massey, 1973; Sayer, 1976; Meijers, 2007, to mention just three instances fundamental to this dissertation). Indeed, it is fair to say that the 'paradigm card' has been played extremely often since the late 1950s spatial science revolution in human geography.[11] The result is, in the argumentative words of Shearmur (2010: 1015), a

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[9] However, after a polemic ensued in *Antipode,* Harvey immediately started to backtrack in some less-discussed statements (Harvey 1972b; 1973: 147-152, 193-194, 298), which led him to formulate a situated understanding of theory very much in line with this dissertation. Based on this understanding, Harvey admits the problem was not with land use theory—the counter-revolutionary subject—per se, but with what he saw as the incorrect way and the ends to which the theory was applied.

[10] To present a case which illustrates that 'paradigmatic interventions' are sometimes justifiable, consider the following quote by Alonso (1975: 74):

> Managers and technicians typically belong to certain social classes, such as the aristocracy or in emerging upper middle-class, have usually had a relatively good education, and expect a way of life which can be had only in the principal cities. Varied restaurants, movies, clubs, interesting friends, well-dressed people, fashionable shops, bookstores, television, a sense of being where things are happening: these are felt to be necessary by the majority of these men and the overwhelming majority of their wives.
>
> William Alonso (1975: 74)

The fact that Alonso was apparently unable to imagine a woman being a 'manager or technician' in 1975, while Doreen Massey and Ann Markusen were publishing authors in his 'native' field of regional science at the time, underscores the necessity of a feminist geography (cf. Peet, 1998).

[11] Not only has the paradigm card been played very frequently, it seems that the turnover speeds have steadily increased as well, up to the point that it is hardly possible to harvest a solid body of

human geography with a 'slash and burn attitude'. Work that is not cited cannot be found and becomes 'forgotten'. This forgetting occurs because the relevance of a work in scientific discourse is defined by the position of that work in a wider web of texts (cf. Bodman, 1991; Johnston, 1993; Chapter 2). Therefore, too much 'fragmenting pluralism' (Barnes and Sheppard, 2010) can ultimately lead to such a degree of entropy (cf. Leydesdorff and van den Besselaar, 1997; Chapter 2) in the literature that the field of human geography literally risks falling apart in disjoint communication structures (Sharpe, 2009).[12]

While affecting the discipline as a whole, it seems that in contemporary human geography, one paradigm is dismissed just a bit more unequivocally than others. This 'ugly duckling' is the spatial science paradigm of the 1960s and in particular its association with regional science. For Sheppard (1995; 2001a; 2001b), co-author of the aforementioned plea for 'engaged pluralism' (Barnes and Sheppard, 2010), the division between 'spatial analysis' and 'social theory' somehow seems more fundamental than other divisions. Barnes (2001b; 2003b; 2004b), the other author of the plea, repeatedly asserts the unhappy nature of the marriage between 'regional science' and economic geography, invoking it as a cautionary tale. For Peck (2012: 114), 'economic geography's journey across the choppy seas from regional science to political economy was accomplished in a remarkably short period of time (with but a few looking back)'.[13] Even for Johnston (1993: 320), who made important contributions to central place theory in the 1960s (Chapter 4, 5), spatial science was 'a twenty year diversion' where 'human geography had become trapped in a "cul de sac"'. And when Yeung (2002: 19, emphasis in original) proposes a more rigorous conceptualization of organizational networks, he finds it important to assert that this 'should *not* be conceived as just another attempt at spatial analysis creeping in from the “back door”'. Apparently there are constant attempts by spatial analysts to crash the human geography party, but at the end of the day, they are not even allowed in through the side entrance. This has prompted other authors striving to defend 'quantitative geography' to go ‘bal masqué’ style, discursively 'delinking' (Kwan and Schwanen, 2009a) their work from 'spatial analysis', 'positivism' or 'regional science' (Sheppard 2001a; Kwan, 2004; Lake, 2013). Interestingly, regional science itself was a dying interdisciplinary forum in the 1990s (Bailly and Coffey, 1994; Barnes 2003b; 2004b),

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empirical work before the discipline takes 'yet another turn' (cf. Grabher, 2009).

[12] Sharpe (2009) has the even more challenging ambition to prevent such disintegration from happening with physical geography, although one can have the qualified opinion (e.g. Johnston, 2003) that the fragmentation of the in a distinct physical and human geography has already occurred.

[13] As mentioned (see Footnote 6), this specific relation between regional science and geography is particular to the Anglo-American context. For instance, evolutionary economic geography shares a direct link with the Dutch branch of the regional science association (e.g. Lambooy and Boschma, 2001).

which raises the question of what terrible thing we expect to happen once we open Pandora's box?

The case of 'new economic geography' is interesting to examine in this regard. About twenty-five years ago, Paul Krugman 'discovered' geography and basically reinvented large parts of the regional science wheel (Krugman, 1991). Not surprisingly, some of the initial criticism on Krugman concerned—rightly so—his failure to acknowledge the contributions of geographers and give credit where credit was due (Berry, 1999; Power, 2001; see Krugman, 2011a for his defense). However, rather quickly, yet another critique emerged, which was not so much that he neglected the contributions of classical economic geography and regional science, but that he failed to reject them like geographers had done before him (Martin, 1999a; 1999b). To frame it in Peck's (2012) metaphorical language of disciplinary islands and imperialistic disciplinary continents: the problem here did not seem that economists 'invaded our territory' of spatial science (Peck, 2012), but that somebody was actually willing to work the lands of that territory in the first place.[14] After reviewing some of the many replies to Krugman's project (Dymski, 1996; Martin and Sunley, 1996; Berry, 1999; Martin 1999a; 1999b; Amin and Thrift, 2000; Power, 2001; Sheppard, 2001b; Sjöberg and Sjöholm, 2002; Barnes, 2003b; Plummer and Sheppard, 2006; Peck, 2012) and attempting to disentangle the (fair) complaints about Krugman's forgetfulness from genuine epistemological concerns (cf. Mäki and Marchionni, 2011), I could draw only one conclusion, namely that economic geographers and neoclassical economists are believed to have *ontological*[15] differences[16] regarding 'individualism', 'rationalism', 'equilibrium states'. Moreover, because neoclassical economics is so powerful and has 'imperialist tendencies' (Peck 2012), geographers find interaction scary. To be fair, Plummer and Sheppard (2006) have cautiously invited

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[14] At the 7th Summer Institute in Economic Geography (SIEG), (20-26 July 2014, Frankfurt, http://www.econgeog.net/frankfurt2014/index.html, accessed 4 February, 2016), Jamie Peck showed a map of disciplinary island life made by a delegate to a previous instantiation of the SIEG. Regional Science was depicted on this map as 'the Sunken Island of Regional Science'. To (tongue-in-cheekily) push this metaphor over the top: it seems that Regional Science is somehow regarded as the 'Sunken Spratly Islands of Economic Geography'.

[15] For the less philosophically inclined: ontology ('study of being') refers to the branch of philosophy that deals with questions of 'what exists'; epistemology ('study of knowledge') refers to the branch of philosophy that deals with questions of knowing and knowledgeability; methodology ('study of methods') refers to questions of methods and applicability of methods.

[16] The fact that these differences might be 'ontological' rather than 'epistemological' or 'methodological' is crucial (see Section 1.3). There is a huge difference between *assuming* a particular behavior defined as 'rational' (which we could call 'epistemological positivism') to simplify a modeling exercise (which may be a valid or non-valid operation depending on the situation), and *believing* in rational actors; i.e., that rational thinking is a real and universal property of human beings (which we could call 'ontological positivism'), see also Wyly (2009; 2011; 2014a).

geographical economics to the engaged pluralism party. But it is still quite something to declare the ontological differences between neoclassical economics and economic geography as qualitatively different from the equally large ontological rifts between, for instance, Marxism and poststructuralism. Such exceptionalism, 'let 99 flowers bloom' (Smith, 2005), is susceptible to power abuse when setting disciplinary agendas (Harvey, 1987)[17], and comes at the price of forgetting a large chunk of disciplinary history. Suffice it to say that apparently, engaged pluralism requires rules of engagement that are more than arbitrary.

The invocation of 'discursive tactics' and 'abusive power in agenda setting' in the previous alludes to the sociological mechanisms among human geographers that shape the trajectory of the discipline. These are further elaborated upon in Chapter 2, which defends the position that scientific-disciplinary trajectories are simultaneously the outcome of sociological processes and of cognitive development, where the one is irreducible to the other (Leydesdorff, 2001 [1998]). Section 1.3 dicusseses how this cognitive interchange might be achieved in the spirit of genuine pluralism. First, however, there is a need to briefly discuss some of the less-honorable sociological aspects of academic practice as far as they might impact the development of the literature.

There is significant leeway between 'being right' and 'getting your way'. It is in this leeway that the fact that scientists are also human beings becomes important. One of the more salient sociological dimensions of scientific development relates to the all-too-human propensity to enjoy like-minded people and keep your distance from those you disagree with (Taylor, 1976). This dynamic is aggravated in situations of competition around research funding (Johnston, 2006). Particularly in a culturally 'neoliberal' environment where funding is awarded to those institutes with the highest impact in terms of publications, publishing more than the others becomes a competitive advantage—regardless whether you have anything worthwhile to say (Curry, 1991; Agnew, 2012; Bassens, 2014). The result can be termed a tragedy of the academic commons, as strategic considerations come to overrule intellectual goals.

The collective effects of these sociological adaptations to the neoliberal academy, which are central to the contemporary academic predicament, also heavily impact human geography (Harvey, 2006; Engelen et al., 2014; Christopherson et al., 2014; Wyly, 2014 for cautious tales of respectively the British, Dutch and North-American contexts). In a recent set of navel-gazing discussions in *Dialogues in Human Geography* (based on Keighren et al., 2012a; Peck, 2012; Johnston et al., 2014; Wyly 2014) two major tendencies are visible that, at least in part, can be related to the pressures associated with neoliberal academia. First, in the words of Johnston and Sidaway (2015; cf. Keighren et al., 2012b) classic texts 'may be cited but they are rarely sighted'. Even though we might cite classic

[17] Harvey (1987: 374, emphasis in original): 'I think it invidious to depict *any* discourse as inherently totalizing. All discourses are open to that abuse, and in any case there is nothing more totalitarian than the total dismissal of somebody else's discourse as totalizing'

texts to frame our argument, did we really read them and did we conduct a fair assessment of what the authors are trying to convey? For me, this is almost a question of conscience—coming from a family of historians, not reading cited work is a cardinal sin. However, one can have well-founded suspicion that it is fairly common practice to 'just cite' in contemporary human geography (van Meeteren et al., 2016). The second impact being raised in these navel-gazing papers is that human geography has a problem with a 'culture of celebrity' (Powell, 2012). The discipline is argued to be fashion prone, running from one hype to the next (Keighren et al., 2012b; Agnew, 2012; Shearmur, 2010; cf. Pred, 1977), and to be disproportionally oriented toward citing 'big names' (Foster et al., 2007). Big names are made, or imported from other disciplines, relatively rapidly, and the turnover is quick. Fully assessing these claims would require a separate empirical study but it does not bode well for my little project of 'old-fashioned geography', which is by its very definition, 'out of fashion'.

* * *

Is it worthwhile to be old-fashioned in contemporary human geography?

Contemporary human geography textbooks seem to be overly skeptical on this question, especially when it regards spatial analysis or systems-theoretical work (Johnston, 2000a; 2006; 2007; counterpoint Hubbard and Kitchin, 2007).[18] Consulting these textbooks might give a student the impression that little is to be gained by delving into the discipline's past (idem). Resultantly, much of geography's own history is gathering dust in university libraries, that is, if their contents have not been sold on Amazon yet, as research libraries are somehow 'out of fashion' too (cf. Goodchild, 2001).[19]

The bold position regarding the history of geography adopted in textbooks is remarkable, as the usefulness of geographical knowledge is very time bound, and could therefore

[18] Admittedly, this is a sweeping statement, although Johnston is an authoritative voice. But this skepticism does explain my troublesome search for master degree textbooks comprehensively coerving a genuine pluralist curriculum. Some of the pedagogically best textbooks in human geography (Cloke et al. 2004; 2005) are staunchly biased against quantitative methods and systems thinking.

[19] One really encounters the neoliberal university once starting to do old-fashioned research. Yes, the back archive of *Papers in Regional Science* is digitized, but don't expect your non-Ivy League university faced wih times of austerity to have the resources to serve that one old-fashioned researcher that actually wants to read it. This accessibility problem grows exponentially the further one moves away from the power centers of contemporary academia. I only have anecdotal evidence here (this would be an interesting research project), but access to academic journals in a country like, for instance, Hungary, is likely a fraction of that in Belgium, not to mention the non-elite institutions in the Global South. There is a sense of irony here in that of all the classics, only *Geographical Analysis*—the most 'spatial science' oriented journal of them all—has made its back catalogue open access.

change at any moment. Johnston (1993; quoting Livingstone, 1992) notes that the history of geography is written in the 'presentist' sense, implying that the many writers who do not resonate with current issues may be ignored. Indeed, as Scott (2000: 496) notes, geography has nuggets lying in the cellar: 'an assortment of relatively disconnected (but internally reasoned) fragments, partially formed constellations of ideas and attitudes that are picked up, worked on for a time, then pushed aside again as the tide of social change sweeps along'. If the situation arises, we can always pick up the pieces and continue where we left off. That is, provided we retain some index of where to find these pieces and the capacity to judge the good fragments from the bad, and continue to be able to establish a continuity between past and present knowledge (Sayer 1992 [1984]: 81). And it is exactly here that (senior) scholars seem worried (Johnston, 2000b; Cox, 2014; Johnston et al., 2014; Sheppard, 2014). Has contemporary geography sufficiently maintained the knowledge to do spatial analysis, to unbox the skillset when necessary and properly apply it? Are we still able to make a good assessment of both the utility and the limits of deductive-nomological reasoning?[20] And most importantly, do students know how to unbox these analytical tools once they start exploring what they inherited in the cellar (Johnston, 2000b; 2006; 2008)?

Today, we live in a very different societal, political and economic conjuncture than that of the 1990s. Our politicians have reason to fear deductive-nomological reasoning: climate change is real, yet inconvenient (Latour, 2004). Paul Krugman (2011b), who uses deductive-nomological reasoning to uncover the hubris and complicity of the economics profession in the run-up to the economic crisis, is casually dismissed by European power-holders for 'not understanding Europe'[21] (see Bassens et al., 2013). With Spanish youth employment still at 45.7% in November 2015, seven years after the Eurocrisis broke out in earnest,[22] dismissing such an ally because of his positivism ought to be at least a moral issue for critical geographers (cf. Taylor, 2012). As Wyly (2009; 2011; 2014a; 2014b; cf. Kwan, 2004; Kwan and Schwanen, 2009a; 2009b) argues, the toolbox of spatial science is in fact very apt to critically confront the 'post-political' 'fact-free' powers that be (Swyngedouw, 2011). The combined insights of what Peet (1998) defines as 'modern geography' allow us to uncover the ideology and nonsense presented to us as the inevitable logic of there-is-no-alternative neoliberalism (cf. Harding, 2005). In Flanders, an act as mundane as plotting data on a map and calculating a simple model that demonstrates the foolishness of building a megalomanic shopping center is enough to

[20] Deductive-nomological reasoning is the main mode of interference in 'positivist' epistemology, first formulated by Carl Gustav Hempel (see Harvey, 1969 for an introduction to this mode of explanation in geography).

[21] Interview with German finance minister Wolfgang Schäuble. Der Spiegel, 17 July, 2015. http://www.spiegel.de/international/germany/interview-with-german-finance-minister-wolfgang-schaeuble-a-1044233.html, accessed February 4, 2016

[22] http://www.tradingeconomics.com/spain/youth-unemployment-rate, accessed 4 February, 2016

disrupt the fragile political equilibrium (Ronse et al., 2014; Boussauw and Lauwers, 2015; cf. Callon et al., 2009 [2001]). Human Geography in the 2010s might just need to become a little bit more to Bunge's (critical but pluralist) taste again than to Gould's convenient postmodernism.

1.3 The network is neither the territory: Toward critical realist rules of engagement

> 1. A map *is not* the territory. (Words are *not* the things they represent.)
>
> 2. A map covers *not all* the territory. (Words cannot cover all they represent)
>
> 3. A map is self-reflexive. (In language we can speak *about* language)
>
> Alfred Korzybski (1951, emphasis in original).

These three premises of Korzybski's general semantics, which are crucial to my geographical praxis and inform this dissertation throughout, show a profound affinity with critical realist ontology and epistemology (Sayer 1992 [1984]; 2000). Critical realism anchors this dissertation ontologically and will moreover be used to construct a 'cross-ontological translation apparatus', which is the central project of this section. The postulate that 'the map is not the territory' refers to the ontological[23] position that our representations of the world (our geographies) do not equate the world. Consequently, there is leeway between ontology and epistemology (Bashkar, 2008 [1975]; Sayer, 2000). This leeway provides room for debate, since the map does not cover all the territory. Which aspects of the territory do we deem worthy of the map, and which aspects do we leave out? What is part of our conversation and what not? What are the selection criteria? Barnes (2004a) makes the case that knowledge is not just temporally but also spatially situated. It is the spatio-temporal context that determines which research questions are asked, which facts are produced and how these facts are constructed and construed. From a critical realist perspective, this implies that although our social world is real and material, how we carve it up into researchable concepts and categories is the outcome of contextual circumstance. This process of 'carving', as a self-reflexive researcher realizes, can again influence how the world is, bestowing her or him with considerable ethical responsibility (Sayer, 2000: 10-11). Unfortunately, the selection criteria applied in the carving process are not always made explicit. What geographers write and what they leave out is colored by the questions at hand, the means available, and the ends that are pursued at a specific moment (Driver, 1988; van Meeteren et al., 2016; Chapter 4). The consequence is that all knowledge bears its birthmarks and it is only when taking those

[23] See Footnote 15.

birthmarks into consideration that we can responsibly gauge its relevance and its applicability to travel. Fortunately, we can talk about the responsibility to scrutinize the genesis of knowledge since the map is self-reflexive.

To insist that geographers take Korzybski's (1951) analogy literally may sound like intellectual *Spielerei*, but it is crucial. Korzybski's premises resonate with the observations made by some geographers that the geometrical figures we draw on our maps only get their social content through what they represent (Saey 1968b; Sack 1972, cf. Wood, 1992). Geometry itself cannot explain anything outside the domain of geometry. Geometry is, as Harvey (1969) makes unambiguously clear, a language: the language by which we draw the map that subsequently is a partial representation of the territory. From this, it follows that the idea of spatial separation, or spatial causality—popularized by Schaefer (1953) and Bunge (1966 [1962]) in the 1950s and 1960s—is logically impossible (Sack, 1972; 1973; 1974). To conjoin the spatial and the social, one needs to understand unfolding processes in time-space (Korzybski, 1951; Blaut, 1961; 1962; Hägerstrand, 1984; Harvey, 2005; Massey, 2005). What sometimes seems to be forgotten in contemporary human geography is that this could be as true for topology as it is for Euclidian geometry. The network, from a geometrical perspective, is just another map, not the territory (Chapter 3).[24] Therefore, whether you focus on topology or on Euclid, reducing geography to a science of space is, to quote Massey (2005: 36), to create a 'prison house of synchrony'.

Despite agreeing that the map is not the territory, and that we have to reflexively discuss what to put on the map and what to leave out, we can still disagree on the nature of the territory. That is, we can still disagree on ontology (van Meeteren et al., 2016). This returns us to the thorny question of incommensurability between paradigms. Incompatible ontological positions do exist. Engaged pluralism, by its very definition, intends to build bridges between incompatible ontological positions (King, 1976; Chouiard et al., 1984; Kwan, 2004; Wyly, 2009; Johnston and Sidaway, 2015). In particular, it envisages the idea of 'trading zones': 'an intermediate domain in which procedures [are] co-ordinated locally even when broader meanings clash' (Galison, 1996: 46 cited in Barnes and Sheppard, 2010: 196). As critical realism is a very 'inclusive and luxuriant' ontology that is argued to be able to incorporate and provide arbitration in the canonical dichotomies and rifts in the human sciences (Collier, 2005: 234), it seems to be a particularly interesting candidate to facilitate a trading zone by bringing allegedly incommensurable scientific positions in dialogue. Unfortunately, as Sayer (1992 [1984]: 73) puts it, paradigmatic thinking makes:

> [it] appear […] that there can be no shades of difference of meaning, only either total conformity (within paradigms) or total incompatibility (between paradigms). The extent

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[24] At this moment, I am still grappling with how the focus on 'topology as ontology', i.e. 'post-mathematical topology' (Martin and Secor, 2014) explored by scholars doing 'assemblage/*agencement*' geography (Müller, 2015) fits into this. My brain short-circuits if I try to imagine a post-mathematical mathematics.

of redundancy and unresolved tensions within theories is underestimated, as there are the areas of overlap between them on which there is agreement or indifference. Having exaggerated the unity of major theories it then appears that any falsification of a part must be fatal to the whole.

Andrew Sayer (1992 [1984]: 73)

The reason for this overdrawn appeal to incommensurability is that ontological positions are ultimately metaphysical. As with religion, everybody has preferences, which is often a product of socialization processes during one's coming of age. While it can be inspirational and enriching to explore ontologies promiscuously (Gibson-Graham, 2006), look for syncretism, or abandon your church, ultimately, deciding on the nature of the world takes a leap of faith.[25] Hence, convincing others of your ontology is the work of missionaries, not of scientists, and reduces scientific interchange to theology. Consequently, those not sharing your faith might become regarded as 'heathens' or 'heretics'. As long as the idea is retained that there must be a direct correspondence between the objects that we (think we) observe and the objects we theorize, as is part of positivist philosophy of science (Steinmetz, 2005), the 'religion problem' remains. However, as was noted in the discussions around Kuhn's (1970a [1962]) *The Structure of Scientific Revolutions*, new paradigms[26] do not necessarily explain the same phenomena studied by the old paradigm equally well (Feyerabend, 1970), although they tend to bring new aspects and perspectives into view. Moreover, it has been argued that a transition between paradigms necessitates the old and the new to exist simultaneously in order to make a transition between them theoretically possible (idem). Hence there is nothing that prevents a researcher from observing the same phenomenon through different paradigmatic lenses simultaneously, which is a prerequisite for engaged pluralism. However, despite his emphasis on the social construction of paradigms, Kuhn (1970a [1962]) himself was very skeptical about the possibilities for such pluralism, as reflected in his invocation of 'incommensurability'. But in contradistinction to his critics (Feyerabend, 1970; Kuhn, 1970b) who interpret incommensurability in terms of logic, Kuhn's (1970a: 175) explanation for incommensurability is sociological: it is the difficulty of translation between different viewpoints that prohibits scientific communication across paradigms.

We can reconcile this ambiguity in Kuhn through the observation that as long as one adheres to a strict correspondence theory of truth where ontology is collapsed into

[25] Kuhn (1970a [1962]) has been criticized by other philosophers of science for making paradigm choice in his framework amount to religious conversion (Lakatos, 1970: 93; Popper, 1970: 57; Watkins, 1970: 33). Kuhn (1970b, cf. Masterman, 1970), for his part regarded this criticism a caricature of what he was trying to say, but did consider that this very interpretation was testimony to the difficulty of speaking across paradigms.

[26] Paradigms are defined here as 'the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science' (Kuhn, 1970a: 175).

epistemology (Pratt, 1995), sociological misunderstandings between paradigms will be difficult to reconcile. Nevertheless, since critical realist ontology is stratified, where there is no necessary correspondence between our theories of the world (an epistemological conundrum) and the world itself (ontology), we can agree to disagree on our ontological premises and still examine how far we agree on our descriptions and knowledge about the world, or in other words, create a trading zone. However, we do need instruments to gauge conflicting truth claims, to be at least able to pinpoint where the conflict between truth claims exactly lies and, preferably, a set of normative propositions that can be used for adjuciating contradicting analyses based on these claims (Steinmetz and Chae, 2002). Critical realism has interesting properties to offer for both accommodation and adjuciation of difference. The 'critical' aspect can provide normative epistemological guidelines to weigh conflicting truth claims. The 'realism' part, in turn, can encompass more observations about the world than is sometimes assumed.

* * *

Intellectuals, academics and scientists are social categories on which society bestows authority. To what extent we, as practitioners, like that is partly irrelevant. The academic profession, and the fact that society allocates resources to that profession, has to deal with the fact that academics—whether their analyses of the world are adequate or not—are supposed to be 'experts' (Latour, 1987; Mitchell, 1998; Callon et al., 2009 [2001]). With authority comes the responsibility to act ethically and honorably, *noblesse oblige*. But what are the normative standards, the code of conduct, for academics?

Although revision is necessary, Merton's system of good scientific practice (1973 [1942], as summarized in Curry, 1991) still provides a useful starting point for constructing such a code of conduct. It is based on four normative ideals (see Curry, 1991: 128), namely: i) 'communism'; ii) 'universalism', iii) 'disinterestedness'; and iv) 'institutionalized skepticism'. For Merton, there seems to have been homology between his normative assessments of good scientific practice and the actually existing scientific system (Curry, 1991: 128), which reads as horrendously naive nowadays. Moreover, post-positivist critique provides good reasons to be suspicious of both Merton's second principle, 'universalism', and the third principle, 'disinterestedness', as their unattainability easily degenerates into arrogance and ideology (Wyly, 2011; 2014a). However, Merton's first and fourth principles retain their usefulness since they reinforce pluralist thinking, rather than providing instruments for undermining it.

The first normative principle is that of 'communism', which entails an obligation to give credit where credit is due. This works in two ways: not only is one to give credit to what one reads, but one also needs to read what one gives credit to (Keighren et al., 2012a). As long as these two dimensions are respected, the associated knowledge is a public good. Credit ensures that the scientist's work is rewarded, not only through citations, but also through the honor of being worthy of somebody's scarce reading time. Furthermore, this principle not only helps to ensure the visibility of all who contribute, but also penalizes the undue appropriation of ideas. It thus underscores the vital importance of ensuring to make open access publication work in an equitable way.

Merton's fourth normative principle is that of organized skepticism, including being skeptical of one's own work. From the perspective of this ideal, the most-valued academic shows a willful urge to disprove his or her own hunches. This implies that finding anomalies, 'stress-testing' one's own theories and dismissing one's discoveries when found at fault are imperative (Burawoy, 2009; Peck, 2015). Moreover, a good academic develops the willingness to listen to somebody claiming that you are wrong, even though such willingness does not automatically make criticism valid. These behavioral guidelines are easily undermined by am unreflexive culture of celebrity, which underscores the hazards of a society and/or academia cherishing 'rockstar scientists'.

While crucial for fostering pluralist thinking, Merton's two enduring principles, communism and organized skepticism, only provide the setting in which engaged pluralism can occur. A third notion, which can provide guidance on how to evaluate opposing claims to truth, needs to be instated, especially now that Merton's second and third propositions have become suspect. This is where critical social science can provide additional guidance. Critical social science sees it as the imperative of social science to reduce the amount of illusion in society. Critical social scientists are 'not only [to] identify false beliefs and the practices they inform but [also] why these false beliefs are held' (Sayer, 2009). The goal of explaining 'why beliefs are held' can only be attained by comparing more and less plausible explanations of the same phenomena (Sayer, 1997; Olson and Sayer, 2009). From this, it logically follows that we need mechanisms to distinguish between more and less truthful explanations (see Livingstone, 2006; counterpoint Barnes, 2006).

* * *

If critical social scientists are obliged to propose alternative, less false, explanations for phenomena, mere deconstruction is insufficient (Olson and Sayer, 2009; Lake, 2013), but must be accompanied by reconstruction. This requires 'positive' assessments of the degree of correspondence between empirical phenomena and our proposed explanations for these phenomena, rendering the specter of positivism (Steinmetz, 2005) unavoidable in critical social science and engaged pluralism (Wyly, 2011; 2014a; Lake, 2013; 2014; counterpoint Sheppard, 2001a; 2014). Although one might disagree with its stratified ontology, on the epistemological level, critical realism provides a way to make positive assessments of explanations without lapsing into the empiricism that is associated with 'ontological positivism' (cf. Sheppard, 2014). By allowing translation between paradigms, it becomes possible to insert old-fashioned geography in contemporary debates.

According to Cox (2014), post-1950s human geography can be divided in three broad 'styles' that have different ontological positions. These styles can be described as i) spatial science; ii) materialist social theory; and iii) discursive social theory approaches. The appealing property of Cox's categorization is that in contrast to the more common 'epochal presentation', it is sensitive to continuities between these styles over the past 50 years, and seeks overlaps and complementarities rather than discontinuities and rifts. In the following, it will be shown how some of the central concerns of these three styles can be brought into dialogue, drawing on some of the main tenets of critical realism (Sayer, 1984 [1992]; 2000 are the authoritative textbooks in human geography).

As mentioned, critical realism posits a stratified ontology where distinction is made between the level of the 'real', the 'actual' and 'the empirical' (Sayer, 2000: 12-13). The empirical is that what we observe, the actual is that what we can observe, and the real is that what exists, regardless of whether we can observe it. In critical realism, causality is conceptualized as the 'causal power' of (combinations of) structures and mechanisms. Structures and mechanisms create the preconditions for an event to occur, 'the necessary conditions', but whether it occurs is always contingent (idem: 14-15). From this, it follows that 'causal mechanisms which generate empirically observable outcomes, are real structures, which exist independently of our knowledge of them and of the ability of our science to explain them' (Chouinard et al., 1984: 357). Conceptually grasping these structures as precisely as possible provides the most accurate tools for explaining concrete events. This makes it paramount in critical realist analysis to define the correct level of abstraction (Sayer, 1984 [1992]). The latter is achieved when a theoretical object is created that allows the necessary conditions of the causal power of that object to emerge with at least noise as possible—i.e. isolating the necessary properties of a theoretical object. In the critical realist nomenclature, objects need to be defined on the level of abstraction where their properties are ‘emergent’ (Sayer, 1984 [1992]: 119). The more precisely one is able to do this, by shedding away unnecessary properties, the more closely this abstraction corresponds to empirically identifiable phenomena (Beauregard, 2012; Chapter 5).

Within this abstraction process, a particularly thorny geographical issue is defining the correct geographical scale where emergent properties appear. A proper abstraction defines the geographical scale for a causal mechanism where the properties of that mechanism can be isolated (Smith, 1987). If the scale is defined too large, we risk ending up with ‘contentless abstractions’ implying that our concepts, while not necessarily false, are able to explain very little about concrete geographies (Sayer, 1992 [1984]: 98-99). If we define the scale too small, our abstractions can become chaotic, meaning they lump together the inessential and split up the necessary properties of causal mechanisms (Sayer, 1992 [1984]: 138, see Chapter 5). It is here where historically defined demarcations of regions or cities can be in tension with the scale at which a particular region functionally works (Smith, 1987; this issue emerges in Chapters 2, 3, 5, 6, and 8). This does not imply that the different causal mechanisms that are entangled at a particular place necessarily need to have the same scale. As Chapter 5 illustrates, understanding metropolitan regions requires an appraisal of the intermingling of different causal mechanisms working at different scales. It is in the process of assessing the generalizability of causal mechanisms—the wider set of cases in which we have confidence that a certain mechanism is at work—where 'positivist' methodology can come into play.

Based on the premise that our abstractions have been properly made, the 'cleanest' way to compare different instantiations of combinations of necessary and/or sufficient conditions is through the deductive-nomological model associated with positivism (cf. Harvey, 1969; Hay, 1978). This model describes strict procedures to derive the logical outcomes of premises that in turn allow estimations of probabilities, significance, and variance and so forth. The result of such an exercise is not an ontological 'truth', but 'practically adequate explanations' (Sayer, 1992 [1984]), or stronger confidence that the abstraction of a structure or mechanism has indeed been properly done and applies to more cases (cf. Chouinard et al., 1984). The deductive-nomological model cannot replace the 'intensive research' that has to establish the plausibility of causal mechanisms in the first place. Moreover, the deductive-nomological model cannot by itself revise these mechanisms, as the conceptual boxes representing causal mechanisms do not always have self-evidently empirically observable referents (idem; Pratt, 1995; Yeung, 1997). There is an inherent trade-off between generalizability and making our concepts as concrete as possible (Sartori, 1970; Chapter 2, 5). The more abstract concepts are defined, the more likely they are to be generalizable over a larger number of cases. However, as a high level of abtraction raises the risk of obtaining contentless abstractions, it comes at the cost of not being able to say much about the specifities of a particular instantiation of a phenomenon. A very simple example can illustrate the point. To state that the entire world economy is primarily capitalist is no longer a controversial claim (Altough see Gibson-Graham, 2006 [1996]). However, knowing that the world economy is capitalist can tell us very little about how capitalist social relations play out in concrete instances. Therefore, defining capitalist social relations in a more specific (i.e. less abstract) way, for instance as related to a specific region or sector, will allow us to make more precise statements on concrete instances, even if this implies restricting the domain and generalizability of our claims.

In addition to enabling comparisons of configurations of causal mechanisms, deductive-nomological procedures have the advantage of facilitating the cumulation of knowledge. In particular, they allow for the construction of elliptic arguments—provisionary statements that combine different causal building blocks (Hay, 1978). These elliptic arguments are not eternal truths: they are always open to revision and scrutiny. However, they do free scholars from the need of having to elaborate a full argument from scratch in each instance, as long as the underlying arguments are not controversial (cf. King, 1976).[27] Interestingly, critics of positivism tend to employ positivist rhetorical strategies 'strategically', for instance challenging an argument through falsification, particularly when discrediting 'positivist' research (Hay, 1978: 9; Steinmetz and Chae, 2002; see Smith, 2014 for a recent example). This is not surprising. Epistemologically, the deductive-nomological model (as elaborated in Harvey, 1969) is little more than a formalization of logical arguments. Indeed, as Chouinard et al. (1984) note, on the level of empirical research practice, the positivist and materialist social theory approaches differ far less in terms of methods and inferential logics than the polemics in our textbooks would suggest.

[27] See Latour (1987) on the importance of the distinction between controversial and non-controversial arguments and the politics of ‘controversializing’.

This implies there is common ground, allowing these approaches to be brought into productive dialogue.

Turning to the third category distinguished by Cox, that of discursive social theory approaches, these can be divided in two subgroups (Cox, 2014). The first group, which is associated with humanistic geography, has specific attention for agency and the way in which social agents construct meaningful worlds (Ley, 1977). The second group, which is generally associated with poststructuralist approaches,[28] predominantly looks at the performative effects of discourses (Cox, 2014: 102-103). Therefore, it is important to briefly examine how meaning, (the effects of) discourse, intentionality and subject positionality fit into critical realism.

Critical realism acknowledges that there is no unequivocal relation between the sign, the signifier and the referent and therefore, that the causal powers that are assigned to structures and mechanisms are influenced by and influence the way we conceptualize them (Sayer, 2000: particularly 35-40). This duality of structure and agency—critical realism has affinities with structuration theory[29] (Gregory, 1981; 1982; counterpoint Ley, 1982)—was widely debated in the early 1980s (idem; Thrift, 1983; Pred, 1981; 1983; 1984; cf. Giddens, 1984; Hägerstrand, 1984). These debates emphasize how people construct their worlds through their definition of the situation and act upon that definition (Ley, 1977), and how this definition institutionalizes in structures of social reproduction that again impinge on how we define situations. Particularly relevant for geographers is how these institutionalizations drive the formation of geographical objects. Places, regionalizations, and scales all emerge through meaning-making and subsequently obtain causal powers as discursive structures (Pred, 1981; 1984, van Meeteren and Bassens, 2016; Chapter 6). As how we perceive the world is causally significant, it is paramount in the thorny process of 'reconstruction'. If critical social science is predicated on the imperative to provide less-false accounts of the world, the human geographer needs to 'write alternative worlds'. A critical geography needs to take seriously these discourses and their effects, for instance those informed by colonial, racial or gender stereotypes, which requires the occasional breaking up, reexamining, and reconsidering of elliptic arguments (van Meeteren et al., 2016). Hopefully, the result is that readers of the work of Alonso (1975, see Footnote 10) not only detect its gender bias, but are also convinced that the social roles enacted by men and women are not cast in stone, and that women can be technicians and managers—and men shoppers and childcarers.

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[28] It is beyond the scope of this introduction, and out of my capacity, to do justice to the full diversity of the post-prefixed currents in human geography. Furthermore, as discursive social theory plays a relatively limited role in this dissertation, it was decided to keep the discussion brief. The interested reader is referred to the aforementioned Cloke et al. (2004; 2005), which provide a more thorough introduction than Cox (2014).

[29] The extent to which critical realism and structuration theory are compatible is the object of considerable controversy (Pratt, 1995; Stones, 2001).

In relation to urban-geographical theory, the 'thorny process of reconstruction' becomes particularly salient once one starts to assess its consequences for spatial planning. This dissertation was built on the promise of creating knowledge that could be utilized in strategic spatial planning in Flanders. Consequently, one of the goals of the research project was to produce knowledge that contributes to 'self-conscious collective efforts to re-imagine a city, urban region or wider territory and to translate the result into priorities for area investment, conservation measures, strategic infrastructure investments and principles of land use regulation' (Healey, 2004: 46). Knowledge conducive to strategic spatial planning has to contribute to the normative goal of achieving the desired societal outcomes as set in the planning process (Albrechts, 2004). However, in the field of spatial planning, a strongly articulated skepticism has emerged in the last two decades about the potential of 'old-fashioned' geography to contribute to this normative goal (Graham and Healey, 1999; Healey, 2004; Boelens, 2006). It is argued that the planners representing planning issues in 'worn-out essentialist Euclidian space' (Healey, 2004: 48) impose a particular representation of the world at the expense of others and do injustice to the multiplicity and multiscalarity of spatial relations (Graham and Healey, 1999). If the above considerations about a critical realist re-interpretation of spatial science are correct, such a strong rejection of old-fashioned geography needs to be nuanced. Korzybski's (1951) remarks about the relation between the map and the territory apply to planning too, in particular the third premise ('a map is self-reflexive'). Therefore, dismissing the map outright because it is not the territory is an undue argument: we all know it is not the territory, but let's discuss what is missing to make a better map.

Davoudi (2006) observes that 'evidence-based' planning is oftentimes a farce: much of the knowledge that planners and applied geographers produce ends up gathering dust 'in the drawer' either because politicians are not interested in expert-informed findings and want to govern by gut-feeling or because civil servants lack the (wo)manpower or intellectual tools to fully appreciate and implement a nuanced assessment. This observation qualifies the critique leveled by critical planners against 'essentialist Euclidian space'. Apparently 'top down' geographical representations in Euclidian geometry only function as a 'dominating geography radiating a false objectiveness' if it suits power-holders (cf. Wood, 1992). Otherwise, it might be just 'drawer food'. Therefore, I concur with Davoudi (2006) that we have to scrutinize, rather than outright dismiss or embrace, the idea that better knowledge of the world—including knowledge described in the language of Euclidian geometry—will in one way or the other lead to better policies impacting on the world.

Davoudi (2006) argues for an 'enlightenment model' rather than an 'instrumental model' of the knowledge-planning interface, where policy is not evidence-based but evidence-informed. This notion of evidence-informed policy resonates with the critical realist methodology elaborated above. First of all, whereas evidence-based notions of policy tend to be focused on the outcome of policy processes, evidence-informed policy looks at the causal mechanisms that might become activated upon the enactment of a policy (Johnston and Plummer, 2005). Hence, this conception fits with the critical realist premise of focusing on causal mechanisms rather than on constant conjunction in assessing evidence. Second, the notion of evidence-informed policy resonates with critical science's emphasis on the scientist's duty to reduce ignorance in the world by identifying what claims about the world are less false than others. Transposed to the domain of policy making, this also entails reducing ignorance with policymakers (cf. Pain, 2006). Since the latter often do not have the capacity or resources to synthesize scientific debates, it is a prime task of scientists in a policy setting, including spatial planning, to propose solutions to problems (Johnston and Plummer, 2005). Moreover, enlightening simulteneously the public and policymakers with academic knowledge opens up the possibility to hold policymakers democratically accountable when remaining ignorant in the face of scientifically-assessed evidence. Thus, a critical realist renovation of urban systems theory cannot only contribute to reinvigorating the contemporary relevance of old-fashioned geography, it might equally help allay the criticisms leveled against old-fashioned geography in spatial planning.

1.4 The methodology of renovation: Outline of the thesis

There are two research conundrums implicated in the title of this dissertation: '*From Polycentricity to a Renovated Urban Systems Theory: Explaining Belgian Settlement Geographies*'. The first is the stated ambition to 'explain' Belgian settlement geographies. This requires a formulation what explanation means in both the Belgian context and in terms of the premises of critical realism. The second is the claim that a renovated urban systems theory provides a better explanation of Belgian settlement geographies than theories of urban polycentricity. Justifying this claim requires that the process through which these theoretical approaches ('polycentricity' and 'urban systems theory') have been adjudicated be made explicit. The two identified research conundrums can be summarized in two formalized research questions, of which the first is subdivided in two subquestions:

1a: What are the shortcomings of theories of 'polycentric urban regions' in explaining settlement geographies?

1b: To what degree can these shortcomings be allayed by a renovated urban systems theory?

2: To what extent can a renovated urban systems theory be utilized to explain contemporary settlement geographies in Belgium?

This section will develop the remaining methodological arguments needed to answer these research questions, which will occur in the subsequent chapters.

Sections 1.2 and 1.3 have made the case that critical realism can provide a trading zone that enables old-fashioned research to communicate with contemporary debates. This is important, since it allows the three-systems model—a hybridization of the local knowledge lignering on the dusty library shelves of the universities of Amsterdam and Ghent—to speak to the contemporary academic literature and creates a bridge that contributes to defragmenting the geographic literature. However, not all old-fashioned theories are instantly ready for use. Therefore, some renovation, cleaning, stripping, salvaging and reassembly will be required. Certain parts might be worn out and need to be replaced, while others might require some fine-tuning.[30] In order to know what and how to renovate, 'explanation' needs to be defined. For instance, in the spatial science era, an urban systems theory such as central place theory was 'tested' by comparing what according to the theory was the ideal distribution of central places to the actual distribution of settlements in the field (e.g. Berry et al., 1962). More complicated studies used a *ceterus paribus* assumption if there were indications that intervening dynamics were in play. Here, the theory was applied in an additive fashion where 'corrections' were made for other urbanization tendencies, like industrialization, which is outside the purview of classical central place theory (Morrill, 1963) and therefore had to be 'controlled' for.[31] This mode of inference has been criticized because 'spatial consequences do not necessarily have spatial causes' (Massey, 1996 [1984]: 12; Eyles and Lee, 1982).

In the critical realist conception, explanation is not derived from correspondence between a theory and an empirically observable reality (such as a settlement landscape) but by assessing whether the causal mechanism that gives rise to a studied phenomenon is present (Eyles and Lee, 1982; Collier, 2005). Whether this causal mechanism is observable in the outcome is contingent on all other causal mechanisms impacting the phenomenon. A causal mechanism is a 'tendency' brought about by the logic of a structure which may or may not realize itself based on a plethora of other circumstances (Collier, 2005). The inability to observe the mechanism does not necessarily imply that it does not exist or does not exercise causal power in a particular instance. Therefore, not finding a hexagonal central place landscape does not refute central place theory. However, concluding that the mechanisms that supposedly give rise to such a landscape do not exist does. Instead of a *ceteris paribus* (all else being equal) assumption, such reasoning draws upon a *ceteris absentius* (all else being absent) clause (see Joseph, 1980 cited in Hägerstrand, 1984). To stick with the example of central place theory: instead of inferring the validity of the theory from the geometrical pattern of settlements, we have to gauge the degree to which there is an interplay between the range and a threshold determining central goods provision (Chapter 4). The actually present central place landscape can and will differ markedly from the *ceterus absentius* model because the world is an open system where innumerable influences can change the actual settlement geography. This thesis contends, in accordance with Mäki (2004), that the three 'renovated' urban systems theories it employs can meaningfully be described in terms of critical realist ontology, implying they are seen as 'mechanisms' that have contingent causal effects.

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[30] The metaphor of theory renovation is derived from Tilly (1984), see Chapter 5.

[31] It should be stressed that the argument developed here does not imply that the studies of Berry et al. (1962) and Morrill (1963) drew wrong conclusions. It only suggests that, from a critical realist perspective, the road toward those conclusions would have been different which could have led to—in this case unlikely on the empirical level—different conclusions.

The search for regularity in causal mechanisms instead of causal outcomes implies that we cannot rely on inductive measures—doing so would entail a selection on outcomes—to first stipulate our mechanisms (Sayer, 1992 [1984]: 158). Indeed, determining which causal mechanisms need to be considered is one of the core challenges in operationalizing critical realist research projects (Pratt, 1995; Yeung, 1997). Sayer (1992 [1984]: 159) asserts that this selection cannot guaranteed from *a priori* logic, and therefore necessitates a judgment call based on 'practical adequacy'[32] established through, for instance, triangulation (Denzin 1978 [1970]). In order to collect these potential practically adequate mechanisms, critical realism relies on 'retroduction' where causal mechanisms are proposed based on other cases where we we have confidence that a particular causal mechanism was in play, as derived from backward reasoning from the consequences (Sayer, 1992 [1984]: 107; Saey, 2012 [2009]: 111-112).

Saey's (1968: 145) 'new orientation in geography' provides a methodology to systematically embed retroductive reasining in a larger geographical research project. Saey stipulates that geographic research projects can take on two guises, having either an ecological or a chorological momentum. A study with ecological momentum describes a research cycle that starts and ends with theory and aims to study the 'causal functional relationships' between phenomena (Saey, 1968: 138). This implies that a project starts with a set of theoretical propositions which are 'put to work' in the wild, after which the findings can prompt a restatement of the theory. A study with chorological momentum aims to establish the areal connections among phenomena in a given setting (idem) and therefore has the mirror form. Theory is in the role here of a repository that is utilized to explain a concrete reality. In the words of Saey (idem): 'One starts from the reality [sic], abstracts and passes to formation of theory, then to turn back again to reality'. In more recent work, Saey (2012 [2009]) extends this methodology through an interpretation of the Marxist method that is compatible with critical realism. This interpretation introduces a distinction between 'abstract research', where causal mechanisms are isolated and analyzed theoretically, and 'concrete research', which studies events and objects as the outcome of different causal mechanisms (cf. Sayer, 1992 [1984]: 107). In the ecological momentum, abstract research normally precedes the selection of a research site as the primary goal is probing the efficacy of a theoretical proposition. The goal of the chorological momentum is to identify which causal mechanisms interact in a given concrete spatial setting. The potential causal mechanisms are identified after the explanandum. However, both momenta consist of a movement from a concrete to an abstract phase or vice versa. These movements consist of examinations where potential explanations are 'weighed' for their degree of practical adequacy in relation to the particular research project. This requires the 'stress testing' (Peck, 2015) of the proposed underlying causal mechanisms. Therefore, passage between abstact and concrete phases benefits from thinking back and forth between paradigms and judging the relative merit of causal mechanisms proposed in these various paradigms. As this procedure ensures

[32] For a definition of 'practical adequacy', see Footnote 2.

consideration of possible controversial elliptical arguments it entrenches a moment conducive to engaged pluralism in the research design (cf. Hägerstrand, 1984). In this dissertation, this procedure leads to the proposition that the causal mechanisms emerging from the spatial science era, which are commonly considered ‘outdated’, are nevertheless good candidates to contribute to contemporary concerns such as the debate on ‘planetary urbanization’ (Chapter 5). The degree to which this proposition has led to useful outcomes in this PhD project will be revisited in Chapter 9.

Ideally, a research project such as the four-year PhD that culminated in this thesis runs a full cycle between abstract and concrete phases. Here, two cycles are possible: from the concrete to the abstract and back to the concrete (CAC cycle), which corresponds to the chorological momentum, and from the abstract to the concrete to the abstract (ACA cycle), which corresponds to the ecological momentum. In practice, this ‘ideal full research cycle’ tends to slightly change direction in the course of the concrete and abstract phases of the research. The practical demands and deadlines levied on the researcher often cause the abstract and concrete phases of the research to be conducted in tandem, where the conceptual apparatus will gradually morph in the course of the research project. For instance, in this project, it was not immediately apparent that polycentricity would fall short on its promise to explain the Belgian urban system. Awareness of polycentricity’s shortcomings and the reasons for its shortcomings, and the proper formulation of an alternative theoretical framework, only emerged gradually. The order of the chapters as outlined below therefore has to be regarded as a mode of exposition that renders the intertwined processes of abstract and concrete research legible to the reader, rather than a chronology in terms of research execution.

Given that the selection of a region (Flanders/Belgium) and a theoretical frame (polycentricity) were given starting points for this research project, it has chorological momentum. Therefore, the dissertation is set up as a research design in the CAC cycle (Figure 1.2). It starts with the concrete settlement geography of Belgium (Figure 1.1), which is followed by exercises in abstract research in the first half to identify relevant causal mechanisms (Chapters 2, 3, 4). In particular, controversial elements of the three-systems model are examined, retrofitted or replaced. Chapter 2 starts with gauging the utility of the toolbox that was handed to me when starting this research project: theories on urban polycentricity. These are found to be wanting, and the outcome is that theories on agglomeration economies/externalities are examined instead. However, from the conclusions in Chapter 2 it becomes apparent that these theories too will cause trouble when plotted on a map. Chapter 3 then examines, and proposes to renovate, the fuzzy concepts of agglomeration and network externalities. These renovated concepts need to be in place to fix the scale problem that emerges when we try to apply the three-systems model, as each of the three systems operates on a different geographical scale (cf. Smith, 1987). Chapter 4 is necessary to examine what judging from the literature (e.g. Meijers, 2007) is the most controversial issue in the renovated urban systems theory, namely, Christaller's (1966 [1933]) central place theory, which is one of the three systems. This is done through an exercise in the analysis of 'big data' which gauges the microfoundations of central place theory. Since the adoption rate of social media was insufficient in Belgium at the time of research, this study was done in Louisville, Kentucky (USA), the then hometown of the co-author of the chapter. Louisville is a typical car-dependent metropolitan area that has seen the gradual decentralization from the central business district that is typical of American cities (Soja, 2011), and is in many ways a 'least likely case' for central place theory. Hence, if it is shown that central place theory retains explanatory value in Louisville, we have no reason to assume this is not the case in Belgium, were historical centralities have been preserved much more rigorously (see Chapters 6 and 7). As Chapter 4 reveals, Christaller's mechanisms still exert causal power on the structure of settlement systems, implying that maintaining this theory is justified.

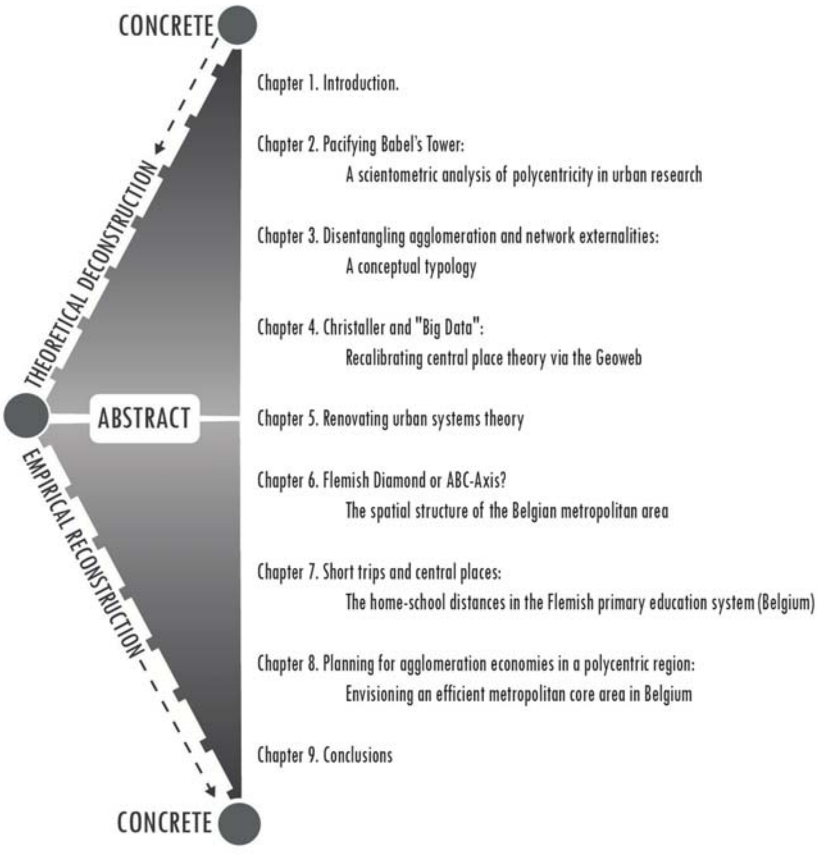

Figure 1.2 Structure of the dissertation

Chapter 5 is the pinnacle of abstraction in the CAC cycle of the dissertation. Here, the renovated urban systems theory is re-assembled (Sassen, 2008) and interaction between the subsystems are hypothesized. This provides a toolbox to examine the concrete settlement geography of Belgium. Chapter 6 introduces the Belgian case and examines the development of its metropolitan structure through the different eras of capitalist development that characterize the evolution of Belgium's political economy. This leads to the qualified conclusion that we see a renewed centripetal tendency in the Belgian political economy in line with post-2000 theories on metropolization and the cultural-cognitive economy. Chapter 7 zooms in on the micro scale and provides indications that in Flanders, the settlement structure still influences central place provision.[33] Chapter 8 lands on a very concrete level, proposing a regional strategic planning strategy, based on the insights generated through the process of renovating urban systems theory. This strategy is intended to make the Northern Belgian metropolitan region both economically stronger and ecologically more sustainable. Chapter 9, by means of general conclusion, returns to the issues raised in Chapter 1 and evaluates the relevance of doing old-fashioned geography today.

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[33] The notion of a 'competitive metropolitan region' (Chapter 5, 8) played an important role in the research aims set by the funder of the research, the Flemish Government. Therefore, some of the specified interdependencies on the level of the daily urban system and the central place system did initially not get research priority. As a result, they are only scantly empirically elaborated in this dissertation. However, with a research consortium of scholars based in Ghent, Delft and Brussels we did conduct empirical research on these topics in a number of auxiliary research projects, of which Chapter 8 is the first tangible outcome. The full results, which focus on the central place and daily urban systems, are codified in two Dutch language reports (Storme et al., 2015; van Meeteren et al., 2015), and will find their way to English-language publications in due course.

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2. Pacifying Babel's Tower: A scientometric analysis of polycentricity in urban research

Van Meeteren M, Poorthuis A, Derudder B and Witlox F (2015) Pacifying Babel's Tower: A scientometric analysis of polycentricity in urban research. *Urban Studies* 52(6): 1278-1298

Abstract

It is sometimes claimed that the degree of polycentricity of an urban region influences that region's competitiveness. However, because of widespread use and policy relevance, the underlying concept of polycentricity has become a 'stretched concept' in urban studies. As a result, academic debate on the topic leads to situations reminiscent of Babel's Tower. This meta-study of the scientific literature in urban studies traces the conceptual stretching of polycentricity using scientometric methods and content analysis. All published studies that either apply the concept directly or cite a work that does, were collected from the Scopus bibliographic database. This resulted in a citation network with over 9,000 works and more than 20,000 citations between them. Network analysis and clustering algorithms were used to define the most influential papers in different citation clusters within the network. Subsequently, we employed content analysis to systematically assess the mechanisms associated with the formation of polycentric urban systems in each of these papers. Based on this meta-analysis, we argue that the common categorization of polycentricity research in intra-urban, inter-urban and inter-regional polycentricity is somewhat misleading. More apt categorizations to understand the origins of polycentricity's conceptual ambiguity relate to different methodological traditions and geographical contexts in which the research is conducted. Nonetheless, we observe a firm relation across clusters between assessments of polycentricity and different kinds of agglomeration economies. We conclude by proposing a re-conceptualisation of polycentricity based on explicitly acknowledging the variable spatial impact of these different kinds of agglomeration economies.

2.1 Introduction

In their most recent collaborative step regarding spatial policy, the Territorial Agenda 2020 (CEC, 2011), the European Union ministers of spatial planning stress that:

> Polycentric and balanced territorial development of the EU is key element of achieving territorial cohesion [sic]. Where the most developed cities and regions within Europe cooperate as parts of a polycentric pattern they add value and act as centers contributing to the development of their wider regions. Urban development policies also have a significant role in this regard. Polycentric territorial development policy should foster the territorial competitiveness of the EU territory also outside the core 'Pentagon area'.

Commision of the European Communities (CEC, 2011: 7)

This quote is illustrative of the large causal power that EU governments attribute to the polycentric spatial structure of urban systems, in this case to achieve 'territorial competitiveness' and 'territorial cohesion'. The discussion on the relation between urban form and competitiveness is particularly articulated in Europe, but extends to urban studies worldwide (Hall and Pain, 2006). Meanwhile, most recent academic research that discusses the underlying concept of polycentricity[34] has stressed its fuzziness and polyvalence (Cattan, 2007; Green, 2007; Lambregts, 2009; Burger and Meijers, 2012; Vasanen, 2012): the term means different things at different scales and to different authors, and over the years the concept has become 'stretched' (Sartori, 1970).

Conceptual stretching is particularly problematic when large causal claims are invoked, because any discussion on a concept's utility for either policy or scientific analysis drowns in Babylonian misunderstandings (Sartori, 2009 [1975]; cf. Markusen, 1999). According to Davoudi (2007), the ambiguity of the polycentricity concept in planning circles has even been instrumentalized: as every actor involved in a political process can attribute their own interpretation to it, it becomes easier to (seemingly) establish consensus. Although such instrumentalism might be practical in the politically charged situations associated with spatial planning, this situation is detrimental for scientific communication and theory development. How can we establish an academic debate on whether polycentric urban systems enhance economic competitiveness if we do not even have consensus on what a polycentric urban system is?

According to previous literature reviews on the topic (e.g. Kloosterman and Musterd, 2001; Davoudi, 2003; Green, 2007; Burger and Meijers, 2012), academic debate on polycentricity in urban studies has revolved along two broad axes: those of i) scale; and ii)

[34] Vandermotten et al. (2008: 1207) suggest distinguishing between *polycentricity* as an analytical concept and *polycentrism* as a normative planning concept. Although this distinction is useful, it has so far not been consistently applied in the literature. Instead, it was found that the terms were generally regarded synonyms.

functionality versus morphology. First, Davoudi (2003) discerns different scale-dependent connotations of the concept: intra-urban, inter-urban and inter-regional polycentricity, which all have different meanings and originate in different scholarly debates in urban studies and planning. Second, polycentric urban systems are sometimes analyzed based on morphological aspects and rank-size distributions (e.g. Batty, 2001). However, according to Green (2007) and Burger and Meijers (2012), a morphological polycentric urban system does not necessarily imply that the urban system also functions as such. In their research, they therefore utilize flow data to measure the similarities and differences between morphological and functional polycentricity. Recently, both Burger and Meijers (2012) and Vasanen (2012) have tried to overcome the empirical ambiguities of the concept flowing from these two axes of debate. Although their contributions resolve important research problems, it remains unclear whether a single univocal definition of polycentricity will emerge as a result.

Against this backdrop, the purpose of this meta-study is to understand the full connotative variety of polycentricity in the academic literature in urban studies and explore pathways to alleviate conceptual stretching. This implies providing tentative answers to the following questions: What authors in urban studies employ the concept of polycentricity? What definitions do they utilize? To what extent can we discern the axes of debate that are identified in other literature reviews (i.e. issues of scale and functional versus morphological polycentricity) as well in scientometric citation patterns? And lastly, what is the potential of bridging conceptual differences by proposing a unified abstract concept? This paper seeks to address these questions using a two-tiered, multi-method approach. First, we utilize a range of scientometric methods to create a quantitative 'bird's eye view' of the literature on polycentricity in urban studies. This is followed by a discussion on the possibilities of scientometric analysis for understanding concept formation. The subsequent section discusses the scientometric methods followed by a presentation of the scientometric findings. This results in a 'map' of the polycentricity literature in which the scale debate is clearly recognizable between the subclusters. The second tier of the research, a qualitative content analysis, deepens the analysis and provides insight on the degree of conceptual stretching within and between the intra-urban and inter-urban clusters of polycentricity research. The analysis reveals that the debates regarding polycentricity are implicitly but thoroughly intertwined with debates regarding the spatial scale of agglomeration economies. The concluding section discusses how scientometric methods can help alleviate problems of conceptual stretching, assesses the results and reflects upon to what extent the concept of polycentricity can be 'de-stretched'.

2.2 Conceptual stretching and scientometrics

Polycentricity as a stretched concept

Conceptual stretching occurs because the number of properties ascribed to a concept (the intension) and the number of situations a concept applies to (the extension) expand simultaneously when research is replicated in different contexts and by different authors

(Sartori, 1970). Conceptual stretching is therefore quite often the result of a concept's success. All contributors to a debate emphasize different aspects, use different indicators or methods, and research tends to blur the line between abstract concepts and their concrete manifestations 'on the ground'. This is aggravated by an insufficiently sharp distinction between theoretical and operational definitions of the concept (Sartori, 1970). Conceptual stretching can in principle be alleviated by a proper use of a ladder of abstraction or by specifying a concept with adjectives (Collier and Levitsky, 1997). In order for a concept to be valid in a higher number of cases—increasing extension—researchers need to limit the amount of properties that identify a case as being part of that class—thus decreasing intension. To do so, a concept is often re-formulated on a higher level of abstraction, which increases the breadth of valid cases but also usually results in less discriminating power (Sartori, 2009 [1984]; Collier and Gerring, 2009). For example, a democracy is a regime that has an overarching set of properties (intension), which apply to a number of cases (extension). There exists variety in different kinds of democracy that can be identified with adjectives (Collier and Levitsky, 1997). We can subdivide democracies in parliamentary democracies and federal democracies—all of which have a specific meaning (intension) but therefore a lower number of applicable cases around the globe (extension). Once we add more cases to the concept of 'democracy' without adding extra adjectives, the concept starts to include a wider variety of divergent practices under its label, thereby stretching the general concept of 'democracy'. Alternatively, we can alleviate conceptual stretching by increasing the level of abstraction. In that case, the different kinds of democracies together form a subclass of 'national political regimes' that also includes non-democracies. In the case of polycentric urban systems, the relevant adjectives are hypothesized to be the aforementioned distinctions between scales: intra-urban, inter-urban and inter-regional polycentricity; and the distinction between functional and morphological polycentric urban systems.

Although most commonly used concepts in the social sciences are prone to some degree of conceptual stretching, there are a number of reasons that make polycentricity particularly susceptible to it. In urban studies, the common denominator of the concept, i.e. the definition with the least intension, denotes urban systems that consist morphologically and/or functionally of several urban cores or nuclei (Green, 2007). However, the concept has analogical meanings in biology (e.g. Goldstein, 1961) and political science (e.g. Ostrom et al., 1961), where it denotes, respectively, the multi-centered character of organisms and political decision-making processes. These analogies may lead to 'spillovers': borrowing metaphors and analogies from other scientific disciplines, which are not helpful to maintain conceptual clarity. In addition, the notion of polycentric urban systems is scale-dependent. What may seem a monocentric phenomenon on one geographic scale can be part of a polycentric phenomenon on another. When a functional definition of polycentricity is hypothesized to its theoretical extremes, even the endless urban sprawl of a totally dispersed urban system is a case of 'extreme polycentricity' (Green, 2007). Therefore, whether an urban system is indeed polycentric, and what degree of polycentricity might be socially beneficial is 'in the eye of the beholder' (Lambregts, 2009).

The notion that cities can have multiple cores plays a role in the classic works of Mumford and Geddes (cited in Green, 2007) but only started gaining theoretical momentum because of the popularity of Peter Hall's book The World Cities (1984 [1966]). In this book, Hall makes the case that multi-cored urban regions such as the Dutch Randstad or the German Ruhr Area could be functionally equivalent to large 'monocentric' cities such as Paris or New York. Although Hall's work was very influential in spatial planning circles in Europe, the oldest reference to the literal concept 'polycentricity' in the Scopus bibliographic database is Leven (1978). His contribution is part of a wider debate in urban economics over whether the monocentric Alonso-Muth-Mills land value model should be replaced by a polycentric version. Leven does not cite Hall, and it is unclear whether Leven used the term being aware of Hall's contribution. As we will see below, these two separate origins mirror the later distinctions in the literature between intra- and inter-urban polycentricity. Meanwhile, a third research tradition with strong normative overtones has emerged that discusses inter-regional polycentricity in the European context (Davoudi, 2003). Thus, the use of the term polycentricity in urban studies has itself polycentric scholarly roots, which might contribute to its polysemic character.

Scientometrics and the sociology of science

The academic fields of scientometrics and the sociology of science can help interpret the conceptual stretching of polycentricity. Scientometrics is concerned with quantifying knowledge and scientific developments, for example by analyzing citation patterns derived from bibliographic databases. Relatedly, the sociology of science studies the behavior of scientists and their role in society and concerns itself with questions such as 'why do scientists cite each other'?

Ever since the Institute for Scientific Information (ISI) started evaluating citation behavior in the 1960s, the resulting 'web of knowledge' revealed all sorts of regularities (e.g. Small and Griffith, 1974). Pioneer Henry Small (2003) famously calls it a map or 'landscape' of knowledge. Such a landscape of co-citations exhibits recognizable 'hills', 'valleys' and 'clusters' that can be analyzed using statistical methods. But what do these statistics mean? Does the clustering of nodes represent the interlocked groups of scientists, 'invisible colleges', that supposedly sustain academic paradigms (Crane, 1969)? And do strong connections illustrate the 'Mertonian' reputational rewards of scientific progress or the 'Kuhnian' paradigmatic rifts (Pinch, 1997 [1982])?

In reality, the act of citing has many reasons. Most importantly, people cite as part of a rhetorical strategy (Latour, 1987; Cozzens, 1989) through which they try to convince the academic audience of their point of view on a particular subject. This may include citing papers that an author disagrees with, as well as citing token references to align with 'seminal publications' in the field. But there also exists a moral economy of science in which behaving according to a citation etiquette has important reputational effects (Cronin, 1998; cf. Leydesdorff and Amsterdamska, 1990). Scientists might also cite others because of who they are and not because of what they wrote. Thus, the resulting 'map of knowledge' cannot be interpreted purely as a measure of 'scientific progress'. Rather, it is the sediment of cognitive development and scientific discourse as well as a reflection of a sociological process among scientists.

Leydesdorff (2001 [1998]) has shown that the network of interwoven texts that is created by a set of papers citing one another is a communication structure that shows emergent, system-level properties. The evolutionary trajectory of interlinked texts has self-organizing features: citing is not totally reducible to the (social) properties of the contributing authors, nor is any author fully capable of controlling the behavior and discourse production of the others in the same field. This implies that cognitive and intellectual development remains possible even when all involved authors cite for reputational rather than intellectual reasons. However, we can expect correlations between scientometric measures and discursive variations in (sub)fields of science because of preferential attachment of like-minded authors (cf. Barabási et al., 2002). The analysis of 'citation maps' thus consists of a combination of sociological clusters, the invisible colleges, and discursive clusters that combine to become different 'subparadigms'. Comparing the content of these different clusters can provide an adequate overview of the degree of conceptual stretching in a body of academic literature, and this is how we will approach the polycentricity concept.

2.3 Scientometric research strategy

To collect data on all the published scientific research that uses the concept of polycentricity, we rely on Elsevier's Scopus database. Apart from Scopus, there are two other major citation databases: Google Scholar and Web of Science. Although Google Scholar's database is extensive, preliminary analysis showed that its metadata and citation information is incomplete and inconsistent, which makes it more difficult to use for scientometric analysis. The Web of Science maintained by Thomson Reuters, for its part, has a smaller selection of journals available and is generally more US-focused (Falagas et al., 2008). Overall, Scopus has the most extensive selection of academic journals and books incorporated in its database. It also contains comprehensive citation information for articles—not books—published after 1995. Published works pre-1995 are part of Scopus' data set, but do not contain a readily accessible list of works cited (Falagas et al., 2008).

A data collection script that interfaces with Scopus' website was written in Ruby, making extensive use of the Nokogiri HTML parser library. The script queries all books and journal articles that have the word 'polycentr*'[35] in either the publications' title, keywords

[35] The asterisk should be read as a wildcard indicating that all variations that at least begin with the letters 'polycentr' are included in the search. This means that both papers invoking the terms 'polycentricity' and 'polycentrism' are included.

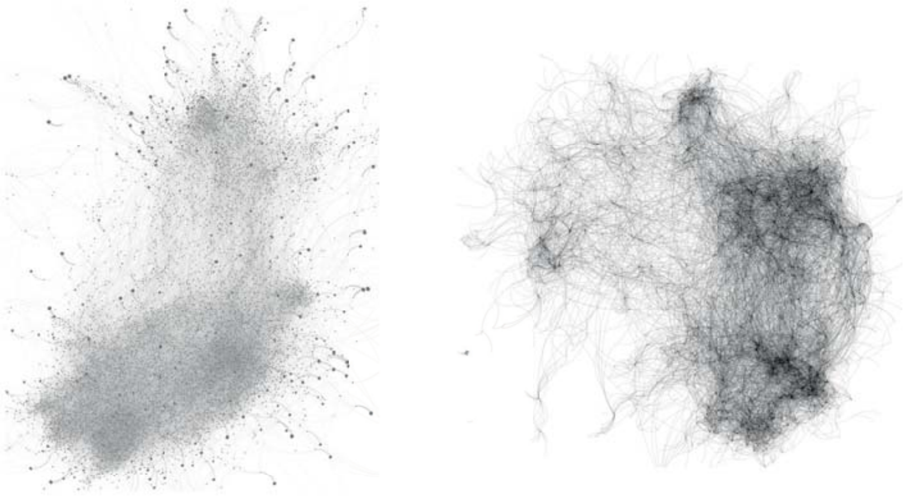
or abstract. In network terms, we call each of these publications a node. This first query resulted in 509 starting nodes that directly matched the search term. For each of these nodes, we then collected both the references within the publication—in network vocabulary, outgoing ties—as well as other publications that cite the specific node in question, which thus form the incoming ties. Although we started with just 509 publications, these starting nodes are directly connected to roughly 11,000 other so-called 'first-degree' nodes.

However, for a complete analysis of a citation network, it is important to also find out how these first-degree nodes are connected amongst one another. In other words, if paper A cites both book B and article C, we would also like to know whether B and C possibly cite each other. In network terms, we thus also need to collect the ties between first-degree nodes. To do so, we collected both incoming and outgoing ties (cited by, versus references to) of all 11,000 first-degree nodes as well. Since we are only interested in whether B and C cite each other, we only retained information on ties that connect to other first-degree nodes. In this way, we constructed a complete ego-network for each of the 509 starting nodes. Merging all these networks together results in a total network of 11,000 nodes and 42,000 ties. In simple terms, the collected data now contain every publication inside of Scopus' database that either mentions, is cited by, or cites a publication that mentions the term 'polycentr*'. The entire data collection was performed in August 2012.

The earliest published work in the data set is Hobbes' Leviathan (1914 [1651]) and the most recent articles are from 2011. As pointed out earlier, because of Scopus' specific design, work published before 1995 only has incoming citations and no outgoing references. Furthermore, books do not have outgoing ties either since their contents are often not available in a digitally structured format. This means that there are two important caveats in the resulting dataset. First, the information regarding citation patterns before 1995 is partial and incomplete. Most of the pre-1995 works that are still cited today, 'the classics', are present by virtue of their current-day citations. However relations between pre-1995 works as well as 'forgotten influential contributions' that are not cited after 1995, are simply absent from the data. By the same logic, to the extent that they still contribute directly to the debate today by being cited, influential papers on closely related terms[36] 'polynuclearity', 'policentricity', 'multicentricity' or 'the multiple core model' are included by virtue of their current citations. The second caveat is that the data contains a certain time lag, giving a comprehensive overview of the state of the academic debate a few years ago. Since there is considerable delay for academic publications to gain measurable influence (as it takes time for others to read new work, take notice and, most importantly, for papers that cite these new works to get published

[36] Synonyms for the concept from the 1990s and before.

themselves), works that have been published in most recent years are at a disadvantage. The method therefore documents rather than predicts the academic debate. In the case of polycentricity in urban systems this implies, for example, that the current discussion on borrowed size and agglomeration shadows (Burger et al., 2015) in polycentric urban regions is absent. Some of the conceptual issues identified in this paper might thus already have been resolved.



(a) (b)

Figure 2.1 Transitory visualizations of network pruning

Figure 2.1 visualizes the resulting data as a network. In the figure, we use a force-directed visualization algorithm (Openord) in which nodes (i.e. publications) repulse each other, except when they are connected by an edge (i.e. citation), which acts as a spring. In other words, citations prevent publications from being removed too far from each other—in the same way that the force a spring exerts increases the further one tries to pull it apart. Ultimately this results in an equilibrium state in which closely connected nodes are placed spatially close to each other as well (Martin et al., 2011). However, as is clear from Figure 1a, using this approach on the raw data still results in an incomprehensible blob of ties and nodes without clear clusters or patterns. To circumvent this issue, we use a multi-step cleaning approach. First, all nodes with fewer than two incoming ties (i.e. cited by less than two publications in the network) are removed as they are not significant (yet) in the polycentricity debate at the moment of data collection (Figure 1b). Second, since not every publication carries equal weight in academic communities, we calculate the relative importance of each node. We do so by dividing the grand total number of cites for each publication (including those outside of the 11,000 node network) by the number of cites within the network. We then use the lower bound of Wilson's 95% confidence interval

(Wilson, 1927) for that score to effectively weigh each node.

$$importance_{lower} = \frac{(2c + 1.96^2 - 1.96\sqrt{1.96^2 + 4c(n-c)})}{2(n + 1.96^2)}$$

Where c is the number of cites within the network and n the total number of cites. This ensures that a node with 2 out of 3, or 20 out of 30 cites, within the network does not carry the same weight as one with 200 out of 300 cites. We apply the confidence interval for two reasons. First, as confidence intervals are originally designed, we need to account for chance. If an academic work is only cited three times, the fact that two of those citations are within the network could be an effect of pure chance. Second, as an academic work gets more popular, it becomes more likely that others will cite it outside of the small group of academics that is directly engaged with a specialized topic. Hence, a relative citation rate within the network of 67% is much easier to obtain with two out of three citations than it is with 200 out of 300 total citations. These first two steps result in a smaller network of 3500 nodes and 15,000 edges. More importantly, we now also know the 'relative importance' of each node within the network, which we can use both for visualization as well as analytical purposes (see Figure 2.1b).

As indicated, based on the heterogeneous disciplinary origins of the polycentricity literature, we expect the existence of distinct academic communities that research polycentricity in different research traditions, at different scales, and in different geographical regions. Based on the literature review in the introduction, we specifically expect to discover clusters regarding the: intra-urban/inter-urban/inter-regional polycentricity and the morphological/functional polycentricity distinctions. To identify these communities, we use Louvain's modularity method (Blondel et al., 2008) to detect communities within the citation network. Much like ANOVA, modularity methods try to find communities that have a high 'modularity' or internal cohesion: a community within the overall network that has relatively strong 'internal' connections (i.e. with other community members) and relatively sparse 'external' connections (i.e. with the remainder of the network).

2.4 Scientometric results

Based on the pruned network, the community detection algorithm finds eight specific communities, or clusters. In Figure 2.2, each cluster is given a different color. An assessment of the works based on their title and abstract within each cluster was made to gauge whether this algorithmic, quantitative, subdivision also makes sense based on the actual content of the books and articles in each cluster. This coherence is remarkably strong, as each of the eight main clusters represents a distinct academic subfield. We indeed find the expected three scale-based central clusters that engage specifically in debates around polycentricity. The other five clusters can be regarded auxiliary debates, within and outside urban studies, relevant but not directly discussing polycentricity in urban studies—much in the same way as trawling for a specific fish inevitably leads to bycatch.

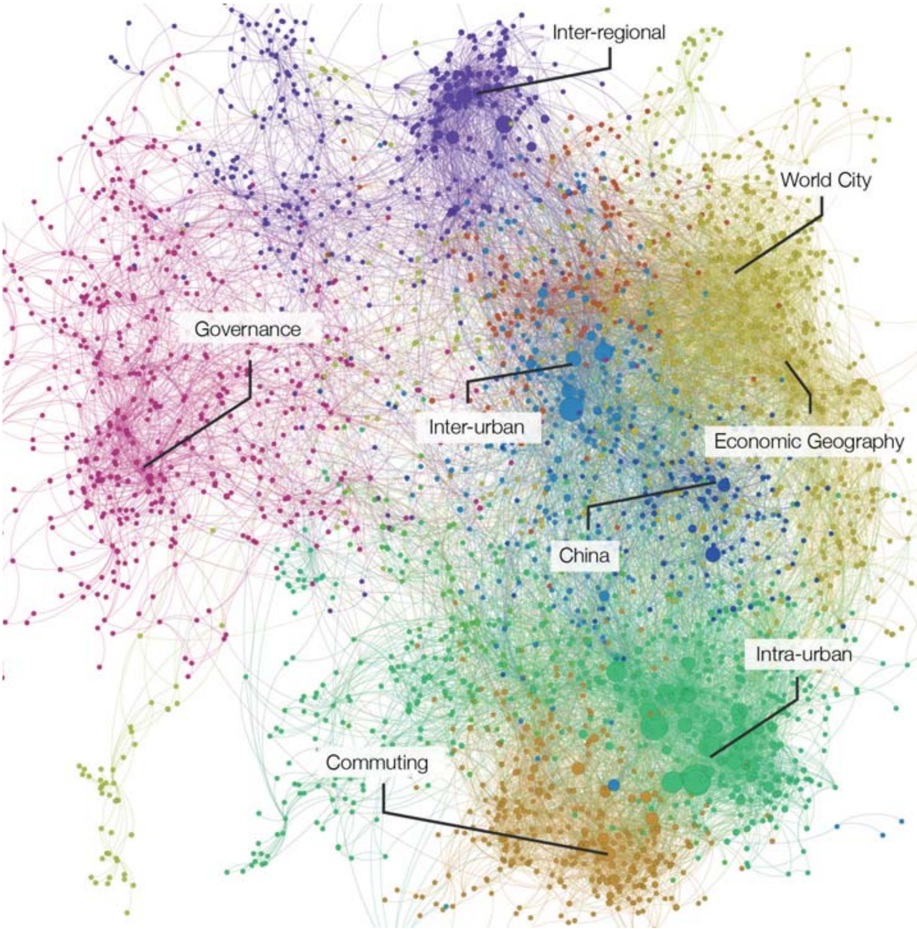


Figure 2.2 The citation network with clearly demarcated communities/clusters

Each cluster is given a name based on its topical content. Table 2.1 provides basic descriptive statistics for each cluster. It lists the number of works, the average year and the average importance score, and the standard deviation of that score for each cluster. The higher the deviation, the more the distribution of scores within the cluster is skewed (e.g. only a few core central/important works). Finally, the 'insularity'—defined as the number of citations within the cluster divided by the total number of citations within the network—and the inner-cluster density—which is calculated by dividing the number of citations within the cluster by the total number of possible citations and which indicates how frequent publications in each cluster tend to cite other publications in the same cluster—are provided for each cluster.

Cluster	Size	Avg. year	Avg. importanc e	St. Dev. Avg. importanc e	Insularity	Inner-cluster density
Intra-urban	365	1995	0,08	0,19	0,7	0,018
Inter-urban	260	1993	0,06	0,18	0,56	0,017
Inter-regional	360	1998	0,04	0,13	0,82	0,012
Governance	495	1995	0,01	0,03	0,89	0,007
World City	252	1999	0,03	0,06	0,65	0,02
China	122	2000	0,04	0,12	0,64	0,04
Commuting	314	1997	0,04	0,09	0,7	0,019
Economic Geography	386	1996	0,01	0,03	0,75	0,016

Table 2.1 Descriptive statistics of the 6 communities within the polycentricity citation network

The modularity algorithm divides the core of the network in three distinct clusters that correspond neatly to, respectively, an intra-urban, inter-urban and inter-regional view on polycentricity. This corroborates the subdisciplinary division in the approach to polycentricity mentioned in overview articles in the literature (e.g. Davoudi, 2003). There are five additional clusters that show a strong internal coherence. First, as mentioned earlier, a distinct literature discussing 'polycentric decision-making' exists outside of urban studies in political science. We find this community in our citation network as well and label it governance. Over time, a link between this body of work and the literature on, particularly, inter-regional polycentricity within urban studies was established. That link is relatively weak and, from an urban studies perspective, the governance cluster is peripheral. This is remarkable because with 495 nodes, it is by far the largest community but exhibits a very high level of insularity (0.89) and a low average importance score (0.01) signaling the separation of political science from urban studies debates in terms of citation patterns. Second, we find a diverse collection of (urban) economic geography and regional science papers that we label economic geography. As regional economic competitiveness has been one of the main drivers of polycentricity research, it is not surprising to find a connection with that literature. The research on 'world cities' is a third cluster. The idea that a polycentric network of cities could be a substitute for a 'real monocentric world city' (Hall, 1984 [1966]) appeared very early in the contemporary polycentricity literature (Batten, 1995; Dieleman and Faludi, 1998) and was further elaborated by Hall and Pain's influential *'The Polycentric Metropolis'* (2006). The latter would probably have been far more prominent in our analysis if Scopus had included data on its references. The remaining two clusters represent the emerging research on polycentric urban systems in the Chinese context, which is currently receiving increased attention, and a cluster that consists of transport geography with a focus on commuting research. Contrary to expectations, none of the clusters expresses a clear morphological/functional polycentricity divide.

The visualization algorithm in Figure 2.2 is the same as used in Figure 2.1. Therefore, the position of each node is based on its connections to other nodes; nodes that are close together share many connections; nodes that are spatially far apart, are also far apart in terms of shared citations and thus, most likely, far apart conceptually as well. This principle applies on the node level as well as on the cluster level, i.e. clusters that are visually close to each other have more interaction than communities that are on opposite ends of the map. Distance between published works in Figure 2.2 can therefore be thought of as a visual approximation of the cognitive distance within the communication structure of the citation network and/or of the social distance between the contributing authors. Furthermore, within communities we can distinguish large differences in clustering. For example, the 'governance' cluster is fairly spread out (which is consistent with its low inner-cluster density), while the intra-urban cluster is very concentrated (with a much higher density).

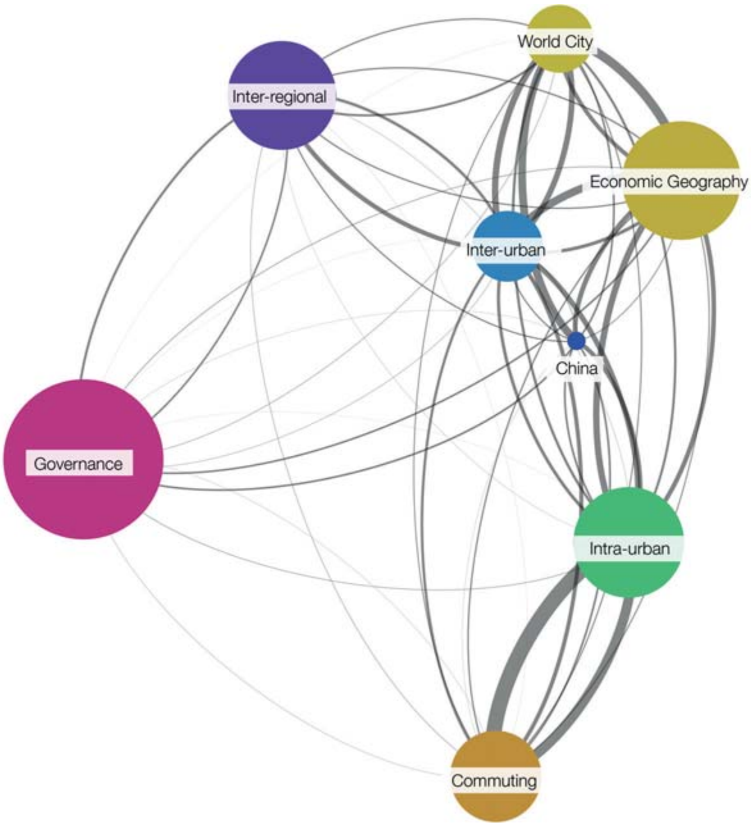


Figure 2.3 Aggregated relations between clusters

Taking this into account, visual inspection of Figure 2.2 already signals that the concept of polycentricity is stretched. When a field has an internal coherence in the cognitive and sociological sense we would expect it to exhibit a singular central cluster around which auxiliary scientific fields are located in a star-like pattern. However, with polycentricity this is clearly not the case. In particular the intra-urban and inter-regional clusters have a very high distance from one another (with only 22 citations between them), with inter-urban polycentricity performing a somewhat bridging role. When we take into account that some of these scarce citations might even be 'negative' ones, used to differentiate between different conceptualizations or subfields, the fragmentation of the field only becomes more salient. We also observe that each of the three main clusters is more closely related to the five peripheral clusters than to each other. This becomes even more apparent when we study Figure 2.3. Showing the relations between the clusters in an aggregated way, it reveals that the literatures on inter-regional polycentricity and intra-urban polycentricity are very far apart. In general, inter-regional polycentricity is highly insulated (i.e. 83% of all its citations are entirely within its own community) and is connected more strongly to the governance cluster literature than the other more urban-focused communities. This is because inter-regional polycentricity concerns itself mainly with urban and regional planning rather than the analysis of polycentric urban regions (see below). And finally, we see a strong mutual interdependence between the commuting and transport and the intra-urban polycentricity clusters while the commuting and transport literature plays a far smaller role in the other polycentricity literatures. It will become apparent below that the intra-urban polycentricity cluster shares much methodological affinity with transport geography and commuting studies while this is far less the case with the other subfields. Finding a division of labor between research on the intra- and the inter-urban scale in particular is in itself not remarkable. Such a division has been foundational to the field of urban geography at least since the 1950s (Taaffe, 2005). However, it remains unclear to what extent this division has led to divergent theoretical approaches between the clusters or whether differences merely reflect diversity within each cluster. In order to answer those questions, we have to investigate the contributions qualitatively.

2.5 Qualitative content analysis of the polycentricity clusters

Having established how papers on polycentricity are interwoven with the wider scientific discourse, this section delves into the specific differences of the definitions of polycentricity between the three main clusters (intra-urban, inter-urban and inter-regional polycentricity). We conducted a content analysis of these clusters to assess conceptual differences regarding polycentricity: how is polycentricity understood in these clusters, what methods are employed, and in which contexts is the concept applied? 'Content analysis is a research technique for making replicable and valid inferences from texts to the context of their use' (Krippendorff, 2004: 18). The associated set of procedures allows addressing issues of validity and reliability in the analysis of texts. The units and categories of analysis have to be explicated and consistently applied to allow for replication of research and intersubjective textual interpretations (Weber, 1990). The content analysis was based on the ten most influential publications in each cluster—based on the measure of relative importance explained above. An individual publication is the ‘recording unit’ that is analyzed (Weber, 1990: 21). The 10 publications are the most heavily cited within each cluster, they can be considered key publications and are assumed to be influential to and representative of the general thinking in each cluster. Each of the texts was coded twice to provide reliability through measurement stability (Krippendorff, 2004: 211–216). A first coding and analysis was conducted in March 2013 to score each of the publications on the categorical properties of: (1) the publication’s research object, (2) the publication’s research subject, (3) the publication’s methods, and (4) the utilized data sources. Table 2.2 summarizes the provisional dominant features in each cluster regarding the four categories after the first coding round.

Scale	Dominant object	Dominant subject	Dominant methods	Dominant data sources
Intra-urban	Large US metro regions (Greater LA, San Francisco Bay, Greater Chicago)	Urban decentralization	Spatial modeling, regression analysis	Commute, employment, and real estate data
Inter-urban	Polycentric urban regions' (Randstad, Ruhr, Central Scotland)	Urban integration/ fusion	Conceptual papers, desk research, descriptive studies	Commute data, firm network data, location quotients
Inter-regiona l	European urban structure	Polycentricity as a normative goal / political compromise	Discourse analysis	Planning documents, literature reviews

Table 2.2 Dominant features of the three polycentricity clusters

The content analysis yields insights and the possibility of a comparison of intension and extension for the intra-urban and inter-urban cluster. Inter-regional polycentricity, as a cluster, was not coherent enough to be analyzed in the same manner. Without a single exception, most of the important publications in this cluster were found to be not about polycentricity as such, but about the discursive role of the concept in urban and regional planning on the European scale (Waterhout, 2002). Rather than discussing the empirical merits of an inter-regional polycentric system, this literature mainly concerns the ‘performance’ of the concept in the policy field (cf. Harrison and Hoyler, 2015). Since this diverges significantly from the empirical conceptualization of polycentricity in urban systems in the other clusters, further detailed conceptual analysis of the inter-regional cluster was subsequently set aside.

The coding procedure was repeated in December 2013. Since an alleged changing character of agglomeration economies was repeatedly mentioned in the papers across the intra- and inter-urban clusters as the driving force of the increased prominence of polycentric urban systems, the second coding round additionally investigated that issue. In addition to re-evaluating the four categories of the first coding round for the remaining two clusters, the definition and operationalization of agglomeration economies was explicitly examined.

Table 2.3 shows the 20 most influential publications in the intra- and inter-urban polycentricity clusters as defined by the scientometric analysis. The influential papers within the inter-urban cluster were written in a fairly short time span. Articles from special issues in *Urban Studies* (2001) and *European Planning Studies* (1998) dominate the list. The top articles in the intra-urban cluster come from a wider variety of journals and span a longer period, but here too, a select few authors contribute to several top-tiered articles.

	Intra-urban polycentricity		Inter-urban polycentricity	
Rank	Publication	Journal	Publication	Journal
#1	Gordon and Richardson (1996)	Journal of the American Planning Association	Dieleman and Faludi (1998)	European Planning Studies
#2	Cervero and Wu (1997)	Environment and Planning A	Kloosterman and Musterd (2001)	Urban Studies
#3	Giuliano and Small (1991)	Regional Science and Urban Economics	Davoudi (2003)	European Planning Studies
#4	Gordon et al., (1986)	Environment and Planning A	Batten (1995)	Urban Studies
#5	McDonald and Prather (1994)	Urban Studies	Parr (2004)	Regional Studies
#6	Small and Song (1994)	Journal of Urban Economics	Champion (2001)	Urban Studies
#7	McMillen and McDonald (1998)	Journal of Urban Economics	Van der Laan (1998)	Regional Studies
#8	Garreau (1991)	Book	Bailey and Turok (2001)	Urban Studies
#9	Berry and Kim (1993)	Geographical Analysis	Albrechts (1998)	European Planning Studies
#10	Anas et al (1998)	Journal of Economic Literature	Kloosterman and Lambregts (2001)	Urban Studies

Table 2.3 The 10 most influential papers in the intra- and inter-urban polycentricity clusters

When we examine the extension—the breadth of situations that a concept applies to—of the polycentricity concept in the most influential publications, two remarkable patterns emerge. First, influential texts in intra-urban polycentricity are all case studies of US metropolitan areas: Greater Los Angeles (Gordon et al., 1986; Giuliano and Small, 1991; Small and Song, 1994; Gordon and Richardson, 1996), San Francisco (Cervero and Wu, 1997) and Chicago (McDonald and Prather, 1994; McMillen and McDonald, 1998). In comparison, the inter-urban literature almost exclusively[37] features case studies from northwestern Europe: the Dutch Randstad dominates (Batten, 1995; van der Laan, 1998;

[37] The only exception is Batten (1995) that compares the Randstad with Japan's Kansai region.

Kloosterman and Lambregts, 2001), but also the Flemish Diamond (Albrechts, 1998) and Central Scotland (Bailey and Turok, 2001) are examined. The remaining papers in both clusters are of a more conceptual nature, but stick to the geographical context of the rest of their respective cluster. Based on this observation, it seems that conceptually dividing the literature in a classification of 'intra-urban' and 'inter-urban' scale is somewhat misleading. The studies on the US context that we labeled, following the literature, 'intra-urban' tend to be about bigger populations spread over equal or larger areas than the European cases that we designated, again following the literature, as 'inter-urban'. However the content analysis indicates that, instead of subdividing these studies in terms of scale, a better interpretation of the differences between the clusters would be to distinguish between geographic contexts. The distinction of Champion (2001) between polycentric regions emerging from urban decentralization and polycentric urban regions emerging from urban integration or fusion seems more apt. Cases in both the US and EU contexts are becoming more polycentric because of the upscaling of daily urban systems and changes in how agglomeration economies function, but do so in a radically different historical context, giving rise to processes that seem more divergent than they actually are (Clark and Kuijpers-Linde, 1994; Clark, 2000).

A second pattern of difference in the extension of the concept between the two clusters pertains to the question of what are viable cases of a polycentric region. In the inter-urban cluster, following Hall (1984 [1966]), the Polycentric Urban Region (PUR) is regarded a discrete type of actually existing urban region (Parr, 2004). Some papers (e.g. Kloosterman and Musterd, 2001; Parr, 2004) subsequently engage in the endeavor of classifying existing regions in either the monocentric or polycentric type. On the other hand, without exception, the intra-urban polycentricity cluster, following Leven (1978) and the urban economics tradition based on the Alonso-Muth-Mills framework (Clark, 2000), discusses the polycentric versus the monocentric *model* of a city. The discussion is about which model has a better fit with reality in terms of explained variance (Clark, 2000). Not a single author assumes that this model actually exists in its pure form—with the possible exception of Garreau's Edge City (1991), which is geared more to a non-academic audience. From this perspective held in the intra-urban cluster, the debate within the inter-urban cluster on whether a region is sufficiently polycentric to be categorized as such is moot. The point here is not whether a region is polycentric, but rather how regions are becoming more polycentric. Such a misunderstanding between those looking at abstract models of reality versus 'actually existing' urban forms occurs often when theory travels between the methodological and empirical disciplines of regional science and human geography (cf. Mäki, 2004, for a comparable discussion regarding von Thünen's *Isolierte Staat*, 1966 [1824]). Therefore, the difference in extension between the intra-urban and the inter-urban cluster is not so much based on scale, but on social context, method, and applicability. In Collier and Levitsky's (1997) terms: the inter-urban cluster's attempts to alleviate conceptual stretching involved decreasing the extension, by making the theory only applicable to a particular kind of region. On the other hand, in the intra-urban cluster, polycentricity exists at a higher level of abstraction by specifying it in terms of an abstract model.

Differences in intension between the intra- and inter-urban clusters

When we compare the intension—the properties ascribed to a concept that 'do' the theoretical work—of polycentricity in the intra-urban and inter-urban clusters, the positions taken in individual papers do not conform neatly to the boundaries of the clusters these papers are in. While we did not find remarkable within-cluster variations regarding the extension of the concept, the contrary is the case with the intension. There is a widely-held consensus across the two clusters that a new form of urbanization gradually became dominant in the second half of the 20th century, of which the spatial outcomes diverge from the classic model of the monocentric city. Some of the authors emphasize near-universal car ownership as fundamental to this change (Gordon and Richardson, 1996), others emphasize demographic factors (Champion, 2001). However, in a nearly univocal chant among the 20 articles, the changing pattern of urbanization is attributed to fundamental changes in how the spatial economy works. Although some authors mention terms such as 'post- industrial' (Albrechts, 1998), 'post-modern' (Berry and Kim, 1993) or 'post-Fordism' (Kloosterman and Musterd, 2001) to typify this new economic regime, an overarching consensus on the theoretical implications of such terms is absent. Nevertheless, all authors tend to agree that the change in urban structure is related to a parallel qualitative and/or quantitative change in how agglomeration economies function (Anas et al., 1998). Therefore, in the literature surveyed for the content analysis, discussion on the appearance of polycentricity in urban systems unequivocally disguises a debate on changes in agglomeration economies. 'Agglomeration economies', however, is a slippery concept in itself that encompasses a variety of external economies of scale emerging from socio-spatial processes that operate on different geographical scales (Rosenthal and Strange, 2003). Different definitions of agglomeration economies in each of the 20 papers therefore play an important role in explaining different assessments of polycentricity in urban systems.

Rosenthal and Strange (2003) define three different kinds of agglomeration economy effects, i.e. labor market pooling, information spillovers between firms and shared inputs. In a polycentric urban system, size can be shared between cities (Alonso, 1973; Burger et al., 2015) in order to reach certain threshold values for each of these three mechanisms leading to increased competitiveness. Of course, these three mechanisms have different threshold values and therefore they each refer to different (potential) geographies of polycentric urban systems. Hence, in the second round of coding, we assessed how agglomeration economies supposedly generate increased polycentricity of the urban system. Furthermore, by examining the methods utilized, we can infer how agglomeration economies are implicitly operationalized. We classify these by using Rosenthal and Strange's (2003) elaboration of Alfred Marshall's (1920 [1890]) threefold taxonomy of agglomeration economies.

Logically, given that commuting data is often available for urban regions, the labor market effects have been central to research on polycentric urban systems. Increased labor market pooling is positively associated with thicker travel-to-work areas (Melo and Graham, 2014). Therefore, an increase in geographic scope of the travel-to-work area through commuting is indicative of a greater potential for labor market pooling. Out of the 20 papers studied in depth, 11 feature an empirical analysis; and only four of those 11 (McDonald and Prather, 1994; Small and Song, 1994; Gordon and Richardson, 1996; Kloosterman and Lambregts, 2001) do not take commuting patterns or effects as a basic building block of their empirical research. Commuting analyses imply the definition of a functional urban region, and this is emblematic of the lack of morphological studies in this sample of highly influential papers. Only Gordon and Richardson (1996) and McDonald and Prather (1994) and arguably Small and Song (1994) are morphological rather than functional studies.

Apart from labor market pooling, the other two agglomeration economy effects defined by Rosenthal and Strange (2003) are also acknowledged in the 20 papers examined here. Several authors (Garreau, 1991; Giuliano and Small, 1991; Batten, 1995; Albrechts, 1998; Dieleman and Faludi, 1998; McMillen and McDonald, 1998; Bailey and Turok, 2001; Champion, 2001; Kloosterman and Lambregts, 2001; Kloosterman and Musterd, 2001; Davoudi, 2003; Parr, 2004) note that sharing inputs is a relevant mechanism of agglomeration economies. Sharing inputs results in specialization, affects the regional spatial division of labor and increases complementarity between locations. Interestingly enough, information spillovers were less emphasized than initially expected, but were still considered to be worth mentioning in quite a few studies (by Giuliano and Small, 1991; Cervero and Wu, 1997; Anas et al., 1998; McMillen and McDonald, 1998; van der Laan, 1998; Kloosterman and Lambregts, 2001; Kloosterman and Musterd, 2001; Parr, 2004).

Although all three types of agglomeration economies are widely acknowledged as driving forces in the polycentricity literature, the question remains to what extent they influence each other. Can we aggregate these descriptions of different external economies of scale across papers into a coherent spatially homological narrative of a region becoming more polycentric? How do papers deal with the interaction between the various agglomeration economy effects? Do well-integrated labor markets attract firms that subsequently appear agglomerated? Or, inversely, do agglomerated firms induce migration of workers? An intermediate solution would be to specify some kind of co-evolutionary process between household and industry location determining the functioning of the urban system (Clark and Kuijpers-Linde, 1994). These questions regarding causality seem to be pivotal to understand what kind(s) of polycentricity might enhance competiveness. In the US-based ('intra-urban') cluster, papers are making both the case for a 'household location determines industry location' mechanism (Garreau, 1991; Small and Song, 1994), and, somewhat more implicitly, the opposite (Gordon and Richardson, 1996). The European inter-urban cluster exhibits consensus regarding the co-evolution between the two processes (Albrechts, 1998; van der Laan, 1998; Champion, 2001; Kloosterman and Musterd, 2001), although such a position is neither completely absent from the US literature (Anas et al., 1998; McMillen and McDonald, 1998). This variety of positions on causality across the clusters exemplifies that the intension of polycentricity is contested within the clusters as well as between them, despite the intra-urban cluster having a more parsimonious shared theoretical apparatus owing to its modeling methodology.

Apart from the differences on causality, there seems to be agreement across some papers that different types of agglomeration economies play out on different scales (McMillen and McDonald, 1998; van der Laan, 1998), as well as that different (sub)populations, in particular based on educational attainment, show different scalar effects (Cervero and Wu, 1997; Kloosterman and Lambregts, 2001). This implies that a polycentric region in the singular based on the idea of a coterminous geography of several different agglomerative processes is nowhere explicitly argued for in the literature: labor markets, shared inputs and information spillovers all work on a different geographical scale (cf. van Meeteren, 2013; Burger et al., 2014b). Nevertheless, apart from van der Laan (1998), the regions do tend to be defined in the singular and thus implicitly adopt that very frame of coterminous agglomeration economies. The influential papers in this sample do not yet assess the multiplexity of effects influencing urban system formation that have more recently become central in the academic debate (Burger et al., 2014a; 2014b).

2.6 Conclusion

Before we draw some final conclusions on the extent to which conceptual stretching has hampered urban polycentricity research and propose some suggestions to prevent that in the future, we would like to reflect briefly on the methods employed in this paper. This study shows that an informed quantitative scientometric study of a specific research domain can yield qualitative meaningful results. The quantitative 'mapping' of a citation network—effectively creating a bird's eye view of a body of literature—and the subsequent qualitative assessment of key works could be extended to other academic discussions or communities. Apart from being an efficient way to identify key works or acquaint oneself with a new literature in an efficient manner, such a 'literature review from above' can be useful to assess the alleged versus the real paradigmatic differences in scientific debates from a somewhat more distant standpoint, than is the case if one describes a literature from 'within' a position in the network.

That such an approach can indeed challenge some taken-for-granted aspects within a certain field is apparent from our analysis of the polycentricity debate in urban studies. A priori, we identified two major axes of debate around which the stretching of polycentricity is alleged to revolve: a discussion on functional versus morphological polycentricity and a discussion on scale. However, our analysis shows that neither are pivotal causes of conceptual stretching. Morphological empirical analyses of polycentric regions are conspicuously absent among influential papers. Furthermore, the alleged scale difference between different strands of the urban polycentricity literature appears not related to geographical scale but to different methods and empirical contexts. Instead, we reasoned that the ambiguity around the geographic impact of different kinds of agglomeration economies and implicit questions regarding the direction of causality between these kinds are a more important cause of the 'confusion of tongues' within the polycentricity debate.

In order to rectify this conceptual confusion, we have to re-conceptualize the stretched concept of polycentricity. According to Sartori (2009 [1984]: 126), a useful approach to this end is to separate the defining, or necessary, properties from the accompanying, contingent, properties of a concept, and then re-assess how many different concepts we need to categorize all the empirical objects we want to make statements about, for example by assigning adjectives (Collier and Levitsky, 1997). We have seen that the intra-urban cluster defined polycentricity on a higher level of abstraction than the inter-urban cluster. Although this can potentially resolve the extension problem—all cases of urban systems are up for consideration—we nevertheless lose some discriminating power as regards the context-sensitivity of the theory. This shows that strategies to achieve clarity are theory-dependent.

Another possibility would be specifying the theory differently by critically re-evaluating the adjectives. With regard to the intension of polycentricity, we conclude that the conceptual stretching ultimately relates to an undue focus on fixed geographical scales. Nearly all authors of the influential papers studied herein have implicitly tended to assume that agglomeration effects were spatially coterminous when studying urban regions. There are two ways out of this false assumption, both of which are already explored in recent work (Burger et al., 2014a; 2014b). Either we discuss one type of agglomeration economies at a time, such as labor market pooling or shared inputs, and then compare the spatial structure of urbanized regions of roughly equal size and population to assess the degree of polycentricity. Alternatively, we can compare the spatial reach of different kinds of agglomeration economies while acknowledging that each spatial object will have a different geometry, making comparisons of geographical entities more complicated. Urban geographers might prefer the first approach that focuses on the specific urban region while economic geographers and regional economists might prefer the second approach that studies a particular spatial-economic mechanism. Nevertheless, whatever approach one prefers, we caution researchers against conflating their empirical results with theoretical treatises of the other variety, as doing so will only reinforce the Babylonian confusion that has hampered the academic discussion on polycentricity.

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3. Disentangling agglomeration and network externalities: A conceptual typology

Van Meeteren M, Neal Z and Derudder B (2016) Disentangling agglomeration and network externalities: A conceptual typology. *Papers in Regional Science* 95(1): 61-80.

Abstract

Agglomeration- and network externalities are fuzzy concepts. When different meanings are (un)intentionally juxtaposed in analyses of the agglomeration/network externalities-menagerie, researchers may reach inaccurate conclusions about how they interlock. Both externality types can be analytically combined, but only when one adopts a coherent approach to their conceptualization and operationalization, to which end we provide a combinatorial typology. We illustrate the typology by applying a state-of-the-art bipartite network projection detailing the presence of globalized producer services firms in cities in 2012. This leads to two one-mode graphs that can be validly interpreted as topological renderings of agglomeration and network externalities.

3.1 Introduction

One of the main debates in regional science in the last decades concerns the choice of 'appropriate' spatial units and the relevance of 'interaction' between these spatial units. Are cities, regions, or other types of agglomerations the crucial geographical units of analysis if we want to understand economic development or is it better to focus on the interactions between these units, that is, networks of regions, cities and agglomerations, to fathom this conundrum? Testimony to the relevance of this discussion, which is now over 25 years old, is that it is addressed in some of the most heavily-cited papers in the spatial-economic sciences in the 1990s and the 2000s (e.g Amin and Thrift, 1992; Bathelt et al., 2004). Yet, the argument sometimes seems to be a needle stuck in its groove, with conclusions becoming somewhat repetitive in spite of obvious progress in methods and data quality (e.g. Ducruet et al., 2011; Camagni et al., 2015; Liu et al., 2015).

There appears to be consensus in the literature that both agglomerations and their interconnections matter, separately as well as conjointly. However, in spite of this consensus, which takes on the form of a 'stylized fact', actual research on how (much) and why this matters generates a fair dose of controversy. For instance, scholars still puzzle over the causal direction between the development of agglomerations and inter-agglomeration networks (Rozenblat, 2010; Neal, 2011; 2012a; Pain et al., 2016). Similarly, it remains unclear whether interaction patterns between the two remain stable over time. Furthermore, the findings are interpreted differently: is the importance of 'networks' in the equation the result of the business cycle (Neal, 2012a; Camagni and Capello, 2015), or rather structurally related to new technological paradigms (Castells, 1989; 2000; Camagni 1993; Neal, 2011)? Although these are all pertinent questions and debates, they risk becoming unproductive once there is ambiguity regarding the research object (van Meeteren et al., 2016 [Chapter 2]): as soon as polyvalence arises in terms of how we understand what an 'agglomeration' or what a 'network' is, and how these are spatially articulated, the debate becomes muddled. Adding to the confusion is that these fundamentally academic questions tend to get adopted by policy makers as they start considering urban size and/or urban network connectivity as policy goals to allocate scarce public resources (van Oort et al., 2010; Rodriguez-Pose and Fitjar, 2013; Pain et al., 2016).

The debate about agglomeration externalities, network externalities, and their interactions is held across disciplinary boundaries, but as a research problem it most pertinently speaks to regional science. As the problem is both policy-laden and multidisciplinary, regional science's explicitly interdisciplinary focus can help build a common vocabulary to debate the issue at hand (Isard, 1960). The issue that needs to be tackled if such a vocabulary is to be developed is 'observational equivalence' (Overman, 2004): how can we know which aspects of this 'stylized fact'—that agglomeration and network externalities both matter—explain our observations? McCann (2007: 1218) makes the case for tackling observational equivalence by applying 'quantitative approaches using the methodological rigor and internal consistency' that he associates with regional science. Although we concur with McCann (2007) that a more rigorous and consistent application of methods would foster a better understanding of what Johansson (2005) has aptly called the ‘menagerie of agglomeration and network externalities’, observational equivalence can never be resolved across studies by rigorous and consistent methods alone as long as the underlying concepts remain fuzzy. As put forward by Markusen (1999: 702), a fuzzy concept

> posits an entity, phenomenon or process which possesses two or more alternative meanings and thus cannot be reliably identified or applied by different readers or scholars. In literature framed by fuzzy concepts, researchers may believe they are addressing the same phenomena but may actually be targeting quite different ones.
>
> Ann Markusen (1999: 702)

Since the conceptual frameworks that exclusively address agglomeration or network externalities are already fuzzy among scholars and disciplines, attempting to combine both perspectives compounds the issue, as one may have to choose between incompatible building blocks. The prime purpose of this chapter is to make the case for a coherent approach to the conceptualization and subsequent empirical operationalization of combinations of agglomeration and network externalities. Rather than formally testing the relative importance of both perspectives and their interaction in an econometric exercise, the empirical focus is on exploring how such a coherent conceptual approach might look like in practice. To this end, we present a topological perspective on agglomeration and network externalities that can be discerned in intra-city and inter-city complexes of globalized producer services firms.

The remainder of this chapter is organized as follows. Based on a review of the fuzziness of the notions of agglomeration and network externalities (Section 3.2), we argue that existing juxtapositions can—in addition to their commonsensical referents as cities and city-networks—be understood through three different dimensions (which coincide with different disciplinary traditions): an industrial-organizational dimension (market versus network), a spatial-economic dimension (gravity-type versus archipelago-economy type interactions), and a geometrical dimension (topological versus projective geometry). Rather than advocating a ‘correct’ combination, Section 3.3 emphasizes that undue juxtapositions may lie at the basis of much of the confusion in the literature. A meaningful combination of the different approaches thus requires a coherent framework. In Section 3.4, by means of illustration, the utility of the typology is explored through developing one possible combination of agglomeration and network externalities. Through elaborating the topological perspective on both externality types, we infer some of the decision-making rules used by globalized firms to choose where to locate their branch offices. We apply Neal’s (2014b; 2016) stochastic degree sequence model to data detailing the relative importance of 175 producer service firms’ branch office locations in 526 cities in 2012, as presented in Taylor and Derudder (2016). This produces two one-mode graphs that can be interpreted as topological renderings of agglomeration and network economies, respectively. The relevance of this approach is subsequently demonstrated by discussing a number of tangible examples. Section 3.5 draws conclusions.

3.2 Agglomeration and network externalities as fuzzy concepts

Cities and networks of cities: Theoretical selection criteria

Building a theoretical framework that combines agglomeration and network externalities requires compatible building blocks. However, before we are in a position to identify these, we need to specify how to benchmark the available options. Two considerations are important here: (i) the degree of empirical correspondence with a geographical observable research object ('cities' within 'networks of cities'), and (ii) the level of analysis (firms versus the wider geographical environment impinging on these firms).

When we think of the world as a 'network of agglomerations', a commonsensical geographical association of a multitude of connected cities is invoked. Although it would be an empiricist or a 'naive objectivist' (Sayer, 1992 [1984]: 44) fallacy to assume that such a commonsensical observation automatically corresponds geographically and theoretically to a research object, we nevertheless agree that a practically adequate degree of correspondence between a commonsensical sign/signifier and its theoretical referent is important (Sayer, 1992 [1984]: 55-84; Gregory, 1994: 12). Thus, a first important selection criterion of our conceptual building blocks is whether a degree of reference to the commonsensical notions of 'city' and 'network of cities' can be retained.

The second consideration concerns the appropriate level of analysis our theoretical framework should adopt. According to Olsen (2002), the central misunderstanding between economic geography and geographical economics regarding externalities relates to whether the theoretical object refers to the perspective of the individual firm, or to the wider geographical environment in which firms are situated. The associated difference between 'internal' and 'external' agglomeration effects has been widely recognized in the literature (Parr, 2002a), and can be understood as the difference between 'agglomeration economies' and 'agglomeration externalities' (Parr, 2002a; 2002b). Since we are primarily interested in environmental-level effects that accrue *across* firms we adopt the definitional yardstick that 'externalities or spillovers occur if an innovation or growth improvement implemented by a certain enterprise increases the performance of other enterprises without the latter benefiting enterprise having to pay (full) compensation' (Burger et al., 2009: 140).

Agglomeration externalities

Over the years, many scholars have formulated different city-scale externality categorizations that suited their respective research questions at that moment. The resulting typologies crosscut one another and tend to have different geographical referents (Gordon and McCann, 2000). We first analyze the two canonical taxonomies and associated ideas regarding their geographical footprint: the typology initially put forward by Ohlin, Hoover and Isard (Isard, 1956), and the one initially put forward by

Marshall (1920 [1890]). This is followed by a discussion of a number of notable alternative categories: MAR externalities, Jacobs externalities, and a family of 'complexity externalities'.

We commence with Isard's (1956: 172 *paraphrased*) elaboration of the Ohlin/Hoover taxonomy. It concerns a tripartite classification of agglomeration economies consisting of (i) large-scale economies, which refer to scale advantages for the individual firm at an individual location; (ii) localization economies, which refer to the benefits accruing to a single industry at a single location; and (iii) urbanization economies accruing to all firms in all industries at a single location. Here we disregard the first type since we are interested in economies outside the boundaries of the firm (i.e. externalities, see Moulaert and Djellal, 1995; Parr, 2002a). Note that in Isard's formulation the taxonomy is not mutually exclusive: localization economies are a subset of urbanization economies. Moreover, there is vagueness in this definition regarding the geographical scale of the phenomenon, where each effect refers to a nondescript 'location', reminiscent of Lösch's (1954 [1940]: 11, 68) equally sketchy 'punctiform agglomerations'. Although Burger et al. (2008), following McCann (1995), argue that localization economies tend to have a smaller geographical scale than urbanization economies, Isard's 'nested' definition does not warrant such a claim solely based on geographical properties. For instance, a specialized amenity only relevant for particular sectors such as a port might have a spatial range that is far beyond a specific city (Parr, 2002b). Moreover, too tight a focus on industrial sectors might obscure observations of sector emergence or coalescence (Neffke, 2009). However, defining agglomeration externalities solely for specific sectors does give advantages when operationalizing the concept empirically. For instance, Duranton and Overman (2005) find that locational clustering associated with a localization economy mostly takes place at small scales under a distance of 50 km even though the intensity and degree of effect will most likely differ across sectors (McCann, 1995).

The Ohlin-Hoover-Isard typology cuts right across the other canonical typology put forward by Marshall (1890 [1920]), which discerns agglomeration externalities based on 'labor market pooling', 'input sharing', and 'technological spillovers' (Rosenthal and Strange, 2003). Although Marshall mentions these externalities in a treatise of specialized sectors, which are therefore sometimes considered a specification of localization economies (Rosenthal and Strange, 2003; Burger et al., 2009), there is no inherent mechanism that restricts Marshall's three mechanisms to specific sectors: a shared, or thick, labor market can cut across sectors, as do shared inputs (e.g. infrastructure) and information spillovers. The Marshall typology has been fruitfully applied in work that engages with the spatial dimension of agglomeration externalities, as the three mechanisms commonly allow for identification of spatial thresholds (Rosenthal and Strange, 2003). For instance, labor market pooling tends to adhere to the spatial scale of functional urban areas based on commuting patterns, while the technology spillovers based on close-knit interaction is generally present solely on a very small neighborhood-level scale (Larsson, 2014). By contrast, inter-firm interactions might define a larger scale outside the bounds of the administrative city, which are nevertheless geographically constrained (Phelps et al., 2001). Hence, agglomeration-externality fields, defined with whatever typology, consist of various mechanisms operating at different scales. This makes the ‘agglomeration’ a unit with a variable geometry, where certain effects overlay several cities while others are confined to more local environments (Lang and Knox, 2009).

Over time, authors have made additions and/or proposed alternatives to these canonical typologies. Without the pretention of being exclusive, we mention a few others that have come to play a major role in theorizing the relation between agglomeration and network externalities. First, there is the MAR versus Jacobs externalities debate which concerns the question whether related or unrelated industries foster knowledge-based competitiveness (Glaeser et al., 1992; Henderson, 1997; Neffke, 2009). MAR-externalities (named after contributing theorists Marshall, Arrow and Romer) are a specification of localization externalities that attribute knowledge and innovation-related externalities to intra-industry dynamics (Glaeser et al., 1992). Jacobs (1969) externalities, in turn, theorize innovation to be the result of interaction between diverse industries. Furthermore, some authors propose another urbanization-externality mechanism that refers to a specific kind of uncertainty reduction for firms located in that region. Parr (2002a; 2002b) calls these ‘economies of complexity’, while McCann (1995) describes them as a family of ‘hierarchy-coordination’ effects and Moulaert and Djellal (1995) as ‘economies of overview’. Although all of these conceptualizations, henceforth addressed as ‘overview externalities’, differ slightly in their elaboration, they have one crucial feature in common: they posit that large cities, on account of their knowledge- and/or size-related possibilities of recombining and retooling assets across markets and sectors, offer enhanced benefits to firms located in that city.

Network externalities

In its most basic guise, the concept of a ‘network’ refers to an observable pattern of ‘linkages’ between ‘nodes’, the ensemble of which can be directly or indirectly examined using the tools of graph theory. Although interest in ‘networks’ in geography and regional science dates back to at least the 1960s (e.g. Nystuen and Dacey, 1961; Haggett and Chorley, 1969; see Poorthuis, 2015 for a recent overview), we can observe a surge in interest in the concept since the 1990s: references to ‘urban networks’ have grown dramatically in the scientific literature (Neal, 2013a), and these networks are currently explored within many social but also natural science disciplines (e.g. Bettencourt and West, 2010). Research now extends over many scales of analysis from the intensely local formation of social networks (e.g., Hipp et al., 2012) to the global formation of transnational economic networks (e.g., Alderson and Beckfield, 2004).

It is not easy to identify why ‘networks’ and ‘network analysis’ have entered our collective analytical toolkit, as very different kinds of interlocking processes seem to have played a role in its popularization. For instance, urban network research commonly but patchily refers to the relevance of information and knowledge being routed through branch location networks of enterprises (Pred, 1977; Rozenblat, 2010; Taylor and Derudder 2016), the densification of telecommunications, airline and high-speed rail networks fostering increased but uneven time-space convergence (Haig, 1926; Janelle, 1969; Castells, 1989, 2000; Veltz, 1996; Zook and Brunn, 2006), and the vastly increasing depth and spatial extent of trade and investment networks in an increasingly globalized and urbanized economy (Dicken, 2011). Observing these processes, scholars were increasingly interested in determining how, why and which economic interactions were affected by uneven patterns of time-space convergence. Moreover, they tried to make sense of relations that remained spatially proximate in the face of the ostensibly declining relative importance of distance (Amin and Thrift, 1992; Bathelt et al., 2004). Altogether, these developments converged in a research agenda concerned with the generic phrase 'urban networks'.

Whatever the lineage of the 'network' concept, it is clear the concept is now commonly deemed useful for making sense of cities and regions. To be analytically sensible, any network perspective implies that the object of inquiry can be fruitfully related to that perspective (Neal, 2014a). In the case of externalities, for instance, an economic perspective could highlight utility considerations about the costs and benefits of being connected to a network. Network externality perspectives thus tend to focus on the extent to which benefits of one entity being connected to the network spill over to the other entities. Katz and Shapiro (1985) provided a first formulation of network externalities in which they examine goods where 'the utility that a user derives from consumption of the good increases with the number of other agents consuming the good' (Katz and Shapiro 1985: 424). For example, they discuss telephone and ICT infrastructure (cf. Capello and Nijkamp, 1996) where 'the utility that a given user derives from the good depends upon the number of other users who are in the same "network"' (Katz and Shapiro, 1985: 424).

Camagni (1993) and Capello (1996, 2000) have proposed a similar notion of 'network externalities' to understand the economic benefits associated with inter-city interactions. They emphasize that benefits accrue on the level of the city production function as inter-city networks deliver 'synergies', and 'complementarities' (Camagni et al., 2012; cf. van Oort et al., 2010): where connections between cities lower transport costs and times, and as information between places travels first and foremost through the people communicating through these networks, all sorts of asymmetries between cities emerge based on their level of connectivity to other cities (Neal, 2011). These asymmetries can often be related to infrastructure, for example with the classic (spatially uneven) lowering of costs and increased utility when a place is connected to an infrastructure network (Zook and Brunn, 2006; Ducruet et al., 2011). However, most applications of network externalities engage with knowledge asymmetries. Overview externalities, for instance, thrive on localized knowledge asymmetries that are theorized to induce agglomeration of economic activity (Amin and Thrift, 1992; Moulaert and Djellal, 1995; Bathelt et al., 2004; Liu et al., 2015; van Meeteren and Bassens, 2016).

Similar to agglomeration externalities, the problem of observational equivalence looms large when specifying a network externality mechanism. That two different phenomena can be meaningfully represented in a network does not mean they automatically refer to the same object. The question thus remains to what extent inter-governmental collaborations, inter-firm networks, airline and maritime networks, etc. add up to a generalized 'urban networks' concept (Nystuen and Dacey, 1961). How much 'isomorphism' or' 'homology' between networks do we need to identify before two different phenomena are considered part of the same urban network (e.g. Choi et al., 2006; Tranos et al., 2014)?

3.3 A combinatorial typology for agglomeration and network externalities

Three disciplinary perspectives on the menagerie

Despite the varied building blocks used for understanding agglomeration and network externalities, scholars from several scientific disciplines have attempted to meaningfully combine them. Given the variety of possible starting points sketched above, compounded variation and hence fuzziness is to be expected. Nevertheless, we argue that the different disciplinary positions and the main dimensions they highlight do not preclude meaningful classification and subsequent comparison of 'agglomeration' and 'network' and different axes of analysis have been proposed to that aim. We discern three different perspectives (Table 3.1): an industrial organization perspective, a spatial-economic perspective and a geometrical perspective. We do not have a preference for any of these axes of analysis. Rather, the disciplinary perspectives are different ways of carving-up the same empirical reality into different scientific objects. The merit (or the lack thereof) of each of these combinations needs to be assessed on its own terms. They cannot assumed to be generalized notions of the agglomeration/network externalities-menagerie. The typology serves to emphasize that any juxtaposition will benefit from a conscious combination of the different axes of analysis, as it decreases fuzziness without disregarding the contributing disciplinary traditions.

Axis of analysis	Agglomeration	Network
Commonsensical association	City	Network of Cities
Industrial organization perspective	Public good	Club good
Spatial-economic perspective	Gravity-type interaction	Archipelago-economy type interaction
Geometrical perspective	Projective geometries, e.g. Euclidian geometry	Topology

Table 3.1 Combinatorial typology of agglomeration and network externalities

The industrial organization perspective

Many different conceptualizations of networks could have been used to complement the perspective on agglomeration externalities in regional science. However, it is the analysis of city networks based on industrial relations and transaction cost theory that initially grabbed the attention of economic geographers and regional scientists (Camagni and Capello, 2004; Grabher, 2006). This 'industrial organization perspective' is the first dimension through which we will unpack the agglomeration/network menagerie. The industrial organization perspective on networks emerged out of dissatisfaction with the ideal-typical dichotomy of 'markets' (unplanned coordination) and 'hierarchies' (completely planned coordination) in theories of the firm (Richardson, 1972; Powell, 1990). Industrial organization theory claims that stable 'network' relations between firms are an important backbone of the economy, and are even becoming more important as the industrial system becomes more flexible: buyer-seller relations are governed by trust and stability rather than by price competition alone. Therefore, being part of a network of interlocked firms enhances the efficiency of the economic system as a whole (Powell, 1990). From the perspective of the firm, being part of the industrial network is a 'club good' rather than a public or private good, where semi-excludability and the right balance in number and quality of participants determine the economically optimal outcome (Buchanan, 1965). Being embedded in a network conveys certain advantages to participants (Granovetter, 1985): it opens up the network externalities to those who are part of the club (Capello and Nijkamp, 1996). In analogy to this industrial organization perspective on the level of firm networks, an up-scaled distinction has been proposed for city networks as a club good (Capello, 1996; 2013; Camagni et al., 2015). From this perspective, being part of an inter-city network conveys network externalities to the participating cities that complement the endogenously created agglomeration externalities. Again, a crucial aspect of this conceptualization is the excludability, or the 'club good' character of the network externalities: only some cities can participate (Capello, 1996). As a corollary, agglomeration economies are non-excludable and hence 'a market' (Johansson and Quigley 2004): by being located in the city, by simply 'being there' (cf. Gertler, 1995), a firm can reap the advantages. Cast in Bathelt et al.'s (2004: 40-41) metaphorical language of 'local buzz and global pipelines', the local 'buzz' is ubiquitously accessible to all locally-present firms, but cities' participation in the 'global pipelines' requires some sort of conscious effort.

Although the industrial organization perspective provides important insights as to why certain inter-city relations are present and others not (e.g. it would clearly be useful to explain the above-average connections between major international financial centers such as New York and London), two inconsistencies appear when we try to project this perspective on the commonsensical definition of cities and inter-city networks. The first inconsistency is that many of the clubs we intuitively think of when considering the externality literature are profoundly local: whether it is Granovetter's (1985) diamond traders or industrial districts and clusters (see Powell, 1990 for an overview), many of the archetypical networks to which the theory applies are in fact intra-urban. Second, in urban economics there is a modeling tradition that explicitly conceptualizes agglomeration externalities as a club good (Rosenthal and Strange, 2003). In this tradition, in order to isolate the effect of presence of agglomeration externalities, location in a particular city is modeled as membership of a club. In other words, every city is conceptually 'nodalized': assumed to be a monocentric nodal region with its own hinterland (Nystuen and Dacey, 1961; Parr, 2002b; 2014). If a firm wants to accrue the agglomeration-externality, it has to bear the operating costs of presence in that nodal region, which indeed can be modeled through an analogy of paying club membership fees. These two inconsistencies show that a conceptualization of the agglomeration-network menagerie singularly based on the governance analogy of markets and networks is insufficient. A spatial-economic dimension, in which distance plays an instrumental role, has therefore been put forward as well (Camagni and Capello, 2004).

The spatial-economic perspective

A second way to distinguish between agglomeration and network externalities is by observing that the former attenuate with distance (e.g. Gordon and McCann, 2000; Parr, 2002a; 2002b; Rosenthal and Strange, 2003; Johansson, 2005). Since this attenuation effect is traditionally modeled in a gravity-type model, Camagni (1993) has suggested naming this kind of interactions 'gravity-type interactions'. It is argued (e.g. Castells, 1989; 2000; Camagni, 1993; Batten, 1995; Veltz, 1996) that the technological possibilities offered by consecutive information- and communication-technological revolutions have made different kinds of interactions between localities more prevalent: those where distance does not matter anymore. Castells (2000: 14) describes this mechanism as 'the technological and organizational possibility of organizing the simultaneity of social practices without geographical contiguity.' Noteworthy examples of such interactions mentioned by Camagni (1993) are financial city networks where transactions are virtualized, tourist cities connected through cultural or historical 'itineraries', or innovation networks between connected industrial sectors. Rodriguez-Pose and Fitjar (2013), following Veltz (1996), suggest the term 'archipelago-economy interaction' for inter-city interactions where distance does not matter (cf. van Meeteren and Bassens, 2016). Camagni (1993; Camagni et al., 2012; cf. Batten, 1995) proposes to reserve the term 'city networks' for relations between cities of such an archipelago-economy interaction type. Taken together, this suggests we can define the spatial-economic dimension of both types of externalities as follows: agglomeration externalities are defined as externalities that attenuate with distance, while networks are externalities where the effect of distance has become negligible. This distinction has been fruitfully applied in empirical research (e.g. Bentlage et al., 2013; Camagni et al., 2015, Pain et al., 2016).

It is important to note that 'gravity-type interactions' and 'archipelago-economy type interactions' are ideal-typical poles on a continuum where the exception—that of global financial networks—might be dictating the rule. For instance, many of the city-network externalities described in the literature on polycentric urban regions (Hall and Pain, 2006; Meijers and Burger, 2010; Van Oort et al., 2010) do attenuate with distance. The fact that the cities of the Randstad are on average 55 kilometers apart is causally significant. And even Castells (1989: 110) mentions that a three-hour plane ride to Silicon Valley was an important distance threshold facilitating the emergence of new industrial spaces in the American west in the 1980s. As Haig (1926: 201) put it: 'Better aeroplanes will undoubtedly be built, but even tho San Francisco is brought within an hour of New York, instead of a day, an hour remains an hour' [sic]. Of course, if a plane is the only available mode of transport, by virtue of the networked structure of the air-travel system, one could still make this cost/time attenuation endogenous to an urban network analysis (Zook and Brunn, 2006; Matisziw and Grubesic, 2010). This kind of analytical move, which involves assuming that an urban concentration can be treated as a point location (Lösch, 1954 [1940]; Parr, 2002b: 727), namely, nodalization, is widespread in research on agglomerations in networks. For instance, any study abstracting a dichotomous 'proximity' variable to indicate agglomeration is in fact nodalizing, albeit often implicitly (e.g. Amin and Thrift, 1992; Bathelt et al., 2004). Moreover, once 'geographical proximity' is substituted for more sociologically defined proximities (Boschma, 2005; Torre and Rallet, 2005), research loses its geographical anchor altogether. However, as Parr (2002b) notes, the larger our study area, the more questionable the nodalization assumption becomes and the more an appreciation of distance attenuation might be relevant (van Meeteren, 2013). Therefore, whether abstracting locations into a nodal region is a valid reduction of rich geographical information is ultimately an empirical question.

The geometrical perspective

The issues of information reduction, geographical description, and comparability bring us to the heart of the geometrical issues involved in denoting agglomerations and networks. That two different phenomena can be meaningfully represented in a network does not mean they automatically refer to the same thing. This is why Burger et al. (2014a, 2014b) insist that urban networks are multiplex, i.e. the effects and reach of urban networks differ from network to network. Multiplexity in this sense is the conceptual analogue of the 'variable geometry' in agglomeration externalities. Both agglomeration- and network-externality effects have a geographical instability to them. Nevertheless, different sets of agglomeration or network effects are often tied together by appealing to geographic referents (cities and networks of cities). By appealing to a geographic referent, we refer to the geometrical properties we associate with the city and network form. In the case of a city, a specific place and configuration on the earth's surface is invoked which we associate with Euclidian geometry: the specific projective geometry that is fairly accurate for describing distances up to 250 miles and resonates with our commonsensical perception of space and objects located in that space (Harvey 1969: 224). In the case of a network, we appeal to topological geometry: a more basic geometry that focuses on connectedness (Bunge, 1966 [1962]; Harvey, 1969).

Regional scientists are not the only scholars trying to make sense of externalities. Importantly, there has been a recent surge of interest in measuring the importance of externalities by physicists seeking to 'solve' the city mathematically using network analysis. Bettencourt and West (2010), for instance, have observed universal scaling in cities, and argue that the degree of scaling can be analytically derived from the topological properties of branching distribution networks. However, in our view, these kind of attempts to devise a unified 'theory' of cities clashes with the insights of Saey (1968) and Sack (1972), who have made the case that it is logically impossible to derive social substance from a theory or model that merely consists of geometrical properties. There is, therefore, no such thing as spatial laws that have economic or sociological validity on their own terms. The fact that we can fruitfully model different spatial interactions with a geometrical model derived from an analogy with the laws of gravity does not mean there is a 'universal law of gravity that applies to socio-spatial systems', giving people a propensity to attract (Lukermann, 1958). The underlying monist idea that theories of physics can explain both human and non-human worlds is scientifically contentious (Barnes and Wilson, 2014). Similarly, the fact that we can model different social phenomena as networks (infrastructure, information networks, office networks) does not automatically imply that there is a 'social law of networks'. At best, a network model or a gravity model with a good fit provides analogies that inspire a scientist to construct theories drawing on a *substantive* mechanism that subsequently proves practically adequate for a research endeavor (Mair, 1986; Barnes, 1996); non-substantive models are insufficient as an explanation on their own terms (Sheppard, 1978). Hence, irrespective of the analytical rigor and exciting innovation in research on 'typical' network structures such as 'small world networks' and 'scale-free networks' (Ducruet and Beaugitte, 2014), ultimately these typical networks need to be backed up by a plausible social-scientific theory or mechanism in order to count as explanation (Neal, 2013b; 2014a; Taylor and Derudder, 2016). Consequently, geometry should be considered primarily as a language that we can use to describe spatial forms (Harvey, 1969: 192). Different geometries allow us to describe different properties of the same object while they similarly render other properties out of view. Thus, from a geometrical perspective, describing an object as 'a network' or 'an agglomeration' is merely a choice of language based on its presumed efficacy for a particular application (van Meeteren and Bassens, 2016).

This brings us to the key question of what geometrical language suits what kind of research problem. Harvey (1969: 218) expects 'topological theorems to be applicable to geographic problems if the geographical problem itself can be realistically and successfully be stated in terms of connectedness'. Therefore, if connectedness is the focus, describing the city and the network of cities as nested networks is a viable research strategy (Rozenblat, 2010; Neal, 2013a). When the choice of geometry is primarily a choice of language, 'nodalizing' becomes a translation from projective geometry in topology (Bunge, 1966 [1962]). However, such a seemingly efficient topological perspective also has drawbacks. Topological perspectives tend to reduce the amount of information in the description compared to a projective geometry such as Euclid's, even though techniques for reducing such information loss are emergent (Hoff et al., 2002). Specifically, the distribution of objects that are difficult to describe in terms of connectedness can inadvertently be rendered out of view. Conversely, projective geometry is particularly helpful to map properties of objects that are best captured by a notion of a 'field'. A Field denotes a sphere of influence in a two dimensional area between a center and its periphery. Fields are 'theoretically continuous distributions with a very rapid fall-off near their center and a very slow, almost asymptotic fall-off at their outer ranges' (Haggett, 1965: 40-41). Analyses of potential of population and accessibility (Stewart and Warntz, 1958; Sheppard, 1979), with subsequent applications such as deriving potential markets (Harris, 1954) and prices (Warntz, 1957) are renowned applications of field analysis. Many topics associated with spatially attenuating phenomena—labor markets, central place market areas—concern in fact field properties (Phelps et al., 2001) and are hence difficult to fully grasp with topological perspectives.

Towards a consistent combination of agglomeration and network externalities

In this and the previous section, we have reviewed the intricacies associated with a coherent approach to the conceptualization and subsequent empirical operationalization of (combinations of) agglomeration and network externalities. In addition to the confusion that may arise from an incoherent combination of conceptual dimensions in Table 3.1, effective combinations are often further compromised by limitations induced by the available data sources. One obvious way in which data-based inconsistencies can be sidestepped is by using a single dataset. In the next section, therefore, we present an example that achieves this particular kind of consistency: we analyze 'cities as networks within networks between cities' (Neal, 2013b after Berry, 1964) by using a bipartite dataset detailing the co-presence of branch locations of globalized producer services firms in and across world cities. This allows us to simultaneously operationalize agglomeration and network externalities using the identical dataset and method.

Cast in our typologies discussed, this implies we will make the following choices in our combinatorial typology. First, by opting for graph analysis on the city and city network levels, we abstract both into topological language. Hence, we assume that in this case, both the city and the network of cities are best described as nodalized. On the level of inter-city interactions we assume that archipelago-economy interactions sufficiently capture the dynamic while for the inter-firm interactions we assume a co-location dummy of proximity sufficiently accurate to speak about potential agglomeration externalities (subject to a significance test). Whether our interactions on the city or network levels are public (market) goods or club (network) goods depends on the barriers of entry to the producer services economy. Since this would require an institutional analysis of this particular sector, we cannot make definite statements on that matter.

3.4 A topological rendering of the APS economy

GaWC measures of the APS economy

Our empirical illustration is based on an examination of the producer services economy as explored in world city network analysis. In world city network analysis, advanced producer services (APS) firms are conjectured to be crucial facilitating actors in the global economy (Bassens and Van Meeteren, 2015; Taylor and Derudder, 2016). It is the office networks of APS firms that relay business knowledge, i.e. overview externalities, between well-connected cities in the global economy. These global networks are assumed to be embedded at the city scale in a strong localization economy where the information is locally decoded, recombined and transmitted (Amin and Thrift, 1992, Moulaert and Djellal, 1995; Bathelt et al., 2004). Hence, the APS economy is an exemplary case where externalities associated with both the city and city-network levels come together. We first explain the basics of our data and method, after we illustrate results in the next section through a discussion of selected examples.

Data are derived from the research carried out in the context of the Globalization and World Cities (GaWC, http://www.lboro.ac.uk/gawc) research network. GaWC was formed in the late 1990s to advance our understanding of the changing worlds of cities under conditions of contemporary globalization. Its core business has been to more narrowly focus on one conspicuous topic in research on globalized urbanization: the external relations of world cities. Following early inventories of world cities based upon their *level* of advanced producer services (Beaverstock et al., 1999), most of GaWC's quantitative research has been premised upon the application of the 'interlocking *network* model'. The interlocking network model (INM) essentially provides an empirical specification of Allen's (2010: 2898) observation that 'city powers are mobilized through inter-city networking in financial and business services.' To this end, a universe of producer service firms located in world cities is defined. The elemental measure is a service value v_{ij} with information on the importance of the presence of firm j in city i. These observations can be arrayed as service value matrix **V**. In the most recent 2012 GaWC data gathering, the data comprises standardized measures of the relative importance (ranging between 0 if a firm has no presence, and 5 for the global headquarters of a firm) of the branch locations of 175 service firms in 526 cities (for more details, see Taylor and Derudder, 2016).

In network analysis, the service value matrix **V** is commonly termed a two-mode network (Liu and Derudder, 2012; Neal, 2012b). In contrast to one-mode networks, where actors are directly linked, a two-mode network is characterized by connections between two separate sets of nodes. In this case, **V** is a network connecting cities with firms, respectively. In the initial specification, there is no direct linkage within the same set of nodes: we simply know which firms are in what cities, and which cities house what firms. However, it is possible to infer two one-mode networks from the two-mode dataset by applying a 'projection function'. The INM is essentially such a projection function (for alternatives, see Neal, 2014a; Hennemann and Derudder, 2014). The two-mode to one-mode projection function entails applying a method converting the service value matrix **V** into a relational matrices **R** of firm and city interactions, and ultimately draws on seeking out co-presences of firms in and across cities. In most GaWC research, the focus has been on deriving inter-city networks (systematic analysis of the location of branch offices of a firm in specific sets of cities), but the same logic can be applied to intra-city networks (systematic analysis of the presence of branch offices of specific firm networks in a city) (Neal, 2008).

The crux of the interlocking network model projection function is (1) the definition of city-dyad connectivity $CDC_{a\text{-}b}$ between cities *a* and *b* and (2) the definition of firm-dyad connectivity $FDC_{i\text{-}j}$ between firms *i* and *j* based on V:

$$CDC_{a\text{-}b} = \Sigma_i v_{ai}.v_{bi} \qquad a \neq b \quad (1)$$

$$FDC_{i\text{-}j} = \Sigma_a v_{ai}.v_{aj} \qquad i \neq j \quad (2)$$

Neal (2013c; 2014b; 2016) has pointed out that results produced by an application of (1) and (2) to the GaWC data, for instance as discussed in Taylor and Derudder (2016), have above all a comparative appeal. For example, inter-city connections are often benchmarked against the New York-London dyad, which is by far the strongest inter-city connection in absolute terms. However, Neal (2016) argues that a potentially more appropriate comparison for substantiating claims of strong connectivity would be to ask whether London and New York are more highly connected than could be expected based on their massive service complexes, which imply that strong connections in an absolute sense are in fact almost a given. Similarly, systematic co-presence of branch locations of 'The Big Four' in accountancy in cities is to be expected given their blanket-type location strategies (Taylor et al., 2014; Taylor and Derudder, 2016: Chapter 5). As a consequence, the question becomes whether, say, KPMG-Deloitte tend to be *unusually* frequently co-located in cities given their massive office networks. As argued by Ellison and Glaeser (1997), we can only assuredly speak of externalities when we have significant confidence that the co-presence of firms is due to interaction between those firms and not the result of mere chance.

To address this issue for externalities described in topological language, we draw on the application of Neal's (2014b) stochastic degree sequence model (SDSM) to GaWC data as elaborated in Neal (2016). The SDSM allows testing the statistical significance of a network statistic (e.g. CDC and FDC) in an observed network (e.g. those produced by the INM) in a sample of random networks that were generated by the same processes responsible for the observed network's development (e.g. firms' site selection strategies). In Figure 3.1 we summarize the steps involved in applying the SDSM to these data, and here we briefly review these steps so that readers are able to interpret the findings reported below. In the first step, the observed firm and city networks are constructed from a service value matrix, **V**, using equations (1) and (2) from the interlocking network model. This yields two one-mode networks in which the strength of the linkage between a pair of cities (firms) is a function of the number of firms maintaining offices in both locations (number of cities hosting offices of both firms), weighted by the size of those offices. The second step involves computing the row and column marginals of **V**, which here are used as indicators of firms' capacity to expand and city's capacity to serve as markets. In the third step, a logistic regression is estimated that predicts the size of each firms' office in each city as a function of these marginal values, then uses the fitted model to compute, for each firm-city pair, the probability that firm *f* would open an office of size *s* in city *c*. In the fourth step, these probabilities are used to generate a simulated service value matrix, $\mathbf{V}'$, which has stochastically identical marginals to **V**.

Step five involves applying the interlocking network model again, this time constructing simulated firm and city networks from the simulated service value matrix. The generation of a simulated service value matrix, and the subsequent construction of simulated firm and city networks, is repeated many times (in the results that follow, we use 10,000 replications). The final step compares a network statistic from the observed network to the distribution of the same statistic from the simulated networks. For example, a statistical test of the strength of a given city dyad connection (CDC) compares the value of the CDC in the observed network to the values of the simulated CDCs in the simulated networks. If the observed CDC is larger than almost all of the simulated CDCs, then the city-dyad connection is deemed statistically significant.

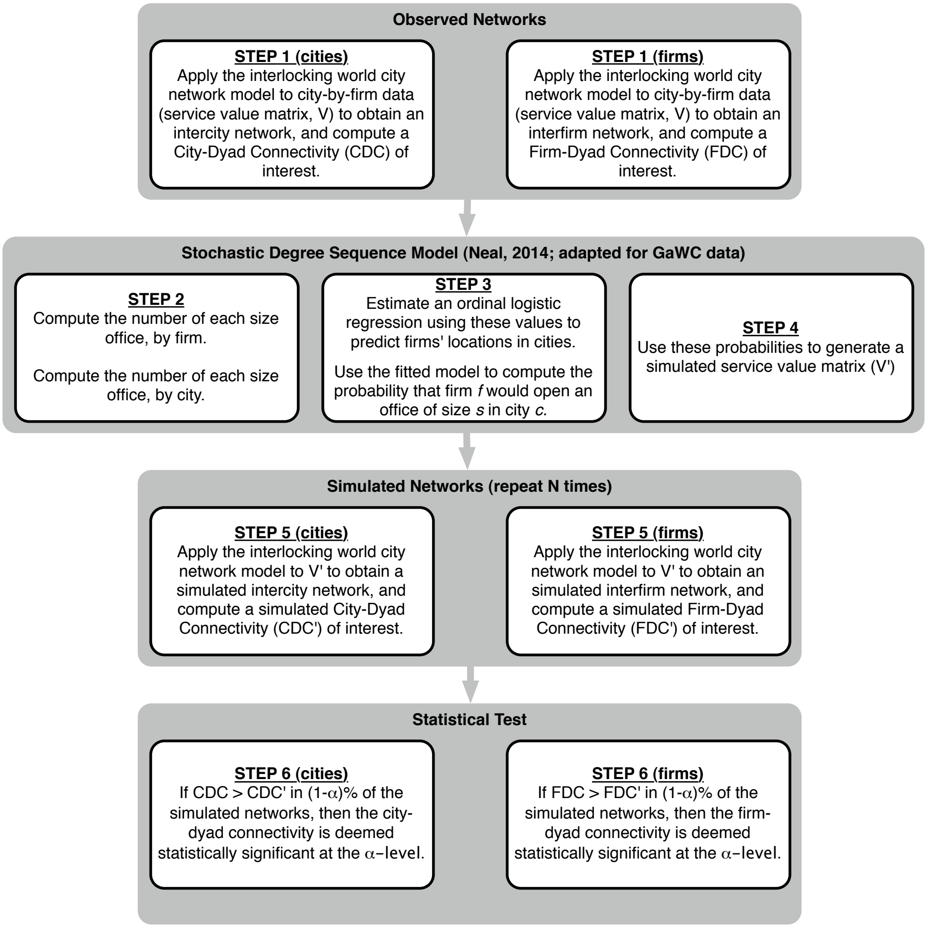

Figure 3.1 Outline of the Stochastic Degree Sequence Model

Results

Our discussion of results is purposively partial: the highlighted cases are illustrative examples, and therefore by no means an inclusive discussion of CDC and FDC patterns around the globe. Rather, our aim of this is to empirically verify the conceptual model of the combinatorial typology and its consistent empirical operationalization by discussing some examples. Figures 3.2 and 3.4 display the complete city and firm networks obtained by applying the SDSM to the GaWC data, while Figures 3.3 and 3.5 display the ego networks for selected specific cities and firms within these networks. All of these figures show a pair of cities (a pair of firms) as linked if their corresponding CDC (FDC) is significant at the $\alpha = 0.001$ level using the SDSM test. We use a conservative threshold for statistical significance here because it yields sparser networks, which facilitates their visualization and interpretation. Substantively, this threshold means that there is a less than one-tenth of one percent chance the links shown were forged between the cities (firms) by chance. Additionally, all of these networks use a spring embedding layout, which highlights the topological rather than topographical relationships among the nodes.

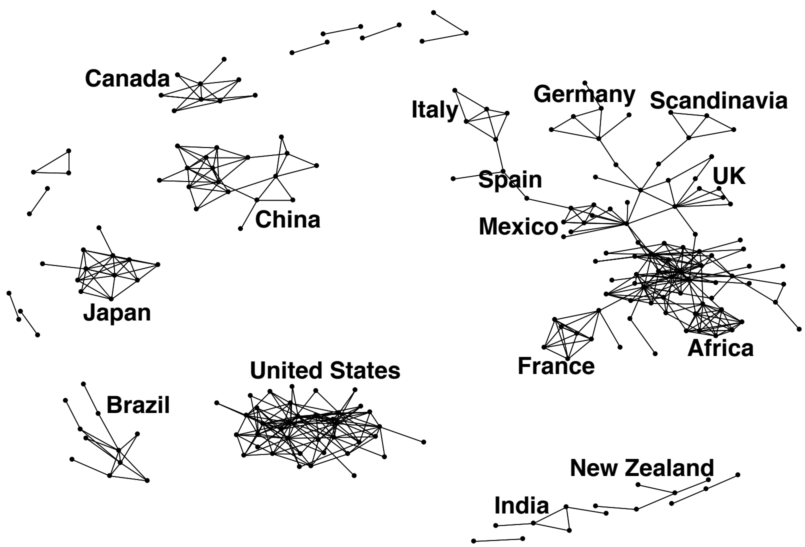

Figure 3.2 Resulting city network

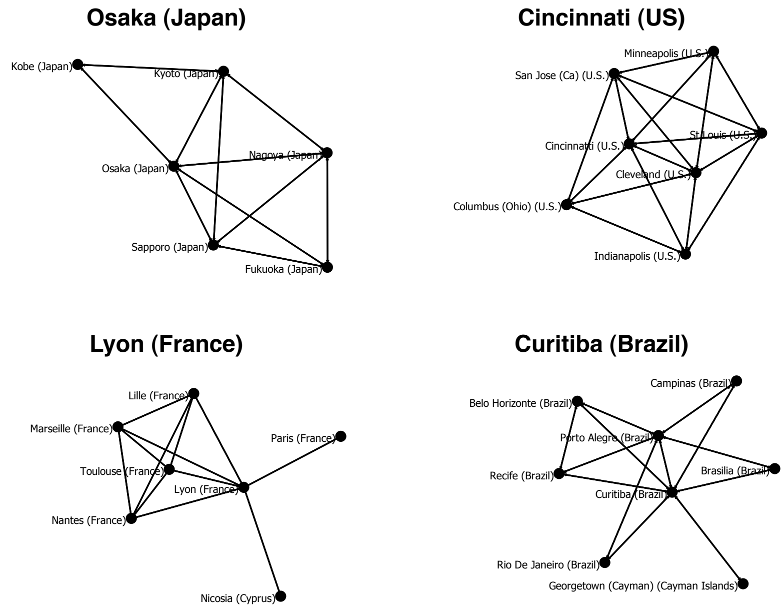

Figure 3.3 Ego networks of selected cities

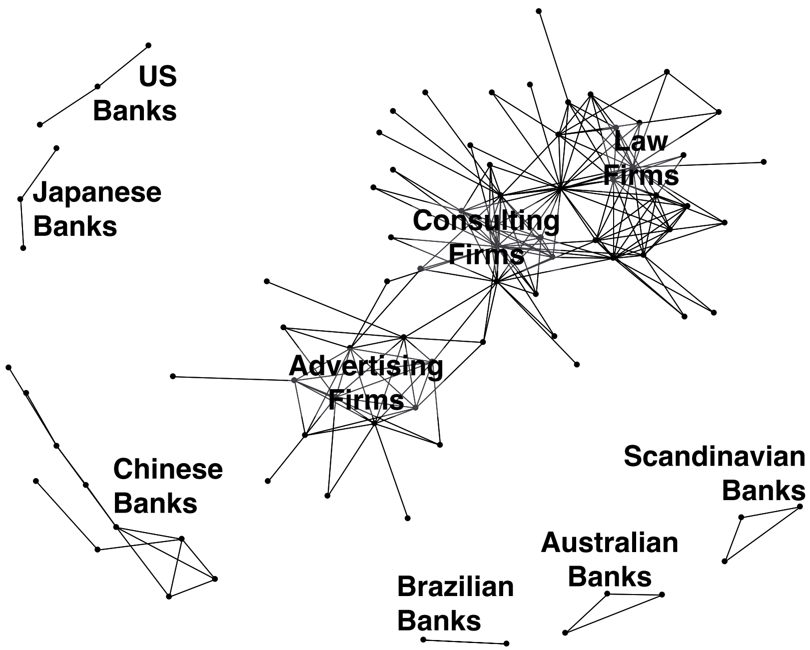

Figure 3.4 Resulting firm network

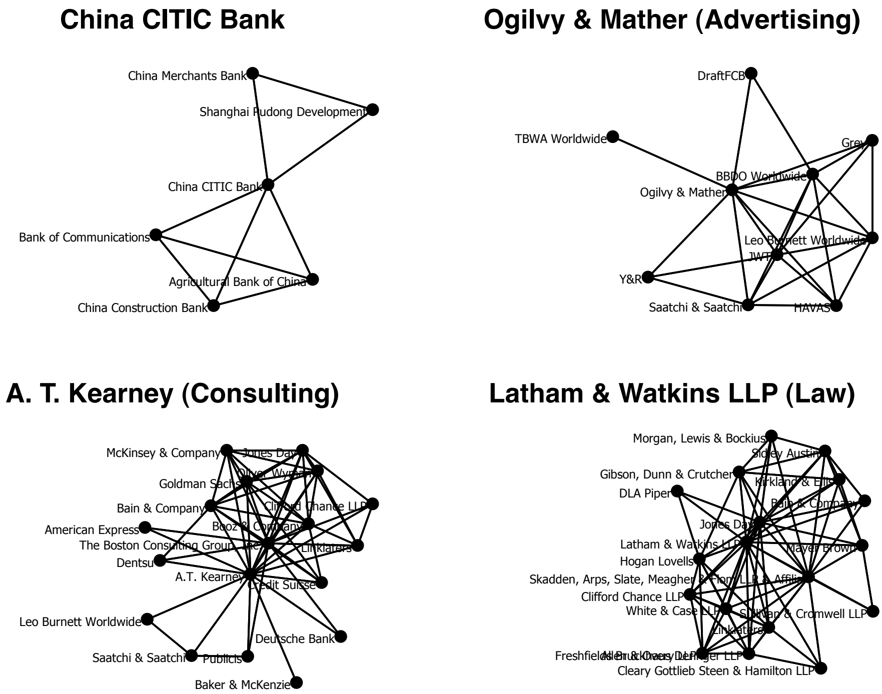

Figure 3.5 Ego networks of selected firms

In the city network shown in Figure 3.2, the nodes represent cities, but only groups of nodes are labeled. While this facilitates readability, it also highlights a key pattern in this network: the topology is organized primarily by regional tendencies in general and national borders in particular. Cities in the United States are linked only to other cities in the United States, and likewise for Chinese cities, Japanese cities, Brazilian cities, and so on. The large component on the right displays a small amount of cross-national interaction, suggestive of greater levels of integration in Europe, as well as lingering colonial influence in Mexico and Africa. However, even here nation-based groupings are still quite distinct: French cities are linked *mostly* only to other French cities. These patterns are confirmed, with greater detail, in Figure 3.3, which illustrates the network immediately surrounding four selected cities: Osaka, Cincinnati, Lyon, and Curitiba. These cities from different world-regions have networks large enough to be interesting, but small enough to be readily visualized, and clearly illustrate that this is the most basic pattern in Figure 3.2. The Cincinnati case, in particular, highlights that in nations with large numbers of major urban centers, the topological organization is first driven by national borders (Cincinnati is linked only to other US cities), but secondly by regional boundaries (Cincinnati is linked mostly to other cities in the US Midwest) (cf. Tobler, 1970).

The patterns revealed in Figures 3.2 and 3.3 provide clear evidence of *agglomerative* *tendencies* by advanced producer service firms. But to understand why requires reflecting on what linkages obtained using the SDSM mean. The linkage detected by the SDSM between Cincinnati and Cleveland indicates that firms with branch offices in Cincinnati have more (and larger) branch offices in Cleveland also than would be expected if these Cincinnati firms expanded their branch office networks based only on the attractiveness of candidate cities and the firm's own capacity to operate a new branch office. That is, these Cincinnati firms could have all sought to open offices in New York, or London, or Tokyo; they did not. Instead, they specifically and strategically sought out Cleveland as a branch office site, thereby establishing an intra-national, and indeed in this case intra-regional, agglomeration. Similar stories are told by the SDSM for each linked pair: firms' strategic site selections combine to yield the nationally-bounded agglomerations seen in Figure 3.2.

In the firm network shown in Figure 3.4, the nodes represent firms, but only groups of nodes are labeled. Again, while this facilitates readability, it also highlights a key pattern in this network: the topology is organized primarily by sector. Advertising firms are linked mostly to other advertising firms, while law firms are linked mostly to other law firms. Two notable exceptions are evident. First, consulting firms serve as a bridge between the advertising and legal sectors. Specifically, consulting firms are mostly linked to other consulting firms, but are also sometimes linked to advertising firms and sometimes to law firms, though rarely to both. This highlights the functional role of consulting firms in assisting multinational corporations to coordinate business services. Second, banks are not only topologically organized by sector (banks are linked only to other banks), but are also topologically organized by nation: Chinese banks are linked only to other Chinese banks. This likely signals unobserved institutional factors, but it is nonetheless noteworthy that no cross-national linkages are observed among banks. These patterns are confirmed, with greater detail, in Figure 3.5, which illustrates the network immediately surrounding one example firms in each sector: China CITIC Bank, Ogilvy & Mather (Advertising), Latham & Watkins LLP (Law), and A. T. Kearney (Consulting). The exclusively within-sector linkages are evident in the networks for the first three of these firms. In contrast, A. T. Kearney's network illustrates the linkages to other consulting firms (e.g. Boston Consulting Group, Bain & Company), but also to advertising (e.g. Leo Burnett, Saatchi & Saatchi) and law (e.g. Linklaters, Jones Day) firms.

The patterns revealed in Figure 3.4 and 3.5 provide clear evidence of *network tendencies* by advanced producer service firms. Again, to understand why requires reflecting on what linkages obtained using the SDSM mean. The linkage detected by the SDSM between Ogilvy & Mather (O&M) and Saatchi & Saatchi (S&S) indicates that O&M has more (and larger) branch offices in the same cities as S&S than would be expected if O&M expanded its branch office network based only on the attractiveness of candidate cities and the firm's own capacity to operate a new branch office. That is, O&M could have sought to open offices in the same cities as A. T. Kearney, or Latham & Watkins, or China CITIC Bank; it did not. Instead, it specifically and strategically sought out to open offices in the same cities as S&S, thereby establishing an intra-sector network of advertising firms. Similar stories are told by the SDSM for each linked pair: firms' strategic site selections combine to yield the sectorally-bounded agglomerations seen in Figure 3.4.

3.5 Conclusions

The purpose of this paper has been to (1) identify the intricacies associated with a conceptually consistent approach to the combination of agglomeration and network externalities; and (2) explore how this can be adopted in empirical research. To this end, we presented a (combinatorial) typology of externalities commonly invoked in the regional science literature, after which we illustrated the remit of adopting this typology by applying a state-of-the-art bipartite network projection detailing the presence of globalized producer services firms in cities in 2012.

Our analysis of statistically highly significant links between firms-within-cities and between cities-through-firms serves a heuristic purpose: given a very specific selection of firms within a very specific selection of cities, our results have no deep-seated value in the context of the extensive literature that tries to make sense of specific empirical patterns of agglomeration externalities, network externalities, and how these interlock. Our results have above all an intuitive, commonsensical appeal: the finding that Chinese banks are strongly inter-linked, and law firms tend to seek out the same set of cities can hardly be called surprising. However, the major point of this analysis is that, as a conceptualization and subsequent empirical operationalization of the commonsensical notions of 'a network of agglomerations', both the agglomeration and the network dimension can be brought into close dialogue without the seemingly unavoidable noise of conceptual discrepancies, fuzziness, and data inconsistencies. The one-mode graphs presented in the different figures can be validly interpreted as conceptually and empirically consistent topological renderings of agglomeration and network externalities. A subsequent analysis systematically examining how the patterns in Figures 3.2 and 3.3 and those in Figures 3.4 and 3.5 can be combined will therefore not suffer from the many hazards associated with undue juxtaposition of fuzzy concepts. It results in valid findings from the economic-geographic and geometrical perspectives that that can readily be hypothesized to be market, public or club goods in subsequent theorizing from an industrial organization perspective. The same could be done for alternative configurations of cities and firms for which there is a theoretically informed assumption. Similarly, the combinational typology will enable other methodological approaches to combine agglomeration and network externalities. For instance, an analysis could involve projective geometries, gravity-type interactions, and market-based exchange in order to construct meaningful and valid analyses of city and city-network effects that nevertheless denote different empirical referents than in our example. This highlights the purpose of this paper, which has been to draw attention to the importance of carefully attending to conceptual and empirical consistency. In our view, this will result in more precise statements on how agglomeration and network externalities interact, irrespective of the sector, scale, or processes being studied.

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4. Christaller and 'big data': Recalibrating central place theory via the Geoweb

Van Meeteren M and Poorthuis A (2016) Christaller and 'big data': Recalibrating central place theory via the Geoweb. *Working Paper.*

Abstract

While originating in the 1930s, Central Place Theory (CPT) is a theoretical monument of the 1960s spatial science era in human geography. Although CPT comes in many varieties that are based on a range of diverging assumptions, it is often presented as a singular rationalist monolithic theory. This simplification particularly occurs in arguments that suggest CPT to be irrelevant, redundant or even abject. In contrast to these dismissals, this paper takes a sympathetic stance towards CPT and gauges its contemporary relevance, particularly as a tool to navigate the 'deluge' brought about by big data. After a critical review of the history of CPT and its reception in human geography, we reconstruct the theory to fit contemporary needs. We continue by probing the contemporary validity of the microfoundations of Christaller's CPT, the threshold and range of a good, for a selection of central functions in Louisville, Kentucky. The range and threshold are estimated by using data gathered from the geosocial media sources Foursquare and Twitter. These sources allow us to assess the centrality of places regardless of administrative boundaries blurring the distinction between intra- and inter-urban central place studies. We recalibrate CPT by assessing the validity of two central axioms of Christaller's original theory: i) Specific central functions have typical ranges and thresholds relating central function structure to population spread; ii) Central functions cluster in settlements based on an approximate hierarchical structure. The findings of this research reveal the ongoing importance of these long-established mechanisms, and our theories of them, in shaping the location of the retail segment of economic activity.

4.1 Introduction

Walter Christaller's (1966 [1933]) Central Place Theory (CPT) carries monumental status in human geography for two reasons. First, it demarcates and commemorates a particular episode in human geography and its associated practices and theorizing: the 1960s spatial science era. William Bunge dedicated the epitomic *Theoretical Geography* (1966[1962]) to Christaller and stated that 'the initial and growing beauty of central place theory is geography's finest intellectual product and puts Christaller in a place of great honor' (Bunge, 1966 [1962]: 133). However, after the critical turn of the 1970s, CPT became a different kind of monument. To some, CPT exemplified what was wrong with spatial science as 'counter-revolutionary' theory, for instance when Harvey (1972: 6) declared that 'yet another attempt to identify the range of a good, serve[s] to tell us less and less about anything of great relevance'. For humanistic geography, CPT was the example of how nomothetic geography led to austere formulations 'which have limited value in understanding real world situations' (Guelke, 1978: 50). Although CPT continued to be widely studied throughout the 1970s before output started tapering off, the second meaning of the term monument—that of some musty artifact which belongs in a museum and needs to be retired (Blotevogel, 1996)—gradually started to emerge after these critiques sedimented. This meaning is implied by Scott (2012: 31) when he states that the 'rather rapid fall of central place theory from grace can almost certainly be understood by the fact that even given its internal logical coherence, it has so little to say about the great issues of urbanization and regional development that we face in today's post-Fordist world, apart from some modest continuing applications in retail geography.'

CPT, in its original formulation, describes the possible relations between the distribution of the population and the provision of central functions—for which consumers bear the consumption cost—to this population. The few contemporary studies (e.g. Morrill, 1987; Dale and Sjøholt, 2007; Neal, 2011; Boussauw et al., 2014 [Chapter 7]; Shearmur and Doloreux, 2015) that still apply CPT in line with this original goal all find meaningful associations between central functions and settlements, thus casting doubt on the theory's alleged obsoleteness. It would seem that even Christaller's (1966 [1933]: 100-107) predictions on how car ownership and changing retail modes (i.e. mail order, idem: 49) might influence the central place system have stood the scrutiny of time. However, although the studies cited above concern empirical studies, they all engage with central place analysis on the macro level, where they tend to assume rather than examine the contemporary validity of CPT's microfoundations: the interplay between the minimum amount of customers necessary for a central place to exist (the lower limit or threshold of a central good) and the maximum distance a consumer is willing to travel to obtain a central good (the upper limit of the range) (Christaller, 1966 [1933]). The primary aim of this study is to fill that gap by gauging these microfoundations through the use of big data and GIS capabilities that Christaller and the spatial scientists of the 1960s could only dream of.

However, before we commence that task, we have to manage expectations, as these were—perhaps unsurprisingly with a theory of monumental status—too high in the past. Whereas Christaller (1966 [1933]: 16-17, 139, 198) repeatedly stresses the restricted scope of his theory, as Vance (1970: 5) argues: 'a whole generation of geographical theorists has sought to account for almost any economic geographical pattern on the basis of central-place notions'. CPT is a theory of the location of central functions, a partial theory of settlement structure, and does not have the pretention to explain populations and/or cities in their totality: a central place is not a city (Carol, 1960; Preston, 1975).

The irony of CPT being the iconic theory of 1960s USA-driven spatial science is that the theory is neither from the USA nor from the 1960s. CPT is the result of Walter Christaller's dissertation, which was written during the early 1930s, and which infused ideas from Weberian location theory in German geography (Christaller 1972 [1968]). Contrary to popular myth (the origin of which is explored by Taylor, 1976), the theory was not neglected in Western Europe and spawned different offshoots and policy proposals during its early years (Bobek, 1938; Dickinson, 1947; Brush, 1953; Müller-Wille 1978; Rössler, 1989), including Christaller's involvement with Germany's Nazi regime (Rössler 1989; Barnes and Minca 2013). This early diffusion of offshoots has contributed to a wide variety of central place theories across time and place that show differing degrees of affinity and compatibility with Christaller's original version (Buursink, 1975). There exists no singlular 'rationalist' central place theory and even the 1960s USA versions have to be assessed in their diversity in order to gauge CPT's contemporary relevance (cf. Barnes, 2003; 2004a). In this paper, we explicate some of the incompatible interpretations that CPT incited in its 80 year long travels across the world and propose a variety of CPT—relatively close to Christaller's original—that answers to some of the critiques leveled at the theory from post-positivist perspectives (e.g. Barnes, 2004a; 2004b).

An important cause of CPT's popularity in the 1960s was that it provided a model that could guide geographers through the information torrent generated by the emergence of computers and advanced statistical methods in the geographer's toolbox, which had 'exploded the data matrix' (Hagget and Chorley, 1967). Instead of inciting a lapse into empiricism, CPT provided a 'mental picture' which prevented an information overload by suggesting which of the infinite possible patterns and associations to study (idem; 32). Fast forward 50 years and geography is confronted with a very similar situation (Graham and Shelton, 2013; Barnes 2013; Wyly, 2014): 'big data' has exploded the data matrix again, and amidst pleas for a most naive empiricism geography is confronted anew with questions on how to navigate its methodological and epistemological troubled waters (see Crampton et al., 2013; Kitchin, 2013; 2014 for introductions to this debate). Therefore, in addition to using big data to gauge CPT, we investigate in this paper whether a monumental theory such as CPT can play a modest role in navigating the big data deluge. We enter the debate by studying the central place system of the metropolitan area of Louisville, Kentucky, utilizing data harvested from the social networking platforms Foursquare and Twitter.

Louisville is the largest city in the state of Kentucky and is a fairly typical American city.

Like any existing city, Louisville is far removed from the isotropic plane in Christaller's 'ideal' landscape, but it is nevertheless a particularly 'clean' case to study contemporary central place patterns. In Louisville and its suburban sprawl, the car is the primary mode of transportation, even for shorter distances, which allows us to limit our analysis to a single mode of transportation. There are two specific noteworthy geographic features that 'break' an otherwise fairly uniform urban fabric and might influence our results. The first feature is the border with Indiana, which follows the meandering Ohio River that cuts midway through the metropolitan area (see Figure 4.1) and that can only be crossed over a series of bridges. The second is the economic and racial segregation within the city. Like many of its peer cities, Louisville is still coping with the consequences of a long history of racial segregation, which is manifested in an East-West divide. Neighborhoods in the western part of the city are predominantly home to less affluent African-Americans, while the suburbs in the east are inhabited by more affluent and often white residents (Shelton et al., 2015). Since these geographical features provide a set of contrasts that can assist in gauging the relevance of CPT, we deliberately included them in the analysis. Therefore, we define our research area as confined within a relatively large bounding box[38] that includes not only Louisville itself but also the surrounding smaller towns.

Although CPT is an old and well-trodden theoretical path in human geography, the multiple interpretations and versions of the theory necessitate a brief review. While Section 4.2 elaborates the epistemological choices on the basis of which we have selected our candidates for theoretical reconstruction, Section 4.3 reconstructs the theory. The two sections that follow (4.4 and 4.5) operationalize the theoretical constructs and provide results for the level of individual central functions (Section 4.4) and the Louisville settlement geography (Section 4.5). Section 4.6 concludes with a discussion of the usefulness of thinking in terms of central places for contemporary settlement geographies.

[38] Latitude 37.75 and 38.70; Longitude between -86.32 and -85.13. In the north this is bounded by the town of Scottsburg, IN, in the south Bardstown, KY, in the west Corydon, IN and in the east Shelbyville, KY.

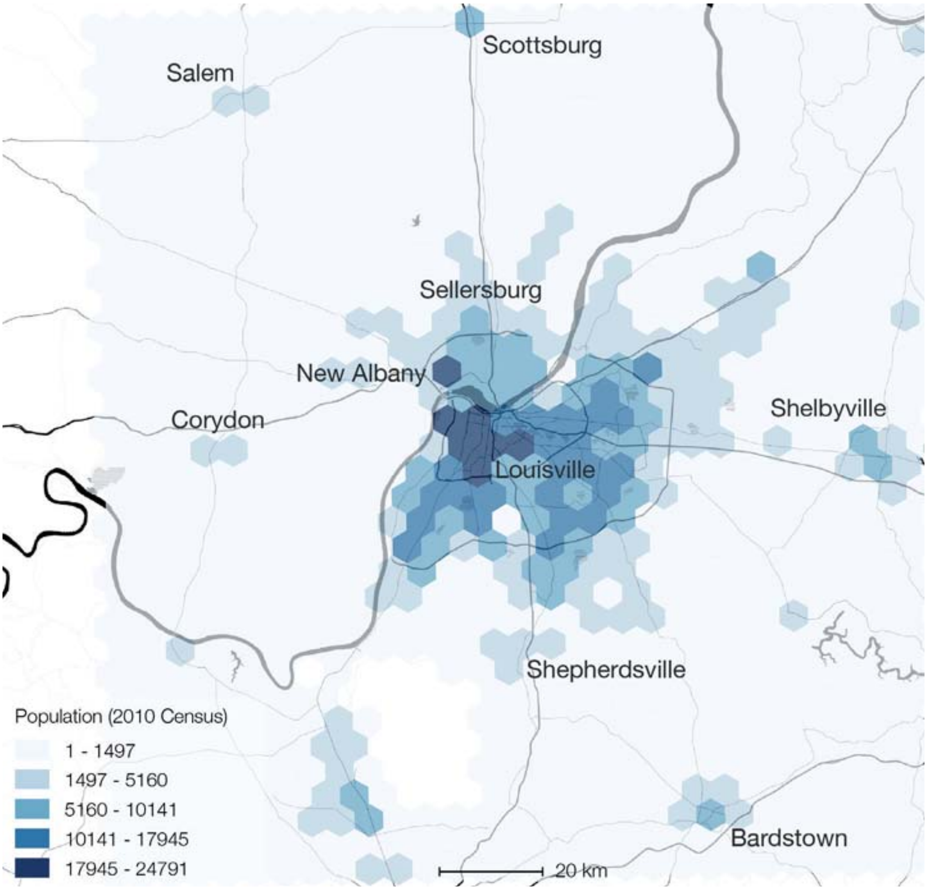

Figure 4.1 Base map and population density of the study area

4.2 Theoretical considerations

Barnes (2004b) argues that different 'epochs' of practicing human geography adhere to different styles of theorizing, of which he explicates two polar varieties: 'epistemological theorizing', which characterized the spatial science of the 1960s, and 'hermeneutic theorizing' which is exemplary of the 1990s cultural turn. Barnes (2004b: 546) defines epistemological theorizing as 'the belief that the central task of theorizing is to develop abstract vocabularies that mirror—albeit approximately—an external and independent reality'. Hermeneutic theorizing, by contrast, 'is not [...theory...] as a mirror held up to the world, but [...theory as a frame for...] conversation and discussion' (idem, 547). Barnes (idem: 549) treads carefully and emphasizes that the two are not mutually exclusive and that both have contested, complex, and overlapping histories. For instance, CPT's role as a 'selection mechanism' to navigate the data deluge (Haggett and Chorley, 1967, see above) clearly has hermeneutic overtones. Nevertheless, during the 1960s, CPT was widely held up as the 'seminal example' of the new style of (epistemological, commonly understood through the contested label 'positivist') theorizing (see Johnston, 1987: 64). In fact, to Bunge (1966 [1962]: 133) CPT was the hopeful proof that geography should be allowed its existence as a positivist science.

However, to what extent can we safely claim that Christaller in the 1930s indeed intended to create the 'mirror' associated with epistemological theorizing characteristic of 1960s human geography? We contend that this inference needs careful scrutiny. Christaller (1966 [1933]: 4-7) explicitly situates himself methodologically in the German location theory tradition of von Thünen and Alfred Weber, and describes his theoretical central place landscape as an 'ideal type' in the sense of Max Weber (idem: 4-5, 9, 200). Gregory (1981; cf. Saey, 1978: 17) notes in relation to Alfred Weber that he was re-cast in a too positivist vein in the 1950s and 1960s, and similar observations can be made in relation to the early translations of von Thünen (by Peter Hall, see Mäki, 2004) and Max Weber himself (by Talcott Parsons, see Tribe, 2007). Indeed, Carlisle Baskin—Christaller's English translator—admits difficulty and reliance on Talcott Parsons in translating key methodological terms from German to English (Baskin in Christaller, 1966: 4). According to Mäki (2004: 1720), these German authors utilize the:

> [C]ombined method of isolation (sometimes referred to as that of "abstraction" or "idealization") and de-isolation (or of "decreasing abstraction" or of "increasing approximation") [...where...] theorizing proceeds first by stating a set of assumptions that are known to diverge from the actual characteristics of the real world, and then by relaxing these assumptions one by one so as to approach a more concrete and complex picture of reality.
>
> Uskali Mäki (2004: 1720)

Christaller's book follows a comparable strategy (Preston, 1985). According to Mäki (2004), the underlying ideal structure has to be regarded as a 'causal structure' in the realist sense, implying it contingently influences complex reality. These considerations are paramount since positivist and realist theorizing employ different methodologies to assess the merits of theory. One does not 'test' Christaller's theory by seeing how closely reality mirrors the ideal landscape. Rather, one assesses the theory's merit by investigating the underlying causal mechanisms (cf. Webber, 1971; King, 1984: 76-78). Although this contains elements of epistemological theorizing—it aims to assess a reality that is in part independent of our discourse on that reality—this interpretation of 1930s German methodology is less rigid than the dominant 1960s interpretation would have it. This is exemplified by Christaller's (1966[1933]: 70) explicit skepticism about the over-use of mathematical formulations since that suggests a precision that is out of place given the style of theorizing.

Although Christaller's theory had many antecedents in German geography (Müller-Wille, 1978), wedding Weberian abstraction with German geography was innovative. A telling example of this novelty is the abstraction from possible underlying rural-agricultural structures that were a preferred topic of interest in the German geography of the time (idem, Bobek, 1938). Christaller (1966[1933]: 1) commences his book with an unequivocal statement that he wants to set aside the urban-rural distinction by isolating central places; a position explicitly criticized by Bobek (1938) and reaffirmed by Christaller (1938) when he reflects on the decreasing importance of the rural through mechanization and industrialization. The idea that CPT, in its original formulation, is rooted in Germanic 'rural romanticism' (Barnes and Minca, 2013) is a longstanding myth related to conflating the central place theorems of Lösch and Christaller, probably originating in Ullman's (1941) influential statement. According to Rössler (1987: 423), it was the absence of such rural romanticism that fostered an initial dislike of CPT among the Nazis. Perhaps as a result, Christaller did re-establish the rural connection in later CPT statements when he worked in the Nazi bureaucracy (Rössler, 1987; Barnes and Minca, 2013).

The 'rural romanticism' issue is just one example of how a messy context becomes translated in hermetic myths about 'what CPT is really about'. CPT's alleged 'staticness', is another (Preston, 1985). Particular interpretations have become entrenched in geography's collective consciousness through canonical, but always partial, interpretations of the theory (e.g. Berry and Garrison, 1958a; Berry and Pred, 1965 [1961] Berry, 1967; Vance, 1970, Beavon, 1977; King, 1984). It is not difficult to find contradictory statements regarding any aspect of CPT in the vast literature the topic has spawned during the eighty years of its existence. For instance, as Saey (1973) argues, Christaller (1966[1933]) and Lösch (1956[1940]) are fundamentally different theories as they build their systems on different axioms, hence any attempt (e.g. Beavon, 1977) at reconciling the two is bound to run into difficulties.

To summarize, CPT is a tree that has branched out in many incompatible directions (Buursink, 1975). Therefore, we have to choose which particular variety of the theory we want to work with to assess its contemporary value: revisionism is unavoidable. What the 'best' choice is in this regard depends on one's own epistemological position and the questions at hand. Therefore, the methodologically right thing to do is to make these choices explicit. For us, five considerations stood out. First, we want to assess CPT as a partial theory of settlement structure. Therefore, the ultimate level of analysis is the level of the settlement system, not the micro-level units of observation of an individual shop/entrepreneur or customer. Second, we want to contribute to the Christaller tradition of CPT that only considers the geography of central functions and has special attention for the upper limit of the range (Section 4.3). Third, we will primarily base ourselves on Christaller's 1933 'first cut' of CPT without reinterpreting that first text through scattered remarks in his later writings which are likely to be influenced by the political and academic contexts he was working in after 1933 (Scott, 2012)[39]. Fourth, we want the

[39] Specifically, at the 1960 IGU symposium in Lund, in a transcribed debate between Christaller and his newfound regional science interlocutors (Norborg, 1962: 157-165), Christaller affirms Löschian interpretations of his theory, such as the uniform distribution of the agricultural

resulting conceptual framework to be able to assess CPT's microfoundations empirically. Last, we want to take advantage of the possibilities of big data to circumvent some of the classical operationalization issues regarding central place theory (Webber, 1971).

Based on these five general postulates we are able to 'take sides' in some of the major theoretical debates over CPT. We will clarify our positions below:

- Big data allows us to analyze relationships between people and their procurement of central goods independent of administrative boundaries. As we can use GIS to analyze central functions and places of residence as point locations and calculate time-distance over the road network, we do not have to define settlements a priori, although we are bound to the US census block level to assess population densities. As a consequence, the dichotomy between 'intra-urban' and inter-urban' CPT (Berry, 1967; Beavon, 1977) becomes superfluous. We can now assess the influence of a central place on the border of a metropolitan area (e.g. a shopping mall) as a new central place instead of something distorting historically determined settlement geographies.

- As a corollary, we do not have to concern ourselves with the difference between nodality and centrality. Nodality and centrality are defined as those parts of the central function that respectively provision the focal settlement (nodality) and its complementary region (centrality) (Preston, 1971; Barton, 1978). Since we no longer have to define the inside and outside of settlements within our study area this problem disappears.

- Incorporating distances over the road network, and calculating real travel time from consumer to central function has become a standard GIS operation. Hence, fitting central place patterns in ideal-typical geometrical constellations, namely, the marketing principle/*versorgungsprinzip*[40], the traffic principle, and the administrative principle (Christaller, 1966 [1933]: 58-80), becomes analytically less important as geometric comparison is no longer the primary way of making inferences in (human) geography (cf. Bunge, 1962 [1966]). It has been a longstanding assessment that real-world geographical features rapidly distort CPT's hexagonal geometries beyond recognition (Rushton, 1972). Consequently, we are less interested in finding exact geometrical patterns and will focus instead on the degree to which we find systems that conform to the stated microfoundations of CPT based on the interplay of inner and outer boundaries of the central function range (Christaller, 1966 [1933]: 27-58; Storbeck, 1988).

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population, which are at odds with the original formulation.

[40] The common translation of *versorgungsprinzip* with 'marketing principle' in the English language literature is somewhat clumsy, as Christaller (1966 [1933]) simultaneously theorized non-commodified and commodified social relations with the same principles.

- For operationalization, we no longer need to assume that customers frequent the nearest center. Christaller (1966 [1933]: 43, 50) was explicit that in reality people engage in multi-purpose shopping and thus not always frequent the nearest center, but he had to assume it when empirically operationalizing his theory. With GIS-based methods, we can easily detect overlapping catchment areas of central functions and their effects, which are unavoidable now that we assign exact locations to central functions. Relatedly, we no longer have to methodologically assume that centers of higher levels encompass all lower level functions. Instead, the degree of inclusion becomes an empirical question allowing analysis of functional complementarity endogenously in central place analysis (van der Meulen, 1979; cf. Lambooy, 1969).

- As we consider CPT to be a theory of settlement systems, the analysis provides a snapshot outcome of a co-evolutionary process between consumers on the one hand and providers of central functions on the other (Clark and Rushton, 1970; Saey and Lietaer, 1980; Dale and Sjøholt, 2007). Hence the theory is neither reducible to consumer preferences nor to entrepreneurial decision-making. It regards emergent properties that can only be grasped on the level of the central place system. Resultantly, inferring individual consumption behavior from the system would be an ecological fallacy, as the wide literature on multi-purpose shopping testifies (e.g. Sheperd and Thomas, 1980).

- A reconstruction of CPT has to acknowledge potential pitfalls. For instance, central place systems are strongly influenced by differences in consumer profiles and spatial variations in purchasing power (Christaller, 1966 [1933]: 52-55; Johnston, 1966a, 1966b; Rushton, 1966). Administrative borders also refract central place systems (Ray, 1967). Nevertheless, for methodological reasons, we will infer the spatial behavior of an 'generic customer' for specific central functions (Saey and Lietaer 1980; King, 1984: 77-79). Therefore, we can expect that aberrations to the anticipated relations between central functions and population distributions are related to the particularities of the Louisville area.

- The patchy quality of big data sources (Crampton et al., 2013) necessitates prioritizing internal validity over external validity. After testing CPT's microfoundations, our second goal is to provide proof of concept of combining CPT with big data. Neither goal requires a comprehensive mapping of the central place system of Louisville, which would be difficult to attain given the quality of the available data and the intricacies of operationalization.

4.3 Microfoundations and the construction of Christaller's central place system

Christaller elaborates (the static part of) his theory in two stages. The first stage (Christaller, 1966 [1933]: 27-58) discusses how the distribution of population, the supply of central functions, and the willingness to procure these functions generate specific central place landscapes for each central function. Subsequently, Christaller (1966 [1933]: 58-80) theorizes how these individual ranges might interact and add up into distinctive hierarchical patterns of central places. We elaborate our interpretation of the theory in the same order, starting with the microfoundations before conjoining them into a larger system.

Christaller's CPT concerns itself with the question how the spatial distribution of a population in an area can possibly be related to the provision of central functions to this population. A central function, which can be a good or a service, is defined as social activity that is procured at a central point (place) and for which the consumer has to bear the costs to reach that point. Typical examples on the level of the consumer are shopping and hospitality services, but certain business services or enterprise procurement may also be central functions (Parr, 2002; Dale and Sjøholt, 2007; Shearmur and Doloreux, 2015). It is evident that, as technology evolves (Christaller, 1966 [1933]: 100-101), what is a central good might change, as do the costs of procurement. Although e-commerce did shake-up the retail landscape in the last decades, it did not render central place activity superfluous, but rather changed the relative importance and range of central functions (cf. Wrigley et al., 2002; Rotem-Mindali and Weltevreden, 2013).

The pivotal insight in Christaller's CPT is that central functions have a range and that this range will differ from central function to central function. This range has an upper and a lower limit. The upper limit consists of the maximum economic distance a consumer is willing to travel before the consumer decides to substitute or even forego consumption, i.e. the distance-weighed elasticity of demand (Christaller 1966 [1933]: 53). The lower limit consists of the minimum scale of consumption that is—economically or socially—necessary for a central function to remain in business. Following the influential treatises of Berry and Garrison (1958a; 1958b; 1958c), the upper limit of the range is simply called 'range' while the lower limit of the range is called 'threshold'[41]. The geographical area served by a central place is the 'complementary region' (Christaller, 1966 [1933]: 21-22). It

[41] In common parlance, Berry and Garrison's (1958b) terms 'threshold' and 'range' have become synonyms for Christaller's respective lower and upper limits of the range (see for instance, Beavon 1977). Therefore, we will apply these shorthand terms. However, as Johnston (1966b) notes, originally, Berry and Garrison (1958b) did not regard the threshold and lower limit of the range as synonyms, as threshold initially only referred to the nodality value. Since this distinction has not been widely adopted, we do not follow this interpretation.

is evident, assuming ceteris paribus operating costs, that the threshold is reached more quickly in areas with higher population density, whereas for the range this is not necessarily the case. Thus an economic landscape is drawn in which variable interplay of range and threshold determines the possible supply of central functions in particular places (Christaller, 1966[1933]; Johnston, 1966a). From this interplay we can already infer that central functions agglomerate in denser areas. More diverse combinations of thresholds and ranges will be achieved in denser areas, suggesting hierarchical tendencies. It is from these hierarchical tendencies that Christaller (1966[1933]: 58-80) constructs his ideal landscapes with the iconic hexagonal geometrical patterns. However, the theory's analytical utility reaches further once we expand the static theory to a situation in which actors make choices.

The landscape of ranges and thresholds is a geographical opportunity structure that determines which central functions are viable to be provided to which parts of the population. Within this geography of (potential) central function provision both consumers and entrepreneurs make choices to (re)locate, which consequently gradually alters the landscape. When a central service provider wants to improve its location only taking the distribution of the potential consumers in mind, we can theorize two opposite rational maxims to act upon the opportunity structure, which Saey (1990) calls the 'Hotelling' and the 'Lösch maxims' (see Parr and Denike, 1970; Ó hUallacháin and Leslie, 2013, for similar arguments with different nomenclature). On the one hand, a central function provider might want to monopolize the market, or make sure that all potential customers in a particular area frequent the provider's central function and not the competitor. The associated spatial logic is to locate as far as possible from your competitor. If all central function providers would behave this way, the range becomes equal to the threshold resulting in theoretical Löschian landscapes (Lösch, 1954 [1940]), hence the name 'Lösch maxim'. On the other hand, a central function provider might choose to optimize the total number of potential customers. Consequently, the best place to locate would be where the highest number of potential customers congregates, even if this is also the most logical place for competitors to locate. The situation that thus emerges is explicated by Hotelling (1928)[42]. Instead of monopolizing the market, a competition between the co-located suppliers occurs. One would expect that this competition results, through a division of labor between suppliers, in specialization of, and complementarity between suppliers. Resultantly, the variety of central functions offered at the central place increases and the central place becomes more attractive, better equipped, and rises in the hierarchy as a result.

Which of the two maxims would be wisest to follow from a profit-optimizing perspective

[42] Lösch (1954 [1940]) does account for mechanisms of optimization in his landscape by 'rotation' towards the highest degree of agglomeration economies (Beavon, 1977: 80-102). However, these agglomeration economies are, contrary to Christaller, exogenous to the basic logic of his central place system.

depends on the kind of good. The higher the spread between the range and the threshold of a good, the higher the potential for specialization of suppliers and hence for the consumer to engage in comparison shopping. By contrast, for goods with a low spread between range and threshold, closeness of supplier is more important than specialization resulting in convenience shopping. As a consequence, the old distinction made in retail studies between convenience goods and shopping/comparison goods (Curry, 1962; Beavon, 1977) retains its usefulness. We expect less spiky central place patterns in the former compared to the latter. The fact that we expect agglomeration tendencies to occur based on these optimizations helps comprehend why Christaller (1966[1933]) insisted on step-wise discrete categories of central places in his theoretical model. There is no theoretical support for any argument that results in a continuum of central places (Saey, 1994; Beavon, 1977 for counterpoint).

Despite remarkable textual eloquence regarding the complex intricacies of his model, Christaller makes a pragmatic assumption in his operationalization that would dominate the debate over urban hierarchies in the subsequent 80 years. Christaller (1966 [1933]: 64) assumes that 'central places of a higher order also contain all the central functions of the lower orders', what Parr (2002) calls the 'successive inclusive hierarchy'. In his 1933 book, Christaller never explicitly mentions the literal word 'hierarchy', but only articulates the relation between two places: one place is of a higher order than another; by which he wants to convey that there are discrete size categories of central places.[43] The word 'hierarchy' gradually emerges in the ensuing CPT discourse (Buursink, 1975), and is used by Christaller (1950) himself in a later truncated introduction to the theory. Eventually the concept of 'hierarchy' is declared to be the 'generic base and single most important statement of central place theory' by Berry and Garrison (1958c: 146). Until today, not corroborating the successively inclusive hierarchy of central places is an argument to question CPT in its totality (e.g. Meijers, 2007). Although the notion of complementarity (Ullman, 1956) is at odds with the notion of a successively inclusive hierarchy, it is not at odds with the notion of hierarchy as such (van der Meulen, 1979).

Complementarity between two central places occurs when they both contain a central

[43] The literal quote states the following:

> 'It is possible to show empirically how many types of goods are marketed in every single concrete central place and to determine the number of types of goods which are sold in each of the different types of central places, for instance the K-place. This, however, would be an enormous task which would in no case be worthwhile. We wish only to demonstrate that the next higher type of central place offers more types of goods than the lower type, and that the progression is not gradual. '
>
> Walter Christaller (1966 [1933]: 64)

function that the other does not have and for which a demand exists—within the parameters of the upper and lower limits of the range of both central functions. At that point there is 'symmetrical' exchange between places and places become complementary to each other[44] (Limtanakool et al., 2007). In other words, the successively inclusive hierarchy that was convenient for Christaller and became dogma for Berry and Garrison (1958c) needs to be re-interpreted as an extreme case of non-complementarity (van der Meulen, 1979; Saey, 1990). The most important consequence of the re-conceptualization is that 'hierarchy' and 'complementarity' are no longer each other's conceptual opposites (Lambooy, 1969) as hierarchy refers to the relative dominance of one place over others in the total supply of central functions.

4.4 Operationalization and results I: Range and threshold

We conduct our analysis of the microfoundations of CPT in a similar stepwise manner as Christaller (1933 [1966]) himself. We start with an analysis of the level of individual central functions—their range and threshold—to examine the applicability of the Hotelling and Lösch maxims. In section 4.5 we subsequently regard the interplay of central functions and the settlement system of Louisville and its environs. As alluded to in the previous, to conduct this analysis. we make use of several fairly unconventional datasets, derived from social media platforms.

Ever since the emergence of Web 2.0, geographers have paid close attention to the ever-increasing amount of data generated through a myriad of platforms enabled by new technologies. Goodchild (2007) coined the term 'volunteered geographic information' (VGI) to indicate how many of these platforms allow ordinary people to create spatial data, which was formerly the prerogative of 'experts' working for larger government or commercial institutions. Whether or not people indeed create this data consciously and willingly is not always clear (Elwood, 2010), and the accuracy and applicability of such data is not guaranteed (Haklay, 2010). Additionally, this explosion of new geographic data does not exist in a vacuum. Geographers are quick to point out these data and associated technologies can also change the very world they are created in. This is reflected in Zook and Graham's (2007) concept of the digiplace as well as Kitchin and Dodge's (2011) work on Code/Space. Whatever name is used to refer to them—big data is the *nom du jour* (Kitchin, 2014)—these data shadows (Graham, 2013; Shelton et al., 2014) both reflect and produce the social world in general, and people's spatial behavior in particular (cf. Silm and Ahas, 2014; Shelton et al., 2015).

For our analysis we utilize data shadows of two specific sources. The first source is a Twitter-based dataset of all geotagged tweets (~11.3 million) sent from Louisville between July 2012 and February 2015. Twitter data are both used to determine whether a person at

[44] Christaller (1966 [1933]: 46-47) provides a discussion on sister [twin] cities where he elaborates this phenomenon.

a specific location is indeed ‘consuming’ a certain a good and to estimate a person's home location. Second, we use a dataset derived from Foursquare to derive the locations of specific central functions (‘venues’ in Foursquare’s parlance). Data on the location of businesses across different industries is relatively hard or expensive to acquire from more conventional sources, especially when administrative boundaries are crossed. As the location of specific venues is instrumental to Foursquare’s core business, the location data used here can be assumed to be relatively accurate, especially after the cleaning steps discussed below.

An advantage of using VGI data is that it is unconstrained by administrative boundaries. A seeming disadvantage is the potential bias present within Twitter data (Li et al., 2013; Longley et al., 2015). Depending on the kind of tweets, and the spatial context, different biases in representativeness can occur, biases which are moreover not straightforwardly similar across contexts. For instance, contrary to the thrust of the main conclusions of Li et al. (2013), in Louisville, disadvantaged groups were sufficiently represented in samples of locally georeferenced tweets (Shelton et al., 2015) to make inferences. Therefore, biases in the representativeness of our subjects are likely, but their direction is uncertain. However, as our study limits itself to a 'proof of concept' of the interplay between threshold and range, and given that we do not aspire to describe a comprehensive model of the Louisville central place system, the influence of the bias is not likely to harm our general conclusions.

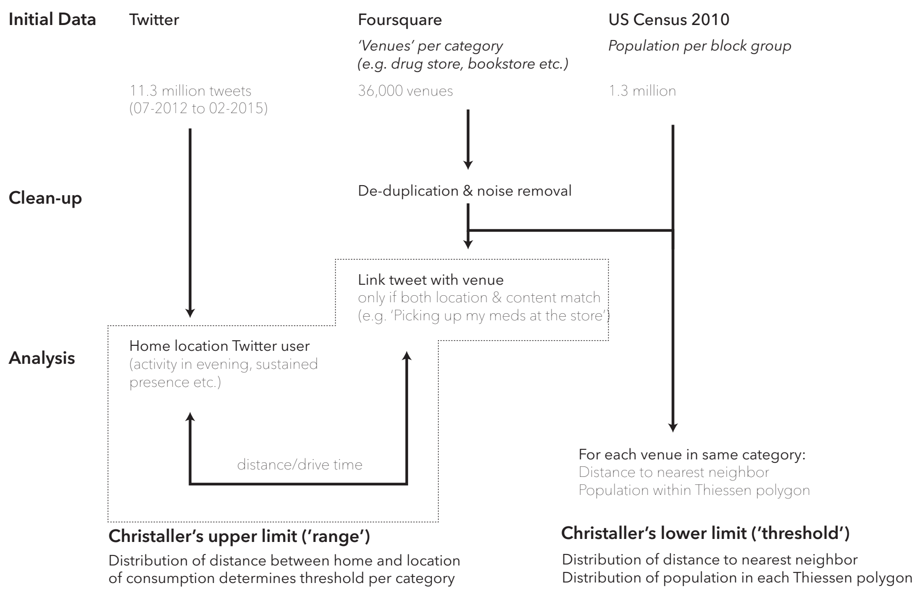

Figure 4.2 Operationalization of range and threshold

We will now go over the steps by which we use these two separate datasets (tweets and venues) to operationalize the range and threshold (Figure 4.2). There are a total of 36,000 venues within our research area in Foursquare's database. Each venue can belong to one or more categories. Foursquare maintains a hierarchical category list[45] that contains main categories such as 'Arts and Entertainment' and 'Food', and sub-categories such as 'Bowling Alley' and 'Ethiopian Restaurant'. Our research goal prioritizes internal over external validity and does not aspire comprehensiveness. This implies that whenever in the operationalization process a manual judgment call had to be made, type I errors (false positives) were avoided at all cost at the expense of making type II errors (false negatives). This played an important role in the selection of the central functions studied. After a trial and error process, we manually selected 10 categories that are hypothesized to cover a range of different combinations of range and threshold (see Table 4.1) The categories can all be classified as 'retail', are relatively unambiguously categorized within Foursquare's taxonomy, and are comparatively likely to be tweeted about. Since Foursquare's data contains duplicates, miscategorized venues and non-existing venues, we used a set of de-duplication rules that look at both the physical distance between different venues and the similarity of the name of each venue. If both physical and semantic distance is very small, it can be reasonably assumed to concern a duplicate. Since the total number of venues for the ten categories is relatively modest, after this de-duplication we manually checked each venue to make sure it is indeed a real business. We discarded the venue in case of any doubts to prevent false positives. The third column in Table 4.1 reflects the final number of venues in each category.

To determine the threshold for each category, we take a two-tiered approach. First, we calculate the distance to the nearest neighbor of the same category for each venue, as the distribution of these distances allows inferences regarding the Lösch and Hotelling maxims. Second, to compensate for differences in the underlying population distribution, we calculate a Thiessen polygon for each venue and determine the approximate population in each polygon. This is done by using population data from the 2010 Census on the block group level. Block groups are the smallest areal unit for which this data is available (~33.000 block groups within the research area; a total of 1.3 million people). Together these two indicators can estimate the (relative) threshold value of central functions.

To determine the upper limit, we first need to establish the most likely home location for each Twitter user in our dataset, and subsequently try to determine definitive links between a specific tweet and consumption at a specific venue. These steps are outlined graphically in Figure 4.3. To determine home locations, a grid of 600 meter hexagons is created over the study area and tweets are joined to the grid cells. Users with less than 20 tweets during the study period are discarded as data would be to scarce for the subsequent step. To determine home location, not only the raw number of tweets per grid cell is

[45] [https://developer.foursquare.com/categorytree], accessed Feb 2, 2016

taken into account but also whether the temporal pattern can be considered as 'home'-like (as detailed in Figure 4.3, cf. Ahas et al., 2010). The 11 million tweets in the dataset are sent by a total of 133,168 users. However, only for 15,506 users are we able to determine the home location in this way—recall that thresholds are purposely strict as we try to minimize type I errors.

Category	Type of good (expected)	# of venues	# of user-venue pairs	Threshold (Skewness Population Distribution)	Range (Third Quantile Drive Time)
Bookstore	Comparison	49	139	0.42	21.0
Clothing Store	Comparison	516	4784	0.44	22.5
Drugstore	Convenience	142	453	0.09	17.3
Furniture & Home	Comparison	293	1431	0.44	20.0
Grocery Store	Convenience	110	410	0.21	20.5
Hobby Shop	Comparison	55	220	0.41	20.9
Jewelry Store	Comparison	72	257	0.47	22.5
Liquor Store	Convenience	205	130	0.24	20.2
Nail Salon	Comparison	103	67	0.30	19.4
Supermarket	Convenience	106	652	0.20	19.3

Table 4.1 Properties of central function categories in dataset

To determine whether a specific tweet sent nearby a venue indeed means that consumption has taken place, we select all tweets sent from within 25 meters of the venue. The goal is to match tweets to venues not only based on location but also based on the tweet content (see Figure 4.3). To do so, we manually code a random sample of 1000 tweets for each category and indicate for each one if the content of that tweet indicates consumption within that category. This sample is then used to train two supervised machine-learning algorithms (Support Vector Machine and Generalized Linear Model). If both algorithms agree AND they are more than 90% certain that a tweet contains content related to a category (e.g. 'Picking up a new dress!'), we consider it a match. We also consider tweets a match if the name of the venue is mentioned directly in the tweet text. This ultimately results in pairs of user home locations and specific venues for each category (fourth column in Table 4.1). For each pair, we finally calculate the car travel time between the two points to make the road network endogenous to our analysis of the range.

Christaller discussed the range of goods as 'typical ranges' by 'generic or 'average' customers (Christaller, 1966 [1933]: 33-35; cf. Saey and Lietaer, 1980; King, 1984). While there is always the proverbial outlier who will travel 100 kilometers to buy a croissant, in general, there is a typical maximum distance beyond which people will forego the French delicacy at breakfast, although social group variations apply (Johnston, 1966b; Rushton, 1966). Indeed, for most lower level goods, people tend to adhere quite fittingly to the heuristic assumptions—such as the nearest center hypothesis—of classical central place studies (Warnes and Daniels, 1979). Spatially, ranges of central functions exhibit field distributions (Haggett, 1965; van Meeteren et al., 2016). A field distribution is a 'theoretically continuous distribution with a very rapid fall-off near the center [of the field] and a very slow, almost asymptotic fall-off at its outer range.' (Haggett, 1965: 41). Therefore, in empirical operationalization of the range, using a measure of central tendency that accommodates skewed distributions is advised. The final indicator 'range' we use in our analysis is the 3rd quartile value in the distribution of the ranges found for specific central functions (sixth column in Table 4.1).

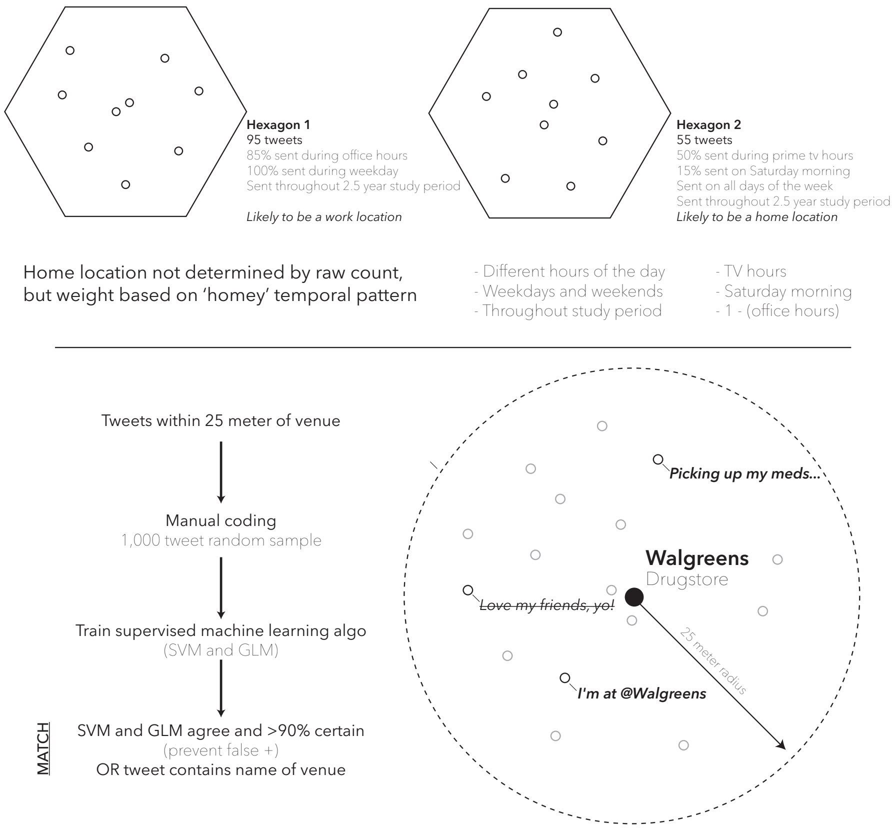

Figure 4.3 Determing home location (top) and determining consumption (bottom)

Results on the threshold

When a central function provider acts according to the Lösch maxim, which is expected if the central function concerns convenience goods, the result is that the range and threshold of that central function converge. Figure 4.4a plots the median population per Thiessen polygon of a central function—which indicates the threshold (X-axis)—and the 'population skewness' (Y-axis). The 'population skewness', here defined as Pearson's median skewness (μ - ν)/ σ, quantifies the skew of the population distribution per Thiessen polygon. The smaller the population skewness, the more equally central functions are spread over the region, and hence the closer the spatial distribution is to the Lösch Maxim. In figure 4.4a, if there would be a perfect linear relationship, a hierarchy of functions appears where the larger the threshold value, the more clustered a central function would be. Central functions in the lower-right quadrant are 'Lösch maxim functions' where threshold is more important in determining the central place location than clustering. Central functions in the upper-left quadrant are 'Hotelling maxim' functions where co-location is more important than the threshold.

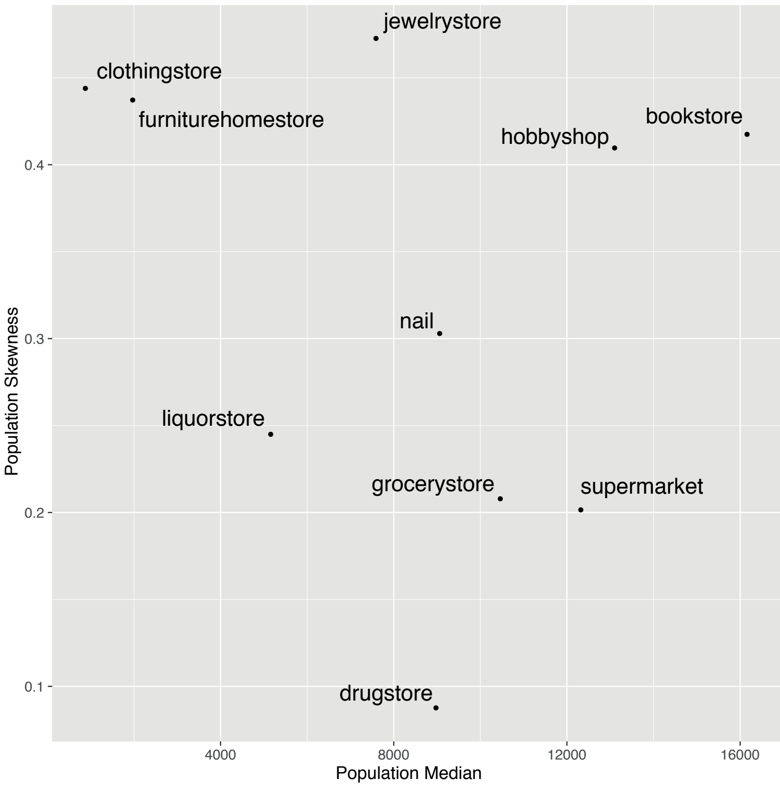

Figure 4.4a Relationship between threshold and population skewness

The results in Figure 4.4a make intuitive sense: the lower-right quadrant contains typical convenience goods central functions: the drugstore, the grocery store and the supermarket. The clothing store, the furniture home store and the jewelry store are in the opposite quadrant. Here, co-locating is more important than scale. This underlines the comparison goods character of these three latter central functions.

The metrics used in Figure 4.4a presume that all central functions are equally sensitive to population density. In reality, however, this sensitivity is determined by the interplay between range and threshold. Some central functions which have a low range can only exist in denser areas to meet their threshold, and are less likely to be located in less-densely populated areas. Figure 4.4b provides a scatterplot that examines the influence of population density on the availability of central functions.

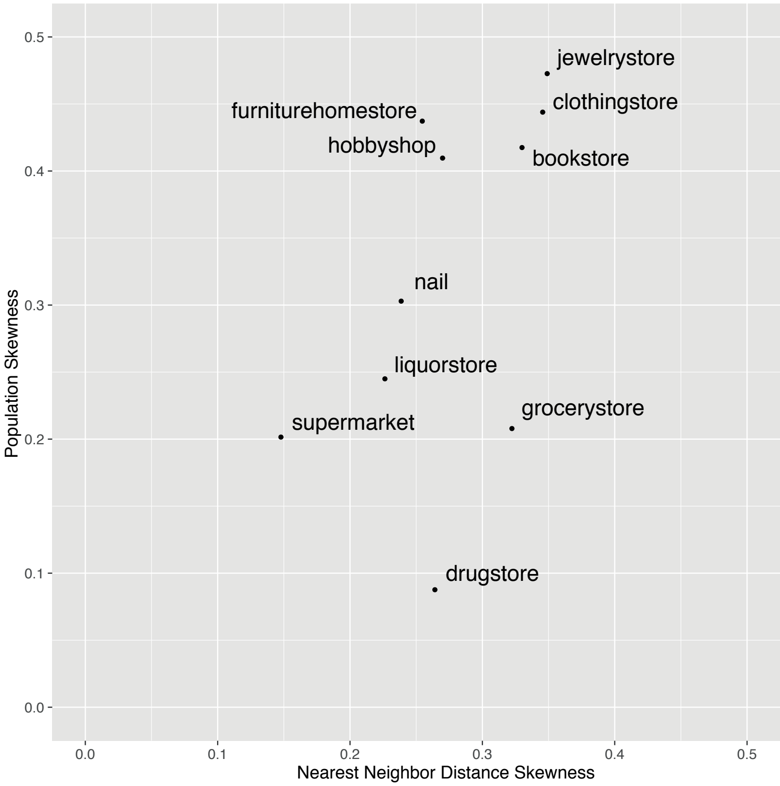

Figure 4.4b Relationship between population skewness and nearest neighbor distance skewness

The 'Nearest Neighbor Distance Skewness'—again defined as Pearson's median skewness—is plotted on the X-axis in figure 4.4b. The higher this indicator, the more sensitive the central function is to a density effect. For reference, the population skewness (indicator for Lösch/Hotelling maxim) is again plotted on the Y-axis. Particularly the jewelry store, the clothing store, the bookshop and the grocery score are dependent on density. Hence it both concerns archetypical comparison goods (jewelry, clothing) and the grocery 'convenience' store. The latter can be explained intuitively. If the density in the neighborhood is too low to support a grocery store, people will immediately frequent the larger supermarket instead. Consequently, the supermarket is the central function in this study least sensitive to population density.

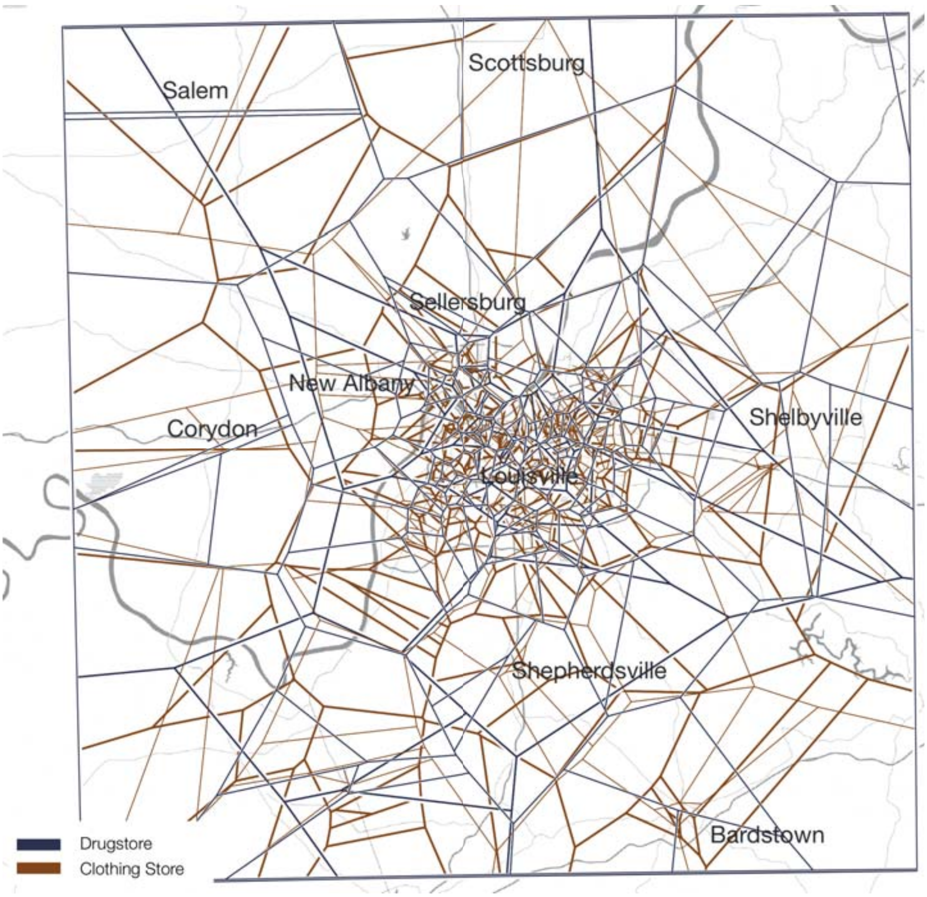

Figure 4.5a Thiessen polygons of drugstore (blue) and clothing store (brown)

Figures 5a and 5b illustrate these two aspects of the threshold of central place provision cartographically. Figure 4a maps the Thiessen polygons for two central functions that score relatively high and low values on the 'Population Skewness' variable: the drugstore (Lösch maxim, in blue) and the clothing store (Hotelling Maxim, in brown). Where the distribution of the drugstore seems to largely follow the population density of the area (Figure 4.1), the clothing stores are much more concentrated. In the centers, particularly mall areas and Louisville's Central Business District (CBD, see Section 4.5), clothing store Thiessen polygons are much more packed than one would expect based on population density figures alone.

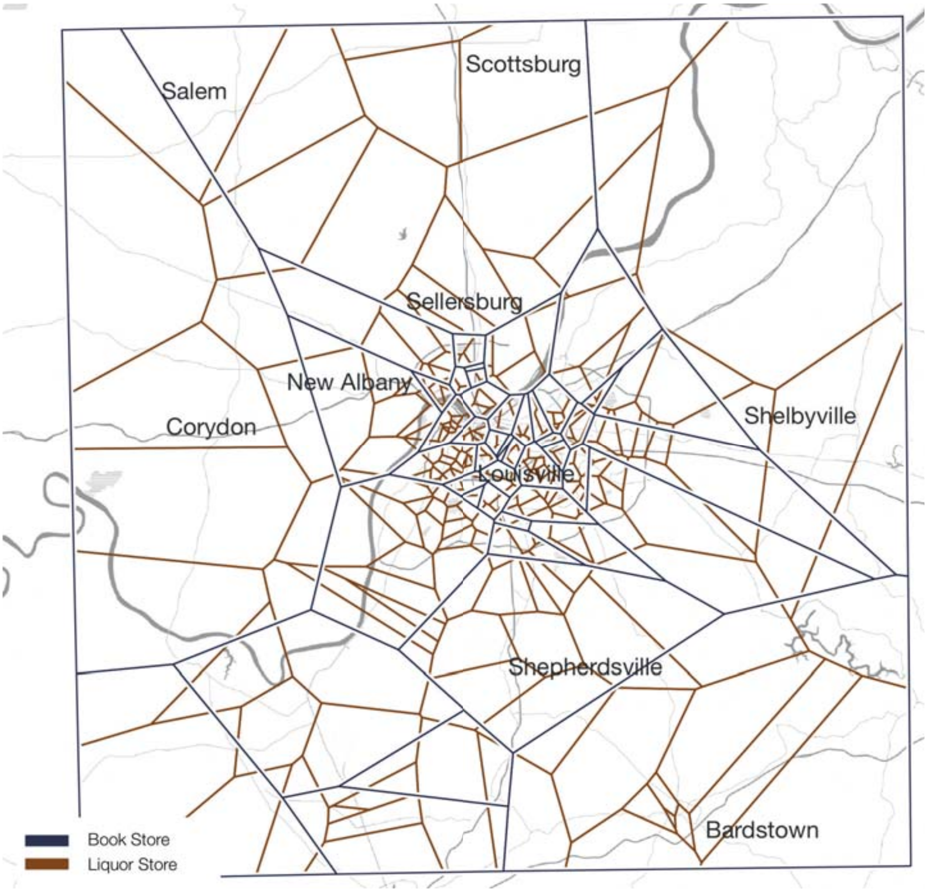

Figure 4.5b Thiessen polygons of bookstore (blue) and liquor store (brown)

Figure 4.5b maps two central functions that elucidate contrasting scores on the Nearest Neighbor Distance Skewness indicator: the liquor stores (brown) and the bookstores (blue). Here, a minimum density appears to play a larger role for bookstores than for liquor stores. As soon as the population density permits it, a place to procure alcoholic beverages seems to appear and people will travel to the nearest pickup point. However, a physical bookstore requires many local costumers. Likely, if the bookstore is too far away, people will just order books online.

Results on the range

Figure 4.6 summarizes the analysis of the range. The X-axis of Figure 4.6 features the drive time in minutes to procure the central function. The Y-axis on the upper half of Figure 4.6 shows the density—the number of cases per unit of the variable on the X-axis—for each central function. As expected, the curves represent a field distribution with many scattered outliers at large distances. Comparison goods show higher ranges than convenience goods and generally tend to have greater numbers of outliers. These outliers are likely to be the result of periodic shopping trips for which larger distances are travelled from more remote settlements. The outlier pattern of the 'grocery store' is unexpected as the function was hypothesized to be very 'local'. Examination of the underlying data reveals that the Foursquare category 'grocery store' both includes convenience corner stores and specialized ‘ethnic’ stores that are mostly found within the Louisville urban core (e.g. Chinese or Vietnamese stores). We suspect that particular demographic groups have a larger range for specialized cuisine central functions. This also explains the unusual spread between the median and the Q3 values for the grocery store (Figure 4.6). The box plots (Figure 4.6) corroborate our general distinctions. Some central functions (clothing store, furniture store, supermarket) have many outliers in the range while others (drugstore, bookstore and nail salon) have few. This confirms our distinction of density-sensitive functions (Figures 4.4b, 4.5b): nobody in the study area was willing to drive more than 37 minutes to visit a nail salon.

Figure 4.7 cross-tabulates the threshold and range indicators. The upper-left quadrant shows those central functions for which people are willing to drive further than expected based on their threshold value. These tend to be 'necessities' (to be bought in a supermarket, a liquor store, or a–probably specialized–grocery store). If there is no such central function in the neighborhood, people will drive there anyway and hence travel longer. Tending toward the lower-right quadrant we find the central functions which people will forego consuming at a central place if they are located too far away. Not surprisingly, in this quadrant we find 'leisurely amenities' such as the bookshop, the furniture shop, the hobbyshop and the nail salon. Therefore, these are the central functions that are disproportionally found in denser, 'urban' areas. On the diagonal we find the drugstore, clothing store and jewelry store where the upper and lower limit are more or less in proportion. Nearly nobody will feel like driving to a remote drugstore, and nearly everybody will have a propensity to travel to obtain clothing or jewelry if desirable.

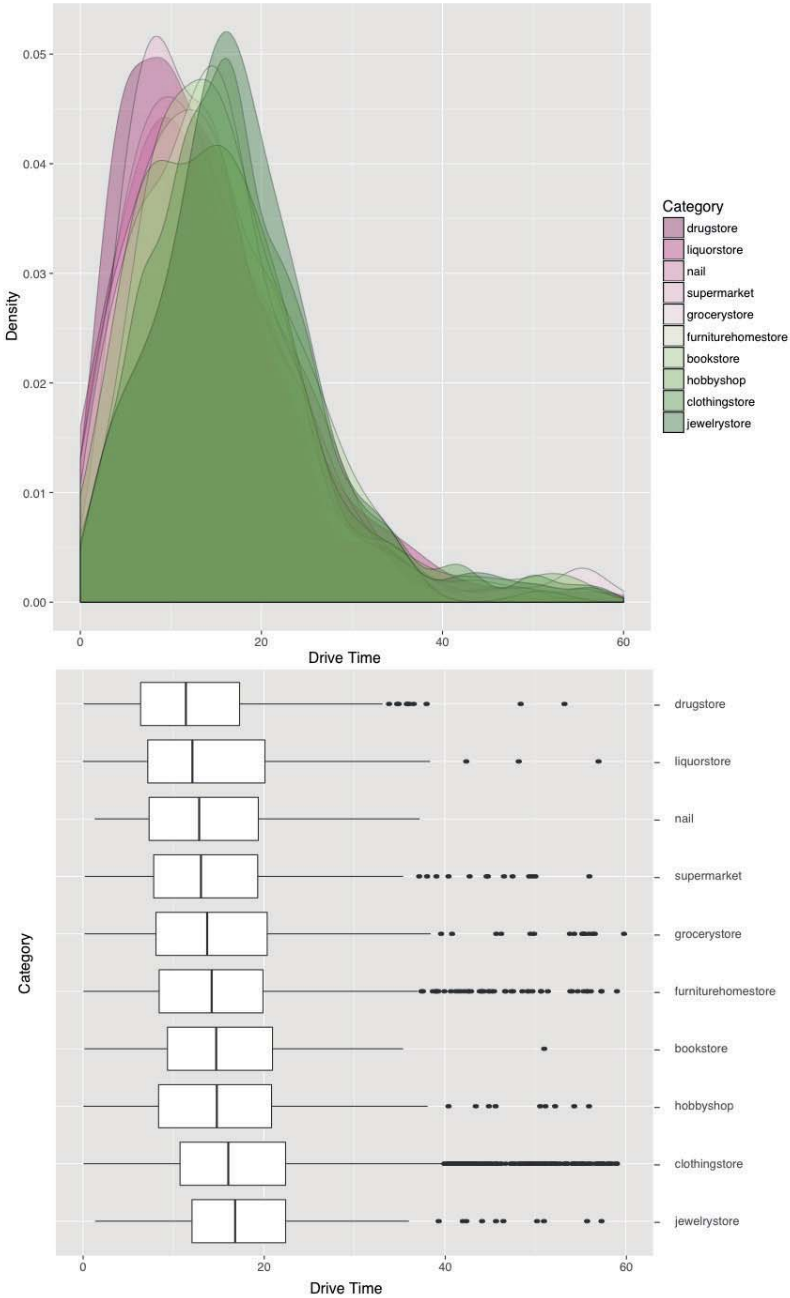

Figure 4.6 Outcomes on the range

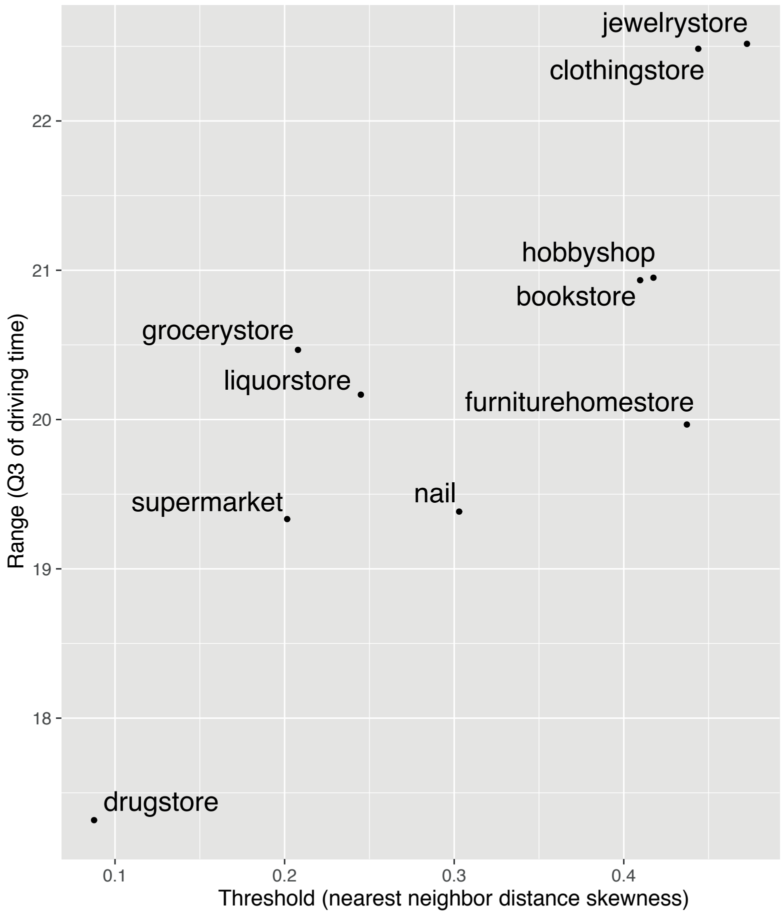

Figure 4.7 Relationship between range and threshold

4.5 Operationalization and results II: Louisville's central place system

In the previous section, we have established the continuing relevance of the interplay between the range and the threshold in understanding the relationship between population density and central place provision. This puts us in a position to move to the second stage, in which the level of analysis shifts from individual categories to the settlement system. The goal here is to gauge how the interplay of range and threshold yields hierarchical patterns of discrete categories of central places.

The most important of these patterns is the assertion of Christaller (1966 [1933]: 30-33) that the interplay of range and threshold has a tendency to form a hierarchy of central places. This hierarchy is an ideal-typical configuration that optimizes the aggregate consumption in central places in a given distribution of the population, range and threshold. Furthermore, multi-purpose shopping trips and the Hotelling maxim strengthen the centralization tendency. Since we only have data on 10 different central place functions, our analysis will necessarily be incomplete. Although we cannot construct a central place system that could be fitted to Christaller's ideal-typical models and which could shed light on the controversies about discrete steps in the hierarchy (Beavon, 1977), we can plot the density of functions analyzed to see whether our findings tend toward Christallerian central place systems. A further analysis examines the diversity of functions within central place clusters to relate diversity to population density.

To change the analytical unit from individual venues and their categories to geographic location, we overlay the study area with a rectangular raster with grid cells of 1.5 kilometer. Although this size is chosen relatively arbitrary, one of the advantages of using Geoweb data is that we can change the scale of the spatial unit dynamically or repeat the analyses at different levels of scale, without worrying about administrative boundaries or data availability. This can help to highlight and examine the issue of the modifiable areal unit problem (Openshaw, 1984) in further research. For each grid cell in the study area, we can now calculate the number of 'venues' in the cell (referred to as venue-density hereafter), as well as a measure that represents the diversity of different categories within that cell. Many different indices for diversity exist, especially in the field of ecology. Since there is no clear consensus on which is the better index (Morris et al., 2014), we use Shannon's diversity index here as it is less sensitive to the presence of either very dominant categories or very rare ones, which is common in many of the locations in our study area. An in-depth discussion of the index is beyond the scope of this paper, but the higher a grid cell scores on Shannon's index, the more spread out its shops are over multiple categories.[46]

In Figure 4.8, we visualize the density and the diversity of venues. A number of observations can be made based on this figure. First, when looking at the total density of venues within the 10 categories selected, it immediately becomes clear that the CBD area ('the urban core') of Louisville is not home to the greatest density of venues. Instead, we see two dense clusters arise: one in the eastern part of town and another one north of the river in Indiana. Both of these clusters are home to a number of large shopping malls.

[46] Cf. Magurran (2013) for a comprehensive treatment on (bio)diversity.

Figure 4.8 Venue density and diversity in greater Louisville

However, once the diversity index is assessed, a more complex picture emerges. The centers of the towns surrounding Louisville, in the corners of our study area, gain much greater prominence. What they lack in sheer number of venues is made up for by the diversity of these venues. Similarly, downtown Louisville itself, not very densely populated with venues, scores much higher on the diversity measure. When we focus on the diversity around the center of Louisville, we observe a number of interesting patterns. The large malls in the eastern part of town indeed do not seem to offer the same diversity of central functions as, for instance, the much older strip malls along Frankfort Ave and Shelbyville Rd as well as Dixie Highway, which are home to many of the area's small and medium-sized businesses. Similarly, one of Louisville's trendy neighborhoods, with a large variety of small shops around Bardstown Road, is also rendered visible. Although definite statements regarding causes would require additional research, these spatial patterns do fit in the spatial sorting patterns described by Borchert (1998) where lower-yielding central functions are driven into older, less central real estate with lower rents. It is these lower-yielding central functions—e.g. the bookshops, the hobby shops, the furniture store– that account for the higher scores on the diversity index in this study.

Louisville's 'two specific noteworthy geographic features' mentioned in the introduction (the Ohio river/state border and the economic and racial segregation of the city) are clearly visible in both the venue-density and diversity maps. For example, just across the river from downtown Louisville, we find the older town centers of New Albany and Jeffersonville. Again, these score much higher on the diversity index than on pure density. This is seemingly unexpected as they are so physically close to Louisville's downtown. Christaller (1966 [1933]: 16, 102-103] explains these kind of features historically where 'bridges, border and custom places' refract the regularities of the central place system and create 'auxiliary central places'. Here we see the effect of the natural barrier of the river: people living in Indiana do not cross the river easily (both physically and mentally), and therefore, the towns on the North bank function as auxiliary central place. Similarly, when we look at the population density displayed in Figure 4.1, it is evident that West Louisville is one of the most densely populated areas in our study area. However, neither the density nor the diversity of shops is present in that area, even though following Christaller's ideal theory one would expect another cluster to be present there. This is a good example of how CPT can also be utilized in a more critical vein. By comparing actual to theoretical central place provision, the social inequalities related to central function provision, as for instance studied in the 'food deserts' literature (Wrigley, 2002; Christian, 2012), could be brought into view.

4.6 Conclusions

The possibility to use CPT for critical analyses alluded to above indicate that there is nothing inherently 'counter-revolutionary' in utilizing theories and methods from spatial science, but that these methods and approaches can just as easily be made part of an emancipatory project (Wyly, 2009). One way to accomplish this is by using CPT to 'frame' large, undirected, messy big data, which is hermeneutic theorizing. This illustrates how associating one particular episode in human geography with 'epistemic theorizing' and another with 'hermeneutic theorizing' (Barnes, 2004b) may render useful applications originating from these episodes invisible. Like the 1960s, the 2010s could benefit from using theories such as CPT to generate important conversations in human geography by navigating the data deluge. However, CPT remains epistemological theorizing as well. From that perspective, this paper has showed that calls to relegate the theory to a museum have been premature. Not only do Christallers' microfoundations still hold and can account for the provision of central functions, central functions add up to a recognizable system on the level of the settlement geography. Contrary to Scott (2012), we argue that this is of more relevance than a 'minor application in retail theory'. To the extent in which ideas about the 'consumer city' hold water (Glaeser et al., 2001; Storper and Scott, 2009), central places are paramount. Although the 'amenities' associated with the consumer city involve intangibles such as climatic conditions (Ullman, 1954), the vast majority of amenities—from a fancy restaurant and a country club to a heavy metal venue and record store— are in fact 'central place functions' (cf. Friedmann, 1956).

However, more needs to be done before the method can be scaled-up unproblematically. Ironically, the extent to which we can gauge the internal validity of our concepts has increased significantly since the days when such 'mirror qualities' of our indicators were still considered—somewhat one-sided—the pinnacle of good theorizing. However, there is always a need for caution. In the case of this paper, its concentration on avoiding type I errors at the expense of providing a more comprehensive picture of central place systems implies there is a need for further research: refining the method and more generally, assess the limit to which it works in describing full central place systems. Yet, the increased ability to test the robustness of data also cautions against over-optimism regarding the potential of big data in this regard (cf. Shearmur, 2015). In this study, we selected ten of the cleanest Foursquare categories available and had to make crude assumptions regarding the homogeneity of our Twitter users in terms of socio-economic background in order to arrive at our results. We could only reach this conclusion after considerable efforts and end up with a very partial geography, with limited relevance to the local population and policy makers. This alerts us to the fact that that although big data is a defining phenomenon of our times, it requires critical scrutiny (Kitchin 2014; Wyly, 2014) and we should be wary of embracing it as a panacea that can replace 'traditional' data gathering and analysis.

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5. Renovating Urban Systems Theory

Van Meeteren M (2016) Renovating urban systems theory. *Working Paper*.

Abstract

In urban studies there is a heated debate on how to understand and analyze the accelerating contemporary urban condition. Contrary to other opinions in the field, this paper argues that planetary urbanization can productively be analyzed by a 'renovated' set of existing concepts rather than through newly introduced concepts and epistemology. This is achieved by setting up a critical realist analytical 'entitation' to reinterpret the twentieth century corpus of theorizing on urban systems. Three subsystems are specified: the system of global circuits of value, the daily urban system and the central place system. It is argued that the interactions between these three systems can provide a valuable, if incomplete, explanation of contemporary urbanization.

5.1 Introduction

> The twentieth century's legacy to twenty-first century urban theory resembles an old house inherited from a rich aunt: worn, over-decorated, cluttered, but probably salvageable.
>
> After Charles Tilly (1984: 17)

Arguably, the easiest way to start a heated debate between urban scholars is to ask them to define their research object: the urban and the city. Provisionary answers to this question run as unresolved common threads through the history of 20th century urban studies (e.g. Castells, 1977 [1972]; Sayer, 1984; Saunders, 1985; Soja, 1989; Beauregard, 2012; Scott and Storper, 2015; Walker, 2016). Harvey (1973: 22-27) provides an important clue as to why this debate is both paramount and unstable: urban studies require blending the sociological and the geographical imaginations. Whereas the sociological imagination invokes urban society as a temporal phenomenon between (wo)man and society, the spatial imagination 'enables the individual to recognize the role of space and place in his [sic] own biography, to relate to the spaces he sees around him, and to recognize how transactions between individuals and between organizations are affected by the space that separates them.' (Harvey, 1973: 24).

Recently, the urban conceptualization debate has been re-ignited by Brenner and Schmid (2012; 2014; 2015; Brenner, 2013), who claim that in order to understand the contemporary urban condition we must dare to jettison 'inherited conceptions of the urban as a fixed, bounded and universally generalizable settlement type [and radically rethink our] inherited epistemological assumptions regarding the urban and urbanization' (Brenner and Schmid, 2015: 151). They also claim that cognitive maps inhabited by urban-rural distinctions involve a chaotic abstraction that 'divides the indivisible and/or lumps together the unrelated and the inessential, thereby "carving up" the object of study with little or no regard for its structure and form' (Sayer, 1992 [1984]: 138, cited in Brenner and Schmid, 2014: 747). The entry point for this contribution is that although such a statement may be justified from the perspective of the sociological imagination—the sociological urban-rural distinction that typified 19th century theories of modernity has long since been argued to disappear (McKenzie, 1933 [1968]; Friedmann and Miller, 1965)—it does not pay sufficient attention to the many caveats *against* such a reading from the geographical imagination. I contend that (cf. Walker, 2015) Brenner and Schmid's 'planetary urbanization' theorizations, in their attempt to repair the chaotic abstraction, risk becoming a contentless abstraction instead, 'not because there is nothing [it] could refer to but because [its] sense-relations are too weakly articulated to allow unambiguous reference' (Sayer, 1992 [1984]: 99). Resultantly, I think the call to 'reset' our epistemological framework is premature, as much twentieth century urban-geographical thinking remains relevant.

It is nevertheless obvious that we are confronted with ever more complex urban constellations that require explanation. As a corollary, drawing distinctions in empirical realities takes much more effort than in the past (Walker and Schafran, 2015 vividly illustrate the challenges). Nevertheless, from a geographer's perspective, the planetary urbanization thesis feels like a provocation. It surely is not a figment of the geographical imagination to see continued merit in analyzing and explaining rising urban complexity. For instance, in the work Jean Gottmann, a prophet of planetary urban thinking, significant explanatory leverage is gained in some parts of his *megalopolis* (Gottmann, 1961, e.g. Chapter 5) by detailed accounts of distinction between more and less urbanized places. However, provocations may be put to productive use. Therefore, this paper will excavate the legacy of 20th century urban geography with the claim (pace Brenner and Schmid, 2014; 2015) that we need to productively *embrace* rather than dispose the parts of our 20th century conceptual history that still serve us well.

This embracement of received theory requires reinterpretation of the planetary urban condition through a more concrete conceptual apparatus that can 'speak to' 20th century urban and settlement geography. Such a recasting provides theoretical, conceptual and empirical continuity with urban geography's past without invoking chaotic abstractions. Undoubtedly, a re-examination will reveal certain conceptual distinctions as obsolete. For instance, it will be argued, likely in agreement with Brenner and Schmid, that a theory-laden town-city distinction (Taylor et al., 2010) veils the very processes of urbanization that it seeks to explain. Nevertheless, this paper's ambition is to show that it is not only possible to distinguish between 'degrees of urban' when mapping the world, but that geographers have been doing this fruitfully for a long time.

The foundation for the theoretical renovation presented herein is provided by a critical realist interpretation of the 'three-systems approach' (van Engelsdorp Gastelaars and Ostendorf, 1986; 1991). This approach theorizes each settlement to be part of three overlapping and non-nested urban subsystems: (i) settlements are theorized as nodes in systems of global circuits of value, (ii) settlements are theorized as daily urban systems and (iii) settlements are part of a central place system. The hypothesized interactions between the three subsystems result in a concrete set of 'vectors of change' that enable the empirical interpretation of complex urban constellations. The renovation will draw from the last 80 years of settlement geography and urban systems theory, while trying to account for some of the criticisms (e.g. Harvey, 1973) that have been raised against urban systems approaches. The remainder of the paper is organized as follows. Section 5.2 situates the three-systems model in the genealogy of urban systems theory and contrasts it with alternatives. Subsequently, Section 5.3 provides a critical realist entitation—specification of analytical terms—of the renovated urban systems theory. Sections 5.4, 5.5 and 5.6 respectively discuss the system of global circuits of value, the daily urban system and the central place system. The relations between the three subsystems are elaborated in section 5.7. Section 5.8 concludes the paper by reviewing the usefulness of the resulting framework for comparative urban studies.

5.2 A brief genealogy of urban systems theory

Theories are time-space laden: the choices of what to theorize and what to regard as noise are by definition the product of temporally and spatially restricted research programs (Driver, 1988; Barnes, 2004). Consequently, theories will always be partial. This does not imply that received theories are necessarily restricted to the domain for which they were originally specified, but genealogical specificities can nevertheless account for theoretical biases and blind spots (Driver, 1988; van Meeteren et al., 2016a). Any theoretical reconstruction therefore has to take into account the context of a theory's genealogy. This section examines the genesis of the three-systems model, which combines three intertwined analytical traditions in urban studies.

The division of labor between intra-urban and inter-urban studies, which has been common sense for generations of urbanists (Palm, 2002; Taaffe, 2005) but bursts at its seams when one considers the idea of planetary urbanization, is nearly as old as urban studies itself. It is associated with the emergence of the metropolitan area as a planning region in the USA in the 1930s (Friedmann, 1956a). Based on this distinction, urban systems theory—which studies the interdependencies between metropolitan regions—(Bourne and Simmons, 1978) emerged in earnest in the 1950s. Particularly influential was the work of Vining (1953; 1955; 1964) whose ideas were widely discussed within the circles of the then nascent Regional Science Association (Isard, 2003). By setting aside the intrametropolitan dynamic through conceptualizing the metropolis as a single functional unit (Bogue, 1950), an interregional model of a set of metropolitan regions could be constructed. This subsequently allowed for calibration—and, as was hoped, planning—of the division of labor and flows of goods and people in national economies (Friedmann and Weaver, 1979). Where previously uniform 'cultural' regions had been the unit of regional planning, the focus of analysis now shifted decidedly to implicit urban-rural and city-hinterland divides inherent in the metropolitan/non-metropolitan distinction (idem; Dickinson, 1947). Central place theory (Christaller, 1966[1933]; Lösch, 1954[1945])—although widely acknowledged (e.g. Berry and Pred, 1965 [1961]) as only applicable to a limited set of distribution-related economic activities (Parr, 2002; Chapter 4)—was used as a basis for early urban systems analysis. It became a staple of 1960s urban studies to juxtapose central place theory with other concepts in order to build a more general theory of the urban system (e.g. von Böventer, 1962; Taaffe, 1962; Morrill, 1963; Dacey, 1966). The fusion with diffusion theory—where innovations 'trickle down' the urban hierarchy—was particularly influential (Berry, 1970; 1972).

By 1970, urban systems theory started to leave the mold of central place theory. It was Vance (1970) who vigorously denounced central place theory and proposed to replace it with a wholesale trade-based 'mercantile model'. Meanwhile Pred (1966; 1973; 1977a) gradually morphed central place theory into something totally different. The spotlight eventually shifted from inter-city to inter-firm interactions as actors were increasingly emphasized. Moreover, these interactions increasingly pivoted toward the distribution of information rather than the distribution of goods (see Deutsch, 1961; Törnqvist, 1977;

Goddard, 1977). These transitions captured much of the *zeitgeist* of the non-radical geographical community of the 1970s. This was the era of the big conglomerates of monopoly capitalism, and many believed in the coming of a postindustrial society where information would replace material goods as the driver of (state-led) urbanization (Berry, 1970, cf. Whitelaw, 1984). By the late 1970s, comparative research on national urban systems was in full swing, although a degree of heterodoxy in what was studied was retained (Bourne and Simmons, 1978; Bourne, 1980). Around this time, a more critical strand of research had emerged that refocused the research agenda on urban decline and inequality (Whitelaw, 1983). Eventually, the enduring crisis, deindustrialization and the failure of development policy to promote economic growth in the Global South prompted a critical reformulation of urban systems theory (Friedmann, 1974; Friedmann and Weaver, 1979). This reformulation, which came to be baptized 'world city research', rubs urban systems and world-systems theory together (Friedmann and Wolff, 1982; cf. Parnreiter, 2014; Bassens and van Meeteren, 2015; for historiographies of this branch).[47]

Throughout this era, a rationalist epistemology was dominant (Barnes, 2004) in that universal, a-historical truths were sought. This led to a general preference in the literature for overarching theories with as few determinations as possible, with the 'master key' (Berry, 1959) perhaps to be found in general systems theory (Berry, 1964a; 1964b) or the rank-size rule (Dacey, 1966), albeit that the degree of this preference varied considerably from one author to the next (compare, for instance, Pred, 1966). One consequence of this rationalism was a bent to cast urban systems in overly hierarchical terms, through an ill-defined abstract idea of ('ecological') 'dominance' (Lukermann, 1966, Kongstad, 1974). Once dominance could be asserted, it was safe to theorize nested sets of settlements, greatly easing the operationalization challenges of quantitative empirical analyses (Nystuen and Dacey, 1961), which was important in an era of limited computing power (Barnes, 2004). Such theorizing results in singular (national) urban hierarchies, the detailed properties of whose parts, it was hoped, could be deduced from the system as a totality. In their history of urban Europe, Hohenberg and Lees (1995 [1985]) explicitly abandon this holism while retaining central place theory and Vance's (1970) mercantile model—which they recast as 'network system'. For Hohenberg and Lees, cities are simultaneously part of both central place and network systems, as these may have different, not necessarily nested, geographical boundaries. Resultantly, historical-geographical urban development can only be understood through combining interpretations of both systems (Harris and Ullmann, 1945; Lukermann, 1966; Garner, 1967; Taylor et al., 2010 make similar arguments). In the 1980s and 1990s, this idea was further expanded to a three-tiered model by a group of urban researchers largely based at

[47] The affinities between the two research programs are probably older as they share nomenclature ('the core-periphery' dualism) associated with theories of imperialism. Before the dualism was made ubiquitous through Wallerstein's (1974) world-systems theory, Friedmann (1966) had introduced it in development theory. Friedmann's analysis or urban cores and peripheries in turn, shows remarkable similarities with Frank's (1966) presentation of metropoles and satellites.

the University of Amsterdam. These scholars were looking for a means to re-insert the intra-urban ecological approaches into urban systems theory, which was achieved through Berry's (1970) rendering of the 'daily urban system' (van Engelsdorp Gastelaars and Ostendorf, 1986; 1991; Cortie et al., 1992). The resulting three-systems model combining central place, mercantile and daily urban systems is the inherited aunt's house for which an entitation is constructed below.

5.3 Entitation

A 'system' is an epistemological term that specifies a set of elements, states, and relations between elements and states. Elements, states and relations are phenomena endogenous to a specified system. Phenomena exogenous to a specified system that can nevertheless influence the system are part of the 'environment' (Huggett, 1980: 1). Social sciences per definition deal with 'open systems' (Sayer, 1992 [1984]), implying that exchange of both matter and energy can occur between the focal system and its environment. System specification concerns entitation, an often underestimated methodological phase in systems analysis where elements, states and relations of the system are specified (Huggett, 1980: 29). It is in this phase that chaotic and contentless abstractions may emerge that cripple empirical research.

The initial problem that entitation needs to tackle is that of the research goal: what empirical phenomenon do we want to understand using systems analysis? For instance, there are important differences between predictive and explanatory system models, particularly from a critical realist perspective (Sayer, 1992 [1984]; Webber, 1984). Explanatory models focus on gauging the causal powers and mechanisms that contingently influence transformation in the settlement structure (Sayer, 1979). Predictive models, by contrast, tend to be tuned toward predicting the future state of a phenomenon given available data, possibly at the expense of obscuring the underlying causal mechanisms. This paper focuses on explanatory models, implying that careful specification of causal mechanisms is preferred over considerations of data availability, operationalization and predictive power. The aim is to arrive at a conceptual apparatus that describes urban systems on a concrete level, which requires positing direct connections between sign/signifier and referent (Sayer, 2000: 32-46).

In the renovated urban systems theory, following Gans (2009), the notion of 'settlement' is preferred over the notion of 'city' as the basic building block of inquiry. This choice is made to accommodate the possibility that the distinction between 'town' and 'city' is theoretically irrelevant (pace Jacobs, 1969; Taylor and Derudder, 2016). The distinction could be little more than one between 'taxonomic collectivities' (Harré, 1981 cited in Sayer, 1992 [1984]: 101) that carry little theoretical weight. Note that this conceptualization should not be considered as an attempt to posit the 'static material object' of 'settlement' instead of a process definition.

A process definition is at the core of systems analysis since as Blaut (1962: 2) notes:

> The system approach completely redefines the concept of object. We apply the term object to any system of process just as long as it pays to do so. [...] An object is therefore a construct or model. The same holds for relationships. An empirical relationship is a process, an interaction between two or more objects which are themselves processes. Whether we choose to call the intervening process a relationship or a separate object in its own right is largely a matter of convenience.
>
> James Blaut (1962: 2)

Blaut's notion of process implies that the social and the spatial are ontologically inseparable and can never be explained without understanding the other (cf. Saey, 1968; Pred, 1977b; Harvey, 2005; Massey 2009). Resultantly, urban systems are 'evolving and open-ended, [and hence] it is patently incorrect to consider either Los Angeles or Chicago illustrative of a stage en route to the development of another New York or, for that matter, to consider any [...] city to be at any stage in any rigid model of development' (Borchert, 1967: 328). Therefore, formulating an urban system as a functional totality that accounts for all known dynamics through concrete empirical referents on the level of settlements is a foolish task (cf. Bourne, 1997). Probably the most audacious attempt at such formulation was that of Friedmann (1972), who gracefully admitted only seven years after publication that he had underestimated the vices of capitalism and overestimated the power and autonomy of the national state (Friedmann and Weaver, 1979: 113, 168, 174). These considerations prompt adoption and adaptation of Pred's (1977a) relatively open-ended definition to understand urban systems. Based on Pred (1977a: 13), an urban system is 'defined as a [...] set of [...settlements...] which are interdependent in such a way that any significant change in the economic activities, occupational structure, total income or population of one member [settlement] will directly or indirectly bring about some modification in the economic activities, occupational structure, total income, or population of one or more other members.'

However, such a general definition of the whole provides little guidance in identifying the system's components, the 'subsystems'. Traditionally, in urban systems theory, the object is defined as a set of individual 'nodes', each of which represents an individual urban region (i.e. the 'city as a system in a system of cities', Berry, 1964a). This renders it possible to study the interaction between nodes very efficiently, for example with the tools of graph theory (Nystuen and Dacey, 1961; Taylor and Derudder, 2016). National sets of nodes, or sets of nodes with a particular economic specialization ('economic regions') are easily demarcated as subsystems (Bourne and Simmons, 1978: 4; Pred, 1973a; Barnhouse Walters, 1985). However, this type of demarcation is based on the presupposition that individual settlements or groups of settlements can be 'nodalized'—assuming that for analytical purposes the region can be described in terms of a nodal region (van Meeteren et al., 2016b [Chapter 3]).

The fundamental risk with ‘nodalizing’ is that while in concrete contexts interactions between settlements are a circulation manifold (Lukermann, 1965), you have to choose what circulation qualifies for nodalization. How many nodes do we identify in the urban system? Do we consider the San Francisco Bay area to consist of [1,2... n] (i.e. San Francisco, San Jose, Oakland, Berkeley, Cupertino...) nodes (Walker and Schafran, 2015)? The answer depends on the definition of the processes being studied: on the manifold. Therefore, much urban systems research is focused on specific segments of the manifold, such as producer services linkages (Taylor and Derudder, 2016) or airline flows (Mahutga et al., 2010). When a research question is geared to a specific segment of the manifold, nodalization is possible, but the resulting analysis is suboptimal to provide detailed descriptions of settlement geographies at smaller scales. As the spatial scale decreases, the daily urban system and the central place system become more prominent influences on the urban landscape. Graph theoretical approaches are less-suited to analyze these systems since the phenomena they describe entail 'field distributions' which are difficult to grasp using graph theory (van Meeteren et al., 2016b [Chapter 3], Chapter 4). Fields describe 'theoretically continuous distributions with a very rapid fall-off near their center and a very slow, almost asymptotic fall-off at their outer ranges' (Haggett, 1965: 40-41).

The benefit of the proposed three-systems approach, where settlements may have different positions in every subsystem, is that it allows each subsystem to have its own geographic boundary specification and to be described with a different geometry (e.g. Euclidian or topology, van Meeteren et al., 2016b [chapter 3]). Since the subsystems do not have to be neatly fitted geographically into hierarchical or contiguous arrangements, this approach helps solve the problem of the manifold. Each of the subsystems is to be regarded as describing a causal mechanism that provides the subsystem with causal powers in the critical realist sense (Sayer, 1992 [1984]): it is a contingent structure always subject to unexpected intermediating factors that make the concrete settlement geography different from theoretical expectations. Key is to find for each subsystem the most concrete level of abstraction to allow for empirical observations without the conceptualization of the subsystem becoming chaotic.

The more abstract a process is defined, the more cases it denotes but the less concrete inferences can be drawn from the cases since the definition connotes less (Sartori, 1970). If we add connotations to a concept without decreasing its denotation or vice versa, the concept stretches (idem; van Meeteren et al., 2016c [Chapter 2]): it becomes fuzzy (Markusen, 1999) and therefore a chaotic abstraction (Sayer, 1992 [1984]). For instance, when 'the global city' is invoked as a concept to connote the whole urban process, it is an undue (Sassen, 2008), 'chaotic' conceptualization. Conversely, concepts formulated at a very abstract level risk becoming 'contentless abstractions'. They say so little about their empirical referents that they cannot carry much explanatory weight for concrete events (Sayer, 1992 [1984]: 98), although their level of abstraction might be wholly appropriate for a different research question. Typical examples of contentless abstractions in urban systems theory are descriptions of urban systems in terms of the rank-size rule or general systems theory. Although these are not erroneous abstractions per se, and although they might even be able to predict events, they are not able to explain the geographies they describe (Sheppard, 1982). The sweet spot, in terms of explanatory weight, is when careful entitation defines subsystems on the level where they exhibit emergent properties that cannot be further reduced to component parts: i.e. where more concreteness would make the concept a chaotic abstraction (Sayer, 1992[1984]: 119). As each process of circulation encompasses a different geographical scale, this implies that the scale of each subsystem has to be adequately assessed (Smith, 1987). This focus on the concrete also means that we have to choose entry-points for empirical analysis. Saey (2008) distinguishes between historical and structural approaches in this regard. While an historical approach explains the genesis of a particular urban constellation, for instance in terms of site and situation, a structural approach explains its cross-sectional functioning—the logic of the system—at one moment. Given the processual nature of socio-spatial relations, a proper urban systems theory needs to grasp both. Although built up from the structural approach, the three-systems model nevertheless integrates an historical perspective given that the interactions between the subsystems indicate vectors of change. If multiple 'slices' of urban systems analysis at different moments are compared, a descriptive evolutionary geography emerges. This is the logic applied in Lukermann (1966), Pred (1966; 1973), Borchert (1967), Vance (1970); Barton (1978), Hohenberg and Lees (1995 [1985]) and van Meeteren et al. (2016d [chapter 6]).

Moreover, the three-systems model is an open system; it does not pretend to be an exhaustive account of contemporary urbanization. For instance, it is evident that governance mechanisms and politics—a major research field in contemporary urban studies (e.g. Brenner, 2004; Hamel and Keil, 2015)—will influence each of the three subsystems and their respective vectors of change. Cities are also a store of surplus and wealth that impact urban form and elite interests in a way that can bend the three subsystems (Walker, 2016). While these factors are not included herein for the sake of coherence,[48] careful entitation should allow for straightforward addition of political and governance theory in concrete applications. In the following, the three core components of the three-systems model are further elaborated, namely, i) the system of global circuits of value, ii) the daily urban system and iii) the central place system, which is followed by a discussion of their interactions.

5.4 The system of global circuits of value

Understanding the relation between urban economies and the capitalist space economy requires situating settlements in (systems of) global circuits of value. 'Economies are circuits of material reproduction involving the continuous flow of values and energy from consumption via exchange to production, via exchange to consumption' (Lee, 2002: 336). The material and organizational entanglements of these circuits of values are what constitutes the capitalist world-economy (Arrighi and Drangel, 1986; Brown et al., 2010; Saey, 2012 [2009]; Yeung and Coe, 2015) and 'involve the construction of economic

[48] Chapter 6 provides cursory information on the political and governance dimensions at the Belgian regional level.

geographies—the material, social and political landscapes of material reproduction' (Lee, 2002: 337). Although these world-spanning circuits have become more 'thickly' integrated recently (Dicken, 2011 [1986]), they are nevertheless polarized geographically. Flows of information and goods tend to bundle—in transport systems for instance—and converge in specific places. The resulting economic geographies are all but random and interface particularly in metropolitan areas (Scott, 1998). It is these metropolitan interfaces, 'nodes in systems of global circuits of value'—a less ambiguous name for Hohenberg and Lees's (1995 [1985]) 'network system'—that are of interest to urban systems theory. The various activities in the circuits ('production', 'distribution', 'assembly', 'consumption' etc.) have different values attached to them. Through social mechanisms—from price setting markets to monopoly powers—some activities are socially (Lee, 2002)[49] considered to be high-value added ('core activities'), while others are low-value added ('peripheral activities') (Arrighi and Drangel, 1986; Saey, 2012 [2009]). Two propositions logically follow from these remarks: i) it is likely that processes of economic or occupational specialization (Barnhouse Walters, 1985; Storper and Walker, 1989) hence a spatial division of labor, will occur in this system; and ii) this division of labor will, *ceteris absentius,* incite a political interest in having each metropolitan node to 'encapsulate' as much 'high value' added activities as possible while leaving the 'lesser jobs' to others.

World-spanning urban divisions of labor precede the late twentieth and twenty-first centuries and were a paramount element of the colonial period (King, 1990). However, in the 'Fordist era', when 'national economies' were considered viable development strategies (Vining, 1955; Friedmann, 1966; Scott, 1998; Jessop, 2002; Taylor and Derudder, 2016), subsets of cities were identified as 'national urban systems' with the idea that these could collaboratively contribute to a nation-state's balances of trade and income (Thompson, 1972; Simmons, 1978). As the national scale has become less important as a geographically defined market for many economic activities (Persky and Wiewel, 1994), the decreased focus on national urban systems seems justified. However, that does not imply that the national scale has lost its relevance to urban systems development. Depending on the context, the national scale still defines many parameters (education, childcare, welfare, sometimes housing) associated with social reproduction and redistributes funds accordingly (cf. Jessop, 2002). Additionally, economic policies such as trade agreements, taxation and currency regimes all crucially determine the economic viability of metropolitan regions (van Meeteren and Bassens, 2016). Despite this, national redistribution has steadily been delegitimized (Jessop, 2002), which has intensified 'competition' between urban regions for the better pieces of the economic pie (Lever and Turok, 1999). Already by the late 1960s, Thompson (1975 [1968]: 211) concluded that '[a]ll products wax and wane, and so the long-range viability of any area must rest ultimately on its capacity to invest and/or innovate or otherwise acquire new export

[49] 'Socially constructed' here has to be interpreted in the Marxist sense. Price and values are the outcome of a social (rather than a 'natural') mechanism and therefore have to be understood on the level of the social (cf. Harvey, 2010).

bases.' This insight has, for the last 50 years, directed a substantial segment of research funding to the panacean search to answer the question of how to encapsulate 'competitiveness' in the metropolitan region (Storper and Walker, 1989; Cheshire and Malecki, 2004). Driven by this quest, urban systems theory focused on the research and development of large corporations in the 1970s (Hansen, 1975), and shifted its attention to the small-firm networks of high-tech regions in the 1980s as these became more prominent (e.g. Scott, 1988). The same agenda explains the continuing interest in 'command and control' functions of circuits of value (Taylor and Derudder, 2016), which do not only account for a substantial part of high value-added activities, but are also partly responsible for constructing and rerouting the global economic geography of circuits of value (Parnreiter, 2013; van Meeteren and Bassens, 2016). However, fully appreciating circuits of value in a comprehensive urban systems theory requires investigating all moments within the circuits: from construction to invention, production, distribution, financing, and consumption. The 'very fact that there is Silicon Valley means that there must be production-only outposts in peripheral regions' (Massey, 1995 [1984]: 110), and not recognizing such uneven development leads to a partial perspective that 'drops places off the map' (Robinson, 2002).

To provide a non-chaotic theorization of the system of global circuits of value, a short exegesis on economic base theory is required to explain and justify the scalar boundaries theorized for this subsystem. Export- or economic-base theory has a long genealogy that will not be reiterated here (see Pfouts, 1960; Williamson, 1975; Illeris, 2005 for conflicting accounts). Instead, a selective definition is proposed that includes all economic activity—i.e. services, tourism, remittances—as potential sources of external revenue (North, 1959; Kay et al., 2007; Markusen, 2007; Segesseman and Crevoisier, 2015), and that is based on balances of income rather than jobs (Leven 1954; Blumenfeld, 1955), while not considering the thorny issue of empirical operationalization (Williamson, 1975). Economic base theory builds on the fundamental insight that no region is autarchic, implying it cannot survive 'by merely doing its own washing' (Jones, 1944 cited in Blumenfeld, 1955: 115). Hence, it is insightful to analytically separate those segments of global circuits of value internal ('local') and those external ('nonlocal') to the focal region. This tabulates into a balance of income where income earned from exports, money transfers, and internal consumption must at least equate expenses on imports, money transfers and external consumption (Blumenfeld, 1955). If this balance is negative, economic crisis or redistribution of funds occurs, or the difference has to be borrowed on financial markets. It is this accountancy mechanism associated with economic base analysis that allows for the definition of the nodes in global systems of circuits of value (Walker, 1988). The conundrum is where to define the boundary between the inside and the outside of a node (Tiebout, 1956a). As the basis for comparison between metropolitan nodes is an (input-output) balance of income, comparing nodes of different sizes is not an analytical issue. Larger nodes tend to logically show both a higher degree of autarchy and more complex interdependencies with the rest of the world (Persky and Wiewel, 1994; Markusen and Schrock, 2009). What is at issue, however, is that the boundary between 'local' and 'nonlocal' may not be arbitrary. Ideally, incomes and their multipliers earned from exports spent locally are to be registered on the local side of the balance sheet

(Blumenfeld, 1955; Tiebout, 1956a; 1956b), which means that all commuting activity and routine central function consumption needs to be part of the same node. In complex megalopolitan regions with overlapping commuting zones, this would imply that in terms of the systems of global circuits of value, the whole complex of interlocking functional urban areas needs to be regarded a single node; unless governance considerations prompt overruling operationalizations (cf. Parr, 2005).

If a metropolitan region aspires to enhance its balance of income position, it can basically do three things: i) gain more income from outside, (ii) diminish expenditures to the outside by import replacement (Blumenfeld, 1955; Jacobs, 1969), or iii) hope for redistributive solidarity from outside. Harvey (1985; 1989) and Molotoch and Logan (1985) provide abstract typologies of entrepreneurial strategies—relating to aspects of consumption, command and control, and production open to settlements—that may be adopted to achieve such an enhanced balance of income position. These entrepreneurial strategies require the provision of the right infrastructure, and to 'be competitive' for certain activities. However, ensuring competiveness oftentimes requires significant risky and public investments (Leitner, 1987), and success is all but guaranteed (Storper and Walker, 1989) even for investors themselves (Walker, 1978). This leads to a pernicious global game, where investors and/or highly demanded sections of the labor force are to be seduced to anchor themselves in particular metropolitan regions (Massey, 1995 [1984]; Scott and Storper, 2009) in the hope that long-term economic growth is secured for the region. However, what makes a region 'competitive'—cheap production factors, highly developed production factors, infrastructure—has been shown to change over time (Phelps and Ozawa, 2003; Sassen, 2008; van Meeteren et al., 2016d [Chapter 6]), which increases the risk that regions might chase outdated development strategies. The result is a world littered with a 'lumpengeography of capital' (Walker, 1978: 32): means of production and infrastructure that lie idle, 'deindustrialized', because other places are deemed to 'offer better incentives for accumulation'. Moreover, success tends to breed success in urbanization. Although 'windows of locational opportunity' exist when new urban-economic geographies are born (Storper and Walker, 1989), generally those places that are successful in previous rounds of accumulation tend to be more successful in subsequent rounds: regional economies develop through uneven processes of circular and cumulative causation (Myrdal, 1957). These processes have important reverberations for settlement geographies and the other urban systems discussed below: they produce backwash (negative) and spread (positive) spillovers to their environment. Spread and backwash effects have been argued to work at different geographical scales: where spread effects predominantly occur in the vicinity of the growing region, backwash effects dominate further away (Richardson, 1976; Gaile, 1979). Spread effects indicate that if an urban agglomeration is growing economically, demand for housing and consumption augmented by local multipliers will expand the region geographically, impacting our other two subsystems. The backwash effects indicate that growth-induced migration will come predominantly from more remote and less successful areas that see a shrinking asset and human resources base and will progressively become less attractive. Therefore, changes in a region's economic base, hence in its position in global circuits of value, will induce positive and negative spiraling effects that reverberate in the other two urban systems.

5.5 The daily urban system

Any individual is constrained by the rhythms of daily life. Within the 24 hours of the day, routine social reproduction—childcare, work, play, shopping, travel, education etc.—has to be organized. This 'daily choreography through time-space' is central to time geography (Hägerstrand, 1970; Ellegård et al., 1977; Pred, 1977b; Neutens et al., 2011), and generates geographical footprints that systematically influence urbanization. Generally, the 'time-space prism' is organized on the household level where arrangements regarding the division of labor of social reproduction are made. These arrangements influence who in the household has what job, where shopping is routinely done, where children go to school etc. (idem, Palm, 1982; Droogleever Fortuijn and Karsten, 1989; Kwan, 1999). Every household knits a complex set of 'rubber bands'—routinized time-space paths—that geographically tie the household in a web of spatial constraints. It is this web of constraints that makes households dependent on their immediate social environment and that hampers the ability to migrate, change jobs or schools (Cox and Mair, 1988). Therefore, the geographical footprint of the household is the crucial scale of the daily urban system. However, as travelling to work tends to be the (oftentimes) daily interaction of most households that requires the furthest travel, it has long since been argued that travel-to-work areas are a useful analytical scale to study 'daily urban systems' (Berry, 1970, borrowing from Doxiadis) on an aggregate level (idem, Coombes et al., 1978).

Given that every household has to organize its daily urban system, it is not surprising that institutionalized patterns of behavior are visible on the scale of the wider region. People with similar social backgrounds in terms of demographic, social-cultural and socio-economic characteristics tend to solve their time-space problems in similar ways. Mapping these patterns was the staple of classic urban sociology where 'stylized facts' eventually emerged, like that 'family oriented households prefer suburban environments', 'richer households prefer newer housing', and 'ethnicities cluster' (see Johnston 1971 for an overview). We now know that these particular geographies of classical human ecology were very much a time-bound phenomenon: suburbs have diversified, gentrification emerged, and the social geography of the contemporary metropolis has completely reshuffled compared to the 20th century clichés (Gober and Behr, 1982; Gober, 1989; Wyly, 1999). However, this does not imply that all that is urban is the same: the outcome of the urban sorting process still exhibits social regularities (Wyly, 1999).

Arguably, the two mechanisms identified by Feldman and Tilly (1960): i) social choice of households based on lifestyle considerations, and ii) economic competition between households, can still account for many, if not most, regularities in the social geography of the contemporary metropolis. First, specific social profiles—status groups, or what some call 'class fractions'—tend to have lifestyle-based preferences for certain housing environments (Rérat and Lees, 2011; Boterman and Musterd, 2016). In part, this is related to social status considerations, but there is also an intimate connection with the daily urban system (Van Acker et al., 2010). Within the 'Global North', and possibly elsewhere, a set of social transformations dubbed 'the second demographic transition' (Buzar et al., 2005) has made households a much more complex and heterogeneous phenomenon. For instance, two careers have to be managed in the daily urban system, which necessitates a larger labor market (Thompson, 1972) and specialized services such as childcare. This heightened complexity exacerbates the time-space constraints on households and makes proximity to amenities more valuable. For instance, 'distance to work' was hardly a decisive factor in housing choice in the 1960s and 1970s in the Global North (Johnston, 1971; Short, 1978), but it is doubtful whether that finding is still valid today in many places in the world. Gentrification is therefore not just the result of different housing preferences: for many households, moving to certain areas is a necessity for managing their daily urban system (Karsten, 2007; van Diepen and Musterd, 2009). This 'social choice' mechanism severely impacts the economic competition dynamic. As Harvey (1973: 168) notes in relation to a free market housing market with a limited stock: 'those who enter do so in order of their bidding power [, therefore] those with money have more choices, while the poorest take up whatever is left after everyone else has exercised choice'. Thus, when centrality is valued in the market, *ceteris absentius*, poorer households will be pushed to the periphery, *regardless of the social needs of these poorer households.* Even when restricted to these two mechanisms, a social geography of the city will emerge that impacts the other two urban subsystems.

5.6 The central place system

The original conceptualization of a metropolitan/nodal region was never that everybody was expected to work in the Central Business District (CBD) but that the metropolis, with its CBD, provided 'integrating services' for its hinterland (McKenzie, 1968 [1933], Bogue, 1950; Carroll, 1963). The nodal region was assumed to be a regional urban hierarchy, with several employment centers, that as an integrated whole interacted with other metropolitan regions (Nystuen and Dacey, 1961; Haggett, 1965). Thus, taking central place theory, which theorizes the spatial structure of such a regional hierarchy, as a starting point for urban systems theory was not illogical. Parr (2008: 3016) notes the similarity between the theories of metropolitan regions and the L-type regional capital city that was the integrative level for Christaller's (1966 [1933]) analysis. Notwithstanding, even if we consider this regional hierarchy to be the unrealistic 'successive inclusive hierarchy' of some renderings of classical central place theory (Chapter 4)—where all central places of a higher level contain the central functions of lower levels (Parr, 2002)—it is obvious that in the uncomplicated metropolitan region of the 1950s USA, the nodal region was larger than a daily urban system. For instance, considering a classic CBD that contained all the higher order functions, there was no necessity for everybody to be there every day, although most people probably needed to be there once in a while.

When we observe the large metropolitan areas of today, it is even more obvious that these are much larger than daily urban systems. However, like in the past, there may be central functions that are not be part of the daily procurement routine, but that are nevertheless spatially constrained because they are weekly or monthly, or would not be procured if the travel effort is too high. Daily urban systems are imbricated and within the overlaps between systems it is to be expected that some places remain more central and accessible within the total metropolis than others (Anas et al., 1998; cf. Lang and Knox, 2009). Furthermore, in market systems, centrality is likely to translate into the location of central functions. As in this aspect there is no fundamental difference between the contemporary metropolis and that of 50 years ago, we can assume that the central place system still influences metropolitan organization, and fills the gap between the scale of the daily urban system and the nodal region.

Central place theory, like economic base theory, has generated much debate over the years. Again, space constraints only permit a brief description based on one particular conceptualization, thus setting other incompatible interpretations aside. Central place theory is approached here in a Christaller-based (1966 [1933]; Chapter 4), dynamic (Morill, 1963; Preston, 1985), functional rather than a geometrical interpretation (Golledge et al., 1966; Buursink, 1975), whereby no distinction is made between intra-urban and inter-urban interactions (Carol, 1960; Warnes and Daniels, 1979). Consequently, the difference between nodality and centrality (Preston, 1971; Chapter 4) becomes superfluous. A Christallerian central place system describes the settlement regularities that are theorized to emerge under ideal-typical circumstances—i.e. when only the central place causal mechanism is present—from the provision of market-oriented functions (Parr, 2002: 37). Market-oriented, which can include business-to-business relations, means that the distance-dependent costs in time and/or money of central function provision are borne by the buyer of the good or service. Therefore, economic functions of which the intra-metropolitan transport costs are negligible are outside the scope of the theory (Parr, 1973; 2002). Fortunately, it is exactly those interactions that are captured by the economic base logic. When i) a minimum number of consumers is necessary for a central function to exist, and ii) the average consumer has a fixed upper limit above which they will no longer procure the central function, an urbanization dynamic emerges (Christaller, 1966 [1933]; Chapter 4). What follows is that the (field) distribution and/or concentration of consumers will determine the level and degree of central functions augmented by their consumer preferences and aggregate purchasing power (Johnston, 1966). The interplay between central functions will induce a hierarchical tendency among central places that functionally does not preclude complementarities between these places to emerge (Lambooy, 1969; Chapter 4).

5.7 Interactions between the three systems

Now that a brief entitation of the three subsystems and their internal logic has been enunciated, it becomes possible to theorize the interactions between the subsystems. It is the core contention of this chapter that these interactions still hold explanatory power for the complex urban geographies associated with planetary urbanization (Brenner and Schmid, 2012). Each interaction between the subsystems indicates a 'vector of change' that elucidates the settlement structure. These interactions are summarized in Figure 5.1, while the outgoing vectors per system are discussed below.

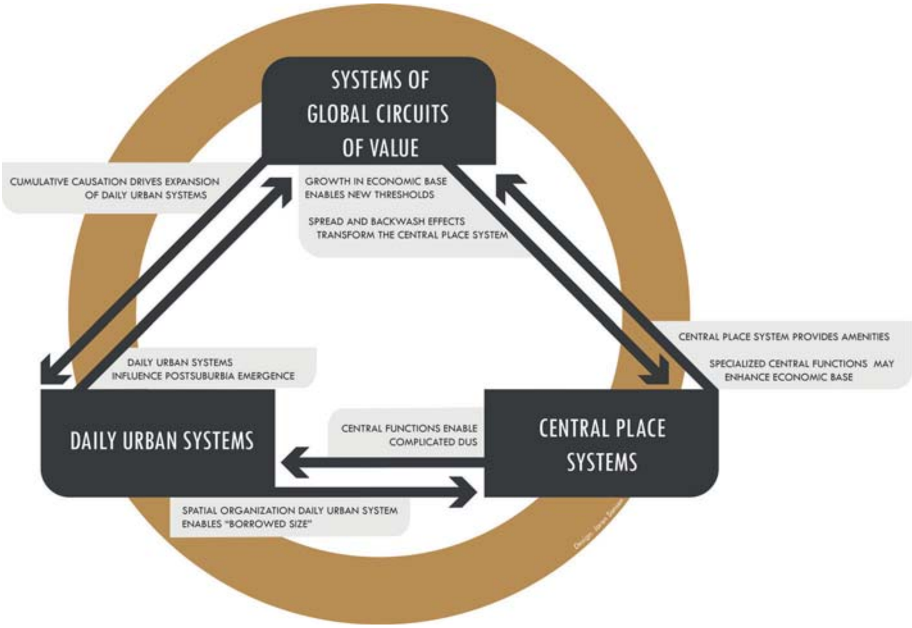

Figure 5.1 The three systems model of settlement geography

Influence of the central place system on the other two systems

Amenities play an important role in the academic debate on economic competiveness (Glaeser et al., 2001; Storper and Scott, 2009). Amenities were first theorized by Ullman (1954) as 'pleasant living conditions' that are a catalyst for migration and urban growth. For Ullman, these conditions were both of a climatic and man-made nature, with the former taking precedence over the latter. Friedmann (1956b: 226), however, latching on to the amenities debate, was quick to point out that 'business executives are frequently guided in their location decisions by "personal" factors, such as preference for opera, night clubs, libraries, book stores, society life, big athletic events, good restaurants, foreign movies, or theater-amenities which are found in only the larger cities.' Indeed, seducing highly-demanded or executive sections of the labor force to settle in your region has been theorized as important for the development of metropolitan regions ever since (e.g. Alonso, 1975; Glaeser et al., 2001; Storper and Manville, 2006; Storper and Scott, 2009), although some controversies regarding causality remain (Storper and Manville, 2005; Storper and Scott, 2009). Note that all of Friedmann's man-made amenities are 'classical' central place functions whose market viability is wholly dependent on the distribution of the population and temporal visitors such as tourists. Additionally, 'network-bases' such as airports (Alonso, 1975; Neal, 2011) oftentimes qualify as central functions as well. Moreover, as the literature on consumption and gentrification so aptly reveals (Zukin, 2010), particular lifestyle-induced daily urban systems are highly dependent on the availability of particular central functions—'exotic' foods, 'hip' record stores, golf courses, childcare, specialized gyms. These specialized amenities could in turn incite retirement migration or tourism that spike the economic base through income transfers (Segessemann and Crevoisier, 2015). Therefore, insofar as amenities are an important source of metropolitan competitiveness, analyzing the central place system could be worthwhile. Moreover, as Markusen and Schrock (2006; 2009; citing Blumenfeld, 1955 and Jacobs, 1969) argue, local consumption cultures—whose economic viability is related to the regional central place system and its more locally distinctive elements—are important for augmenting the economic base in two ways. First, local ownership implies that less of the multiplier 'leaks' away to other regions, therefore positively augmenting the balance of income (cf. Pred, 1977). Second, local consumption cultures can lead to distinctive specializations of central functions, and hence innovation, which may eventually result in new exports. It is these mechanisms that render it problematic to associate the central place system with 'town' as something distinct from 'city' (pace Taylor et al., 2010). Many aspects of 'cityness', including much that is commonly associated with Jane Jacobs (1969), are generated by the central place system.

Influence of the daily urban system on the other two systems

The daily urban system describes the spread of the population and its activity radius. This activity radius is crucial when we theorize the central place system. In Christaller's (1966 [1933]) work, the interplay between the upper and lower limit of the range of a good is crucial. While the upper limit describes the average consumer's willingness to travel, the lower limit threshold indicates the number of customers necessary for a good to exist (Saey, 1973). If sufficient customers are located within the upper limit, a specialized amenity can exist. Therefore, the distribution and concentration of people with particular consumption preferences determines whether their demands can be catered to through market mechanisms. As metropolitan regions expand, new opportunities for a more intricate central place system emerge (Berry, 1960; Parr and Denike, 1970). Hence a virtuous cycle can be hypothesized where specialized amenities and a daily urban system attenuated to those amenities co-evolve, as often happens in gentrification processes (cf, Zukin, 2010). Moreover, as daily urban systems overlap, the collective demand of these systems can pass specialized amenity thresholds enabling 'borrowed size' (Alonso, 1973; Phelps et al., 2001; Meijers et al., 2016). Another way in which the daily urban system intimately connects to the system of global circuits of value is through the labor market. It is commonly understood that, especially in knowledge-intensive economic growth, thicker labor markets are competitive assets (Ahlin et al., 2014; van Meeteren, 2016d [Chapter 6]). As people with particular skill profiles pool together in daily urban systems, new central locations for places of work emerge, which subsequently become attractive locations for enterprises (Scott, 1988; Storper and Walker, 1989). Consequently, labor market pooling contributes to the emergence of new central locations, which subsequently plausibly induces postsuburbia—where residential areas evolve into independent job centers (Phelps et al., 2006).

Influence of the system of global circuits of value on the other two systems

As mentioned above, if a metropolitan region performs well economically in the system of global circuits of value, the region may enter into a process of circular and cumulative causation (Myrdal, 1957). Such a polarizing effect (Friedmann, 1972) has two important consequences for the other two urban subsystems: i) an increase in the total population of the region, through backwash effects; and ii) an increased purchasing power in the region. This extra population will need to be housed, leading to an expansion and/or intensification of the daily urban systems. Expansion will be further amplified through the urban land market, as activities with lower bid rents will be pushed outwards (Haig, 1926; Scott, 1988; Anas et al., 1998). These are the spread-effect spillovers. As spread effects are somewhat predictable, it is likely that the urban expansion process will be accommodated by a real estate boom (Ball, 1994; Savini and Aalbers, 2015). The boom might make the built environment expand even more feverishly than output growth figures vindicate. Hence, the growth spiral might be further catalyzed by self-fulfilling prophecies, as growth becomes anticipated and people invest accordingly. Therefore, there is also a potential virtuous and a potential vicious cycle—the latter perhaps being set in pace as the real estate bubble bursts—between the system of global circuits of value and the daily urban system.

A spiraling effect is even more evident when we examine the relations with the central place system. Higher purchasing power in the region will cause more thresholds of central place functions to be met. Consequently, the level of amenities will increase (Johnston, 1966; Dale and Sjøholt, 2007), making the place a more attractive place to live. Furthermore, as the metropolitan region expands, more minimum requirements are met throughout the whole regional economic system (Ullman and Dacey, 1960; Ullman, 1962, 1968; Pred, 1966): less materials need to be imported and more stages in the process of augmenting circuits of value can be retained in the region, decreasing the liabilities on balance of income. Additionally, even though some of it might leak away to absentee owners, the more activities are locally executed, the stronger the primary and secondary multiplier effect, whereby jobs maintain other jobs through local expenditure (Pred, 1966).

5.8 Conclusions

Comparing metropolitan and megalopolitan urban constellations across the globe is an endeavor that can most certainly be filed in the category 'big structures, large processes, huge comparisons' (Tilly, 1984). Such a task requires us to sharpen our theoretical tools, 'renovating them' by salvaging the good parts and by tearing down extensions that in hindsight were perhaps misguided. Where Tilly's (1984) renovation was all about bringing history back into 19th century social theory, to create a potent political theory for the 20th century, this paper's task is to bring 20th century geography back into a historical theory of the urban that is apt for the 21st century. To that end, an open three-systems model was proposed that prioritizes careful conceptualization so that it can 'speak nicely' to amendments and alternatives. The three subsystems can be theorized to interact synergistically and as such provide a finer-grained conceptualization of Myrdal's (1957) circular and cumulative causation. Each of the three subsystems can be caught in virtuous and vicious cycles of urban growth and decline, which will influence the other subsystems. These processes result in ever-more complex urban forms: Centers and settlements move, change, grow, decline, and turn inside out. Contrary to homogenizing processes in accounts of the 'urban field' (Friedmann and Miller, 1965) or the spatial disorder of the 'postmetropolis' (Soja, 1989; 2011; Dear and Flusty, 1998), this does *not occur without order*. The key point is that while contingent, these developments are not ungraspable with human-geographical theory as urban geography spawned a long tradition in understanding the underlying causal mechanisms. There is eighty years of valuable insight gathering dust on library shelves which risks falling into oblivion if we continue to prioritize 'new' over 'old' epistemologies of the urban. This is not to say that ‘old theories’ are able to resolve all the problems of the present, but they can form important building blocks. Moreover, constant changes in conceptual nomenclature harm the comparability of studies and the cumulation of knowledge. As changes in nomenclature come at the price of decreased commensurability, they need to be carefully weighed. The risk is the decay of the intellectual infrastructure of the past, which at a certain point might be beyond renovation if new, and often incompatible layers are continually superimposed. Therefore, we have to be very conscious about what is discarded and what needs to be salvaged from the treasure trove of past theory.

Criticizing particular varieties of urban systems theory provided an important impetus to the emergence of critical realist theorizing in human geography in the late 1970s (Sayer, 1979a; 1979b). This paper, written as a staunch endorsement of critical realism, has partly been an attempt to salvage some of the useful parts from the theoretical wreckage that this critical realist critique helped to inflict. The renovation resulted in an entitation of the three-systems model that adheres to critical realist insights about proper abstractions. The model describes three causal mechanisms that are supposed to be abstract enough to travel between contexts without becoming chaotic, but still needs to be put to the test regarding its capacity to engage in the 'huge comparisons' that need to be made to understand contemporary urbanization. There is reason for confidence about that task. First, each node in the system of global circuits of value will face the question of balance of income. If a metropolis imports more income than it exports, then redistribution of people and money, or austerity, are necessary outcomes. Second, the procurement of central place functions, whether through fixed shops, temporary markets, in a monetized or other moral economy, is a prerequisite for social reproduction. And third, all people in the world are bound to the time-geographic rhythms of everyday life. The most lucid insight from the planetary urbanization literature is that the everyday rhythms of capitalism reverberate increasingly loud across the globe, impacting the time-space paths of ever more people (Lefebvre, interpreted by Soja, 1989: 50). Therefore, rather than being an antagonist Other, a renovated urban systems theory could contribute to the substantive research agenda of planetary urbanization.

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6. Flemish Diamond or ABC-Axis? The spatial structure of the Belgian metropolitan area

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Abstract

This contribution traces the evolution of the Belgian urban system by adopting an historical taxonomy of agglomeration-economy regimes, and poses the question whether a new centralizing agglomeration-economy regime based on renewed 'metropolization' can be observed. Belgium has federalized into three regions during the last decades, and different spatial perspectives emerged about how the central metropolitan area crosscuts the regional borders. After placing Belgian metropolization in its historical context, we engage with its contemporary geography. We inquire if the metropolitan core of Belgium is more akin to the 'Flemish Diamond', with capital city Brussels as the southernmost node, or whether a spatial pattern reminiscent of the historical 'Antwerp-Brussels-Charleroi (ABC)-Axis' is a more adequate description. To answer these questions, we examine the spatial integration of the Belgian labor market utilizing Vasanen's (2012) connectivity field method and a 2010 nation-wide travel-to-work dataset. The results indicate that contemporary metropolization in Belgium can be topographically expressed as an area that is more trans-regional than the Flemish Diamond yet more polycentric than an extension of Brussels, thus pointing to renewed economic centralization tendencies at the supra-regional level.

6.1 Introduction

Although cities and 'the urban' are considered paramount to present-day economic growth, there is far less agreement on how the contemporary city and particularly its borders should be defined (McCann and Acs, 2011; Dijkstra et al., 2013). Even if we straightforwardly adopt the urban economics perspective that cities exist because of agglomeration economies (Rosenthal and Strange, 2004), it turns out that agglomeration economies consist of different social processes that have different spatial-economic effects and reach (Phelps, 2004). Agglomeration economies accruing from labor markets will define a different city scale than an urban region defined by inter-firm linkages or a settlement system derived from the geography of amenities (van Meeteren et al., 2016 [Chapters 2-3]). Moreover, the types and geographical scales of agglomeration economies that manifest themselves at particular segments of time-space depend on sociological and technological contexts, as well as on the position of an urban region in the international division of labour (Cox, 2002; Sassen, 2008): different eras, due to different technologies, economies and mobilities, have produced spatially variegated geographies (Phelps and Ozawa, 2003). Henceforth, we will call these spatial-temporal fixes (Jessop and Oosterlynck, 2008) 'agglomeration-economy regimes'.

In the ongoing debate concerning the geography of knowledge-intensive economic development and the cognitive-cultural economy (Scott, 2012), a new agglomeration-economy regime referred to as 'metropolization' has recently been identified (Krätke, 2007, cf. Scott, 2012)[50]. According to McCann and Acs (2011: 29), city regions need a minimum population threshold of approximately 1.5 to 2 million people to achieve a competitive rate of knowledge-related agglomeration effects. In the context of the Netherlands or Belgium, with their dense patterns of historically relatively independent small- and medium-sized settlements, metropolization entails a tendency towards greater functional interdependencies between these settlements inducing larger polycentric functional urban regions (Champion, 2001; Meijers et al., 2014). Nevertheless, we should be wary not to overstate the relevance of the present conjuncture on economic geographies. Any assessment of the economic performance of contemporary metropolitan regions needs to take path dependencies into consideration (Pain et al., 2016).

In this chapter, we examine metropolization as a new episode of the historical development of Belgium's urban system. Belgium is a small country of about 11,2 million inhabitants, located in Western Europe. The northern half of the country is strongly urbanized, taking on a suburban sprawl-like morphology interspersed with historical cities and villages (Antrop, 2004). The resulting fragmented landscape is locally known

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[50] Although part of a broader theoretical argument that remains unexamined in this chapter, Scott's (2012) claims about the emergence of a new 'cognitive-cultural economy' discusses the same agglomerative mechanisms as Krätke's (2007) 'metropolization'.

among planners and urbanists as the 'nebular city'.[51] This metaphor is apt: aerial photographs of the region show a sprawled urban topography reminiscent of a nebula, even when compared to the neighboring polycentric regions of the Dutch Randstad and the German Rhine-Ruhr area (cf. Albrechts, 1998). While such morphology might convey the impression of homogeneity, the regularity of the nebula on the map hides a turbulent history that strongly shapes Belgium's contemporary culture, politics and economy.

Although Belgium has long been a unitary state, during the last fifty years, it witnessed a gradual process of devolution that resulted in three largely autonomous regions: Dutch-speaking Flanders in the north, French-speaking Wallonia in the south and the multilingual Brussels Capital Region (BCR). With increasing regional autonomy, the economic narratives of the three regions have diverged. While Wallonia is represented as a region that is slowly recovering from harsh deindustrialization in the 1970s and 1980s (Van Criekingen et al., 2007), Flanders is described in the terms of a 'post-Fordist' narrative of urban networks (idem), and the BCR represents a truncated world city squeezed by institutional barriers (idem; Kesteloot and Saey, 2002). However, to what extent does metropolization integrate older socio-spatial structures? How does the (alleged) emergence of a metropolitan region in Belgium relate to often-invoked spatial imageries such as the Flemish Diamond, the Walloon Triangle, Greater Brussels, or a larger area that might be more reminiscent of the ABC (Antwerp-Brussels-Charleroi)-Axis of yesteryears' Belgian unitary state?

In order to answer these questions, this chapter presents an investigation of metropolization based on the spatial structure of Belgium's labor market using Vasanen's (2012; 2013) connectivity field method. After elaborating the theoretical concepts of agglomeration-economy regimes, metropolization, and regionalization, and discussing their spatial-economic implications in Section 6.2, we will provide a concise overview of the historical regionalizations of the Belgian urban systems in Section 6.3. Sections 6.4 and 6.5 will discuss the connectivity field method as applied to the Belgian case. Section 6.6 will conclude by reflecting on the tensions generated by the mismatch between economic geographies and geographical imaginations about Belgium.

6.2 Agglomeration-economy regimes

Since the advent of the industrial revolution, the role of technology in the evolution of the spatial economy has been cyclical and has largely followed the pattern of Kondratieff cycles (see Boschma, 1994 and Vandermotten *et al.*, 2010 for respective evolutionary-institutionalist and political-economy elaborations of Kondratieff cycles in the Belgian context). Kondratieff cycles last between 45 and 60 years and consist of distinct 'A' and 'B'

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[51] The term 'nebular city' (*'nevelstad'* in Dutch) was adopted from the Italian concept of *città diffusa*. Who exactly first introduced the term in Dutch is unclear, but it quickly became widespread in Flanders, undoubtedly due to its intuitive appeal in the Flemish context (Dehaene and Loopmans, 2003).

phases. The A phase is a period of strong economic growth where several basic and a cluster of related innovations emerge in a short period. These basic innovations usually concern general-purpose technologies (steam, railroads, cars) that fuel tremendous productivity growth, transform mobility systems, and lead to growth spirals based on local economic endowments (Boschma, 1994). The B phase of each cycle consistently implies diminished growth, gradual diffusion of innovations, and a relative scarcity of profitable investments. Historically, the key mobility technologies of the A phase have tended to give rise to time-space compression (Janelle, 1969), resulting in growth in the size of the Functional Urban Area (FUA). Consequently, each Kondratieff cycle resulted in distinctive geographies of urbanization, that is, agglomeration-economy regimes. Sometimes labor was the dominant structuring mechanism in the urban geography, sometimes capital, a complexity compounded by changing modes of transport. Economic historians have established three and a half Kondratieff cycles that are more or less undisputed. The last undisputed cycle was the end of the Fordist era in the 1970s that corresponds with the passage from the A to the B phase of the fourth cycle. Analyzing (drivers of) the subsequent period has been a source of academic contention ever since. Empirically, it is observed that in an initial post-Fordist phase in the 1980s, agglomeration economies increased in importance again in the Global North, but only to a limited degree in historic inner cities (Scott, 1988a; 1988b). Since the 2000s, the urban resurgence has intensified (Turok and Mykhnenko, 2007; Scott, 2012) involving the whole city-region, with intensifying centripetal forces and large metropolitan centers as renewed focal points (Scott, 2012), although there is considerable spatial variation in this regard (David et al., 2013; Dijkstra et al., 2013). It is this post-2000 agglomeration-economy regime that we denote with metropolization (Krätke, 2007).

Settlement geographies are a path-dependent result of the agglomeration-economy regimes that were present when urbanization occurred. Agglomeration-economy regimes induce migration, urbanization, and infrastructural development that further structure the evolution of the urban system (van der Knaap, 1980). As people settle, acquire real estate, and routinize their day and life paths they become dependent on these socio-spatial urban scales (Cox and Mair, 1988; [Chapter 4]). Moreover, specific routinized interactions over the *longue durée* generate the discursive material for the economic imaginaries, mental maps, and regionalizations that subsequently inform senses of belonging and political narratives (Allen et al., 1998; Oosterlynck, 2010), even if these mental maps diverge from material reality. In the long term, the socio-spatial artifacts of different agglomeration-economy regimes get absorbed in new scales, but are also superimposed on top of each other in a palimpsest kind of manner (Harvey, 1996: 49). This generates a layered structure of social relations consisting of the social and demographic inheritance, spatial and social imaginaries, and built environments of different eras of spatial divisions of labor (Massey, 1979; Harvey, 1996; Albrechts, 1998; Allen *et al.*, 1998;).

Already in the 1930's, McKenzie (1968 [1933] [cf. Chapter 5]) observed that urban-rural relations between the traditional city and its hinterland had dissolved in 'metropolitan communities'. Drivers of this process were identified as a deepening division of labor in conjunction with adoption of mobility technologies. Scott (1988a: 121) defines a 'modern metropolis as a bipartite system of production and social spaces tied geographically to one another by commuting habits [...] of workers'. For much of the twentieth century, metropolitan development implied a centrifugal fanning out of the functional urban area. However, it is plausible that as the economy has become more knowledge-insensitive and based on flexible labor relations, a renewed centripetal layer of social relations is deposited on the existing urban fabric, i.e. metropolization (Krätke, 2007; Scott, 2012).

In metropolization, deep and thick labor markets are paramount (Scott 1988a; 2012). Interpreting McCann and Acs (2011), it is the division of labor enabled by a concentration of 1.5 to 2 million people that allows the degree of diversification and specialization that enables an urban region to integrate in the global urban networks that are associated with contemporary economic growth (Scott, 2012; Taylor and Derudder, 2016). However, this general statement requires qualification. First, a metropolitan region can comprise a polycentric system of smaller settlements (David et al., 2013; Dijkstra et al., 2013). Second, Krätke (2014) urges to cautiously observe differences between 'real economy' and 'financial economy' trajectories of metropolitan regions – where the latter trajectory is related to financial accumulation and real estate speculation (cf. Bassens and van Meeteren, 2015). Lastly, David et al. (2013) and Pain et al. (2016) advocate critical scrutiny of network perspectives that do not take the wider economic-geographical structure and history into account (cf. Chapter 3). These cautions inform our elaborate scale-sensitive historical methodology.

6.3 A concise history of the Belgian urban system

The Belgian economic-geographic historiography commonly utilizes a Kondratieff cycle periodization to chart the country's spatial-economic transitions over time (Vandermotten, 1998). Phelps and Ozawa (2003) augment this perspective through providing an explicit historic-geographical theorization of agglomeration economies. They propose four ideal-typical forms dominant in different historical eras of capitalist development: proto-industrial, industrial, late-industrial, and post-industrial [52] agglomeration economies. Although Phelps and Ozawa (2003: 585) mention the importance of technological change to understand the changing geography of agglomeration economies, they do not elaborate that point further. Yet the typology follows largely similar temporal boundaries as standard Kondratieff cycle theory since it describes the same historical changes. By juxtaposing Vandermotten's Kondratieff periodization with Phelps and Ozawa's typology we obtain a fivefold agglomeration-economy regime typology fitting the development of Belgium's urban system: proto-industrial (until 1840), industrial-A (second Kondratieff cycle 1840-1895), industrial-B (third Kondratieff cycle 1895-1948), late-industrial (the A phase of the fourth Kondratieff

[52] The utilization of the term 'post-industrial' is to provide consistency with the literature. This should not be understood as an *a priori* endorsement of post-industrial theory.

cycle 1948-1974), and post-industrial (from 1974 onwards). Figures 6.1 and 6.2 provide reference maps of contemporary population density and the Belgian administrative and city systems.

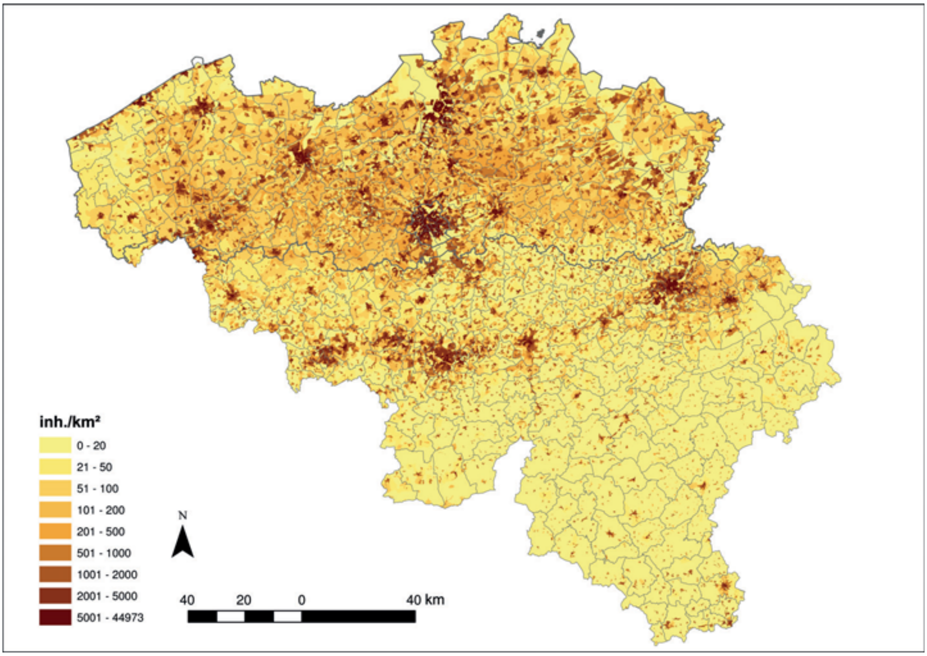

Figure 6.1 Population density in Belgium (Source: Statistics Belgium, 2010)

Figure 6.2. The Belgian administrative and city systems (Source: Open Street Map, Creative Commons Licence, 2014)

Central places: The Belgian proto-industrial urban system

Although the present-day Belgian settlement system has some roots in the Roman era (Arlon, Tournai, Tongeren) (Vanneste, 1985), the northern anchors of its current structure largely emerged during the Medieval period (Braudel, 1984: 98). The kernels of the city system formed around strategic points on fluvial transportation routes on the banks of the Scheldt-Leie (e.g. Antwerpen or Antwerp in English, Gent or Ghent, Tournai) and Meuse (e.g. Liège, Huy, Namur, Dinant) rivers, while the in-between space remained relatively unpopulated (Vandermotten and Vandewattyne, 1985; Vanneste, 1985). In the thirteenth century, the economic pivot shifts towards the North Sea as the city of Brugge (Bruges), becomes one of the most important trading centers in the world-system of that era, while nearby Ghent becomes the center of the world textile industry (Braudel, 1984; Abu-Lughod, 1989). The surroundings of these cities—roughly equivalent with present-day West-Vlaanderen, Oost-Vlaanderen, Vlaams-Brabant, Brabant wallon and the western part of Antwerpen provinces—develop a densely populated market-based settlement system congruent with central place logic (Vandermotten and Vandewattyne, 1985; Van Nuffel and Saey, 2005). In the fourteenth century, the Ghent textile industry diffuses in the neighboring countryside (Abu-Lughod, 1989: 85), giving an impulse to a long-lasting rural proto-industrial putting out system of small family-based cottage industries (Musyck, 1995; Vandermotten 1998). While the position of Bruges is eventually overtaken by Antwerp in the fifteenth century, before moving on to Amsterdam after 1585 (Braudel, 1984), Brussels gradually becomes an important administrative center under the various political regimes that rule present-day Belgium. During the period of the United Kingdom of the Netherlands (1815-1830), Brussels also becomes a financial center (Vandermotten *et al.*, 1990). This marketplace-based city system with its center of gravity in the north of the country would gradually draw the surrounding countryside within its economic orbit (De Wachter and Saey, 2005) congruent with the trade-based agglomeration-economy regime dominant in the proto-industrial era (Phelps and Ozawa, 2003; Scott, 2012). Shortly after independence from the Dutch in 1830, Belgium has five cities with over 30,000 inhabitants (Brussels, Antwerp, Ghent, Bruges, and Liège), all of them located in the northern and central parts of the country alongside a few smaller historical settlements based on the river system in the center-south (Van der Haegen et al., 1982: 275; see Figure 6.4a in Section 6.5).

The Walloon Axis: Belgian urban system development in the second Kondratieff wave (1840-1895)

Soon after independence, Belgium becomes the first continental European country to industrialize. Given the paramount importance of transport costs in this era, industrialization and related urbanization take place there where natural resources are found (Hohenberg and Lees, 1995 [1985]; Vandermotten, 1998; Phelps and Ozawa, 2003: 591). Consequently, the coal-deposit areas of the previously thinly populated south in the Meuse-Sambre river basins develop vigorously. Besides the strong growth of existing cities such as Mons, Namur and Liège, previously marginal places such as La Louvière and Charleroi gain prominence (Vandermotten and Vandewattyne, 1985). However, Belgian industrialization develops unevenly within its arc-shaped Walloon Meuse-Sambre industrial axis (see Figure 6.4b in Section 6.5). High value-added industries only develop in those urban centers with historically built-up knowledge bases. For instance, steel industry develops in Liège, a historic center of artisanal metalworking, but not in the Borinage region in Hainaut (Vandermotten, 1998; cf. Boschma, 1994). Furthermore, due to its underdeveloped demographic weight, the Walloon industrial axis had severe labor shortages, preventing the eastern and western part of the axis from coalescing and developing complementarity (Vandermotten et al., 1990: 17; Vandermotten, 1998). According to Vandermotten (1986: 55), the Walloon Axis is spatial metaphor that suggests a functional coherence that never existed in reality. Meanwhile, in the more strongly urbanized north, only the Ghent textile industry is is able to adapt to the new technological imperatives of industrialization. The rural, proto-industrial, textile-manufacturing sector based on the putting-out system quickly collapses under the weight of international competition, pauperizing the population (Vandermotten et al., 1990: 16). Although some migrate toward the south, the Belgian ruling elites decide on a different scheme to counter the spatial mismatch between labor supply and demand. The Belgian steel and railway industries roll out the largest railway network in the world, with support from the government who sponsors railway subscriptions for laborers (De Block and

Polasky, 2011). By the 1890s, more than two million (!) people commute to work every day (De Decker, 2011: 1640). Commutes totaling four hours a day are not uncommon and will ultimately stimulate a commuting culture that is still very present today (idem). The added advantages for industry are that the rural laborer can be 'protected' from unionization and secularization, while wages can be kept low as the laborers' family is *de facto* semi-proletarianized through the continued prevalence of subsistence farming (Mandel, 1963). In this era, the hilly south of Belgium (the Ardennes) and the forested and infertile sandy area in the north, which starts east of Antwerp (the Kempen, Campine in English), retain a traditional peasant character (Vandermotten et al., 1990: 21-22).

The ABC-Axis: Belgian urban system development in the third Kondratieff wave (1895-1948)

The economic-geographic history of Belgium cannot be properly understood without appreciating the role of centralized holding banks, of which the *Société Générale de Belgique* (incorporated in 1822, acquired in 1998 by the French company *Compagnie Financière de Suez*) is the major example. When capital centralizes in a context of capital scarcity, as was the case during large parts of the nineteenth and twentieth centuries, a decision to invest in one location implies a lack of investments elsewhere (Mandel, 1963; Vandermotten, 1998). It was the Brussels-based large holding banks that chose to invest in the Walloon Axis in the nineteenth century, shifting their spatial strategy toward the north and to foreign countries in the early twentieth century (Vandermotten, 1998). For Belgium, 1890-1950 is a period of diminished growth where domestic industrialization strategies are partly substituted for foreign adventures by the holding banks (Mommen, 1994: 34; Vandermotten, 1998: 84). Domestic Investments are diversified toward electric appliances, non-ferrous metals and petrochemicals. Raw materials are imported from overseas, largely from Belgian Congo, and semi-finished products are re-exported. Spatially, a new development axis, perpendicular to the old Walloon Axis, develops between the cities Antwerp, Brussels and Charleroi (the ABC-Axis; Vandermotten et al., 1990). Brussels and Antwerp, proximate to consumers and the labor force, become important industrial centers. (Vandermotten, 1998: 85). Meanwhile, the Walloon Axis remains specialized in the nineteenth-century heavy industries. Hampered by the holdings' lack of willingness to invest capital (idem) and its weak demographic basis, the region starts to stagnate (Vandermotten et al., 1990). This shift northward is exemplified by the fact that by 1920 half of the activities of Société Générale in Belgium are located in Flanders (De Wachter and Saey, 2005: 161).

Furthermore, in the late nineteenth century, the Campine region, located strategically between the Antwerp harbor and the German hinterland, is opened up through canals (Vandermotten et al., 1990). Dirty industries spill over from Liège and Antwerp, and coal pits are established in Limburg following the First World War. While the coal industry induces strong demographic development, the region remains peripheral until the 1950s (Kipnis and Swyngedouw, 1988: 151; Boschma, 1994: 118). The geographic centralization of capital in the ABC-Axis is further strengthened by the arrival of new industrial players. By the 1920s, enterprises in Flanders are developed with autonomous Flemish capital, organized around Dutch-speaking catholic elites (Oosterlynck, 2010). The 1920s also witness the arrival of foreign direct investment (FDI) from the United States (USA): both Ford and General Motors start operating in the Antwerp harbor (Vandermotten, 1998: 86-87), as stimulated by tariff policies from 1935 onwards (Boschma, 1994: 115; Mommen, 1994: 94). Meanwhile, the state continues to reinforce a non-urban culture. While in 1889, a law is enacted that prohibits the construction of large-scale working-class quarters and encourages rural homeownership for laborers (De Meulder et al., 1999; De Decker, 2011), in 1928 subsidized loans for homeownership for large families are introduced (De Decker, 2011: 1641). By around 1945, this fostered the development of the geography depicted in Figure 6.4c in Section 6.5.

Belgian Fordism in the late-industrial era (1948-1974)

Belgian economic development in the 1950s and 1960s is a textbook example of a Fordist accumulation system (Swyngedouw, 1990). The Fordist period is so memorable that the decades are still referred to locally as the 'Silver Fifties" and the "Golden Sixties". In the 1950s, corporations from the USA massively internationalize toward Europe due to growth exhaustion in the US domestic market (idem). Meanwhile, the Belgian government becomes conscious of its dependence on basic industries slated for restructuring within the newly minted European Coal and Steel Community (ECSC) [1952], and starts to make plans to diversify the economy (Ryckewaert, 2011). These include the expansion laws [1959, 1966], which create an attractive tax climate to lure foreign corporations, chiefly US FDI (idem; Vandermotten, 1986; Mommen, 1994: 122). The state also executes an ambitious highway and canal plan to provide ample space and infrastructure for large-scale economic development (Ryckewaert, 2011). Completely in line with the Fordist paradigm, where the government supplies and subsidizes the preconditions for private capital accumulation, the 'De Taeye law' [1948] is enacted that fiscally promotes homeownership for Belgian families and helps set off a consumption spiral of suburban living and car ownership (De Meulder et al., 1999). By the 1960s, all the elements are in place for the late-industrial agglomeration-economy regime in the dispersed form of an urban field (Friedmann and Miller, 1965).

The regional effects of these measures confirm Friedmann and Miller's (1965) predictions: the outer boundaries of the urban system expand and economic growth diffuses. The strategically located Campine area develops an intensive branch plant economy. Conducive to this development are a coal industry induced labor surplus, lower wages than in the rest of the country, and sudden accessibility through new infrastructure—in particular the bundle of the Albert Canal [1939] and the Koning Boudewijn (A13/E313) motorway [1958] (Kipnis and Swyngedouw, 1988; Swyngedouw, 1990). Furthermore, the harbor complexes in both Antwerp and Ghent and the north of the ABC-Axis continue to strongly develop (Vandermotten, 1998). However, these expansions are oriented toward suburban or peri-urban development rather than to the core city (idem; Ryckewaert, 2011). The key exception is Brussels, which from the 1960s onwards starts to rapidly deindustrialize, and loses population due to suburbanization (Kesteloot and Saey, 2002). Simultaneously, Brussels is actively promoted as a tertiary growth pole (Ryckewaert, 2011) and becomes the headquarters of several European Institutions. While these developments induce strong central business district (CBD) formation, most CBD employees nevertheless commute inwards (Boussauw et al., 2012), contributing to population peaking in 1967 (Kesteloot and Saey, 2002). These are all signs that two other features of the late-industrial agglomeration-economy apply: decentralization of production and centralization of control (Scott, 1982, Phelps and Ozawa, 2003). Another area that develops strongly in the Golden Sixties is the southwestern part of Flanders, around Kortrijk, where the traditional flax industry is successfully diversified toward exports of, for example, carpets and wooden chipboards. This economic renaissance occurs relatively independently of the economic core area as Labor, capital, entrepreneurship, and technology are local affairs, making the region an example of a successful new industrial district in the 1990s (Musyck, 1995).

For Wallonia, by contrast, the Golden Sixties are rather greyish. The region is hit hard by the closure of the coal pits and the ageing basic industries (Vandermotten, 1986). The ECSC stipulates that the least productive (and hence the old Walloon) European mines are to be closed first and economic aid is made contingent on painful industrial restructuring (Ryckewaert, 2011). Similar to Flanders, industrial policy focuses on linear development, here pivoted around the new Autoroute de Wallonie [A15/E42], connecting the Ruhr area to Paris, which is expected to revitalize the Walloon Axis by fostering the development of new industrial estates (Vandermotten et al., 1990: 42; Ryckewaert, 2011). Although some new investments are secured, they are less prominent than in Flanders and do not offset the losses in the old industries (Vandermotten, 1986; Mommen, 1994: 127). Consequently, the demographic and economic weight decisively shifts back to Flanders (Vandermotten, 1986; 1998). It is in this context of uneven regional economic and demographic development that the lingering political conflict between the Dutch and the French speaking populations of Belgium explodes in the late 1960s (Witte *et al.*, 2005). Although there had been calls for the federalization of the country from the Flemish side for decades, and the language struggle was an important rallying point for these demands, it is not before Walloon socialist elites decided that autonomy might help them tackle the economic woes that constitutional reform and federalization become politically feasible (Vandermotten et al., 1990: 60-62; Mommen, 1994: 128; Witte et al., 2005: 419-440; Oosterlynck, 2010: 1169).

Competing 'post-industrial' imaginaries: 1974- the present?

As an industrial country heavily reliant on the propulsive and capital goods sectors, Belgium is severely struck by the crisis of the 1970s, signaling the demise of the Fordist era and late-industrial agglomeration-economy regime (Mommen, 1994: 146-174). Once again, the losses are unevenly distributed geographically and the old industry in Wallonia and Brussels suffers more than the newer industry in Flanders (Vandermotten, 1986). In the midst of painful economic restructuring and in part due to the regional political tensions caused by crisis management (Witte et al., 2005), the Belgian state is federalized through a series of constitutional reforms. These reforms result in the devolution of policy fields such as spatial planning, industrial policy [1980], and public works [1988]

(Oosterlynck, 2009; Boussauw and Boelens, 2015). Consequently, the newly minted regional governments, (1980/1981 for Flanders and Wallonia and in 1988/1989 for Brussels) start constructing new spatial-economic discourses and imaginaries, drawing on locally dominant perceptions and assessments (Oosterlynck, 2009; 2010).

Although there is broad consensus that Fordism ended with the crises of the 1970s, academic debates on after-Fordism and its spatial expression have never been fully resolved (Keil and Ronneberger, 1994). Tellingly, in 1984, Peter Hall speculates in the postscript to the third edition of his book 'The World Cities' that his earlier assertion of an 'urban future' might need nuance and that this future could also entail further dispersion and urban-to-rural migration instead (Hall, 1984: 230-253). This ambivalence is echoed in Phelps and Ozawa's (2003: 595) Peter Hall-inspired discussion of post-industrial agglomeration economies. 1980s' economic-geographical theorizing suggests bundled dispersal of economy activity away from the traditional urban centers (Scott, 1988b: 178), a development confirmed in contemporary analyses of the Belgian spatial economy (Cabus and Vanhaverbeke, 2003). Combined with the political and cultural discourse of federalization, this centrifugal urbanization popularized 'new regionalist' discourses that de-emphasize the role of the unitary state and traditional large cities among the newly minted Belgian regions (Oosterlynck, 2009; 2010).

Flemish new regionalism of the 1980s and 1990s emphasizes regional economic autonomy (Oosterlynck, 2009) and idealizes Southwest Flanders as *the* Flemish industrial district (Musyck, 1995; Reid and Musyck, 2000). Additionally, as studies reveal the significant innovative capabilities of the branch plants in the Campine region, Limburg seems to be ready for new regionalism too (Kipnis and Swyngedouw, 1988; although Swyngedouw, eg. 1990, would later qualify these claims). The appeal of urban dispersal even reaches the point where retention of economic activity in the central Flemish urban area—due to competition in the Campine and Southwest Flanders—becomes a policy issue (Vanhaverbeke, 1998; Albrechts and Lievois, 2004: 357). In the 1997 spatial structure plan for Flanders (RSV, 1997), this central area is baptized 'The Flemish Diamond'. Four cities (i.e. Antwerp, Ghent, Leuven and—interestingly, since it is outside Flemish jurisdiction—Brussels) are to be considered a polycentric urban network that is able to compete with similar networks like the Dutch Randstad and the German Ruhr area (Albrechts, 1998). According to Albrechts (1998: 420-421, corroborated by Vanhaverbeke, 1998; but questioned by Vandermotten et al., 2006 and Van Crieckingen et al., 2007) there was 'ample evidence' that the Flemish Diamond had the characteristics of a functional region, although it was regarded an 'urban network in the making' since organizational linkages and a shared regional imaginary were are absent when the spatial structure plan for Flanders was conceived. Hence, the Flemish Diamond is an aspirational policy notion that reflects emergent social-spatial realities (Albrechts and Lievois, 2004). Eventually, the Flemish Diamond becomes an important example of a polycentric urban region in the international literature (van Meeteren et al., 2016).

Walloon new regionalism similarly turns to the image of a polycentric region. Regarding reluctance by Flanders- and Brussels-based elites to invest in Wallonia as an important cause of the Walloon slump, the region initially aims for an independent revitalization of the Walloon industrial axis (Vandermotten et al., 1990; Oosterlynck, 2009). In 1986, the regional capital is established in Namur, which is only the third city in Wallonia, and the administrative functions are spread over various cities as a '*polyville Walonne*', a strategy strongly criticized for its naivety (Vandermotten 1986; Vandermotten et al., 2006). When the economy gradually starts to recover in the late 1980s and 1990s, it is particularly the Brabant wallon province that exhibits growth, while the outer edges of the Walloon industrial axis compete with one another (Vandermotten et al., 1990). This unevenness is attributed to the presence of technological research and development activities and spillovers from Brussels in Brabant wallon (Reid and Musyck, 2000). These developments are incorporated into the Walloon spatial plan (SDER, 1998) that reveals the spatial concept of a Walloon Triangle connecting the axis Mons-Charleroi-Namur and Brussels. Like the Flemish Diamond, the Walloon Triangle is only considered to have limited validity as an empirical spatial object, but is meant to emphasize the interdependency between Brussels and Wallonia (Van Criekingen et al., 2007; see Figure 6.4d in Section 6.5).

This strong emphasis on new regionalism, together with the administratively constrained size of the BCR, has long obscured Brussels' economic renaissance, which becomes increasingly apparent from the 1990s onwards (Kesteloot and Saey, 2002). After 25 years of absolute population decline, the BCR's net population starts growing again after 1996 (idem). Furthermore, the tertiary complex, based on the international institutions complemented by business and tourist travel, augments its contribution to the GDP (Vandermotten et al., 2009). Moreover, when considering the functional urban area rather than the restricted administrative boundaries of the BCR, a case can be made for a growth center mechanism based on the core city spreading out toward Flanders and Wallonia (Vandermotten et al., 2006; Thisse and Thomas, 2010; cf. Chapter 4). This casts doubt on the dispersal narrative that has been the hallmark of the Belgian variety of new regionalism (cf. Riguelle *et al.*, 2007). However, despite these indications of the renewed relevance of Brussels to the Belgian national economy, the most recent round of regional policies in Flanders and Wallonia reinforce the old centrifugal narrative by stressing regional ruptures between the Flemish and Walloon regions (van Oudheusden et al., 2015). These ambiguities and tensions between spatial imaginary and economic geography set the stage for the following analysis of contemporary metropolization in Belgium.

6.4 Labor market connectivity analysis: Data and method

From a metropolitan perspective, commuting data provides an important indicator of economic interdependency between geographical entities (Scott, 1988a). The more a labor market integrates multiple settlements, and the higher its total mass, the more likely it is that the required skill-specialization threshold for metropolization is met. Recently, Vasanen (2012; 2013) developed the 'connectivity field method' (CFM) that allows interrogation of these interdependencies. The CFM is a variation on more traditional methods of spatial interdependency analysis, and relies on the interaction between spatially defined entities such as municipalities, census blocks or traffic analysis zones, with the aim of providing an analysis *independent* of predefined boundaries. This independence regards all spatial demarcations except the data container, which in our case refers to municipalities. Just as in the classic gravity model (Stewart, 1948), Vasanen's method is capable of measuring interaction by means of flows of traffic, telephone communication, or data transfer. In the present study, following one of Vasanen's case studies (2012; 2013), we use commuting flows. Although covering a rather small share of daily mobility patterns, these flows highlight the regional labor market interdependencies that are theorized to be crucial in metropolization. Another important reason for using commuting flows is the availability of high quality data in Belgium.

The CFM employs an origin-destination matrix of regional interactions and proposes three analytical concepts: the 'connectivity field', the 'potential field', and the 'level of connectivity'. The connectivity field of a specific zone within the study area is defined as the spatial distribution of the origins of interactions (e.g. trips) arriving in the considered zone. Translated into commuting flows and municipalities, this points to the spatial distribution of the working population that is employed in the studied municipality. The second analytical concept, the potential field, is defined as the spatial distribution of the departures of all interactions in the entire region under study, with the exception of intra-zonal trips. Translating this concept in terms of commuting flows and municipalities, this concept regards the spatial distribution of the residences of those who work in another municipality than where they live. Both distributions can be visualized on a map. While the connectivity field is represented by as many maps as there are zones in the studied region, the potential field is represented by only one map for the entire region (Figure 6.3). The third and final concept, the 'level of connectivity', is defined as the Pearson's correlation between the connectivity field and the potential field, and is calculated separately for each zone. This connectivity metric indicates the extent to which the spatial distribution of the incoming commuter flows of the considered zone is similar to the spatial distribution of the outgoing commute in the entire region. A positive value indicates that the local labor market is embedded in the region, while a value near or below zero indicates that the local labor market operates autonomously, and perhaps even depends on zones outside the studied region. Since the dataset regards a population and not a sample, we do not consider statistical significance thresholds.

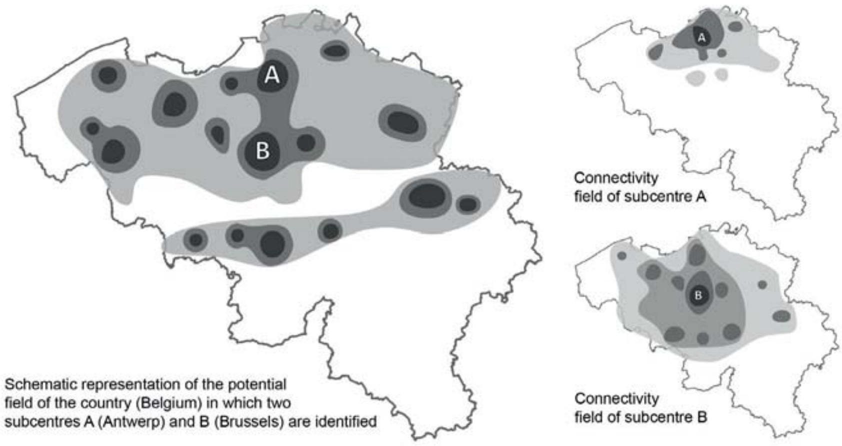

Figure 6.3. Schematic representation of potential field and connectivity field (Based on: Vasanen, 2012; 2013)

Methodologically, a few caveats apply. By ignoring the intra-municipal commute, the importance of central cities with a positive jobs-housing balance is somewhat underestimated. As a corollary, the calculated connectivity indicates how well the area in question is linked to the labor market of the entire region studied, but ignores the economic activity represented by the internal commute of the zone. The advantage of the CFM in this respect is that the analysis acts as a kind of filter that allows us to squint away the dominance of historically grown concentration patterns and thus reveals emergent indications of metropolization. Moreover, an unbiased connectivity assessment would require a system of spatial aggregation in which every zone would contain exactly the same number of jobs, meaning that zones would become smaller where employment density is higher. In that case, it would be reasonable to also include intra-zonal trips since variation in the number of such trips would no longer correspond with the (invariable) number of jobs per zone. In practice, however, this way of working is not feasible, since available data is usually aggregated into administratively defined fixed boundaries.

Application to home-work travel in Belgium

In Belgium, there is a long tradition of using commuting flows in mapping socio-economic and spatial processes (e.g. Dickinson, 1957). Following the censuses of 1970, 1981, 1991 and 2001, which are generally perceived as being very complete, commuting data have been used to define urbanization classes, attributing an important role to the commute in the perception of urbanization processes, both in academia and among policy makers. The commuting data set utilized in this study dates back to 2010 (RSZ, 2011). We use this dataset to calculate the level of connectivity and spatial integration of the Belgian labor market. In addition, we mapped the connectivity field for the five largest cities (Brussels, Antwerp, Ghent, Charleroi and Liège). In the case of Brussels, for mapping purposes, we first aggregated the nineteen municipalities that make up the BCR. Such a move is vindicated since the Brussels municipality *sensu strictu,* contrary to the other cities, was never consolidated in the administrative reform of 1975 (Kesteloot and Saey, 2002: 56; cf. Corijn and Vloeberghs, 2009), which was enacted in 1977 and in Antwerp in 1983, respectively. After presenting the results of this analysis, we discuss the observed regional distribution of connectivity levels and the differences in the size of the connectivity fields of the five studied urban areas in relation to the spatial-economic structure of Belgium as it is portrayed in the relevant literature.

Properties of the social security data

Our dataset is based on the central database of the Belgian National Social Security Office (NSSO). It takes the form of an origin-destination matrix with all 589 Belgian municipalities as aggregation zones. This database (details in RSZ, 2011) contains the residence and place of employment on 31 December 2010 of the large majority of Belgian employees. The registered residence is the address where the employee officially lives. The place of employment is the applicable branch address of the employer, which in some cases can differ from the place where the actual work is done. The database is generally known as very dependable, although the addresses are the least accurate part since data gathering relies on employers' self-reporting. As far as possible, missing data are supplemented by the administration of the NSSO.

While seen as reliable, there are several biases in the database. A limited number of people who are part of the current active labor force register in separate social security provisions, and are thus not included in the NSSO database. Staff members of municipal and provincial governments, seamen, and the self-employed in the strict sense (those who are not registered as an employee of their own company) are key examples. At the same time, employees with two or more places of employment, for example because they combine several part-time jobs in different organizations, appear several times in the database, again causing some bias.

6.5 Findings

Before examining the degree of integration of the Belgian labor market, it is important to properly gauge the relevant building blocks, both historically and contemporarily. Section 6.2 discussed the development of the Belgian urban system in regard to agglomeration-economy regimes, concluding that by the end of the 1990s, a 'post-industrial' geography of the Belgian urban system seemed to have solidified in harmony with the literature of the time, although the renaissance of Brussels posed questions to the endurance of this after-Fordist geography. Table 6.1 and Figure 6.4 summarize Section 6.2. In Figure 6.4 several maps of historical Belgian urban system regionalizations have been redrawn:

Regime	Period	Dominant agglomeration logic	Dominant spatial expression / Spatial narrative in Belgium
Proto-industrial	Before 1840	Urbanization around market centres	Central place system in Northern Belgium
Industrial A	1840-1895	Urbanization based on natural resources	Walloon industrial Axis
Industrial B	1895-1948	Urbanization based on Population centres	ABC-Axis
Late-Industrial	1948-1974	Dispersal of Production; centralization of control	Dispersal of industry and population, rise of Brussels as service growth pole
Post-industrial	1974- (+/-) 2000	New regionalism based on new industrial spaces	Flemish Diamond, Walloon Triangle, industrial districts
Metropolization	(+/-) 2000 - present	Urban system integration	Subject of the paper

Table 6.1 Agglomeration-economy regimes in Belgium

We now extend these historical observations with the findings of our application of the connectivity field method to the current Belgian urban system. Figure 6.5 shows the connectivity fields—the distribution of places of residence for the employees registered to work in these cities—for the four largest Belgian cities other than Brussels (Antwerp, Charleroi, Ghent, and Liège). Note that Figures 6.5 and 6.6 show the intra-municipal travel-to-work activity as well. Figure 6.5 displays quite 'classic' monocentric functional urban areas in terms of labor markets. A degree of reciprocal interdependence is only present between Antwerp and Ghent. However, adding the BCR to the equation (Figure 6.6) changes the image dramatically. Not only is the size of the BCR labor market area significantly larger, it interacts to an important degree with the other four big cities. This relationship is not reciprocated by any of these four cities and therefore clearly hierarchical (Limtanakool et al., 2007: 2127).

Figure 6.7 visualizes the hierarchy and balance (Limtanakool et al., 2007; Burger and Meijers, 2012) of the intercity commuter flows. The nodes represent the urban agglomerations—aggregations of the core cities and their respective suburbs (Luyten and Van Hecke, 2007: 37)—allowing for meaningful comparison. Note that this implies that the Brussels urban agglomeration larger than the BCR and tri-regional since its agglomeration exceeds both the Walloon and the Flemish regional boundary (ibidem). The size of the nodes on the map represents the sum of the internal commute within the respective agglomerations and the incoming commute from the four other urban agglomerations. Arrows specify these incoming commuter flows.

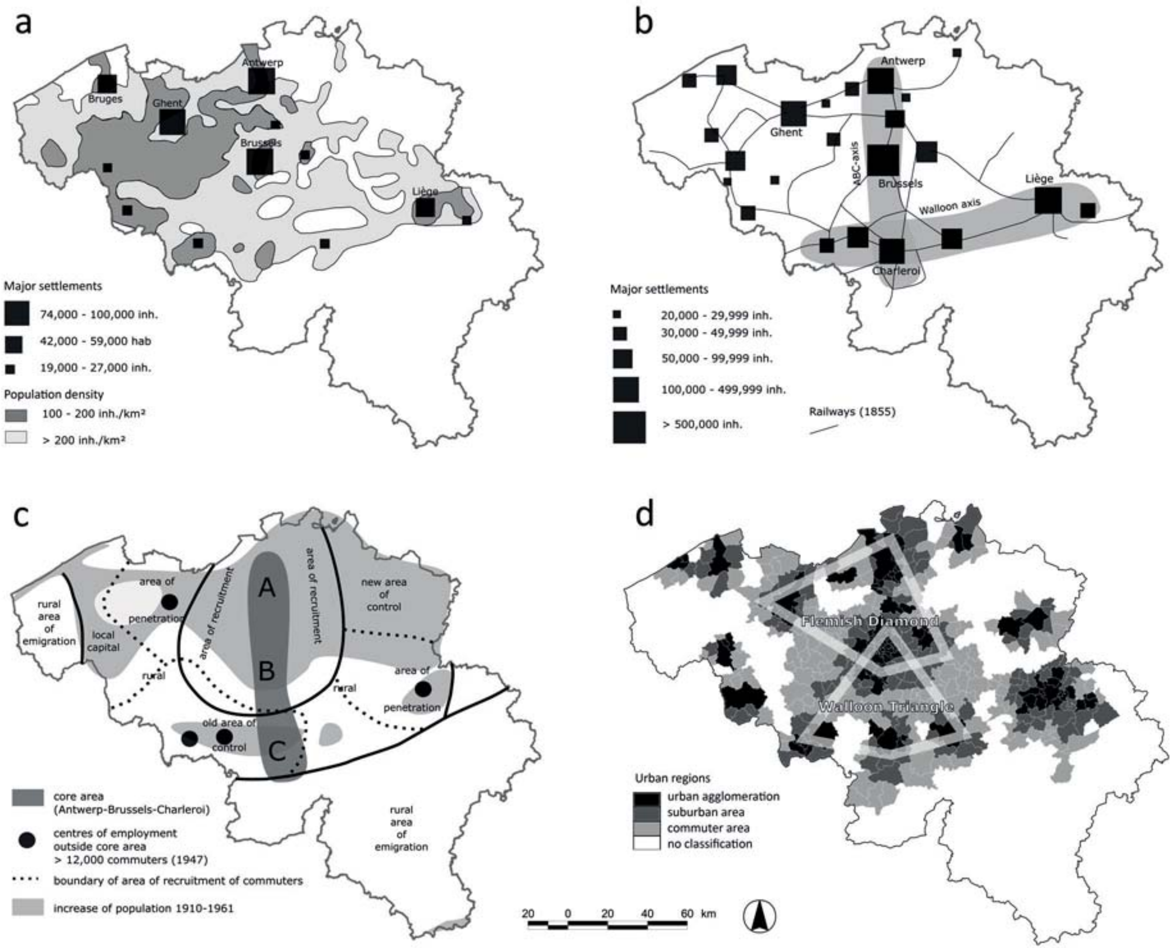

Figure 6.4 Development of the Belgian urban system approximately 1830(a), 1910(b), 1945(c), 1998(d)

A) The Belgian urban system in 1830, at the dawn of the industrial era (Redrawn from Vandermotten et al., 2010: 27)

B) The Belgian urban system in the industria era. (City population data (1910), Van der Haegen et al., (1982), Paul Kevers' data on railways were used. http://www.dotinternet.be/visualisatie-spoorlijnen-belgie-1830-1855/ Visited Februa 5, 2016.

C) The Belgian urban system at the dawn of the late-industrial era (1945) (De Wachter ar Saey, 2005: 162, *slightly adapted)*

D) The competing imaginaries of the Belgiar urban system in the 'post-industrial' era (199 (Van Criekingen et al., 2007: 107)

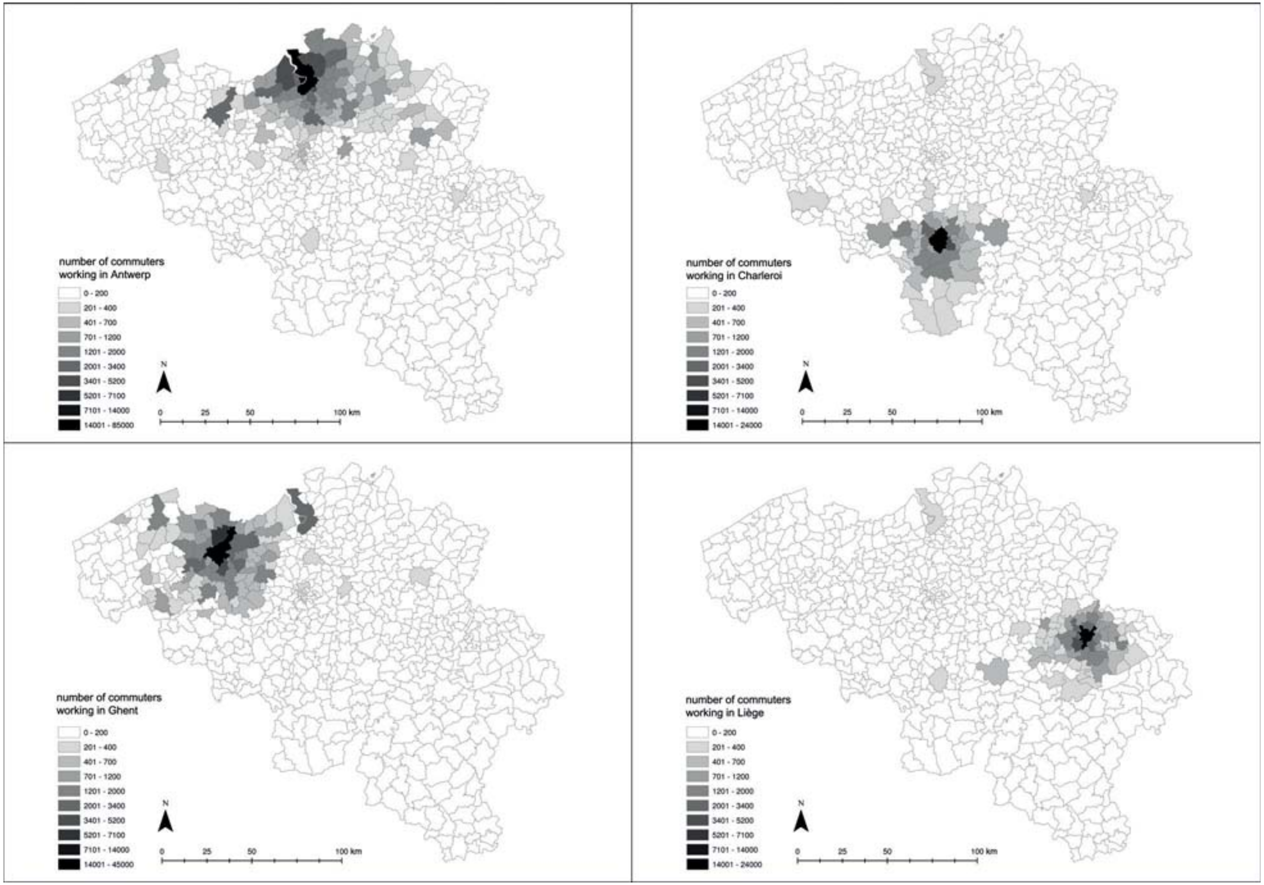

Figure 6.5 Connectivity fields of Antwerp, Charleroi, Ghent and Liège

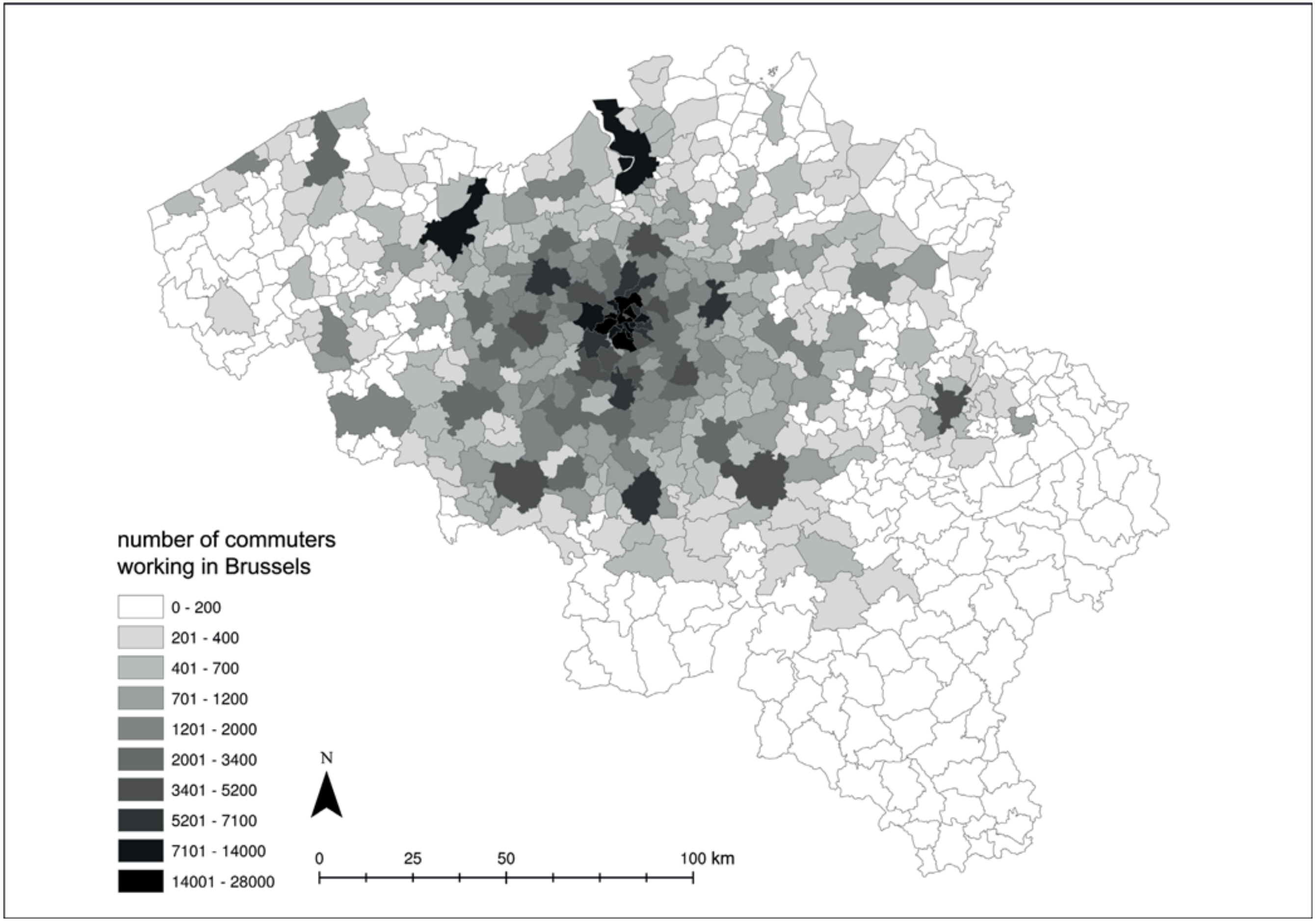

Figure 6.6 Connectivity field of the Brussels Capital Region

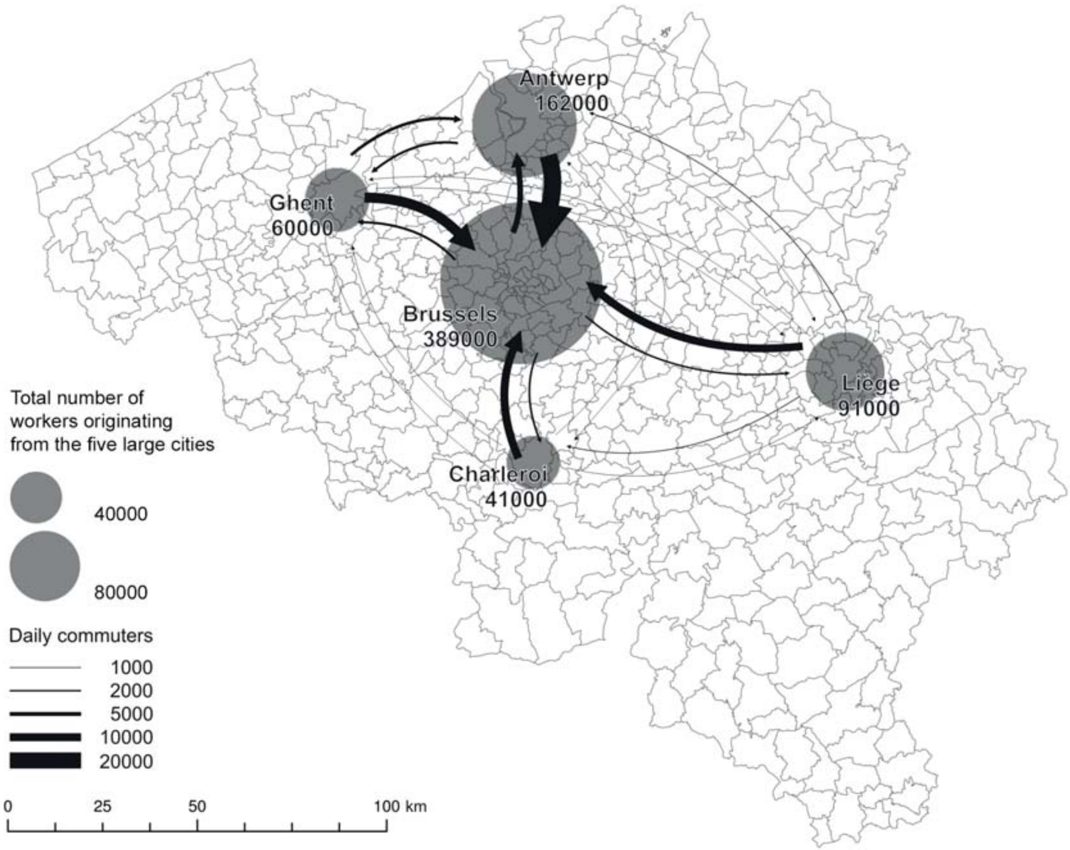

Figure 6.7 Commuting flows between the five largest Belgian urban agglomerations (Source: RSZ, 2010)

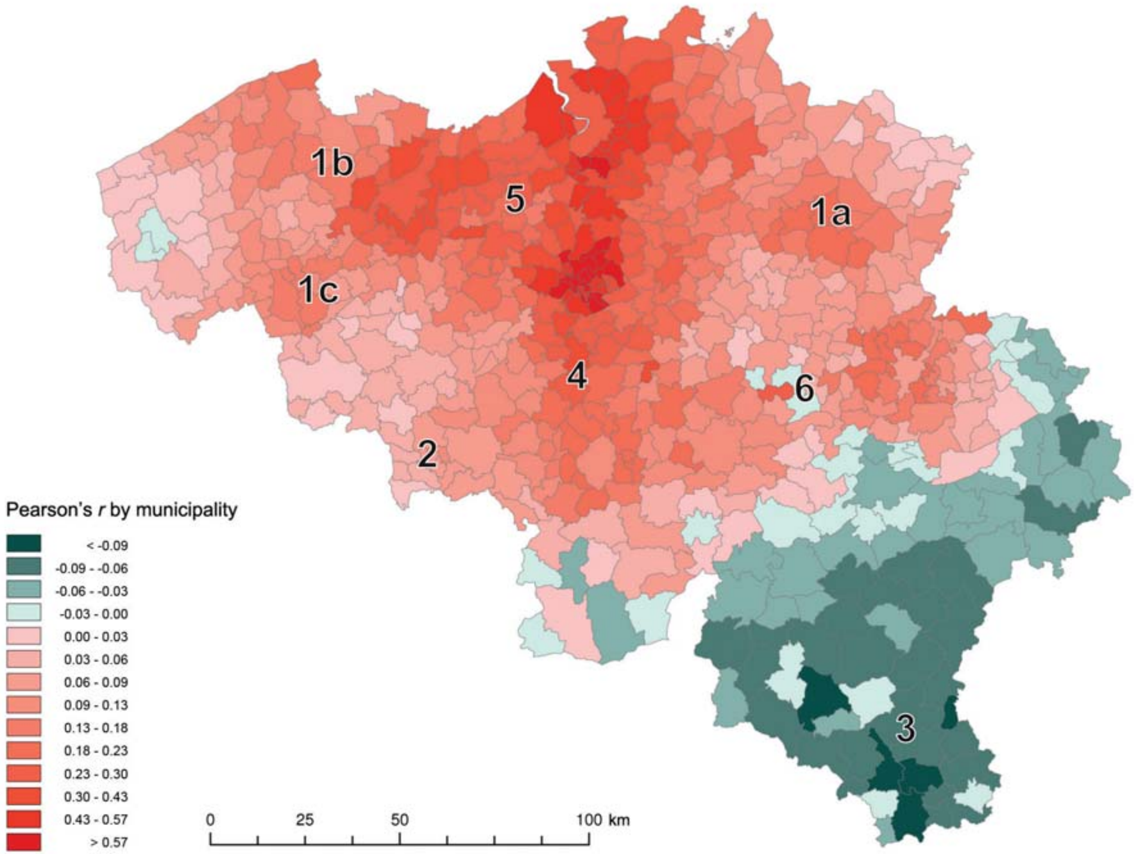

Figure 6.8 The central Belgian metropolitan area: Levels of labor market connectivity

Figure 6.7 displays a number of important features. Notably, it confirms the dominant position of Brussels in the Belgian labor market. People commute to Brussels from the other municipalities (53.1% of the jobs located in the Brussels urban agglomeration), but this relation is hardly reciprocated (only 7.3% of the Brussels agglomeration's population works elsewhere). In the urban agglomerations of Charleroi (28.3%) and Ghent (29.1%) a little below one third of the labor force living there works somewhere else (again particularly in the Brussels urban agglomeration). We see that the individual labor markets of the larger urban agglomerations Antwerp (19.6%) and particularly Liège (17.0%) are more self-directed since a substantial smaller fraction of the labor force commutes to elsewhere. As mentioned, the only somewhat reciprocal relationship between urban agglomerations in terms of a balanced polycentric region is between Antwerp and Ghent, although it pales in comparison with the commute to the Brussels agglomeration.

In Figure 6.8, the intra-municipal relationships are excluded. This highlights the longer commutes, which tend to positively bias the specialized and higher-educated professions that are important for metropolization (Burger et al., 2014). By applying the intra-municipal filter, the resulting map illuminates the degree of integration between a municipality and all the other municipalities.

Figure 6.8 maps the level of connectivity for each of the Belgian municipalities. Remember that this is a Pearson's correlation between the distribution of the origins of the actual commute towards that municipality and the distribution for the country as a whole. Therefore, the darker the red shade on the map, the more a municipality's travel-to-work pattern resembles the average nation-wide travel-to-work pattern. In the cases where the value is close to (light shades) or below (blue shades) zero, this may be interpreted as a sign of dissimilarity (see below). Interestingly, Figure 6.8 provides us with a contiguous topographical representation of a coherent metropolitan region. Comparing Figures 6.6 and 6.8 is insightful: Figure 6.6 shows the spatial distribution of the origins of the incoming commute in Brussels, while Figure 6.8 indicates the extent to which the incoming commute in every Belgian municipality resembles the geographical distribution of the commuter trips departing from all Belgian municipalities. The similarity between the two maps stresses the importance of Brussels as a national employment center, while the differences between the maps indicate that Belgium should not just be seen as the periphery of Brussels.

We will now run through a number of salient features (labeled #1a through #6 on Figure 6.8). First, Figure 6.8 renders both the Flemish Diamond (#5) and the Walloon Triangle (#4) visible, making them more than policy phantasmagorias. Although weaker in the Walloon Triangle, both regions show integration in labor market patterns. Not only does the metropolitan core area include the municipality of Charleroi and the municipalities directly south of Charleroi, it also extends east and west of Charleroi toward the other vertexes of the Triangle (the cities of Mons and Namur). On a larger scale, the conjunction of the Flemish Diamond and the Walloon Triangle indicates that the old ABC-Axis might be regaining some prominence as the backbone of the Belgian metropolitan area, albeit that the area extends far beyond the ABC-axis. For example, we can clearly see some of the linear urbanization patterns that were the hallmark of Belgian Fordism as outward extensions of the Flemish Diamond (#1a, #1b and #1c on Figure 6.8), which all follow major infrastructure axes. Despite being girded on a similar major infrastructure belt, the Walloon Axis still does not extend beyond the base of the Walloon Triangle and retains its fragmentation (#6). This is exemplified by the position of the Liège agglomeration, the only somewhat isolated region that still contributes enough to the Belgian average commute to achieve prominence, although we note that this is not true for the core municipality of Liège itself, underscoring its self-reliant position. In sum, this investigation indicates that an integrated metropolitan labor market exists. Its shape is hourglass-like with a somewhat weaker Walloon base than Flemish roof. Note that apart from the infrastructure-heavy Brussels-Charleroi corridor, the language barrier indicates a spatial breach in the labor market system (cf. Verhetsel et al., 2009: 28). However, as the area is relatively thinly populated (Figure 6.1) and tangential infrastructure that evades Brussels is scarce (Figure 6.2), we cannot make definite inferences on the causes of that barrier.

It should be stressed that there is notable diversity in municipalities exposing low correlations, i.e. those who are outside of the central metropolitan area. This could either indicate a somewhat thick but autarchic local labor market, such as the municipality of Liège which is filtered-out by excluding the intra-zonal commute, or rather idle areas in terms of local employment and commuting as in the Luxembourg province. In this respect, it is important to examine some of the areas with high population densities (Figure 6.1) that are nevertheless located outside the integrated region in Figure 6.6. Area #2 (the Borinage) indeed qualifies as a problem region, having a high population density and an absence of jobs combined with underemployment (cf. Verhetsel et al., 2009: 45). In contrast, the region west of #1c, the southwest Flanders cluster, has a low average commuting distance, which signals a degree of autarchy (Boussauw et al., 2011) congruent with its industrial district autonomy. Furthermore, the Campine area (north of #1a) seems relatively weakly connected to the metropolitan core area. This is the branch plant economy that developed in the late-industrial era and has seen signs of deindustrialization lately. Consequently, the average commute is increasing (Boussauw, 2011). Lastly, the negative coefficients in the Belgian Luxembourg province (#3) catch the eye. Although cross-border commuting is not directly captured by the dataset, these values, which indicate divergent commuting patterns, corroborate claims by other authors (e.g. Vandermotten et al., 2006) that the area is functionally integrated with the nearby city of Luxembourg.

6.6 Discussion and conclusion

Imagine a 'naive' spatial economist, with no prior knowledge about Belgium's history and urban system, set loose on the commuting data on which this study is based. Little doubt s(he) would quickly conclude that the small state of Belgium is in fact an enlarged city state where growth in a higher-tier city, Brussels, spills over in the second tier cities close by and write this up in an elegant parsimonious model. However, as time passes, our spatial economist would increasingly observe aberrations from this model. The spatial imaginaries and policies in Flanders and Wallonia consider Brussels the geographic frontier rather than the center and people act accordingly. Thus, Brussels finds itself increasingly unable to enact the policies necessary for its own growth. Additionally, s(he) would learn that Belgian people tend to cling to their own homes and their own communities, despite that migrating to Brussels would be by far the more 'rational option'. In other words, there is a huge difference between the outsider perspective of our spatial economist who will see the homogeneity of the nebular city and the insider perspective that sees so much complexity that it sometimes feels that each little droplet of the nebula is a world of its own and fails to envision how things cohere on the Belgian level.

This chapter is an attempt to steer a middle course between these two extremes, highlighting continuities and change by contextualizing the spatial-economic analysis historically. Whether representing actual economic activities on the ground or being mere policy-informing geographic phantasmagorias, historical urbanization patterns and scales (the Walloon Axis, the ABC-Axis, the Flemish Diamond and the Walloon Triangle) cannot be cast aside. Simultaneously, we have to acknowledge that patterns of urbanization are contingent and have changed form and function over the last centuries. Thus, we have to seriously consider 'metropolization' as a potential emerging agglomeration-economy regime.

To examine the applicability of metropolization, we have studied the inter-urban commuting patterns in the Belgian urban system. The result shows a contiguous geography that can be regarded as a metropolitan core area as far as labor markets are concerned. The description of an hourglass-shaped metropolitan area whose (Walloon) base is less developed than its (Flemish) roof seems an apt geographical metaphor. The weakly developed base fits into the history of deindustrialization of the Walloon Axis, although the analysis confirms that growth spreading out from Brussels is re-integrating parts of this Axis. However, the roof—primarily consisting of the Flemish Diamond—plays a role that is a too important to consider metropolization as a mere extension of Brussels. Equally, metropolization is not a simple re-constitution of the ABC-Axis. The observation that that the core area extends outwards from the Flemish Diamond into three corridors underscores the wider relevance of cities other than Brussels.

Our analysis is, like any other, partial. Since we want to understand labor market integration, the study emphasized inter-municipal commute over intra-municipal mobility. Moreover, an analysis of different regionalization indicators yields different geographies, which always interact with one another. Thus, the importance of Brussels for business networks (Vandermotten et al., 2006; Hanssens et al., 2014) will be a centripetal influence on the labor market system described herein, while the relatively local focus of Belgian social networks (Blondel et al., 2010) will likely induce centrifugal urbanization tendencies. Furthermore, when considering the provision of daily amenities, Belgium's spatial structure retains central place system characteristics (Van Hecke, 1998; Boussauw et al., 2014). This multiplicity of urban subsystems and their interactions (Burger et al.,

2014) necessitates qualification of the ideal-typical story of hermetic agglomeration-economy regimes.

These conclusions bode challenges for Belgian policy-makers for whom centrifugal economic development has for a long time been coupled with centrifugal political reform. The regional governments now responsible for most spatial and economic policy are for the first time confronted with centripetal economic development. Additionally, if the Belgian state wants to profit optimally from the economic benefits that a well-functioning metropolitan region may offer, it will be inevitable to address the question of how to provide environmentally, politically and economically sustainable spatial planning for the administratively constrained BCR.

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7. Short trips and central places: The home-school distances in the Flemish primary education system (Belgium)

Boussauw K, van Meeteren M and Witlox F (2014) Short trips and central places: The home-school distances in the Flemish primary education system (Belgium). *Applied Geography* 53: 311–322.

Abstract

This paper examines the extent to which home-school trip length in northern Belgium is influenced by the spatial distribution of the school sites, and to what extent this distribution contemporarily functions according to propositions of central place theory. Furthermore, from a sustainable mobility perspective, it is evaluated if the primary school network's density supports a daily urban system based on short distances. The results indicate that the overall system's density meets the requirements of a non-motorized system, while the distribution confirms central place mechanisms. The majority of the pupils live within walking or cycling distance from their school, while opportunities exist to further reduce this distance by choosing an alternative school. However, depending on the structure of the concerned settlement, school accessibility varies considerably. Finally, the results suggest that recent increases in school trip length and motorization are mainly caused by non-spatial factors.

7.1 Introduction: Short trips and central places

A considerable literature describes the relationship between the built environment and mobility patterns, in which the working hypothesis invariably assumes that a properly designed spatial structure can steer people's travel behavior in a more sustainable direction (Banister et al., 1997; Stead and Marshall, 2001; Van Acker and Witlox, 2010). High residential density and thorough spatial mix of housing, amenities and jobs are usually considered spatial features that lead to less car use and shorter daily trips. Therefore, a high degree of spatial proximity is associated with a more sustainable form of daily mobility (Boussauw, 2011: 19).

However, the impact of spatial proximity on trips is highly dependent on the type of destination. The more specialized the trip end is, the greater the distance one is willing to cover and the less likely one wants to or will be able to exchange it for a similar destination closer to home (Berry et al., 1988). In Flanders, in the north of Belgium, for example, the average one-way commuting distance today amounts to 19 km (Janssens et al., 2011), while travel to less specialized destinations such as schools (primary, secondary and higher education combined: 9.5 km) or shops (3.5 km) is associated with shorter trip lengths.

These findings suggest that local, more or less generically available, services continue to play an important role in how daily urban systems are structured. The proximity to daily amenities such as supermarkets, bakeries, nurseries, schools and cultural and sports facilities, but also green space or transport network access points, largely determines the attractiveness of a particular residential precinct (Reginster and Goffette-Nagot, 2005). Additionally, the availability of proximate convenience amenities such as childcare or primary schools becomes more important as dual career households engage in ever more complex work-life balance puzzles (Karsten, 2007; van Diepen and Musterd, 2009).

The spatial influence of these daily amenities on travel behavior is traditionally gauged through Central Place Theory (CPT), as developed by Christaller (1933 [1966]). CPT provides a framework for an urban subsystem based on the relation between the specialization of central functions and the spatial reach of these functions. Central functions have a range consisting of a lower limit, which denotes the minimal size of the complementary area for the function to exist, and an upper limit, which indicates the maximum average distance a consumer wants to travel to procure a central function (Christaller 1933 [1966]: 22). Christaller (1933[1966]: 20) took into account that what is considered a central function, as well as their respective upper and lower limits differ according to spatial and temporal context. Indeed, as individual transport became cheaper, people became more inclined to travel to alternative central places, further from their home, in order to have access to goods, services, or jobs better meeting their individual preferences (Lambooy, 1969). This observation made Hall (2002) to argue that the three lowest levels in the hierarchy of Christaller would no longer exist today altogether.

The work of Berry and Garrison (1958) made the applicability of CPT within expanding conurbations in the form of sub-centers in growing or grown residential areas around the traditional core city explicit. This approach was gradually incorporated in transport geography, where the term 'polycentricity' was introduced to argue that sub-centers decrease aggregate car use (Cervero and Wu, 1997). Subsequently, further cultivation of these sub-centers in terms of urban planning is regarded a sprawl-curbing urban development strategy (Bontje, 2004). The principle whereby spatial proximity is organized on the basis of an intra-urban polycentric structure is illustrated by Bertaud (2004) in his so-called 'urban village' model. Bertaud acknowledges that this builds on the improbable hypothesis that people prefer the nearest available location to procure their central functions. In practice agglomerations often contain sub-centers, although consumers do not necessarily visit these in order to minimize their travel, a vision supported by the research of Krizek (2003), among others. Structures like the urban village model offer opportunities to strengthen spatial proximity between a number of services and the center of gravity of the residential area. For example, the presence of a range of schools in a suburb of a larger city will increase the likelihood that residents will not send their children to the city center. When these facilities are clustered in sub-centers, it is likely that trips will be organized more efficiently (Cervero and Duncan, 2006). In the example, picking up the kids from school may be combined with a visit to the nearby supermarket. In contrast, a strong spatial distribution of facilities, without clustering, will also indicate a highly dispersed spatial structure that is associated with crisscross (car) traffic covering relatively large distances.

7.2 Research question: The primary school as a neighborhood level facility?

Unlike Hall (2002), our research departs from the hypothesis that the low levels of the urban hierarchy still have relevance as a central place. We propose that the availability of daily facilities at the neighborhood level may offer opportunities for a more sustainable urban and regional structure that facilitates short trips. From a planning perspective, the presence of a dense network of relatively small amenities may be considered a quality of place, through which accessibility can be maximized while avoiding excess (auto) mobility (Müller, 2011). Rather than the concept of the compact city, which is today perceived as overly naive (Neuman, 2005), the principle of short distances (in German known as '*Stadt der kurzen Weg*', and in French as '*La ville des proximités*') encompasses that also in suburban and rural areas facilities should be present within walking or cycling distance.

We test this hypothesis within the Flemish primary school system (for ages 6-12). Doing so, we consider the primary school as a generic amenity that is indicative of the centrality of the place where these are located. We can justify this choice on the basis of Christaller's definition of a central place of level M, who viewed these as centers in a catchment area of about 3000 inhabitants. While it would be naive to believe that the exact specifications of the hierarchical levels observed by Christaller still exist today, it is striking that an elementary school in Flanders serves on average 2820 inhabitants (Flemish Ministry of Education and Training, 2013), which is very close to the catchment size of Christaller's lowest level. Of course, a central place does not consist of only one single school, and it is outside the empirical scope of this paper to relate the geography of primary schools to other central functions. However, in practice we observe that primary schools in Belgium are often part of a cluster of local amenities, usually within the contours of a former or still existing village center or urban sub-center. Moreover, primary schools are not entirely generic facilities: in Belgium, parents often make a choice between a Catholic or a pluralistic ('official', which here means government organized) school where catholic schools are the majority due to historical reasons (see Section 7.4).

From the general hypothesis that the neighbourhood level still matters, we put forward two research objectives:

1) To determine the extent to which home-school trip lengths are influenced by the spatial distribution of the school sites, and to what extent this distribution confirms the expectations of CPT.

2) To test whether the distribution of schools meets the requirements of a non-motorized daily urban system based on short distances, across different urban contexts in northern Belgium.

The composition of the paper is as follows. First, we provide a brief overview of the spatial structure of the education system in Belgium and Flanders, relating this to the existing literature on home-school trips and school networks. We continue by describing the central place structure of northern Belgium with a particular focus on the contrasting examples of the cities of Bruges and Genk. Then, an empirical analysis is made of the home-school distances in the study area, both viewed from the location of the school, and from the place of residence of the pupil. The data are obtained from a recent centralized dataset that links the addresses of all pupils to the schools where they are enrolled. Both observed and shortest home-school distances are calculated using shortest-path analysis (Neutens et al., 2010). Subsequently we compare observed home-school distances with the shortest possible home-school distances, which determine the theoretical minimum catchment area when the school is considered a central function. The ratio between these two statistics is mapped, after which the hypothetical effect of urbanization on home-school distance is tested. By comparing the cases of Bruges and Genk, we will gauge how divergent central place structures of the cities influence the home-school commute of the individual pupil.

7.3 Schools, home-school distances and spatial structure: the northern Belgian context

School consolidation and home-school distances

In many western countries, including Germany, the UK, the US, the Netherlands and Belgium, we observe a period of expansion of the school system, roughly until halfway the twentieth century, followed by a period of rationalization (De Boer, 2010: 1). Maximizing accessibility of education in an era when mobility was limited was the core idea behind the expansion, which in practice meant the construction of additional schools making the school net more dense in a geographical sense. Rationalization, which followed expansion, introduced business management logics in the organization of the education system, combining public service provision and economies of scale. This resulted in the closure of many smaller branches. In the post-1945 United States, the number of schools was reduced by no less than 70%, while the average size of a school quintupled (Ewing and Greene, 2003). In countries where this rationalization was accompanied with a demographic surge of the school population, negative effects of school consolidation on spatial proximity and accessibility were largest.

In Belgium, the expansion of the school system continued steadily until rationalizations in 1957, when an absolute maximum of 9,029 primary schools was recorded (Leemans, 1998). According to Van Damme (1999), the so-called educational mini-rationalization in 1975 resulted in a reduction of the number of primary schools to 5000 within a few years, after which the school stock continued to shrink to about 4000 in the early nineties. When we link this evolution to demographic data, and express the figure in number of schools per 1000 children, it appears that the rationalization in fact started already two decades earlier (Figure 7.1).

Although the decrease in number of schools seems quite dramatic, the relatively low quality of the available data aggravates this observation somewhat. In historical statistics, one school does not correspond to one branch or one location. One school can cover multiple branches, and multiple schools may be administratively merged. Although the slowdown in the growth of the state budget for education in 1975 indicates that many schools effectively closed their doors, part of the rationalization probably occurred in the form of administrative consolidation of branches that were not necessarily accompanied with closures (Van Damme, 1999). While cutting back on the density of the school network was accompanied by an economic rationalization at the operational level of the school, undoubtedly also some externalization of costs was involved. An increase in average home-school distance means that students are less likely to walk or cycle to school, that the demand for organized transport increases and, particularly, that pupils become more likely to travel as a car passenger (Marique et al., 2013). On the other hand, this relation is not necessarily causal, as we will demonstrate below. Moreover, it is not inconceivable that school closure in small settlements has contributed to the disappearance of other amenities, such as retail.

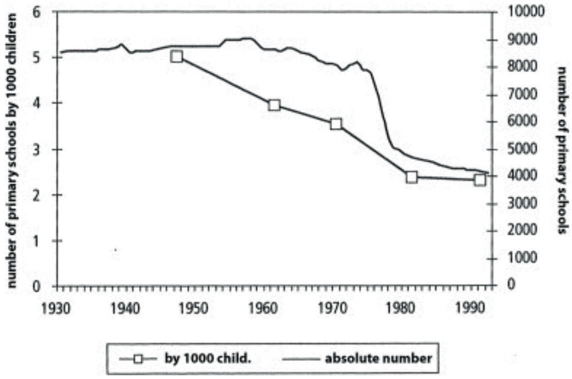

Figure 7.1 Changes in the number of primary schools in Belgium (Van Damme, 1999)

In Flanders, nearly two-thirds of the school sites belong to the Catholic education network, while less than a third is part of the 'official' education system which is organized by the government. The expansion of the official school network was driven by the provision of the Belgian Constitution that school choice is free and that the state is obliged to offer neutral education to everyone (Van Houtte and Stevens, 2009). Although the quality standards and admission terms are equal in both systems, parents' preference for one of these two systems often influences the school choice. Finally, also some specialized education sites exist, including boarding schools. Since these are very rare, we do not distinguish such schools in our analysis. Although the choice of school is free, in many places schools face capacity constraints, obliging them to use waiting lists and deny candidate pupils. This phenomenon mainly occurs in the larger cities somewhat compromising our analysis.

The development of the home-school distances in Flanders and Brussels

The Belgian censuses of 1991 and 2001 assess trip lengths in school commuting. After 2001, the census was discontinued. In Table 7.1 we present the reported home-school distance for pupils living in the Flanders region and the Brussels capital region according to census classification. The figures for the Brussels region are an average for pupils in Dutch-language and French-language schools.

Table 7.2 shows the main transport mode. Although this paper focuses on home-school distance, both tables suggest an influence of the distance to be covered on the mode choice, which is confirmed by Zwerts et al. (2010). Figures are retrieved from Mérenne-Schoemaker et al. (1999) and Halleux et al. (2009).

	1991		2001	
Distance	Flanders	Brussels	Flanders	Brussels
0-5 Km	83.1%	89.3%	76.2%	77.2%
5-20 Km	15.3%	10.1%	20.9%	20.7%
20-50 Km	1.5%	0.5%	2.4%	1.7%
>50 Km	0.1%	0.1%	0.4%	0.4%

Table 7.1 Distribution of home-school distances according to the censuses of 1991 and 2001

	1991		2001	
Modal choice	Flanders	Brussels	Flanders	Brussels
On foot	22.0%	53.2%	13.5%	32.9%
Bicycle	24.2%	0.4%	26.2%	1.7%
Motorbike/moped	0.0%	0.0%	0.0%	0.0%
Car	39.1%	31.7%	50.1%	43.6%
Organized transport	10.3%	3.7%	5.7%	4.2%
Bus/tram/metro	4.2%	10.8%	4.2%	17.2%
Train	0.2%	0.2%	0.2%	0.3%

Table 7.2 Distribution of modal choice according to the censuses of 1991 and 2001

In Flanders, home-school trip length has increased notably between 1991 and 2001. At the time of the census of 1991, more than 83% of the Flemish pupils in primary education lived less than 5 km from their school, while in 2001 this share had dropped to 76%. Over the same period the share of car users in this group increased by 11%, while the number of children going on foot decreased by as much as 39% (Halleux et al., 2009). It is worth mentioning that currently most regular schools are well served by the public transport system, making school buses organized by the schools or by the regional government a rather rare phenomenon. From our analysis, we know that the lower density of the official school network seems to have entailed slightly longer trip lengths, compared to the Catholic system, although this did not impact out general findings.

Only a small portion of the changes in the home-school travel pattern can be attributed to changing school density. In Flanders, in the period 1991-2001, no centrally organized closure of small branches in primary education was implemented, while in the same period the average home-school distance significantly increased. On the other hand, we know that in the 1970s and 1980s indeed quite a number of smaller branches have been closed.

This means that, along with the home-work commute (Dujardin et al., 2012), school mobility has been expanding a lot faster during the last hundred years than the spatial system itself was fanning out (Boussauw et al., 2011; Marique et al., 2013). Moreover, changes in travel behaviour have also encouraged school consolidation, and the residential structure too was slowly but surely fanning out in the course of decades, ending up on average further from traditional town and village centres. However, possible direct effects of school consolidation on home-school travel are not documented in Belgium. In the US, Ewing and Greene (2003) suggest that school consolidation and moving of schools outside urban centres certainly have played a major role in changing travel behaviour of schoolchildren.

The central place system in northern Belgium

Optimizing pupil allocations and determining optimal school locations is a classic subject in applied geography and planning (e.g. Stern and Michlis, 1986). However, in some systems, in particular the US (Glenn, 1989), students are allocated to a school rather than that free school choice dominates. When school choice is free, the principles of lower and upper boundaries of CPT apply, making it a valid application of CPT. Of course, the contemporary geography of central places is more complex than Christallers' stylized models tentatively suggest. There has been a tendency for central functions to scale-up, creating an urban system with far more complementarities and overlapping catchment areas than originally envisaged (Lambooy, 1969; Burger et al., 2014). However, this added complexity is not incongruent with the basic postulates of the theory. Christaller constructed his theory around the upper limit of central functions (Saey, 1973), implying that the higher population density of these overlaps logically entails a potentially higher degree of specialization of central functions within the complementary area (Christaller, 1966[1933]: 33). A clustered distribution of a specific central function will give consumers a higher propensity to choose between different suppliers of a central function. Despite this upscaling, we still do expect to find variation of the central place system within Flanders. The historically evolved structure of central place systems bears the path-dependent traces of urbanization phases (Van Nuffel and Saey, 2005).

According to Van Nuffel and Saey (2005), the Flemish central place system shows three distinct patterns. The western part resembles Christaller's original hexagon scheme as a result of early urbanization in the medieval era. The central part, the economically dynamic area from Antwerp to Brussels, confirms broadly to Christaller's traffic principle. The eastern part only started urbanizing in the 19th century and shows a central place pattern much more strongly attenuated to car travel. To highlight the relevance of these historical differences and because zooming in on the municipality scale allows us to visually interpret individual home-school trajectories, Section 7.5 will present two medium-sized cities and their surroundings as an illustration of the influence of the existing spatial structure on school choice. The choice of the two cities is based on their different genesis and subsequent spatial structure, making the two of them together rather representative of a variety of urban areas in Flanders. The first example is the city of Bruges (in the west), with a strong historical monocentric structure, which has become in the post-1945 period an agglomeration of about 170,000 inhabitants. The second example is the eastern city of Genk, which emerged only in the early twentieth century as the new center of coal mining in the province of Limburg, consisting of a dispersed, suburban-style spatial structure that mainly developed in the post-1945 period. The Genk agglomeration comprises over 100,000 residents. Southwest of Genk, there is a second medium-sized city, Hasselt. The region east of Genk is mainly a forest area. Figure 7.2 shows the northern Belgian urban system and highlights the two examples. The urbanization classes proposed in the map stem from the Spatial Plan for Flanders (RSV, 1997/2004), and are ordered from most to least urbanized: metropolitan area (MA), regional urban area (RUA), structure supporting small urban area (SSUA), small urban area at the provincial level (PSUA), nucleus in the outlying area (NOA) and outlying area (OA).

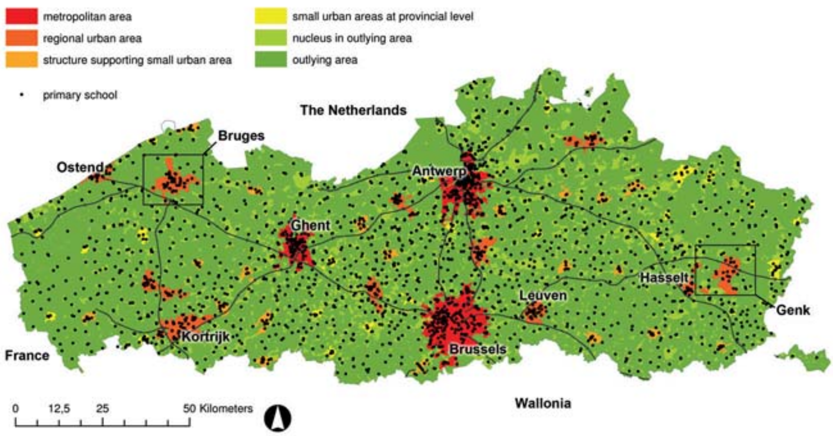

Fig. 7.2 Northern Belgium with urbanization classes according to the Spatial Plan for Flanders

7.4 Method

Data and calculation of home-school distances

Data for this study was provided by the Flemish Ministry of Education and Training. The dataset contains addresses of each school branch and of the pupils who attended this school in February 2012. This single database allows the mapping of virtually all home-school relations within the Dutch-language (Flemish) education system with the highest possible accuracy and contains much more detail than the former censuses. However, the ministry does not collect information on the mode of transport chosen, neither on the chosen route.

In our analysis, only non-special needs schools are included, representing 388,620 pupils or 93% of the total number. The students included in the database correspond with 2,867 school locations, of which 128 are located in the Brussels-Capital Region and one in the Walloon Region. In the Brussels Region, the majority of education is provided by French-language schools. Since we have only been able to include Dutch-language schools, the analysis will be less relevant to the situation in Brussels.

In order to simulate the home-school trajectories and distances from the linked addresses, the school addresses and the corresponding pupils were geocoded using an automated search of the Google Maps directory. In this context, it is important to mention that the home address registered in the database does not always match the address from where the child leaves for school on regular weekdays. For example, children of divorced parents may in reality live at different addresses, children can be registered at the address of the family's retreat residence, while some others are at boarding school or live with their grandparents during the week. On the other hand, there are also pupils who indeed travel large distances to school every day, especially when they ride with one of their parents to a school in the vicinity of the parent's work location. Such details are not documented in the dataset used. We have limited the impact of such biases as much as possible through the use of a judiciously chosen threshold of 40 kilometers. Pupils with a home address located further from the visited school are considered outliers and were omitted from the analysis. Moreover, those results from the geocoding process that were qualified by the software as less accurate, or where obvious errors were found, were omitted. This concerns 2.7% of the pupils and 1.0% of the schools. The remaining analysis relates to 374,061 pupils, corresponding to 2,837 school branches. Although past experiences teach us that even after such a meticulous correction erroneous geocoding remains inevitable, the large size of the dataset did not allow for manually correction of all suspected geocoding errors.

In order to calculate distances, the coordinates of residential and school locations were introduced in a GIS environment and linked to the road network (TeleAtlas' Streetnet). The applied network data also included the lowest category of roads, which are often local roads that are not suitable for through traffic but may be of importance for pedestrians and cyclists.

Using Network Analyst software (within an ArcGIS environment), for each student two home-school routes and corresponding distances were calculated. The first route is the result of a shortest-path calculation (Dijkstra algorithm) between the address of the pupil and the address of the school visited by this pupil, through the road network. In what follows, we denote the resulting figure as the 'observed home-school distance'. The second route is a fictitious minimum home-school route, where each student is assigned to the primary school closest to home. This minimum home-school route stems from the excess commuting literature (Horner, 2002), in which a comparison is made between the minimum distance that must be covered to reach a facility, and the distance that is covered in reality in order to visit a similar but alternative amenity (Boussauw et al., 2012). When calculating the resultant 'minimum home-school distance', actual school capacity is not accounted for since in this theoretical exercise it is assumed that capacity follows demand.

Analysis of the home-school distances

The spatial analysis draws from the observed home-school distance and the minimum home-school distance. These variables are considered both from the perspective of the individual pupil and from the perspective of the school. From the school's point of view, apart from the average home-school distance also the median is calculated, which is more representative given the skewed distribution of the distances.

First, the exploration of the spatial distribution of the home-school distances is conducted in a cartographic and a quantitative way. In addition to a regional mapping approach by means of which the school sites are visualized, we zoom in to the contexts of Bruges and Genk where we will compare the shape and size of the school's catchment areas. This second mapping approach is used to visualize the home addresses of individual pupils in relation to the clustered central place context of Bruges and the relatively dispersed one of Genk. Subsequently, the data are grouped and compared according to the classes of urbanization as used in the Spatial Plan for Flanders (RSV, 1997/2004), as illustrated in Figure 7.2. Based on this, conclusions are drawn regarding the two research objectives.

7.5 Spatial distribution of home-school distances

The perspective of the schools' locations

Figure 7.3 gives an overview of the involved schools, classified according to the median observed home-school distance. Figure 7.4 shows the median minimum home-school distance, while Figure 7.5 displays the ratio between the first-mentioned and the second variable, the excess rate. Apart from the location of the schools, these maps also contain the municipal boundaries and major motorways, as a reference. The maps use quantile classification, reflecting the diversity of the data as well as possible. It is important to note that the minimum home-school distance and the excess rate are much more abstract concepts than the observed home-school distance, which justifies the use of different class thresholds. In Table 7.3, a number of key figures are given for the three mapped variables. Table 7.4 provides a breakdown of the same statistics according to degree of urbanization.

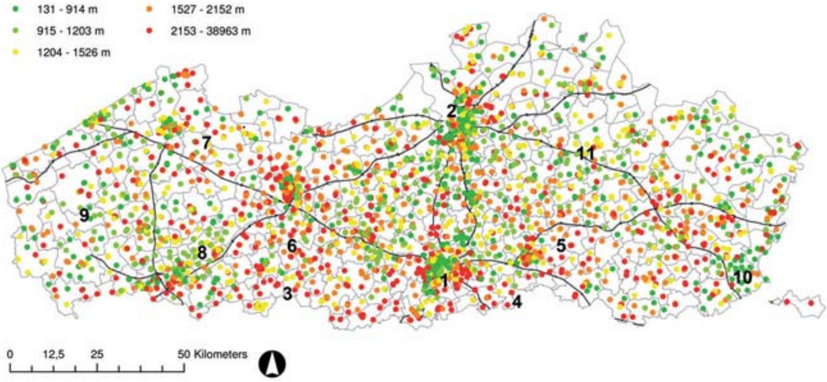

Figure 7.3 Median observed home-school distance by school

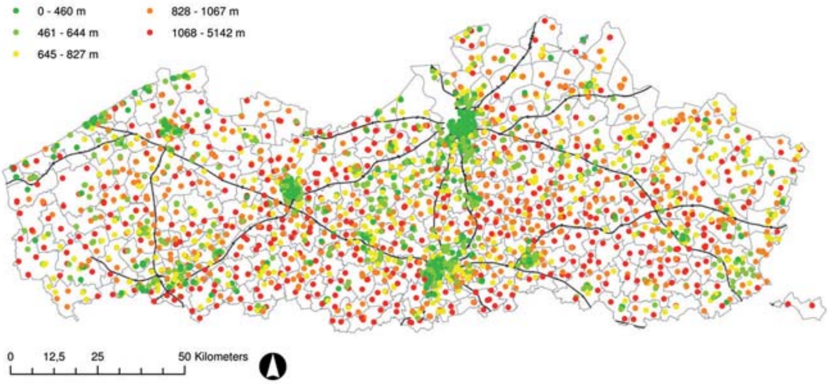

Figure 7.4 Median minimum home-school distance by school

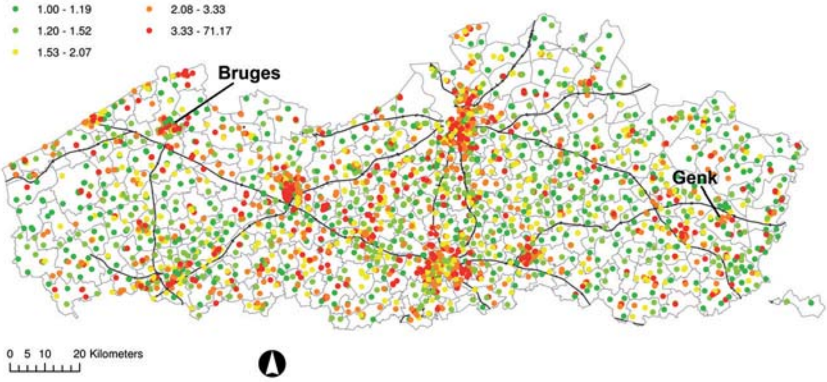

Figure 7.5 Excess rate by school

	Observed home-school distance	Minimum home-school distance	Excess rate	Number of pupils
Median	1346 m	734 m	1.76	122
Mean	1808 m	806 m	2.76	136
Standard deviation	2256 m	455 m	4.01	80

Table 7.3 Statistics calculated on aggregate median observed and minimum home-school distances by school, and the number of pupils per school

	Urbanization class					
	MA	RUA	SSUA	PSUA	NOA	OA
Number of schools	523	349	178	138	1513	136
Median observed home-school distance	1,144 m	1,240 m	1,488 m	1,366 m	1,355 m	2,035 m
Median minimum home-school distance	442 m	562 m	658 m	704 m	865 m	1068 m
Median number of pupils per school	140	130	126	136	112	103
Median excess rate	2.45	2.18	2.16	1.81	1.49	1.76

Table 7.4 Statistics calculated on aggregate median observed and minimum home-school distances by school, and the number of pupils per school, breakdown according to degree of urbanization

In Figure 7.3, following items stand out:

- In the dense residential neighborhoods of the larger cities, particularly in Brussels (1) and Antwerp (2), children are more often living in the immediate vicinity of their schools.

- In the suburban neighborhoods of these cities, as well as in urban schools that are located near major motorways and arterial roads, home-school distances are above average.

- In the vicinity of the Belgian Dutch-French language border (3 and 4), where many schools are populated by Dutch-speaking pupils living in the French speaking southern part of Belgium, the observed distances are large.

- In the more rural areas we see strong variations in home-school distances, which may not always be grasped in clear structures. In some regions, distances are well above average, as is the case in the Hageland (5), Flemish Ardennes (6) and Meetjesland (7). In other regions, average distances are below average, which is obvious in the Leie-region (8), Westhoek (9), the southeastern part of the Limburg province (10) and parts of the Kempen (11).

Figure 7.4 gives a clear picture of the morphological structure, making clear that the school network's density is closely related to the population's distribution. The following issues arrest attention:

- Both in larger cities and in smaller towns, the school network appears to be sufficiently dense from the point of view of offering children the opportunity to visit a school within walking distance.

- In the more rural areas, where both housing is more dispersed and the school network is less dense, pupils have to make longer trips, even if they visit the nearest school.

Figure 7.5 combines both variables into the excess rate, which indicates the extent to which a school recruits pupils living in the immediate vicinity.

- Mainly in the cities we observe that the schools are usually populated by children who do not visit the nearest school. The presence of more opportunities within a short distance, typical of urban areas, allows parents to be more critical in choosing a particular school. This corroborates both the excess commuting literature and CPT: more suppliers within the upper limit of a central function allows for choice and potential specialization. In addition, capacity constraints also play a role, excluding certain schools from the choice range. A third reason is that urban schools are more often located in a destination area for daily commuter flows, meaning that commuting parents will be inclined to drive their children to a school near their work place.

- In contrast, in outlying areas schools are more often populated by children visiting the nearest or the second nearest school.

From Table 7.3, we infer that an average school recruits its students within less than 1800 meters from the school, but that this distance would be reduced to about 800 meters in a geographically optimized system. Table 7.4 shows that schools in metropolitan and regional urban areas recruit their students within relatively short distance. The minority of schools that are not located in an urban or village centre recruit their pupils from much larger distances.

The perspective of pupils' home addresses

For Bruges and Genk, Figure 7.6 and Figure 7.7 show an overview of the residences of the pupils concerned, classified according to the individually observed home-school distance. Figure 7.8 and Figure 7.9 show the minimum home-school distance per student, while Figure 7.10 and Figure 7.11 again provide the ratio between the first and the second variable, the so-called excess rate. In addition to the pupil's residences, these maps also include the road network that was used to calculate the routes, as a reference.

In Table 7.5 a number of key figures are given for the three mapped variables, while in Table 7.6 for each of the variables spatial variations are assessed in relation to the degree of urbanization.

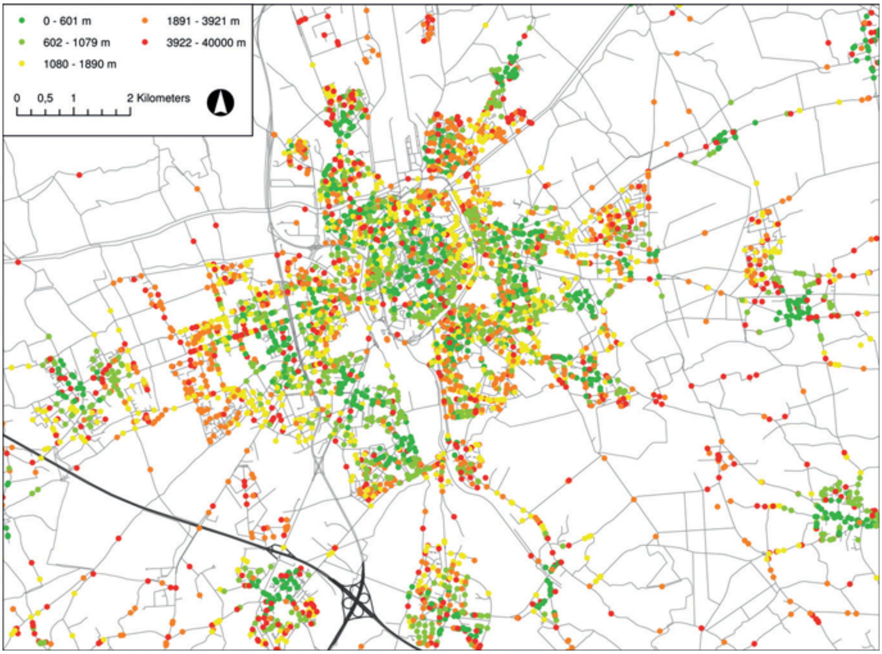

Figure 7.6 Observed home-school distance by pupil, Bruges and surroundings

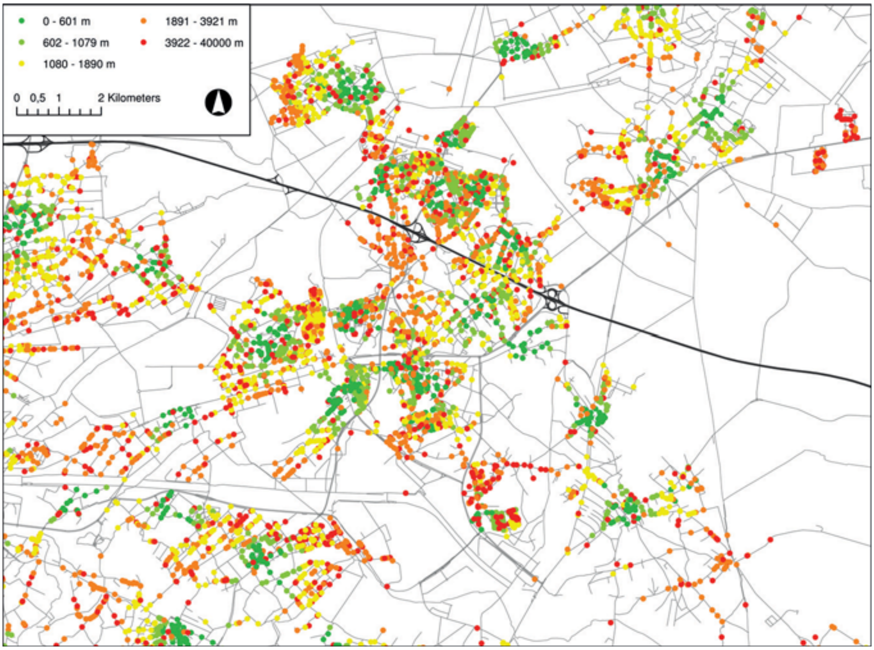

Figure 7.7 Observed home-school distance by pupil, Genk and surroundings

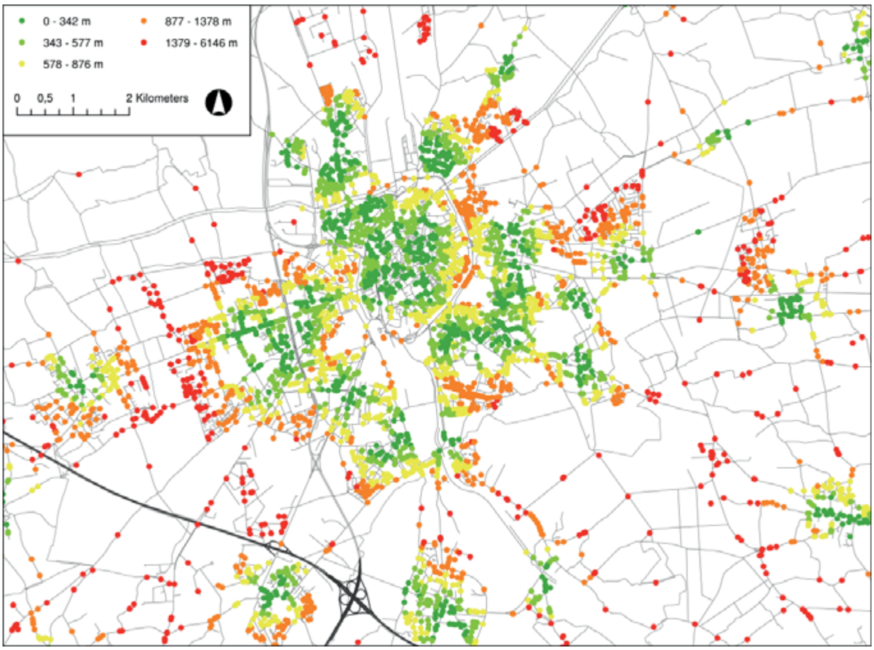

Figure 7.8 Minimum home-school distance by pupil, Bruges and surroundings

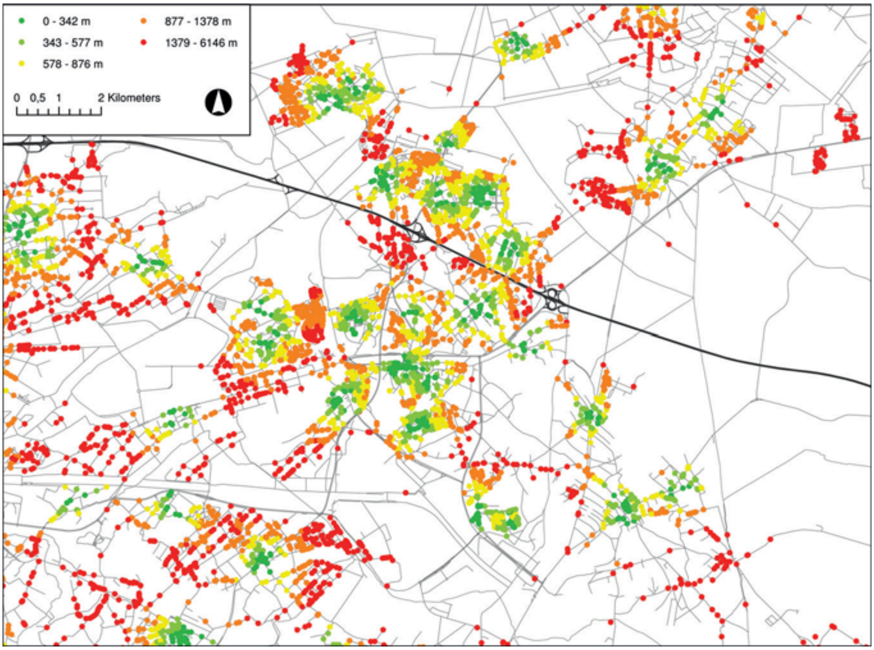

Figure 7.9 Minimum home-school distance by pupil, Genk and surroundings

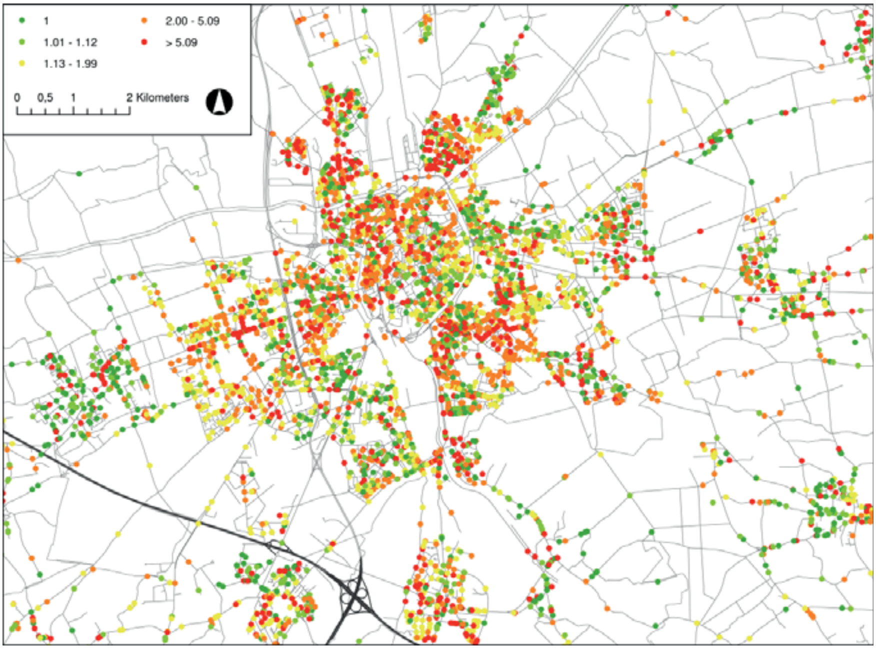

Figure 7.10 Excess rate by pupil, Bruges and surroundings

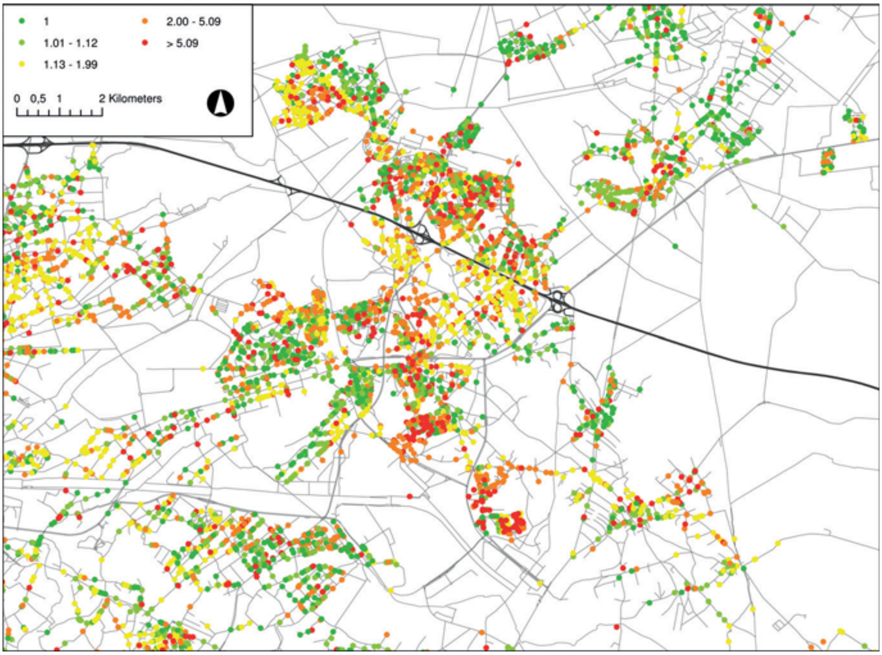

Figure 7.11 Excess rate by pupil, Genk and surroundings

	Observed home-school distance	Minimum home-school distance	Excess rate
Median	1394 m	710 m	1.41
Mean	2752 m	946 m	6.14
Standard deviation	4037 m	1017 m	68.13

Table 7.5 Statistics on the observed home-school distance, minimum home-school distance, and excess rate by pupil

	Urbanization class						
	MA	RUA	SSUA	PSUA	NOA	OA	Outside
Number of pupils	76,545	45,272	18,611	150,95	150,165	63,544	4,829
Median obs. home-school distance	1,078 m	1,165 m	1,156 m	1,094 m	1,307 m	2,289 m	7,768 m
Median min. home-school distance	427 m	572 m	614 m	629 m	753 m	1,415 m	4,950 m
Median excess rate	2.14	1.65	1.56	1.36	1.19	1.24	1.32

Table 7.6 Statistics by pupil, by degree of urbanization. The class 'outside' contains those pupils not living in Flanders or Brussels

The different spatial structure of both case study areas becomes clear when comparing Figure 7.8 with Figure 7.9. The historical structure of Bruges is responsible for the high density of both homes and schools. In the core of the city we see that the catchment areas of clustered schools overlap, causing a large proportion of the students having the choice between several schools within walking distance. Also in the historical village belt around Bruges, where a considerable share of the post-1945 suburbanization wave was directed to, the available range of schools is rather well-covering. Only pupils who live in a recent allotment, or who live very remote, are required to cover distances over 1400 m. In Genk, however, we see a very different picture: there is no cluster of schools in the center of the city. The population density in the inner city's residential neighborhoods is relatively low, and usually each neighborhood has only one school. The map turns strikingly red, which indicates that the spatial structure of Genk does not perform well in terms of spatial proximity compared to Bruges. Lower density figures in combination with the absence of clusters of schools also ensures that choice ranges in Genk are more limited than in Bruges.

When looking at the excess rates, in Bruges (Figure 7.10) pupils living in the core city or in one of the sub-centers of the agglomeration, appear to visit the nearest school less often than average. In Genk (Figure 7.11), however, such structures are less clear; pupils usually opt for the nearest school despite living in centrally located neighborhoods. One of the causes may be Genk's more extensive fragmentation by infrastructure. Even when studying the observed home-school distance (Figure 7.6 and Figure 7.7), it is obvious that in Genk the theoretical catchment areas (Figure 7.8 and Figure 7.9) are better reflected in the observed travel patterns than is the case in Bruges. From a CPT perspective, in Genk we can say that the combination of school availability and upper limit of the range tends to lead to a situation of spatial monopoly, whereas in the more centralized situation of Bruges, from a spatial perspective, there is a potentiality for school choice within the average time-space budget.

The home-school distance statistics in Table 7.5 are of the same order of magnitude as the values already presented in Table 7.3. Also, the values of Table 7.6 correspond fairly well with those of Table 7.4. It is striking that 58% of the Dutch-language pupils in Flanders or Brussels live outside any urban area. However, the share of them (70%) living in a nucleus in the outlying area, usually corresponding with a village, hardly suffer from their peripheral residential location: half of these pupils still choose a school at 1,300 m or less from home, and is faced with the possibility to further reduce this distance to a mere 750 m. For those living outside such a nucleus (17% of the pupils in Flanders and Brussels), in contrast, the remote home location is responsible for the relatively large home-school distance, affecting the autonomy of the child concerned. Pupils living in Wallonia or abroad are naturally obliged to cover above average distances. Since this category of pupils includes some rather inaccurate data, we will draw no further conclusions from the figures for this 'outside' class.

Excess rates roughly decrease when the degree of urbanization increases. This means that, as expected, pupils living more remotely choose more often the nearest school, which corresponds to the observations made on the basis of Table 7.4.

7.6 Conclusions and policy recommendations

Based on the analysis of detailed information about the home-school distances in the Flemish primary education system in Belgium, we are able to answer both research questions. With regard to the first question, we note that at the level of the pupil there is a strong correlation between the minimum home-school distance, which defines the theoretical minimal catchment area of a school, and the observed home-school distance, which represents the real catchment area. Taking into account that schools are often part of a cluster of local amenities, this indicates that the spatial distribution of the primary schools seems to correspond to a certain extent with the pattern that is expected from CPT, corroborating that lower order central functions and places retain analytical relevance. Depending on local properties of the spatial structure, at this level central places are represented by either one school (as is the case in Genk), or by a cluster of schools located within walking distance of each other (as is the case in the center of Bruges). This corresponds with the historical urbanization trajectory of these two urban areas. Although the school's real catchment areas, defined by the observed home-school distances, largely overlap, this overlap is mainly occurring at the local level, in contrast with home-work commute areas which overlap at the regional scale. Also striking is that theoretical and real catchment areas better match up where the surface covered by these areas is larger, especially in the nuclei of the outlying area.

With regard to the second question, the research presents arguments to conclude that the spatial distribution of the Dutch-language primary schools in Belgium is quite well adapted to a sustainable form of home-school travel, based on short distances. The order of magnitude of the median observed and minimum home-school distances allows travel on foot or by bicycle (Cardon et al., 2012), and almost every village core has at least one primary school.

Nevertheless, a few qualifications apply. First, mainly in the 1980s, the rationalization of the primary education system has led to a systematic increase of the average distance between home and the nearest school, a development that has contributed to further motorization of schoolchildren's travel behavior. Second, the housing stock kept suburbanizing during the last decades, which again contributed to the growth of home-school distances. Third, it is still possible to identify a number of villages and residential neighborhoods that are quite remote from any primary school, locally qualifying the coverage of the school network as below average or even insufficient.

We also see that quite a few schools located in an urban area represent relatively large home-school distances. This phenomenon can be partly explained through parents choosing a school for their children on the route of their own commute. In addition, this may indicate a shortage of primary education facilities in some inner cities, particularly in Brussels (Janssens, 2009), but also in Antwerp and Ghent, where schools are often fully booked. This reduces the chance that a child can be enrolled in the school of choice, often the nearest one. The problem of ethnically segregated schools, which are often avoided by autochthonous pupils, reinforces this phenomenon (Van Houtte and Stevens, 2009). A good spatial distribution of schools does not mean that there are no local problems in terms of capacity or social and ethnic segregation.

Finally, the literature review suggests a clearly autonomous growth of home-school mobility, which is at least partly independent from the spatial distribution of schools and homes. The overall increase in mobility, which is caused by various factors, including the rise of prosperity and a more critical consumer's attitude, is present too in the school commute. In practice this is reflected in the increasing number of children taken to school by car, with the commonly known vicious circle of increasing car use (Sonkin et al., 2006) as a result.

Although the primary school network's rather high density, as well as the elevated level of proximity between schools and homes in Flanders should generally be considered as an important quality of place, the spatial distribution of this asset is not homogeneous. In order to maintain the general quality, and in order to ensure a more equal spatial distribution, policy measures are needed. In addition to the well-known ingredients of a compact city policy, such as avoiding sprawl, offering a dense network of amenities and facilitating non-motorized trips, from our study also some less obvious issues are addressed. One of these is the importance of sufficient supply in terms of school capacity, in order to avoid inefficient home-school travel. It is equally important to keep the quality of education as uniform as possible across municipalities, in order to avoid parents choosing distant schools for quality reasons. Lastly, when considering further consolidation of the school network, it should be taken in account that costs saved at the operational level of the school may well be passed in a hardly visible way to the pupils' parents and even to society in general in the form of additional transport related burden. It is our conviction that the latter theme offers a challenging avenue for further research.

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8. Planning for agglomeration economies in a polycentric region: Envisioning an efficient metropolitan core area in Belgium

Boussauw B, van Meeteren M, Sansen J, Meijers E, Storme T, Louw E, Derudder B and Witlox F (2016) Planning for agglomeration economies in a polycentric region: Envisioning an efficient metropolitan core area in Belgium. *Working Paper.*

Abstract

Metropolitan regions owe their existence, at least in part, to the ability to valorize agglomeration economies. The general perception is that these economies increase with city size, which is why economists tend to propagate urbanization. Contrarily, planners traditionally emphasize the negative consequences of urban growth in terms of livability, environmental quality, and congestion. Polycentric development models have been proposed as an alternative form of urbanization that would allow for both agglomeration economies and higher levels of livability and sustainability. This paper addresses the challenge of how such a balance can be achieved in planning practice. We introduce 'agglomeration-potential maps' to visualize the possible contribution of locations in a polycentric metropolitan area to the emergence of agglomeration economies. These maps are applied in the process of developing a new spatial vision for the polycentric 'metropolitan core area', commonly known as the Flemish Diamond, in Northern Belgium. The process goal was to determine where the predicted future population growth in the metropolitan core area could best be located. Based on a literature review of optimum urban-size thresholds and our agglomeration-potential maps, we document how these were instrumental in developing a spatial vision for the Flemish metropolitan core area that optimizes agglomeration economies, while maintaining its small-scale morphological character.

8.1 Introduction

In contrast to many other continents where large metropolitan cities are the dominant form of urbanization, the West-European urban system is characterized by the presence of many comparatively small and medium-sized cities (Dijkstra et al., 2013). The significance of transport costs at the time of these cities' gestation, combined with their reduced contemporary relevance, contributes to these cities sharing their hinterlands with their neighbors. Consequently, more than half of the European urban population lives in what can be called 'polycentric metropolitan areas' (EMI, 2012). These are defined as collections of historically distinct and both administratively and politically independent cities located in close proximity and well connected through infrastructure (Kloosterman and Lambregts, 2001) and which have the potential for further integration.

While the economic potential of such regions has been highlighted often building on notions such as 'complementarity', 'functional division of labor' (Hall and Pain, 2006), 'borrowed size' (Meijers and Burger, 2016), 'city network externalities' (Capello, 2000) or 'urban networks' (Glaeser et al., 2016), it has also been shown that the often small and medium-sized cities in such polycentric metropolitan areas generally do not manage to translate their substantial joint critical mass into a high level of agglomeration benefits comparable to that of single large cities (Meijers, 2008; Meijers and Burger, 2010; Burger et al., 2014b). With their primary focus on fostering economic growth, the policy recommendation by economists generally is to sustain further urban growth and the rise of large megacities, for instance by lifting planning regulations that hamper urban growth (Alonso, 1970; 1971; Mera, 1973; see also Glaeser et al., 2016). However, planners traditionally focus on the negative consequences of urban growth, and one of their recommendations throughout the last century has been to advance polycentric urban development models. This started with Howard's 'slumless and smokeless' Garden City (1902), principles such as 'concentrated deconcentration' (Friedmann, 1959; Rodwin, 1961) and the more recent focus on networks of cities. Empirical evidence that a polycentric urban development model might indeed provide better balance between agglomeration benefits and costs is provided by Meijers and Burger (2010). While European planners often cherish this positive side of small and medium-sized cities (such as lower housing costs, accessibility of green space, strong territorial identities and feelings of belonging), the fear of not being able to withstand competition from large metropolises in the long run because of a lack of agglomeration economies has led to a conundrum among planners.

Flanders (the Dutch speaking part of Belgium) is no exception. The regional government engages itself to develop a 'metropolis Flanders', which ought to be large and efficient enough to position itself successfully in the urban economic network of the Northwestern European delta. According to the Flemish government, the heart of this urban agglomeration is the 'metropolitan core area'. The metropolitan core area comprises roughly the functional space of the quadrangle Brussels-Leuven-Antwerp-Ghent, and is intended as a more politically neutral term[53] for what was previously known as the 'Flemish Diamond' (Albrechts and

[53] The term 'Flemish Diamond' had an interesting hidden geopolitical meaning, since Brussels is not politically or administratively speaking part of Flanders. Yet, the odd situation is that Brussels is the

Lievois, 2004) (Figure 8.1). This densely populated area, comprising more than 4 million inhabitants at over 800 inhabitants per square kilometer, is well-embedded in the European context in terms of accessibility, but experiences a variety of pressures. For instance, a large portion of the predicted population growth of Flanders and Brussels is expected to settle in this area (Willems and Lodewijckx, 2011), and the region suffers heavily from road congestion and landscape fragmentation due to northern Belgium's sprawled urban morphology. Consequently, the further metropolization of the region requires solid strategic planning to cope with these pressures (Albrechts and Balducci, 2013; van Meeteren et al. 2016a [Chapter 6]).

Figure. 8.1 Location of the Flemish Diamond in Belgium

This paper aims to address how urban agglomeration benefits can be realized without compromising livability and sustainability, resulting in a single spatial strategy that can be applied in policy practice. It presents a tool that visualizes the current contribution of a range of urban locations to such agglomeration benefits in a polycentric metropolitan area. We clarify the methodology behind these ‘agglomeration-potential maps’, and show how the input of these maps in a real, multi-actor planning process has led to the identification of a

capital of Flanders, making Flanders the only territorial entity in the world with a—in many policy domains—extra-territorial capital.

new spatial vision that optimizes the balance between achieving agglomeration benefits and fostering livability and sustainability by adhering to a polycentric urban model. This process is part of the ongoing elaboration of a new comprehensive plan for Flanders, for which the guidelines were set out in the Green Paper on Spatial Policy in Flanders (Flemish Government, 2012; cf. Boussauw and Boelens, 2015). Changes of government have delayed the promulgation of this plan, although the complex institutional context is to blame as well. Boussauw et al. (2013; van Meeteren et al., 2016a [Chapter 6]) explain how the Belgian metropolitan node spreads out across three administrative regions (Flanders, Brussels Capital Region, and Wallonia), with the Dutch-French language border as a strong barrier within some sectors (e.g. regarding a range of public services), but nonetheless negligible in many others (e.g. international business). Therefore, the choice to center on the Flemish Diamond is necessarily partial, driven by the administrative structure of Belgium, but not without an empirical basis of a certain degree of self-containment.

The remainder of this paper is organized into three main sections: the paper commences with a literature review, which conjoins the traditional optimum city size question (Alonso, 1971) with the issue of the constraints under which a polycentric region can be considered an integrated urban agglomeration (Meijers, 2008). Subsequently, threshold values derived from the literature are operationalized through accessibility analyses in the second section, leading to what we term 'agglomeration-potential maps'.[54] This 'agglomeration potential' is derived based on the (public) rail transport network as this is congruent with the Flemish government spatial development goals. The accessibility analyses are experimental in the sense that the employed classes do not equal isochrones, but are defined by means of critical population mass thresholds as these are considered essential for a wide range of agglomeration economies to develop. These maps can be considered important tools in directing the planning debate, and their instrumental value is explored in the third section. In this third and final part of the paper, we summarize the resulting spatial vision for the Flemish metropolitan core area by means of three corresponding schematic maps. This is not the official spatial vision as adopted by the Flemish government, but should be considered the authors' input to this decision making process.[55]

[54] Not to be confused with 'population potential' or 'workplace potential', commonly used as accessibility or density measures calculated from single points (see Craig, 1987 for a thorough explanation). The 'agglomeration-potential maps' we present visualize different population thresholds from the perspective of the four major city centres in the Flemish Diamond, and give an indication of the interaction potential of a fragmented urban agglomeration.

[55] The authors were hired to support the planning process, see van Meeteren et al. (2015a)

8.2 Optimum city size

Theoretical conceptions

The quest for the ideally-sized city has captured researchers' imagination for a long time. Yet, the question always is 'optimal for whom?' Since certain people and firms flourish in small cities and others in large, there is not a single answer, making optimum city size subjective by definition and depending on values attached to specific benefits and costs (Richardson, 1972). Batty (2008) states that different city sizes are associated with a wide range of advantages and disadvantages, and therefore concludes that the question of optimum city size is as open as it has ever been. However, not all spatial economists and urban geographers agree. Interestingly, the ideal size of a city is usually formulated in terms of livability and environmental quality (Eaton, 2002). It is implicitly assumed that there is an upper size limit beyond which the quality of life in a city can de facto no longer be guaranteed. In 1960s' analyses of suburbanization, a cultural propensity of rational human beings wanting to live in spacious new houses was often invoked as an explanation for the sprawling metropolis (e.g. Alonso, 1964). This—dated (Wyly, 1999)—microlevel assumption in urban economics is in tension with the macro perspective of (the same tradition in) urban-economics where the motto seems to be 'the more, the merrier': when more individuals can interact with each other in the course of a working day, there will be more potential for division of labor, for specialization, and for matching supply and demand (Alonso, 1971; Mera, 1973; David et al., 2013). This interaction potential is higher in denser urban environments compared to simply more extended urban areas, even though their population size may be similar (Törnqvist, 1977; Glaeser et al., 2016).

It is often hypothesized that market forces, guided by the virtues of near-universal car ownership and unconstrained land markets, 'automatically' lead to an optimal city size. Where negative externalities (congestion, pollution, and nuisance) exceed positive effects (economies of agglomeration), more complex, polycentric, metropolitan constellations emerge (Richardson, 1972; Anas et al., 1998; Fujita et al., 1999; Glaeser et al., 2001). At best, policies can shift this equilibrium a little. When polycentric urban constellations are adequately internally connected, preferably by means of a transport and communication system that is fast and congestion-free, such a system is expected to provide a perfect breeding ground for a thriving economy.

At first sight and from a global perspective, there seems to be evidence for the hypothesis that larger agglomerations, even regardless of their degree of polycentricity, foster stronger economies. But at least in Europe, and in Western Europe in particular, the relationship is less straightforward. David et al. (2013) tested the city size hypothesis on EU cities having over 200,000 inhabitants, and concluded that since 1960 no direct link can be established between the size of the city and its growth rate or its economic performance. This finding can be interpreted in different ways. At the regional level, it is well possible that in the course of time connectivity levels in Western Europe have been soaring so much that the individual city no longer provides a useful unit for measuring economic performance. The systematic increase of commuting distances, which could be observed at least until the beginning of the 21st century, points in that direction.

These reservations are in line with a town planning perspective, where similar opinions have been proclaimed. In '*Garden Cities of Tomorrow*' (1902) Ebenezer Howard described his ideal city as consisting of no more than 32,000 inhabitants, on the condition that this intended garden city would be part of a larger (polycentric) network. This network, however, would serve economic interaction mainly through transport of goods, while inhabitants would be employed in their town of residence and daily commuting between towns would be negligible (Hall, 1988). Alonso (1970) stresses the relevance of distinguishing between new towns that are supposed to be relatively autarchic and new towns that could function as a new node within an existing agglomeration. While he sees potential in the latter, he doubts the economic viability of the former, which only makes the question of what the criteria are for a town to be considered part of a larger agglomeration more pertinent. Nevertheless, new town ideas resonate in several planning concepts of later date, such as in Clarence Stein's 'Regional City' concept (Parsons, 1998). Haughton and Hunter (1994) envision about 100,000 to 250,000 inhabitants, not because they think such a city would provide the most comfortable place to live, but rather because they believe that by definition smaller cities would be deficient in providing a breeding ground for a thriving economy. When we confront this statement with the size of most city regions in the world economy, however, it is apparent that there are size-related agglomeration effects that are significantly larger than 250,000 inhabitants. Camagni et al. (2012), for instance, observe several high-level urban functions that exhibit thresholds between one and two million inhabitants.

However, determining whether two settlements are part of the same agglomeration at a given time is no straightforward exercise. Agglomeration economies have a variable geometry (Lang and Knox, 2009): some types of externalities are associated with the density of the central city, where others are associated with the scale of the functional labor market and yet other effects may cover an even larger area (see van Meeteren et al., 2016b [Chapter 3] for a recent overview). Parr (2005) advocates demarcating the agglomeration with the criterion of reasonable self-containment where the majority of agglomeration effects are within rather than beyond the area. If that is the case, the interplay of the 'daily urban system' (Berry, 1970), which is often empirically based on commuting distances but comprises all daily routine interactions, and the larger metropolitan and central place systems which include also non-daily, but nevertheless localized and regularized activities (van Meeteren, 2016 [Chapter 5]), become important in defining the metropolitan area.

Interaction: Between agglomeration and polycentricity

At present, a large share of urbanization is essentially 'sub/urbanization' where the in-between space gradually acquires centrality: the difference between city and suburb blurs (Ghent Urban Studies Team, 1999; Keil, 2013; Phelps et al., 2006). This complicates the demarcation problem alluded to above, yet the issue is paramount when comparing cities in supraregional networks. The academic literature discussing the position of urban areas in global economic networks commonly assumes that the contributing metropolitan regions can be regarded as nodal regions (van Meeteren et al., 2016b [Chapter 3]; van Meeteren, 2016 [Chapter 5]). However, this procedure of nodalization abstracts from the specific settlement geography by assuming that each metropolitan region has a comparable internal structure. Nodalization largely neglects the friction of distance (Haig, 1926) within the subareas of the nodal region. This might to some extent be warranted in the economic network of the United States where a lot of inter-city movements occur via well-developed domestic air travel, which is relatively less sensitive to distance variance. However, this assumption holds less in Europe, because cities are spaced much closer and inter-city travel occurs via the road (Clark and Kuijpers-Linde, 1994; van Meeteren et al., 2016c [Chapter 2]). Here, assuming polycentric urban regions (Parr, 2008) as consisting of partially overlapping daily urban systems might be a more appropriate assumption.

It has long been assumed that in polycentric regions, different cities could 'borrow size' from one another (Alonso, 1973; Meijers and Burger, 2016), making the sum of settlements more than its constituent parts. However, assuming polycentric urban systems severely complicates the notion of an optimal metropolitan size, and hence the analysis of how borrowing size can help meeting the assumed optimal thresholds. The contribution to critical mass and hence agglomeration benefits of a person living in an urban area is already substantially higher than the contribution of a person in a city's functional hinterland (Burger et al., 2015). Moreover, more compact subcenters tend to be more efficient, so perhaps the thresholds for optimal metropolitan size should be higher in polycentric metropolitan regions (cf. Cervero, 2001).

The type and reach of agglomeration economies also varies, meaning that the different urban nodes become imbricated to a different degree for each type of agglomeration effect (van Meeteren et al., 2016b [Chapter 3]). Even the daily urban system in itself loses its status as a category with a fixed upper spatial limit comparable across regions, as the commuting zone expands when education levels rise (Burger et al., 2014a). As a consequence, some aspects of agglomeration economies tend to be easier borrowed than others based on the differential ways in which settlements interact (Meijers and Burger, 2015).

All these complexities point to the necessity of careful spatial demarcation of one's study region, coupled with due recognition that determining 'the' optimal metropolitan region is impossible and its boundaries perforce contentious. However, we maintain the general rule that agglomeration economies by definition benefit from mass, which may lead to the perhaps naive assumption that bigger is necessarily better. Of course, the economic literature is itself aware of the disadvantages of unlimited growth of urban agglomerations, which are usually classified under the term 'congestion' (Alonso, 1971). In this context, congestion does not only point to a quasi-permanent traffic jam, but refers to all possible problems occurring from an extremely high concentration of activities. In many cases, these problems have no direct net negative economic impact. For many companies, the cost of traffic jams for example, will never outweigh the benefits that are associated with an urban office location – but congestion may adversely influence the quality of life and the local environment, particularly for those who have little choice where to live (Ellegård et al., 1977). Although more difficult, quality of life threats can be expressed in monetary terms as well, and are ever more put forward as arguments against new traffic generating construction projects and infrastructural works (Verbeek and Boelens, 2016). Apart from considerable adverse effects of air pollution on general health (Arden Pope III et al., 2009), in the Belgian context large cities are also known for very compressed, often substandard, housing, the virtual absence of greenery and open space, and pervasive noise problems (Vanneste et al., 2008).

Therefore, it is important to also point to the notion of 'interaction potential'. An agglomeration that is both internally and externally well connected, will represent more potential for interaction, compared to a city that functions in a relatively autarchic way

(Alonso, 1971). This theory appears valid on different scales. In theory, smaller towns that are well connected with each other could form a larger functional polycentric region, even though this is not always evident from empirical studies (see Meijers, 2008; Burger et al., 2015). It is noted that the associated process of metropolization requires policy and guidance, and that analytically derived potential benefits do not automatically materialize (Meijers et al., 2014). Nevertheless, this suggests that the interaction potential with other urban agglomerations or economically strong regions can be more important than the size of the city itself (Friedmann, 1968; Dijkstra et al., 2013), which relays confidence about the broad agreement in the economic-geographic literature that the cities that are (a) largest and are (b) best connected (to other cities, to the hinterland, but also internally), are believed to be the most efficient.

Merging optimum city size and sustainable growth

Although the above-mentioned considerations provide plenty of ambiguity surrounding what the optimal metropolitan size ought to be in the Flemish context, only an informed choice of a threshold can provide the basis of a spatial development perspective. As noted, Camagni et al. (2012) find minimum thresholds between 1 and 2 million inhabitants for high-level metropolitan functions. This number is corroborated by McCann and Acs (2011) who conclude that an urban region must have at least about 1.5 to 2 million inhabitants to be sufficiently big to function as a node in global urban networks. In the analysis of McCann and Acs, the smallest cities that are still in the spotlights are Geneva (0.45 million inhabitants), Auckland (1.2 million), Lyon (1.6 million), Dublin (1.6 million), Oslo (1.8 million), and Helsinki (1.8 million). In what follows, we stick to these reference numbers, where we subscribe to the hypothesis that 'bigger is possibly better' as long as the 'bigger' does not outweigh environmental quality and livability. As mentioned before, there are reasons to assume that thresholds may be somewhat higher with regard to relatively scattered polycentric metropolitan regions.

Additionally, we will delineate the metropolitan core area from a non-automobile oriented perspective. Traditional spatial economic theories view transport as a medium that can be represented in models as a cost, but rarely make distinctions between the various transport modes. However, in present-day Flanders, it is difficult to still defend a car-oriented vision of urbanization, given omnipresent congestion (Dewulf et al., 2015), the high environmental and social costs related to road traffic, the lack of space, and the fading public support to build additional road infrastructure (Boussauw and Boelens, 2015). In the cartographic analyses and the subsequent visioning exercise, we will replace the traditional conception of road accessibility through accessibility by rail transit. We will therefore visualize a metropolitan area that is well situated around the main stations and nodes of high quality public transport, a development concept known as Transit Oriented Development (TOD) (Newman and Kenworthy, 1996; Van der Bijl and Van Oort, 2014).

8.3 Spatial analysis: Visualizing agglomeration potential

Assumptions

Based on the considerations laid out in the previous section, the first thing to note is that the current metropolitan core area already meets the threshold requirement of 1.5 to 2 million inhabitants. Especially since the functional metropolitan region is even larger, as it reaches far into the neighboring region of Wallonia (van Meeteren et al., 2016a [Chapter 6]), stimulation of scalar growth of the total metropolitan region ought not to be the primary policy objective. Rather, directing expected growth in a more sustainable course (Zhao and Pendlebury, 2014), without the system losing its current performance is a more pertinent aim. National and regional forecasts have revealed a significant increase in population. According to the Belgian Federal Planning Bureau, the population of Flanders and Brussels together will increase by more than half a million between 2014 and 2030, which corresponds to an additional need of more than 200,000 homes (Federal Planning Bureau, 2014; Willems and Lodewijckx, 2011). At the same time, there is a consensus on the need to organize new developments in a more compact and less car-dependent manner, in order to break the transport land use feedback cycle (Bertolini, 2012). The existing, dense network of 'traditional' railways in Belgium offers a unique opportunity for compaction. Consequently, the planning challenge reads as follows: How can we ensure that additional jobs and homes engraft on a sustainable and resilient transport system, so that it reinforces the total critical mass of the labor market, while thickening it in the most appropriate locations?

The main guiding principles of our analytical exercise are (1) ensuring the internal connectivity of the region through rail transport (train, metro, light rail, tram), and (2) the observance of the accessibility of the four main cities demarcating the metropolitan core area (namely Brussels, Antwerp, Ghent and Leuven).

Tool: The 'agglomeration-potential map'

In order to deploy an evidence-informed planning exercise (Davoudi, 2006; Faludi and Waterhout, 2006), a method for visualizing the accessibility of critical population masses was designed. Our approach is based on traditional accessibility maps. In their most simple version, one central point—the destination—is selected, after which concentric zones are delineated within a certain travel time from the central point, taking into account the underlying transport network (which could be e.g. road-based, or rail-based). More advanced maps use a set of central points. The boundary of each concentric zone is an isochrone, which is a line of which each point is located at the same travel time (e.g. half an hour) from the central point. Isochrones are generally calculated by means of a shortest path algorithm (Dijkstra algorithm), where an estimated average speed is assigned to the segments of the underlying transport network. It should be noted that this calculation method disregards, and is therefore sensitive to, the existence of all kinds of delaying effects such as congestion. Moreover, since mapping public transport accessibility requires some level of technical capacity, timetables of transit companies are usually not incorporated in the maps of, for instance, the railway network.

In the present study, however, we are not interested in the precise location of the isochrones as experienced by present-day commuters, but we are rather looking for the area within which a certain critical mass of residents (e.g. one million) is located, who are as close as possible to the center or centers of the area measured through cumulative travel time. To produce such a map, it is necessary to select a central point, to delineate a study area, and to select a transport network. As the metropolitan core area is a fairly diffuse spatial concept of which the meaning and scope have not yet fully crystallized, making such methodological decisions is not self-evident.

The metropolitan core area has four main anchors in the cities of Ghent, Antwerp, Leuven and Brussels, which are the most important economic centers demarcating the area. Of the mentioned cities, Brussels is obviously the most centrally located in the Belgian economic system, and also constitutes the main destination of the Belgian commuter flows. However, Brussels is not the most centrally located city in the metropolitan core area from a Flemish perspective (Van Meeteren et al., 2016a [Chapter 6]). Therefore, instead of singling out Brussels, we choose to simultaneously include the four anchor points of the metropolitan core area when doing the accessibility analysis, in order to visualize the size of the area as a whole. The main train station is selected as the particular focal point within each of the four cities. This choice is justified from the planning goal that the metropolitan core area must be supported by an infrastructure of high-quality public transport.

Regarding the use of a transport network, we utilize a computer model of the road and rail (including metro and tram) networks, as well as the related transit timetables. Bus lines are excluded given their volatile nature and smaller effects on spatial structure. Combining car and rail travel in a simplified multi-modal network was contemplated, but without proper data about car congestion levels and other time saving assets of train travel (Gripsrud and Hjorthol, 2012), the exercise was deemed irrelevant. Hence, we decided to separate the car and rail transport potentialities, Moreover, the maps are meant to serve a future-oriented development strategy, which will initially be oriented towards rail transit instead of motorways.

With respect to the rail network, we distinguish between two approaches: (i) the 'theoretical potential use' and (ii) the 'actual potential use' of the rail network. 'Theoretical potential use' refers to an estimate of the average speed of transit services, assuming that the entire railway network is operated in a uniform manner, and that on all available lines trains are continuously departing. Average travel speed for (i) trains, (ii) metro and light rail, and (iii) trams is estimated at 80, 40 and 20 km/h respectively. Feeder transport (the distance between the closest local station and the centroid of the census ward) is simulated at the speed of walking (5 km/h).

'Actual potential use' is based on existing timetables, thus including actual frequencies and incorporating waiting time at stopovers. As a corollary, the friction of distance is not operationalized by the respective average speeds that are assigned to the different transport modes, but rather represented by the timetable itself. However, the results of a network analysis based on transit schedules can vary greatly depending on the starting time that is chosen. A set of analyses, performed on a standard Tuesday in May 2015, were therefore averaged out to account for time-dependent extremities.

These two approaches both measure potential use, since data on the thickness of the effective commuter flows was not included in the analysis. This is justified because the maps will be used to develop a long-term vision for the metropolitan core area, and should be representative of potential rather than the current functional relationships in the considered region.

All calculations are based on the centroids (gravity centers) of the census wards, which is the most detailed geographical scale for which population statistics are available. The central station locations are assumed as the starting points of the network analysis, and the centroids of the census wards are selected as endpoints. The sum of travel times (in minutes) from all four starting points to the endpoint was then assigned to the statistical sector in its entirety. Finally, to calculate the accessible population mass, the cumulative sum of the residents from the census wards was calculated, in descending order of accessibility. Accessibility is represented by a weighted average proximity metric, relative to the four anchor points. Although the constraint of the four anchor points is fairly rigid, the resulting zoning gives an adequate approximation of that part of the metropolitan core area that is exceptionally well connected by means of rail transport. Strictly speaking, the delineated zones only include residences of that part of the population that has a good rail connection with the four stations referred to, but in a broader sense, these zones can also be seen as a search area for organizations, businesses or households who want to settle in the thickest possible labor market while keeping car dependency as low as possible. A central position in this area guarantees a considerable amount of interaction potential with, for instance, employees or employers, especially when this structure would indeed be strengthened in the future.

Resulting maps

Figure 8.2 and Figure 8.3 represent the spatial accessibility of the population from the four anchor points of the metropolitan core area. Through a continuous color spectrum, both maps indicate how extensive the population is that is living closest to the four anchor points. The different colors indicate successive orders of magnitude of this critical mass, expressed in millions of inhabitants, in which the phase from dark to light red represents a mass of two million inhabitants. Orange, yellow, green, blue and purple comprise consecutively larger, but less accessible population masses.

Figure 8.2 shows the accessibility of the population based on rail-bound transport, and more specifically the theoretical potential use. The distance between stations and homes, covered in our model by walking, emerges as an important accessibility constraint towards the intermediate areas where little or no railway infrastructure is built. As an immediate consequence, areas for critical population masses can be found in the vicinity of railway stations and stops. These maps form a promising starting point as search locations for future compact and transit oriented developments. Through concentrating new residential developments at well-connected railway stations or stops, the metropolitan core area could grow in a sustainable matter.

Figure 8.3 is based on the 'actual potential use' of rail-bound transport. At first glance, the differences between Figures 8.2 and 8.3 seem to be small, although these illustrate how accessibility is influenced by something as seemingly ephemeral as a public transport schedule, and hence notion of small differences hides some of the transformational potential that lies beneath these differences. For example, the surroundings of Mechelen, Leuven and the airport are very well endowed, while the reverse is true for the south of the province of East Flanders (south of Ghent).

In the visioning exercise, we have further elaborated this dimension on the basis of the concept of 'service potential', which means that certain parts of the railway network inhibit more potential to open up locations for additional compact development of housing or employment, compared to the current situation. It is important to observe that a number of railway lines are subject to technical restrictions on capacity, for example because these have only a single track, or have not been modernized and thus only permit reduced speeds. On such lines, service frequencies cannot be increased easily, not even if a clear demand for that would exist. Therefore, realizing desired service potentials should primarily be seen as a strategy for the longer term or for the time when funding for upgrading these lines would become available. Note that most rail infrastructure is managed by a single public company, making the implementation of a transit-oriented development scheme far easier than in the case of a greenfield development, a situation comparable to the '*Stedenbaan*' project in the Netherlands (Spaans and Stead, 2016).

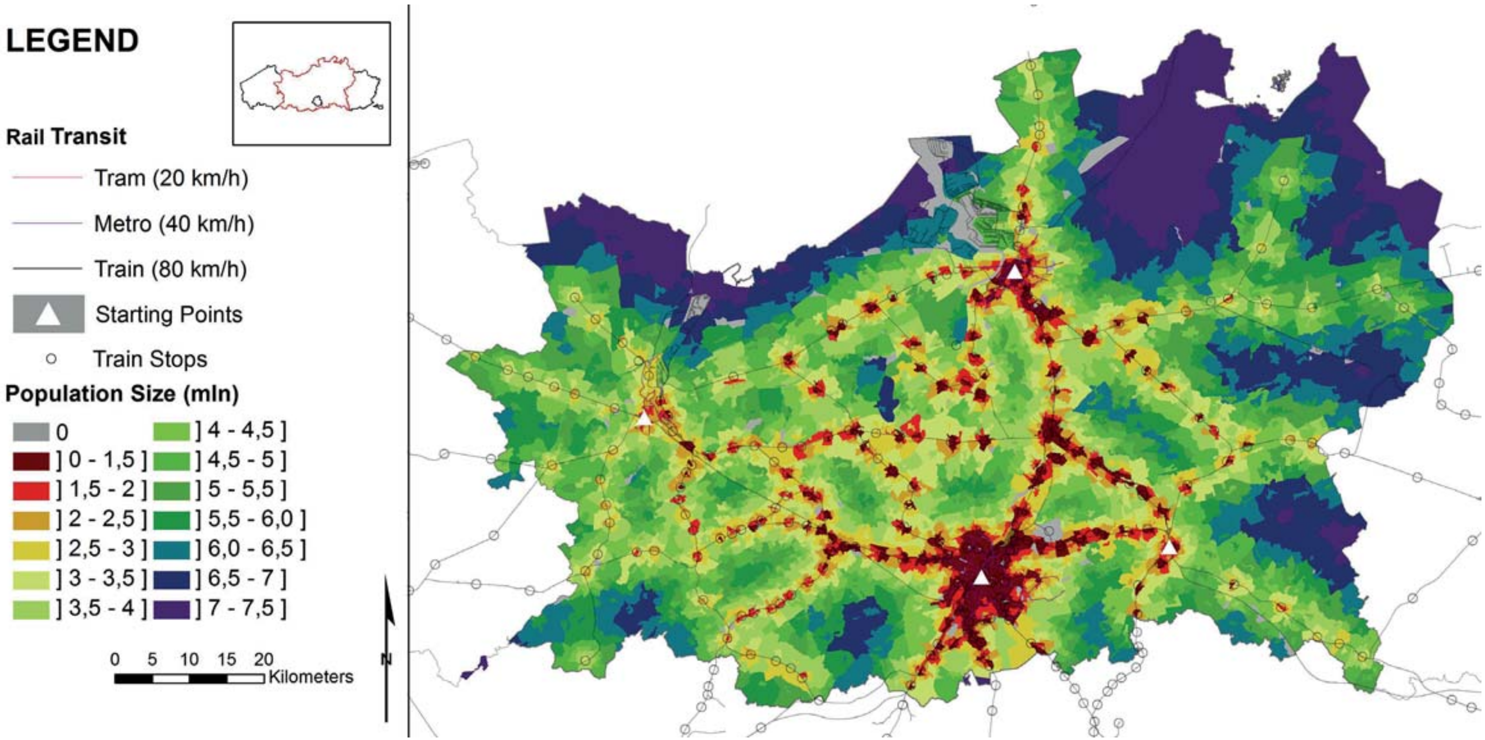

Figure 8.2 Rail network based agglomeration potential map: Theoretical potential use

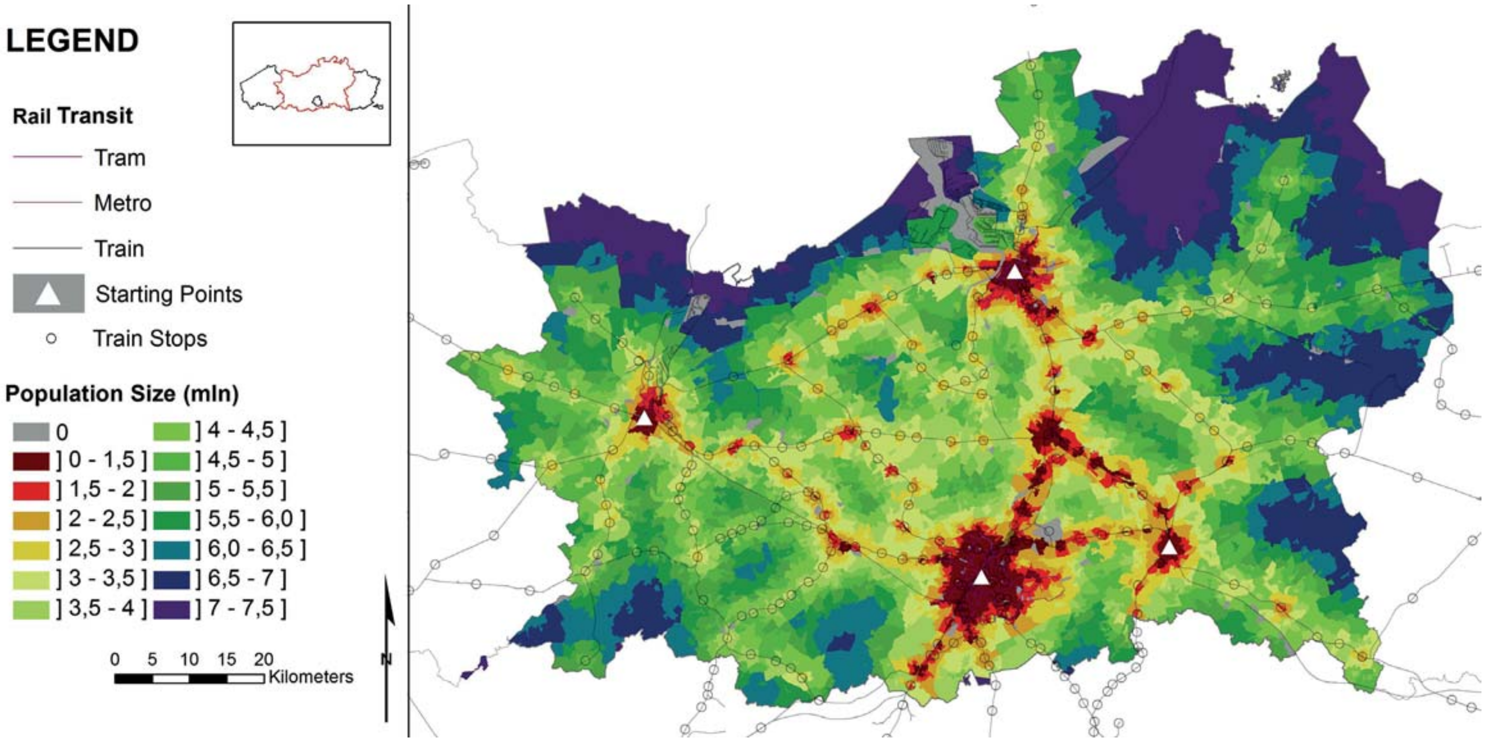

Figure 8.3 Rail network based agglomeration potential map: Actual potential use

8.4 From maps to vision

Introduction

The analyses offer insights into the functioning of residential, employment and transport systems in the metropolitan core area. This third section of the paper reports on the final phase of our study, aimed at developing various scenarios for living, working and the transport system in the metropolitan core area. To that end, in consultation with the commissioning department, it was decided to organize a participatory visioning workshop.

Participatory processes exist in various guises. We briefly situate our method within the two-dimensional framework of van Assel and Rijkens-Klomp (2002), and within the three-dimensional classification of van Notten et al. (2003). Van Assel and Rijkens-Klomp (2002) state that each participatory process is situated on a spectrum ranging from 'process as a goal' to 'process as a means,' while in the second dimension the spectrum ranges from 'reaching consensus' to 'mapping out diversity.' Since the introduction of the concepts of participatory planning (Arnstein, 1969; Forester, 1999), advocacy planning (Davidoff, 1965) and communicative planning (Healey, 1992), the discipline of urban design and spatial planning tends to view the process as an objective in itself. This process often has the intention to identify a variety of viewpoints, thereby fostering a wide range of possible scenarios (Street, 1997). An under recognized weakness of the process approaches is that the process may become mainly or even solely a bottom-up-directed activity. In the context of spatial design and urban planning practice, process approaches are particularly suited to mobilize expertise from everyday users in order to apply it in the design of local projects.

However, in the present regional planning process, we have chosen to only look at the process as a means (and thus not as a goal), with the explicit intention to arrive at a design (and thus to pursue a form of consensus, rather than an inventory of the diversity of present views). Expert stakeholders were selected based on their expertise in the various relevant sub-domains, such as spatial planning, mobility, housing, public transport, regional economics, and public administration. Moreover, the contours of this visioning exercise had already been quite tightly defined, on the basis of the Green Paper on Spatial Development (Flemish Government, 2012), which was further focused through the literature review and spatial analysis discussed above. Moreover, it was explicitly stated that the workshop was meant to provide input for a spatial vision, which would summarize the results of the discussion as much as possible. In other words, we start from a top-down approach, where we only mobilize specialized expertise and attempt to draft a regional vision from a number of goals that may sound rather abstract for the everyday 'user' (as opposed to the 'expert') of the considered region.

To further characterize our approach, we utilize Van Notten et al.'s (2003) distinction between three dimensions in their typology of scenario development methods: the goal of the project (from exploratory to decision supportive), the nature of the process (from intuitive-qualitative to formal-quantitative) and the nature of the content (from complex to simple). Based on the foregoing considerations, we characterize the present process as decision supportive with a normative angle, seeking a balance between a quantitative and an intuitive approach, and to a large extent complexity reducing. Remaining within the framework of Van Notten et al. (2003), we therefore deviate from more common processes in planning practice, which are often highly intuitive and look for a solution to comprehensible (which often means: simple) framings of the problem.

The format of the workshop followed logically from the objectives of the planning assignment. The main purpose of the workshop was to take the opportunity to bring together a select group of experts and to exchange views on various future scenarios in which the perspectives and knowledge of the different actors involved could be fully exploited in a relatively quick way. An appropriate combination of expertise was expected to result in new and valuable insights. This also means that the success of the workshop would to a large extent depend on the input of the participants.

Course of the workshop

A range of expert stakeholders were invited to participate in a visioning workshop, which was organized in cooperation with the commissioning Flanders Department of Spatial Planning mid-2015. By conducting two parallel discussions on the same issue, the possibility to both develop opposing and converging viewpoints was left open. The discussion groups were supplied with a base map of the metropolitan core area serving as working material. Additionally, all preliminary mapping analyses were provided by way of background material that could be shown on a screen. The discussion was organized quite tightly around the three key domains of the study: the labor market, the housing market, and the transport system. Each theme was introduced with a relevant albeit controversial example to elucidate the convergent and divergent opinions among the participants in the spatial visioning process.

The conversation started with opportunities and threats of the labor market in the metropolitan core area. As an example, the discrepancy was outlined between the employee profiles demanded by the Brussels employers, which often require high levels of education, and the labor supply of the Brussels labor market in which underprivileged groups are overrepresented. In other words, jobs for which Brussels' jobseekers qualify, are largely located outside the central city. The associated question is whether spatial policies may play a role in developing solutions for these and related spatial mismatches.

Subsequently, the discussion continued on the theme of housing supply. As an example of a housing market with potential for additional compact development, the town of Dendermonde was proposed, which is centrally located in the metropolitan core area, with a fairly complete range of facilities, and good rail links with almost all central cities in the metropolitan core area but which lacks a direct connection to the motorway network.

Thirdly, the transport issue was discussed. The so-called Brabantnet was proposed as an example. Brabantnet is a future light rail network with the intent to improve the connection with the Brussels metropolitan area in those areas north of Brussels that today are underserved by public transport. This will result in a more sustainable and efficient link between working and living in the region. Within this theme, the main question considered was where such initiatives would be even more desirable or could be profitable.

Outcomes

A detailed report of the discussions is beyond the scope of this chapter (we refer to van

Meeteren et al., 2015 for further elaboration). However, the positions and elements of the vision from both work sessions were synthesized in three spatial structure schemes (Figure 8.4, Figure 8.5, and Figure 8.6). Below, we highlight four main conclusions, which were also included in the legends of the structure schemes.

First, the importance of the Antwerp-Mechelen-Brussels axis as a regional housing market and economic development corridor cannot be emphasized enough. High quality public transport will have to ensure both internal connectivity and external accessibility of this urbanizing area. In order to get such a transit oriented system to work optimally, compact development is considered paramount. The main areas to be opened up to compact and transit oriented development through densification, are the twentieth-century suburban belts of Brussels and Antwerp. The focus on the Antwerp-Brussels connection does not imply that the traditional Flemish Diamond region, and particularly the region around Ghent, is marginalized. The Ghent agglomeration is an important center for the provinces of East-Flanders and West-Flanders. Ghent is an important supplier for highly-educated labor in Brussels, could remain being so and the (network) relation could even be intensified. However, the area in-between Ghent and Brussels is at this moment not yet a contiguous functional urban region. Fully extending the metropolitan core beyond the Antwerp-Brussels axis would likely require a large expansion of the Belgian economic base (van Meeteren, 2016 [Chapter 5]). Contrarily, the housing and labor market of Leuven is through its proximity fully integrated with the core area.

Second, experts warn for an excessively broad delineation of the metropolitan core area, as it can lead to suburban development with much lower densities than are sustainable in a less car-dependent future. By assuming a tighter demarcation of the metropolitan core area, and by selecting a very limited number of growth centers inside, compact development can be facilitated through plan-imposed scarcities on the land market. The density problem could be tackled through a phased development policy for the metropolitan core area, in which the Brussels-Antwerp axis would be optimized first, before having it stretched to the entire metropolitan core area in a later stage, particularly towards the transport hubs of Lokeren, Dendermonde, and ultimately Ghent. Such a phased development exerts continuous pressure on land, housing and business estate markets, and therefore provides an incentive to focus on higher quality, density, and efficiency.

Furthermore, the Brussels Capital Region remains a major employment center, especially for specialist, office type activities, but selective decentralization of such activities towards other cities should be considered. For non-specialist employment, it is clear that the main purpose of job creation is to provide the local population with employment, aiming for more self-sufficiency in terms of economic needs at the level of the municipalities. For location policies on logistics and industrial activities, the presence of waterways, freight rail lines, and motorways is more important than the presence of high quality public transport or the proximity of a large number of potential employees.

Finally, it is important to recognize that there are a number of barriers of administrative or political nature that may prevent the desired reinforcement of the metropolitan core area. An important stakeholder that should be more involved in this and related planning processes, is the national railway company.

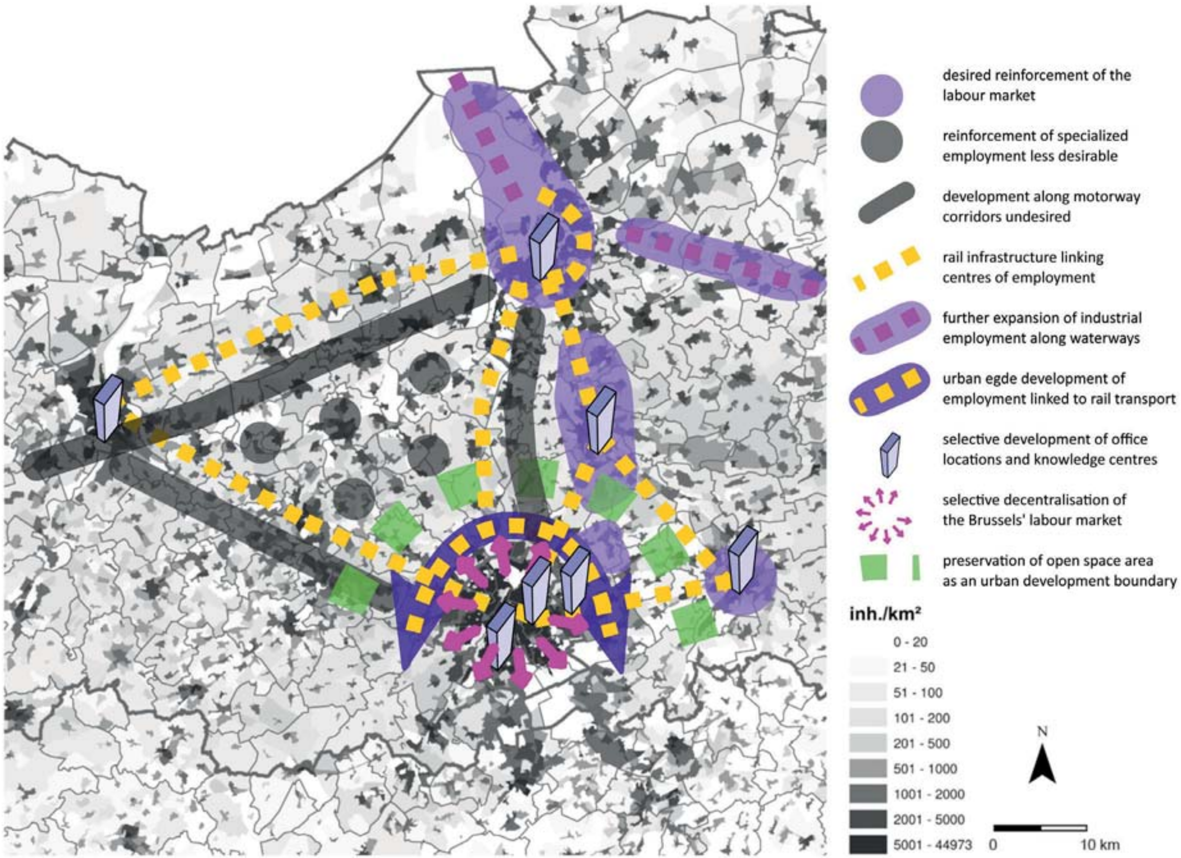

Figure 8.4 Spatial development perspective with regards to employment

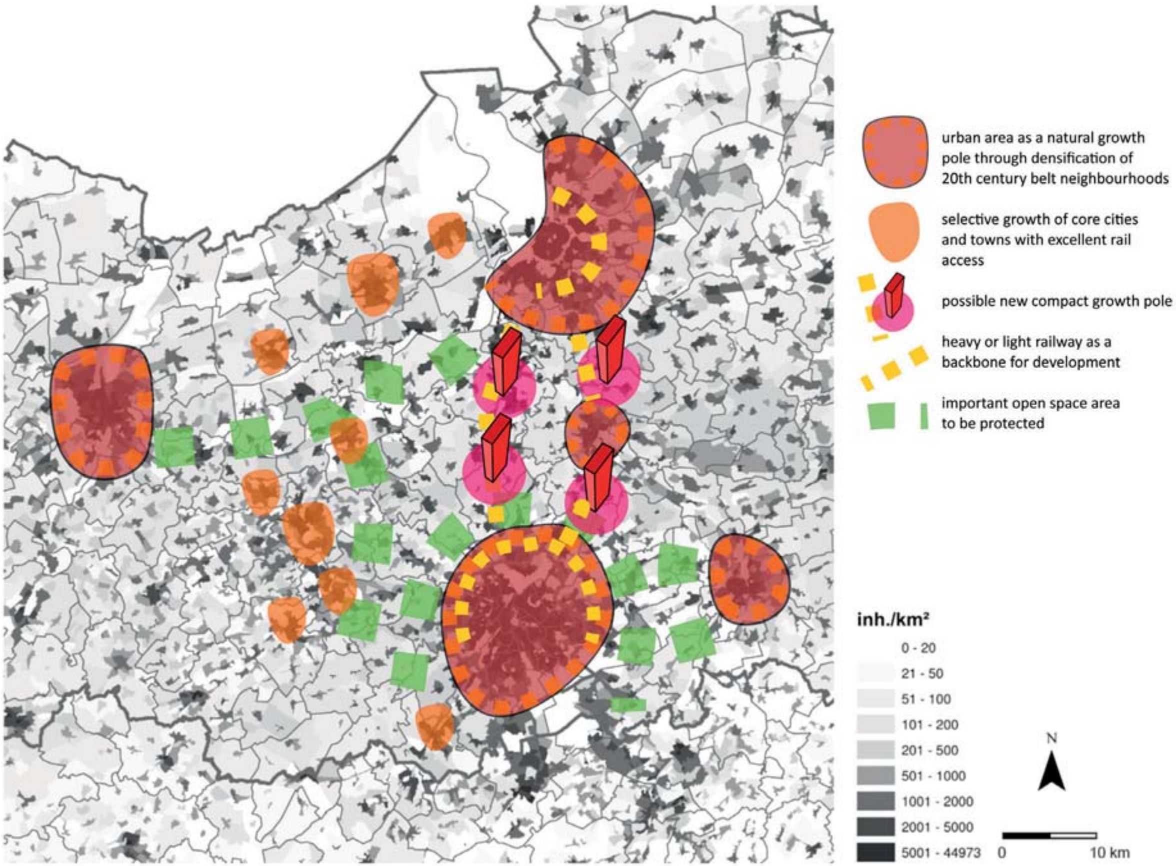

Figure 8.5 Spatial development perspective with regards to residences

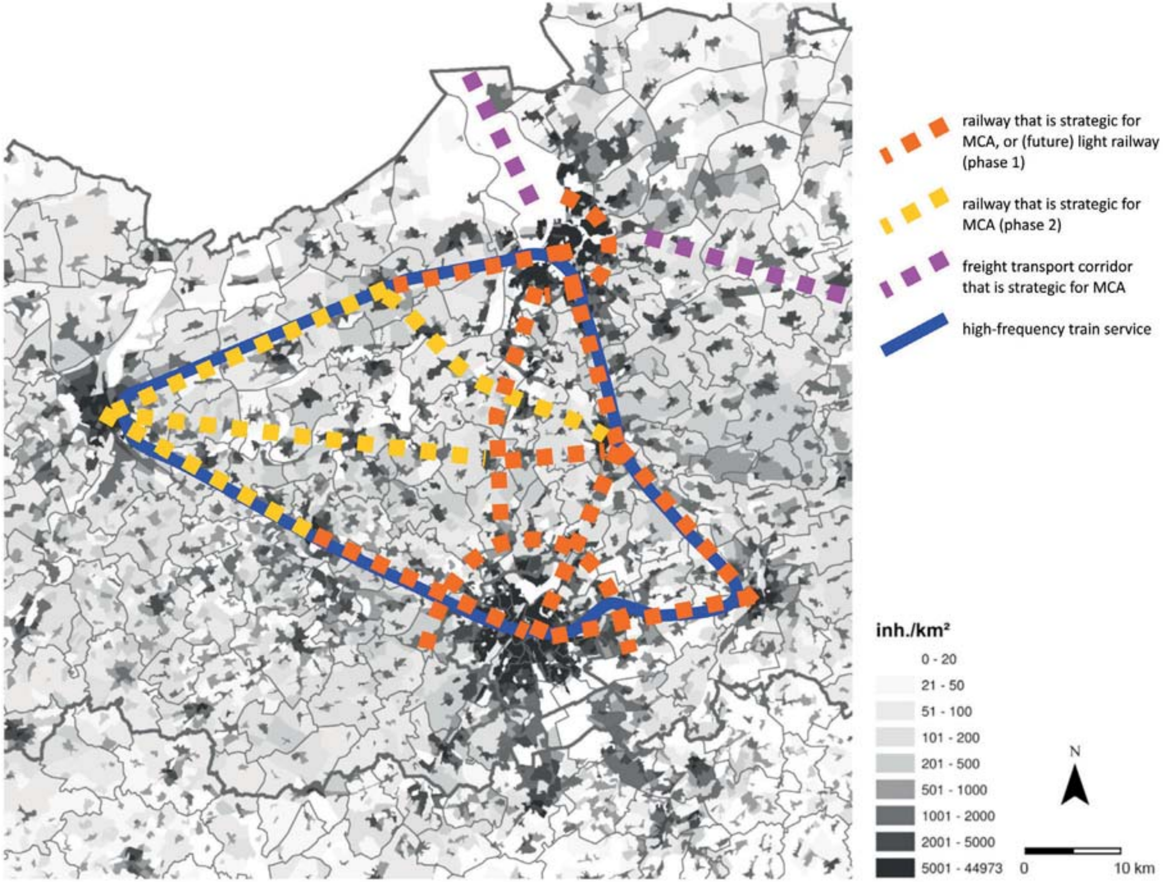

Figure 8.6 Spatial development perspective with regards to the transport system

8.5 Conclusions

In the present study we have linked concepts of agglomeration, polycentricity, and sustainable urban development, and have these operationalized by means of agglomeration-potential maps. Then, we have introduced the developed theory and tools in a visioning process for the metropolitan core area in the north of Belgium, confronting it with multidisciplinary expert knowledge in an effort to generate a new metropolitan spatial development perspective. By framing the analysis from the very beginning within the existing guidelines for a new spatial vision for the Flemish metropolitan core area, the required spatial analyses could be worked out quickly and visions have a high degree of realism attached to them.

Given the objective, outlined by the Green Paper on Spatial Development, to maximize regional economies of agglomeration in an as compact way as possible, and given the geographical scope of the study, the participatory visioning process had a strong focus on the mobilization of specialized expertise and on the achievement of a consensus. In addition, a balance was sought between guidance through quantitative analyses, and a more intuitive way of exploiting existing expert knowledge. The developed overarching spatial vision is visualized by means of three spatial structure schemes.

Typical of a planning exercise as this one is the strong dependence on ready knowledge among the actors involved. Although the contribution of our theory based approach of agglomeration effects and sustainable urban development, and the consequently developed agglomeration-potential maps do not claim to objectify all knowledge necessary for such a visioning exercise, it is clear that it has helped achieving the important task of spatial integration of various policy realms and associated objectives.

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9. Conclusion

9.1 Overview

The primary aim of the research underlying this dissertation was to propose practically adequate analytical tools to understand and explain settlement geographies in Belgium and the Flemish region. Eventually, these tools were derived from what was dubbed 'old-fashioned geography': models and theories from geography's spatial science era. Yet it was argued throughout this thesis that these tools could benefit from re-appreciation and renovation. This required probing into the contemporary usefulness of these theories, and assessing their capacity to explain aspects of concrete settlement geographies in Belgium. This final chapter, by means of conclusion, summarizes the results of that endeavor in its totality.

As was noted in Chapter 1, Belgium's settlement geography—whether its metropolitan core is conceptualized as the 'Flemish Diamond' (Albrechts, 1998) or 'Central Belgium' (Vandermotten et al., 2006)—has characteristics of a polycentric region, where small, proximate, settlements can function together as a large metropolitan region (Kloosterman and Musterd, 2001; Meijers et al., 2016). However, it was also noted that Belgium's settlement geography exhibits characteristics that are remarkably different from the polycentric regions to which it is commonly compared, such as the Dutch Randstad or the German Rhine-Rhur area (Dieleman and Faludi, 1998). In particular, the 'nebular' character of the region is striking. This character renders demarcations between cities and their outside problematic and complicates determining what interacts with what when theorizing the region's settlements as a larger whole. These specificities of the Belgian urban morphology question the extent to which its settlement geography can be understood as a polycentric urban network.

These doubts bring one of the classic paradoxes in geography to the fore: the region's geography is unique amongst its peers but that uniqueness is produced by a succession of spatial-temporal processes that are in themselves comparable across contexts (Schaefer, 1953; Saey, 1968a). Are the theoretical tools at our disposal formulated at the proper level of abstraction to make this comparison possible? Drawing on insights from Saey's (1968a; 2012 [2009]) 'new orientation', Chapter 1 made the case that to engage with the uniqueness paradox, a research project should alternate abstract and concrete phases, although practical circumstances often make the actual research more haphazard where abstract and concrete research are conducted simultaneously. Regardless the sequencing, the alternation between concrete and abstract research incites reflexivity about the chosen approaches and encourages a research project to engage in some of the controversies peculiar to the application of a theory in a specific time-space context.

As this research project started with the concrete question of explaining the Belgian settlement geography—with a first suggested explanatory mechanism: theories of urban polycentricity—it has the character of a study with chorological momentum where the research cycle starts with a concrete geography, continues with examining the candidate theoretical apparatuses that can explain that geography, and then re-writes the geography based on the insights gained through this process (Saey, 1968a: 138). In Chapter 1, the aims of this endeavor were codified in two research questions, and it was specified how these questions would be answered through both concrete and abstract research phases. The research questions are the following:

1a: What are the shortcomings of theories of 'polycentric urban regions' in explaining settlement geographies?

1b: To what degree can these shortcomings be allayed by a renovated urban systems theory?

2: To what extent can a renovated urban systems theory be utilized to explain contemporary settlement geographies in Belgium?

By means of conclusion, these research questions are revisited and each chapter of this dissertation is brought to bear on them. The remainder of Section 9.1 reiterates how in the research process, first assessments of Belgium's concrete geography in the early phase of the research process quickly led to the methodological concerns about controversies regarding old-fashioned geography that was described in Chapter 1. Section 9.2 summarizes the results of the abstract research phase (Chapters 2, 3, 4, and 5), which amounts to answering the first research question (1a and 1b). Section 9.3 regards the phase of concrete research (Chapters 6, 7, and 8) as summarized in the second research question. This leads into Section 9.4 that takes stock of the open ends of this research project and formulates suggestions for further research.

Chapter 1 started, in a very abridged account, by relating a common trajectory for aspiring PhDs. One is put 'in the wild' with a concrete research assignment for which funding is acquired, a knapsack with theoretical tools that are deemed useful on the way, and a blessing of the thesis supervisor. Within a year, the theoretical tools get blunt by repeatedly failing to get grip on the empirical matter, attempts at concrete research fail and one is confronted with existential questions. In my case, I started wondering whether those Belgian settlements all looked like nails because I had been suggested to use a hammer. This is when the Gordian knot alluded to in Chapter 1 started to look insurmountable. The eventual result of this early research phase is that you shamefully stow away your 'hammer tap tap' attempts at concrete research deeply into a drawer, hoping that the world eventually will forget about them, and start to engage in identifying the controversies that restrain you from using alternative frameworks, with the hope that these will ultimately do a better job.

As described in Chapter 1, it would not take long before I identified the most relevant theoretical controversy that would haunt this research project. Soon after realizing that the three-systems model I had smuggled from Amsterdam might be a better tool to explain Belgian settlement geographies, I discovered that the contemporary geographical and urban planning literature strongly discourages, and even shows contempt for, using old-fashioned theories from geography's spatial science era to understand the present. Examining this controversy by separating bias from genuine concerns became the primary aim of the abstract phase of this research project, which resulted in the conclusion that theories from the spatial science era remain good candidates to provide causal mechanisms that can help us explain concrete instantiations of settlement geographies. However, before they can be put to use in a post-positivist setting, these theories need to be renovated.

There are several reasons why this renovation is necessary. First, as 'old-fashioned' theories tend to be cast in the flat ontology of the deductive-nomological model, they need to be reformulated in terms of 'causal mechanisms' instead of 'causal laws of constant conjunction' (Collier, 2005). By doing so, these theories become compatible with the ontology of critical realism which allows them to 'speak to' a far larger range of post-positivist theorizing in human geography. Secondly, spatial science theories are time-worn and have often forked into multiple mutually incompatible variations. In the cases of central place theory and export base theory, for instance, it was observed that so many versions of the theory exist that contemporary scholars no longer share a common sense what these theories exactly entail. Therefore, these spatial science theories need to be restated, by re-examining the causal mechanisms that underpin them.

9.2 Abstract research

Having summarized the main goals of the abstract and concrete phases of this research, and how the methodological and theoretical ground for these projects was prepared in Chapter 1, they are now discussed in more detail by presenting the main findings of each chapter individually, starting with the abstract phase that was embarked upon in Chapter 2. At the start of this project, the conceptual notion of 'polycentricity' was proposed as the primary tool to explain Belgium's settlement geographies. Therefore, the exposition of the abstract phase of this research project commenced with interrogating the causal mechanisms that lie behind the literature on polycentricity. Chapter 2 argues that the polycentricity concept in urban studies is stretched: it has different meanings to different (sub)groups of researchers. This complicates the identification of clear, unambiguous causal mechanisms underpinning the concept. As Chapter 2 concludes, the 'largest common denominator' definition of polycentricity shared throughout the field is little more than an adjective. 'Polycentricity' implies that a phenomenon has more than one center. Such a descriptive concept of form without substantive referent can never be a causal mechanism in the critical realist sense (Chapter 3). Even if there is a process that makes urban regions more polycentric, the proposed causal mechanisms need to address the underlying processes of these decentralizing tendencies directly, and not the outcome of an unspecified process (Sayer, 1979).

Further testifying to the polyvalence of the concept, Chapter 2 also revealed that in the transport and economic-oriented parts of the urban polycentricity literature, polycentricity seems to be a placeholder for a debate about the changing scale and scope of agglomeration externalities. As the scale of agglomeration externalities changes, the urban-economic system might become more polycentric, although the exact ways in which this process unfolds is dependent on historically defined urbanization patterns. From this perspective, the underlying causal mechanisms of polycentricity are located in theories of agglomeration. A third connotation of the notion of polycentricity is the role of polycentricity as a planning concept, which dominates the inter-regional debates on polycentricity at the European scale. This planning concept rests upon the normative conviction that polycentric regions are more sustainable and/or more efficient than monocentric ones. This claim is underpinned by the speculative assumption that polycentric regions retain the supposed advantages of compact settlements while reaping the benefits of larger agglomerations (Vandermotten et al., 2008). However, the analysis presented in Chapter 2 concluded that this normative claim is not sufficiently developed in the literature on urban polycentricity to provide actual causal mechanisms that can support it, causing it to be dropped from the analysis. Moreover, it was observed that there are intrinsic conceptual tensions between the normative and the analytical (spatial-economic) conceptions of polycentricity (Vandermotten et al., 2008), and that this a major source of conceptual stretching. This discussion was picked up again in Chapter 8, which reintroduced polycentricity as a planning concept, albeit after an examination of the urban economics literature from the 1970s that might support the claims of contemporary planners.

Chapter 3 elaborated upon the observation, made in Chapter 2, that 'polycentricity' is oftentimes used as a placeholder for debates on the scale and scope of agglomeration externalities. It did so by taking two salient observations as point of departure. First, 'agglomeration externalities' is a concept that is free of neither fuzziness nor confusion itself. Therefore, abstract research is necessary to distill causal mechanisms from theories of agglomeration externalities. Second, the agglomeration-externality debate seems to get heated when determining the boundary between on the one hand intra-urban effects, commonly theorized as 'agglomeration externalities', and on the other hand inter-urban effects, conceptualized as 'network externalities'. This debate is particularly salient when discussing polycentric urban regions. Is this type of region to be regarded a single region with multiple cores, or an interaction between several quasi-independent units? Moreover, what is the criterion by which that matter is decided? Taking these observations as guidelines for analysis, Chapter 3 produced two findings that directly speak to the overarching research questions of this dissertation. First, it was shown that agglomeration externalities are in fact an amalgamation of different socio-spatial processes occurring at different geographical scales. Therefore, in order to use the notion as a causal mechanism, further specification of these different socio-spatial processes is paramount. To facilitate this project, the chapter proposed several solutions to the problem of how an empirical research object can be meaningfully carved up. The second important finding relates to the importance of geometrical abstractions. More specifically, it was argued that the types of agglomeration economies that exhibit field distributions, such as central place systems or labor markets, are better described in Euclidian geometry than in topological terms, i.e. they are better not reduced to a networked abstraction if the data permits otherwise. This implies that for some types of agglomeration externalities–particularly central place functions–a 'network model' is impractical (pace Camagni and Salone, 1993; Batten, 1995; and Meijers, 2007).

Chapter 4 takes its cue from the statement, made in Chapter 1, that abstract research is particularly important when it regards theoretical controversies, since the claims derived from controversial propositions cannot be regarded as elliptic arguments. Chapter 4 analyzes the theoretical framework that the consensus in the literature suggests *not* to use: central place theory (Blotevogel, 1996; Scott, 2012). However, once we 'bracket' commonsensical interpretations of central place theory—which tend to be the result of how we represent the theory in textbooks (Barnes, 2002; Johnston, 2006)—and re-examine its underlying causal mechanisms, a different picture emerges. Hence, Chapter 4 did not reveal new limitations of central place theory, but rather the limitations of textbooks. This allowed it to show that a method deemed obsolete and superfluous is not only still valid, but can even contribute to the contemporary research frontier by revealing urban inequalities and providing theoretical guidance to counterbalance some of the empiricist tendencies that are manifest in the enthusiasm around the emergence of 'big data' sources.

This raises the question why the literature is so critical of central place theory, even when it has such clear, useful and enduring applications. An answer to this question is suggested by Johnston (1993), who claims that geography textbooks have a presentist approach. They write a 'history of the present' (Foucault as interpreted by Roth, 1981) that codifies what is regarded important at the moment of writing the textbook rather than attempt to provide a measured account of history. However, as textbooks tend to become 'obligatory passage points' in codifying the summary of a field (Barnes, 2002; cf. Johnston, 2000a), this development is worrisome. Textbooks date, and those issues considered the most important in the 1990s might not be the same issues that are salient today. Therefore, while central place theory might have felt dated back then, it might be useful for the contemporary research agenda. This indicates that at the very least, as Chapter 4 concludes, the historiography of central place theory warrants some revision, a conclusion that might hold true for the whole epoch of spatial science and positivist research (Kwan and Schwanen, 2009; Cox, 2014; Wyly, 2014; Johnston and Sidaway, 2015).

Chapter 5 serves a pivotal function in this dissertation, being the culmination of the discussions held in the preceding three chapters. These all vindicate the 'causal mechanism' re-interpretation of spatial science theories in human geography. If the goal is to understand the influence of agglomeration externalities on the functional organization of metropolitan regions, a theoretical framework is needed that is able to disaggregate these agglomeration externalities in different processes working on different scales. Chapter 4 showed in detail that we have no reason whatsoever to exclude central place analysis as one of these layers, as there are indications that this theory still plays an important role in establishing functional coherence in metropolitan regions. This observation, and the other considerations for studying settlement geographies that surfaced in the previous chapters, are all taken into account in the formulation of a 'renovated urban systems theory' that is achieved in Chapter 5, and which subsequently guided concrete research. This renovated urban systems theory described three interlocking dynamics at different scales that shape settlement geographies: the system of global circuits of value, the daily urban system and the central place system.

The system of global circuits of value is based on an interpretation of export base theory. This interpretation argues that this phenomenon should be studied at the scale of the outer limits of a set of imbricated functional urban areas since the abstraction otherwise risks becoming chaotic. It is this scale that can be 'nodalized' relatively unproblematically in global urban (network) analyses. When nodalization is achieved, one can theorize a system that has to achieve a neutral or positive balance of income if economic restructuring or redistribution is not to be a necessary consequence.

Operating on a much smaller scale, the daily urban system starts from the time-geographical insight that households organize their daily lives along routinized time-space paths and that by studying these paths researchers have an important indicator of realized interaction between people. It was argued that the second demographic transition has complicated the time-space paths of households, resulting in an increased articulation of coupling constraints compared to the past. This offsets to a certain degree the loosening of these constraints by new technologies that was prophesized in human geography from the 1970s onwards (e.g. Berry, 1970; Johnston, 1997) Thus, Chapter 5 argued that as people with similar time-space paths tend to cluster in space, aggregating daily urban systems on commuting zones is still a valid operationalization of the daily urban system. This remains the case as long as the commute is likely to be the outer boundary of an individual household's daily time-space prism, although assessing the validity of that hypothesis may require continued research (see, for instance, Grünfeld, 2010).

Regarding the third component of the three-systems model, the central place system, Chapter 5 proposes to conceptualize this system as the 'intermediate' scale of analysis, which in many ways is a continuation of classic urban systems theory where the (regional) central place structure and hierarchy integrate a metropolitan region into wider circuits. This does not imply a restatement of the 'successive inclusive hierarchy' (Parr, 2002), where there is one central business district at the center of the region doing the integration. Central place theory can easily accommodate complementarity and a division of labor between centers within the same region. As an intermediate scale, it can capture those interactions within a metropolitan region that are routinized but not necessarily daily. Therefore, it is a good candidate to cover the scalar middle ground of functional urban relations between the daily urban system and the system of global circuits of value.

Chapter 5 is formulated at a high level of abstraction as it has the pretension to describe a theoretical framework that is applicable to all settlement geographies in the world. A theory with such extension necessarily has a very small intension, focusing on a few broad dynamics that are necessary aspects to explain complex settlement geographies but are surely not sufficient to explain concrete instances comprehensively (Chapter 2; Sartori, 1970). Furthermore, it is to be reiterated that the three systems model is not intended as an exhaustive account of urban systems dynamics. Chapter 5 mentions governance considerations (Phelps et al., 2006; Hamel and Keil, 2015) and the fact that the city is a store of surplus capital, wealth and symbolic power (Walker, 2016) as two additional factors, the causal mechanisms of which could be probed in subsequent research. Despite these limitations, once the 'vectors of change' between the three subsystems have been specified, a clear dynamic model emerges that can account for virtuous and vicious growth/decline spirals of metropolitan regions. Each of the three subsystems impact the other two in a synergistic way. Studying these impacts allows for the formulation, for planning purposes, of expectations regarding how the changes in one subsystem will affect the others.

Chapter 5 concludes the phase of 'abstract research' and hence the trajectory from polycentricity to a renovated urban systems theory that is central to answering the first research question. The abstract phase of the research also generated some additional considerations that proved important for the concrete phase of the research. First, it emphasized that any account of a concrete settlement geography needs to be historically sensitive, as we can only understand present settlement geographies if we take the past and the conditions driving urbanization in the past into account. Second, it highlighted the importance of being attentive to scale. Ideally, the position of an urban region in the system of global circuits of value requires a demarcation of the outer boundaries of imbricated daily urban systems, while the other systems require smaller demarcations. Third, it urged to be cautious in relation to applying networked abstractions for phenomena that exhibit field-distributions, in particular the internal structure of metropolitan regions, i.e. the central place and daily urban systems.

9.3 Concrete research

Chapter 6 is the first chapter of the concrete research phase, which had as goal to gauge the extent to which the renovated urban systems theory is able to (partly) explain Belgian settlement geographies and to generate insights that can be useful to spatial planning. The chapter aimed, in the nomenclature of the three-systems model, to operationalize and demarcate spatially the 'central metropolitan area' in Belgium. How can a Belgian metropolitan node in global circuits of value be demarcated spatially? The results of the abstract research phase, including the three additional considerations outlined above, played an important role in operationalizating these research questions. First, the developed of a central metropolitan area in Belgium was gauged historically through the notion of 'agglomeration-economy regimes'. As noted in Chapter 5, different eras of capitalist development produce different dynamics of agglomeration and a concrete region has to be read as a superimposition of these different agglomeration-economy regimes. Based on a literature review, Chapter 6 argued that contemporary urbanization patterns are likely to be centripetal: an agglomeration-economy regime that Krätke (2007) refers to as 'metropolization'. However, by situating agglomeration-economy regimes historically, it was possible to include some aspects of the Belgian urban system that are not systematically theorized in the three-systems model: the particularities of the changing political geography of Belgium and cultural factors related to housing preferences and mobility. Prompted by the caution (elaborated in Chapter 3) against applying networked models to understand the internal structure of the Belgian metropolitan area, Vasanen's (2012) connectivity field method was chosen for empirical operationalization. The connectivity field method emphasizes the Euclidian rather than the topological perspective on a metropolitan region, which provides much detail on the spaces in-between historically recognized settlements. Hence, it allows to see functional spatial structures within the nebulous urban geography of central Belgium. The results indicate an emerging contradiction between the centrifugal tendencies of the political geography and the (renewed) centripetal economic geographies of the country. Despite the expectations articulated in the 1980s and 1990s, Brussels remains by far the most important economic node in the Belgian space economy and consequently stimulates urbanization and urban sorting processes in its near environs. These are likely to be spread effects (Myrdal, 1957), which were theorized in Chapter 5 as the effects of being a node in global circuits of value on the central place and daily urban systems. Conversely, we see enduring economic stagnation or limited growth further from the economic center, an indication of backwash effects. In Belgium this has the consequence that the growth pole centered on the Brussels Capital Region, which is too small to encompass its own growth, spills over in Flanders and Wallonia. This provides indications for a renewed salience of a tri-regional economic core region in Belgium, which will likely be the single most important spatial-economic governance challenge for Belgium in the coming decades.

Whereas Chapter 6 primarily focused on the demarcation of the metropolitan core area, which was of relevance for assessing its position in global circuits of value, Chapter 7 engaged in the interaction between (an element of) the central place system and daily urban systems in a smaller segment of Belgium (the Flemish and Brussels Capital Regions). The starting point for the chapter was Peter Hall's claim (2002, re-affirmed in Hall and Pain, 2006: 9) that in the contemporary era, the central place system has 'scaled upwards'. Lower levels of the central place hierarchy have supposedly ceased functioning while upper levels have been added. If Hall's claim about the central place hierarchy were unambiguously correct, much urban sprawl would resemble an 'urban field' (Friedmann and Miller, 1965) where there is little order and centrality in extended urbanization. In the case of Belgium this would imply that the nebular city is indeed much more anarchic than was hitherto argued in this dissertation. Fortunately, the findings presented in

Chapter 7 indicate that Hall's claims about the lower levels of the central place hierarchy seem somewhat overdrawn, at least as far as primary school choice is concerned. By comparing the radically different urban structures of Bruges (clustered) and Genk (sprawled), it was subsequently argued that the different ways in which the daily urban system is organized in these different geographical contexts will likely impact the central place structure. However, these conclusions were inferred from the analysis of only one central function for which detailed data was available. Therefore, additional research is needed to further corroborate and extend these observations.

Chapter 8 reintroduces 'polycentricity' as a planning concept, presenting the account of a planning process to optimize 'critical mass' in the Flemish part of the metropolitan core area. As emerged from the literature survey in Chapter 2, a well-developed definition of polycentricity as a planning concept is difficult to discern. Nevertheless, Chapter 8 shows that there is an (old-fashioned) literature in urban economics and urban planning that debates of polycentricity as a planning concept could have referred to: the discussions on 'new towns' and the 'optimal city size'. As the literature review in Chapter 8 demonstrates, there is reason to be skeptical of the self-contained small settlement. However, developing smaller, clustered, nodes in a network of settlements—hence stimulating polycentricity and borrowed size—could be a viable spatial development strategy. In the language of the three-systems model this implies that one tries to retain—through urban and regional planning—much of the lower level central (consumption) functions near the place of residence while stimulating simultaneously a better integrated labor market at the metropolitan scale. It was noted that the current economic base of Northern Belgium is possibly too small to optimize the 'Flemish Diamond' in one single phase of a planning trajectory. Given the relatively slow evolution of the space economy, a phased development of optimizing the currently existing transport system in transport-oriented development was proposed.

By re-introducing the notion of polycentricity as a planning concept, the visioning exercise elaborated in Chapter 8 resonates with existing imaginations of a polycentric metropole in Flanders as set out in the Green Paper on Spatial Planning (Flemish Government, 2012). Moreover, using polycentricity as planning concept allowed for introducing analytically the causal mechanisms of the three-systems model without jettisoning the planning connotations associated with polycentricity. This enabled the production of evidence-informed knowledge that can guide devising solutions to the huge mobility and housing planning challenges that Flanders currently faces. The biggest shortcoming of the planning exercise as it relates to the three-systems model is that we were unable to take the full (tri-regional) scale of the metropolitan area (the position of the metropolitan core area as a node in global circuits of value) into account. Nevertheless, it was argued that governance limitations apply and that the added critical mass of Wallonia can only make the developed argument more robust.

While not undermining the validity of the results in this case, these shortcoming indicate limits in applying the three-systems model in a given spatial context, which also reveal the tensions inherent to applied research (Beaumont et al., 2005). A study with chorological momentum is likely to encounter constraints in terms of data and funding which might prevent it from fully avoiding the chaotic abstractions that were theorized to be detrimental to a critical realist approach. In that sense, the methodology proposed in this thesis is far from a silver bullet to resolve the tensions and contradictions between geographical knowledge production and planning and policy (Beaumont et al., 2005; Davoudi, 2006). The research process as it has unfolded in this project has made those shortcomings manifest, wiring a moment of engaged pluralist reflection into the methodological choices. This speaks to the importance of going through abstract phases of research in which causal mechanisms and critical asides to a research design are formulated. For instance, this research repeatedly revealed the importance of creating spatial visions, like regarding housing or mobility, on scales that crosscut (city and regional) administrative boundaries. This shows how the critical realist method through which urban systems theory was renovated may end up producing critical questions, even in applied research (Pain, 2006). Such an outcome would seem to vindicate the claim that old-fashioned geography can play a role in critically engaging with the world and can be useful for emancipatory spatial planning.

9.4 Suggestions for further research

As regards research question two, which aspired to examine the extent to which the three-systems model can explain Belgian settlement geography, the answer is a humble 'yes but'. It is without doubt that the renovated three-systems model can provide adequate and useful explanations of Belgian settlement geographies and can at least arbitrate between critical research and policy making. However, the concrete phase as developed in this dissertation leaves as many questions about the applicability of the three-systems model to the Belgian context open as it answers. The research cycle followed has ultimately only resulted in positive indications on the applicability of the three-systems model. Turning these careful positive indications into a full-fledged explanation would unfortunately require another research cycle. In this respect, it does not help that, as noted in Chapter 1 (Footnote 33), some of the empirical materials that show the relevance of the central place system and the daily urban system in Belgium still lie dormant in Dutch-language reports (Storme et al., 2015; van Meeteren et al., 2015; 2016b). In part, I have created an explanandum for my explanans without fully taking the last bite and providing the definite proof of the pudding (cf. Saey, 2012 [2009]), at least in this collection of studies.

These rather limited results can be partly explained by the resources ant time spent on constructing the methodological bridge needed to dispel some of the controversial issues associated with old-fashioned research. This excursion distracted me somewhat from my initial research goal: comprehending the settlement geography of contemporary Flanders and Belgium. Indeed, I got carried away by what seemed academically more important issues. And when observing the time-constraints of most tenured academics around me, I can state in full conviction that we might be in serious trouble if even a PhD trajectory no longer provides an opportunity to get carried away. Moreover, the reason for my distraction was to take the time to do a proper inspection of the theoretical building, which was reported upon in the abstract phase of the research. And here, I can assert that haste would most likely have made waste. By adopting a methodology that forced me to inspect the controversial claims within the proposed research design, I developed new and perhaps more important questions than I initially set out to answer.

The advantage of having presented an unfinished journey is that it is easy to distill some suggestions for further research. Just think of the number of citation analyses (as conducted in Chapter 2) that are possible to test the propositions regarding engaged pluralism presented in Chapters 1 and 9. What will happen if we combine all sorts of network-analytical research designs with field-distribution conceptions to unpack this mysterious concept of agglomeration externalities further (Chapter 3)? How many central place studies could be done with a reinvigorated methodology before the study of an upper range of a good will again teach us less and less of relevance (Harvey, 1972; Chapters 4, 7)? How would the renovated urban systems theory hold up in different contexts across the globe? (Chapter 5)? When it comes to suggestions for further concrete research based on the findings of this dissertation, there are plenty of ideas as well. Some of the biggest issues facing Belgium are the triple whammy of a cardiac (c)arrest due to an inefficient mobility system (Boussauw, 2011), a looming housing crisis (De Decker et al., 2015), and—like most countries in Europe—an economy that refuses to reboot (Bassens et al., 2013). Although spatial consequences do not necessarily have spatial causes, geography matters nonetheless (Massey, 1995 [1984]). Knowing that there are government policies imaginable (Chapter 8) that can catch multiple birds with one stone in alleviating these problems sure is helpful.

The biggest issue is perhaps not to identify suggestions for further research, but to determine which ones to prioritize in the face of ever-dwindling resources. Here, the imperatives of critical social science ought to provide guidance on how to allocate the remaining resources. For me, for now, that means focusing on that growth pole in the middle. Where did that renewed centripetal development towards Brussels that seems to rejuvenate the Belgian scale at least economically come from (Chapter 5)? Is it because of 'world city Brussels', that mysterious European power-bundle with all sorts of strange and scary effects? I can't wait to find out.

Coda

This thesis advocates a re-appreciation of theories and techniques from geography's spatial science era. These theories tend to be controversial in contemporary geography because they represent to many critical geographers what Wyly (2011) has called 'Positivist City Hall' whose

> machine politics operate through a distinctive enforced patronage system of modernism, rationality, expertise, race, class, age, gender, sexuality, hierarchy, epistemology, methodology, state authority and (false assertions of) neutrality and objectivity.
>
> Elvin Wyly (2011: 893)

As historical and biographical contextualization has played such an important role in this dissertation, I would like to end, by means of a coda, with contemplating how this perception of Positivist City Hall came to be, what it might tell us about the present, and how it might inform (the ways to engage in) future research.

Modern geography—to borrow a term from Peet (1998)—seems obsessed with the spatial separation theme, according to which we can isolate geographical phenomena, 'thing geographies', from their temporal context, 'process geographies' (Pred, 1983). Spatial separation did not only fit well in the future-oriented discourse of modernism (Ley, 2003), it moreover promised to give geography as a discipline its own non-ideological subject matter (Gregory, 1978). Influential people such as Schaefer (1953) and Bunge (1966 [1962]) asserted that becoming a 'science of space' (and only space) was the only way in which geography would deserve its place under the sun; an argument that landed by force through traumatic events such as the closure of the Geography Department at Harvard due to it not being 'scientific' enough (Smith, 1987).[56] The 'liberation' that spatial

[56] However—and this is at this moment a speculative remark requiring further historical research taking into account all the situational contingencies spelled out by Smith (1987)—this battle over 'science' in geography needs to be placed into historical context. Scientific discourse immediately post-1945 seems to have been highly skeptical of vitalist/organicist discourse (see Kwa, 2011, for an historical introduction), which is–undoubtedly a revisionist hyperbole–particularly associated with German geographers such as Ratzel (Dijkink, 2004; Dittmer, 2013). After the World War II, German geography was suspect in the Anglophone geographic community, not in the last place due to its questionable role in the run-up to the war (Troll and Fischer, 1949). Moreover, as Krugman (2011) argues, non-mathematical economics was also discredited due to its failure to deal with the 1930s economic crisis. It is telling that Wolfgang Stolper, in the preface of the translation of August Lösch's *Räumliche Ordnung der Wirtshaft*, commences with explicitly stressing Lösch's anti-Nazi position, while lauding his rationalism (Stolper in Lösch, 1954: vii). This probably contributed to central place theory being embraced in geography and regional science despite its German origins. It also provides a provisional explanation of why Christaller and other German authors were so heavily reinterpreted in the rationalist mould (Chapter 4).

separatism gave to practitioners of modern geography is probably best expressed by Olsson (1972: 28) when he yearns for a scientific language that would allow him to 'no longer [to] be haunted by the ghost of historicism and no longer [to] be scared, lured, and stultified by the rattling of its doomsday chains'.

It should be remembered that logical-positivism, rationalism, and even modernism (Harvey, 1990) have important antecedents in the antebellum as emancipatory forces, to dispel the militarist and social-Darwinist ghosts of the 19th century (Faludi, 1989; Mirowski, 2005; cf. Wyly, 2011).[57] This emancipatory element provides an explanation for the peace-devoted methodological zealotry of Isard (Glasmeier, 2004) and resonates with the normative positions of Lösch (Lukermann, 1961; Barnes, 2016). Moreover, it goes a long way to provide a psychological hypothesis for the biographical and methodological trajectories of quintessential modernist critical geographers and planners such as David Harvey, Gunnar Olsson, Pieter Saey and John Friedmann (see, for instance, the events chronicled in Barnes, 2004: 589; Pred, 1979; and Olsson, 1983). As some of the promises of logical-positivism, like objective rationalist knowledge, were increasingly believed to be unattainable by the early 1970s, these progressive scholars felt urged to search for other ontologies and epistemologies (cf. Sheppard, 2001; Barnes, 2004; Cox, 2014; Lake, 2014).

The strategy for theoretical renovation adopted in this thesis was to go back to the original authors, interpret the historical context of their respective theories and intellectual projects, place them empathically in that context, and move chronologically toward the present from there. This strategy was also chosen to be able to 'bracket' some of the 1950s and 1960s American experience, which has had an enormous imprint on the common sense in urban geography and the way in which these theories are assessed in the literature. The Positivist City Hall critique on spatial science can primarily be regarded as criticism of the US conception of the world in the 1950s and 1960s (Wyly,

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Little did they seem to know about Walter Christaller's poor choice of employer (Barnes, 2016). However, it remains unclear to what extent Christaller's past was known in the community of urban scholars of the 1950s and 1960s, but judging from Vance's (1970: 166) astonished disgust and Bunge's (1977) emotional denial, it was not widely debated before Carol's (1970) obituary of Christaller. Robert E. Dickinson, who i) did fieldwork in Nazi Germany in the late 1930s; ii) met Christaller there (Johnston, 2000a); and iii) was present at the 1960 IGU meeting in Lund where Christaller, American regional science, and quantitative revolution geography intermingled (Norborg, 1962) might have known or suspected more. However, inferring whether he would have been likely to share this knowledge requires 'professional' historical inquiry. Johnston (2000b: endnotes 9, 24) identifies clues hinting at Dickinson's (not wholly implausible) British military intelligence connections.

[57] In this context, it is probably causally significant that Fred Schaefer was directly exposed to the Vienna Circle in the antebellum (Bunge, 1979; Sheppard, 2014).

2011). We have to make a difference between the tools used and the political context in which these tools were applied (Morrill, 1983), while simultaneously appreciating the impossibility of rationalism in the formulation and demarcation of theoretical concepts (Barnes, 2004). Attempting to cast central place theory in the spirit of its original methodological perspective not only weakened the Positivist City Hall imprint on the theory, but also facilitated a critical realist reinterpretation, as Christaller's methodology of 'isolation' is closer to a critical realist ontology than the 1950s and 1960s reinterpretation of central place theory in spatial and regional science.

Given the prominence of spatial separatism as a defining theme in *modern* geography, it is remarkable that Soja (1989) took the spatial separatist theme as the centerpiece of his *post*modern geography.[58] That Soja was unable to escape the historically-driven Lefebvrian reasoning in his work seems obvious in his later formulations (e.g. Soja, 2011). To me, this tension also bears testimony to the impossibility of the spatial separatist task, as could be foreseen by reading Saey (1968b) and Sack (1972; 1974).[59] And indeed, this dissertation—a plea for the relevance of the geographical imagination—would not have been possible without situating its fundamental building blocks in time and place, in order to gauge their contemporary relevance (Barnes 2004; van Meeteren et al., 2016a). Hence, I concur with Massey's (2009) conclusion that 'synchronism is a prison house' and that temporality and spatiality cannot be ontologically separated if social science is to be truly emancipatory (see also Blaut, 1961; Hägerstrand, 1982; Pred, 1977; Giddens, 1984). This does not mean, as evidenced by Chapter 1, that cross-sectional analysis is *a priori* an illegal methodological strategy to answer tangible research questions in a practically adequate way (Sayer, 1992 [1984], see also Merrifield, 1997; Wyly, 2009). Human geographers can only hope that the discipline is finally ready (as Saey, 1968b; Gregory ,1978; and Smith, 1979 already argued it should) to let go of its longstanding anxiety of not having its own research object, neatly demarcated from those of other scientific disciplines. A research subject will do just fine.

Despite exposing disciplinary fissures and endorsing engaged pluralism, this dissertation intended to show the value of disciplinary thinking (i.e. human geography) in order to contribute to transdisciplinary debates (i.e. urban studies, regional science). Indeed, the geographical imagination has something to bring to the table in debates on the big social issues of our time (see also Eyles and Lee, 1982; Lee, 2002). Disciplines provide a—temporary and unstable—set of rules of engagement that allow for building shared

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[58] 'Geography' in the singular is deliberate here, to be consequent in abstraction: it is the abstracted practice by postmodern geography (singular) of producing postmodern geographies (plural).

[59] Ironically it was the lack of historical sensitivity and acknowledgement of time-boundedness in 19th century social theory that led Charles Tilly (1984) to write the book that inspired the framing of this dissertation.

substantial conclusions and the qualified use of elliptical arguments. Foucault's (1978 [1975]) remarks on how discipline is a technology of the self, a willful albeit not always reflexive subjugation to an imposed discourse to contribute to a bigger cause, are well taken, although Sennett's (2008) empowering account of framing discipline in terms of craftsmanship is a more encouraging way to put it. Therefore, despite sharing our research object with other disciplines in order to bring interesting insights to the table, human geography will hopefully continue to have its own place in the sun. Our task as critical social scientists is then to make that 'contribution to a bigger cause' emancipatory (Sayer, 1997; 2009). The gain of the disciplinary apparatus is the luxury of using elliptic arguments and shortcuts without risking being misinterpreted and losing interlocutors down the road. Nevertheless, the convenience of elliptical arguments ought not be used to silence people, which would render such arguments controversial. Unfortunately, geography has a long history of doing just that. Only in geography, it would seem, is it possible to repeatedly reject the seminal papers of one of the discipline's most cited authors during a large part of the 20th century, Brian Berry (see Bodman, 1991), for 'not being geography' (Berry, 2001), a complaint too repeatedly voiced by people who, with hindsight, are towering figures in the field (e.g. Taylor, 1976; Gould, 1979; Smith, 2005).

These last remarks also remind us why adherence to researcher ethics is so important (Curry, 1991; Lake, 2014)—the 'communism', the 'institutionalized skepticism' and the critical social science duty to 'reduce illusion in the world' discussed in Chapter 1. Let's think of them as a kind of 'Hippocratic oath'. A professional academic is bestowed authority by society in function of her/his social role embodied in, for instance, a PhD degree. When that scientific authority is under pressure and called–often legitimately enough—into question by that very society (Wyly, 2009; cf. Callon et al., 2009 [2001]), we have an even stronger responsibility to preserve that authority. Not in an authoritarian technocratic way, but by being committed to good scientific practice. By giving sufficient credit where credit is due in our citing and reading practices, by relentlessly stress-testing our favorite theories (Burawoy, 2009; Peck, 2015), and by practicing engaged pluralism (Barnes and Sheppard, 2010)—however difficult and sometimes irritating that might be in practice.

* * *

This thesis opened with Andrew Sayer reworking a quotation of a headstrong logical-positivist: Otto Neurath (Faludi, 1989), who compared the development of knowledge to rebuilding a boat, plank by plank, while on the high seas. To inspire future shipbuilding, I will end this thesis with a great modernist geographer who, perhaps more than anyone else, was a master shipwright.

What other montages of the present are to be devised, what other practices of heretical empiricism are to be brought to bear, so as to enable some re*cognition* of the mutual entanglements of modern politics, economy and culture?

What other histories of the present are to be devised so as to make visible the multiple pasts layered within the present moment? So as to startle the reader-observer out of the dream-world of commodity-society-modernity. So as to trigger an awareness of the ever-again-the-same qualities of modern commodity forms and their associated would-be hegemonic discourses, and thereby, so as to render the possibility of sensibilities that are never again to be the same.

What political actions, if any, are to result from the re*cognition* of European modernities that at once possess shared characteristics — as well as complex interdependencies and interactions of past and present — and yet are nationally (and regionally or locally) distinctive? Or from the *recognition* of the multiple modernities that have existed in any one country and that residually persist in the volatile current moment of fast-capitalism and hypermodernity?

What interrogates and re-presentations are appropriate to other European instances?

What are the tension-riddled images to be evoked?

What is to be shown?

What is to be done?

Allan Pred (1995: 264, emphasis in original)

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Summary

The Belgian urban fabric is sometimes described as anarchic, chaotic or haphazard, although locally the name 'nebular city' is preferred to describe the finely grained and spread-out urban morphology of the Belgian urban system. Despite this complex geography, order and coherence can be discerned, as explained in this dissertation 'From Polycentricity to a Renovated Urban Systems Theory: Explaining Belgian Settlement Geographies'. The dissertation defines a framework through which settlement geographies in Belgium and Flanders can be better understood, which yields knowledge that might contribute to better spatial planning.

The Belgian and Flemish settlement geographies have a long history of development. Different eras of urban development have left their traces on the built environment. This results in a complex urban system where the boundaries between the city and its outside are difficult to define. Each urban function describes a city with a different form and scale, hence we make as many different demarcations of cities as we can describe urban functions. Most contemporary accounts of West-European urban systems refer to their 'polycentric' characteristics. The Flemish Diamond, the Dutch Randstad, and The Rhine-Ruhr area are all regarded urban networks of which the regional total is more than the sum of the settlement parts. However, not all scholars are convinced that the notion of 'polycentric urban regions' has sufficient conceptual rigor and analytical precision. Conceptualizing regions as 'networks' can provide clarity, but the method might run into trouble when describing sprawled urban morphologies such as the Belgian settlement geography.

To overcome this dilemma, this dissertation identifies alternative ways to study Belgium's urban fabric. It revisits theories about urban systems developed in human geography in the 1960s, and re-evaluates their contemporary relevance. In the historiography of human geography, this era is known as the 'spatial science era'. The geographical approach developed during that time has been routinely criticized as being 'positivist', 'reductionist' or otherwise lacking, and has therefore slowly disappeared from much of contemporary geographical inquiry. Nevertheless, as the thesis shows, there are important insights that can be salvaged from this 'old-fashioned geography', although not without taking the criticisms directed at the approach into account.

The thesis is organized according to the 'new orientation' of 1960s Belgian geography, being comprised of both abstract and concrete phases. In the abstract phase, causal mechanisms are identified and isolated (Chapter 2-4), which ultimately leads to the formulation of a renovated urban systems theory (Chapter 5). In the second half (Chapters 6-8), the renovated urban systems theory is applied to the Belgian settlement geography. Chapters 1 and 9 provide methodological and historical background.

The four chapters comprising the abstract phase examine controversial aspects of urban

systems theory, assessing its legacy and investigating its potential use for contemporary urban geography. The challenge here has been to 'renovate' those parts of the theory that are still useful for understanding the present. In the last fifty years, the discipline of human geography has witnessed a rapid and accelerating succession of paradigms (or 'turns'). One consequence of these frequent paradigm shifts is that the old paradigm tends to be jettisoned away rather crudely, meaning that 'good parts', or those that could withstand criticism, might become lost. ‘Renovating’ spatial science theories implies recovering those good parts while retaining the capability to incorporate insights of the paradigms that succeeded spatial science. As argued throughout the dissertation, such a renovation exercise benefits from making urban systems theory compatible with critical realist philosophy of science. Adopting a critical realist perspective implies that causality has to be formulated in terms of causal mechanisms rather than laws of constant conjunction. Moreover, a renovated urban systems theory has to take into account that the methods available to the contemporary researcher were science fiction to researchers in the 1960s, who routinely had to do complex workarounds and use crude assumptions to deal with data or computing capacity shortages. These workarounds need to be revisited to gauge whether they are still necessary given the ubiquitous availability of PCs, GIS systems and the big data revolution.

The described ‘renovation’ work mostly takes place in Chapters 2-5. Chapter 2 interrogates received theory about polycentric urban systems, exploring the ambiguity of the polycentricity concept by means of an extensive citation analysis. This leads to the conclusion that an alternative framework based on the notion of agglomeration externalities is to be preferred. Continuing this angle, Chapter 3 contrasts the concepts of agglomeration and network externalities and discusses where the network conception of urban systems falls short. Subsequently, it proposes that network perspectives can be combined through a more territorially-focused conception of the space economy. Chapter 4 provides a methodological and empirical study of central place theory. It concludes that, despite much criticism, the theory retains conceptual and empirical usefulness to study contemporary urban systems.

Chapter 5 combines the results of the ‘renovation’ exercise conducted in the previous chapters to propose a relatively open and pluralist variety of urban systems theory: the 'three-systems model', originally developed at the University of Amsterdam in the 1980s. The three-systems model regards urban systems as the interplay of three, relatively autonomous, subsystems: the central place system as first elaborated by the German geographer Walter Christaller, the daily urban system, which is based on the insights of Swedish geographer Torsten Hägerstrand, and the 'system of global circuits of value', ultimately building on export base theory and the ideas of the Swedish economist Gunnar Myrdal (1957). These three non-homologous urban subsystems influence one another in a co-evolutionary manner, where change in one of the three subsystems influences the two others. While based on ‘old-fashioned’ geography, it is concluded that the three-systems model can still be used to understand the complex urban constellations of today, for instance those theorized in the planetary urbanization research agenda.

The three chapters that comprise the concrete phase of the dissertation (Chapter 6-8) subsequently apply these insights to the Belgian urban system and some of its subregions. Chapter 6 commences with an historical overview of the evolution of the Belgian urban system, and analyzes how the current wave of 'metropolization' articulates itself in Belgium. This analysis shows how metropolization integrates agglomerations commonly theorized as independent entities, even across the boundaries of the Belgian federal regions. Chapter 7 subsequently probes the validity of some aspects of the central place system in the northern Belgian context. Through a micro analysis of home-school travel in the Dutch language primary school system, it is concluded that the lower levels of Christaller's central place theory still have explanatory value and that central functions retain dependence on the spatial structure. Chapter 9 extends the renovated urban systems theory to the concrete realm of Flemish urban and regional planning. Building on the 1960s and 1970s literature of 'optimal city size', the chapter describes a planning workshop for the Flemish Government, where the conceptual apparatus of this dissertation was applied in the field. Based on spatial analysis, optimal locations for densification in housing, labor- and transportation systems were identified that could lead to an economically and ecologically more optimized urban system, while taking into account the political constraints of the current conjuncture.

The thesis concludes with the reflection that old-fashioned geography still has a role to play in an engaged-pluralist human geography, which promotes a continuous dialogue between perspectives that are in tension with one another. The critical-realist tools developed in the thesis can provide an adjudication of truth claims regarding spatial development. Ultimately, this will also benefit spatial planning, as knowing what claims about the world are less false than others is a precondition for changing the world to the better.

Samenvatting

Het Belgisch stedelijk weefsel wordt soms beschreven als 'anarchistisch' of 'chaotisch', al prefereert men lokaal het iets elegantere 'nevelstad' om de fijnmazige en uitgespreide stedelijke morfologie van het Belgisch stedelijk systeem te duiden. Toch is er in deze complexe geografie wel degelijk orde en coherentie te ontdekken. Dit proefschrift "*From Polycentricity to a Renovated Urban Systems Theory: Explaining Belgian Settlement Geographies*"[60] ontwikkelt een raamwerk waarmee nederzettingsgeografieën in België en Vlaanderen beter kunnen worden geduid. Dat betere begrip dient op haar beurt bij te dragen aan een beter geïnformeerde ruimtelijke planning in Vlaanderen.

De Belgische en Vlaamse nederzettingenstructuur, kennen een lange geschiedenis. Verschillende tijdperken hebben overlappende sporen nagelaten in de gebouwde omgeving. Dit resulteert in een complex stedelijk systeem waarin de grens tussen 'de stad' en 'de buiten' moeilijk te definiëren is. Elke 'stedelijke functie' beschrijft een stad die functioneert op een ander schaalniveau en er zijn dus evenveel stedelijke afbakeningen te ontwaren als er stedelijke functies zijn. Beschrijvingen van West-Europese stedelijke systemen met een dergelijke complexe structuur refereren vaak aan hun 'polycentrische' karakter. De Vlaamse Ruit, de Nederlandse Randstad of het Duitse Ruhrgebied worden gezien als stedelijke netwerken waar het geheel meer is dan de som van de nederzettingen die er deel van uitmaken. In de wetenschappelijke literatuur is echter niet iedereen ervan overtuigd dat de notie van 'polycentrische stedelijke regio' rigoureus genoeg gedefinieerd is. Hoewel het zien van stedelijke gebieden als 'netwerken' verheldering kan bieden, brengt het ook blinde vlekken met zich mee. Dit roept de vraag op of deze begrippen wel voldoende analytische precisie hebben om deze metropolen te duiden, in het bijzonder bij een 'uitgesmeerde tapijtmetropool' als de de Belgische?

Teneinde aan de tekortkomingen van de polycentriciteitsnotie te ontsnappen omtwikkelt deze dissertatie een meer adequaat theoretisch kader om de Belgische stedelijke structuur te bestuderen. Het gaat hiervoor te rade bij stedelijke systeemtheorieën uit de jaren zestig van de vorige eeuw, een tijdperk dat in de historiografie van de sociale geografie bekend staat als het 'tijdperk van de ruimtelijke wetenschap'. Deze wijze van geografisch onderzoek wordt in de hedendaagse wetenschappelijke literatuur vaak afgedaan als 'positivistisch' en 'reductionistisch', of zou op een andere manier in gebreke blijven, en is om die reden deels verdwenen uit de hedendaagse geografische praktijk. Dit proefschrift betoogt dat er echter nog veel te leren valt van de 'ouderwetse geografie' uit de ruimtelijke wetenschap, mits men de kritieken die erop geleverd zijn serieus neemt en verdisconteert.

Het proefschrift is opgezet in de vorm van de Belgische 'nieuwe oriëntatie' in de geografie.

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[60] De titel laat zich grofweg vertalen als: "Van polycentriciteit naar een gerenoveerde stedelijk-systeemtheorie: het verklaren van Belgische nederzettingsgeografieën"

In de abstracte fase van het onderzoek worden causale mechanismen geïdentificeerd en geïsoleerd (hoofdstukken 2 tot en met 4), een zoektocht die leidt het het formuleren van een 'gerenoveerde' stedelijke systeemtheorie (hoofdstuk 5). De tweede helft van het werk (hoofdstukken 6 tot en met 8) past de gerenoveerde stedelijke systeemtheorie vervolgens toe om de Belgische nederzettingenstructuur te verklaren. Hoofdstukken 1 en 9 voorzien in methodologische en historische kadering.

De hoofdstukken in de abstracte fase onderzoeken enkele controversiële aspecten van stedelijke systeemtheorie. Ze evalueren die erfenis en verkennen de hedendaagse bruikbaarheid. De uitdaging hierbij is om stedelijke-systeemtheorie te 'renoveren'. De sociale geografie heeft een grote hoeveelheid 'wendingen' en paradigmawisselingen te verduren heeft gehad in de afgelopen vijftig jaar. Een van de gevolgen van die wetenschappelijke wendbaarheid is dat oude paradigma's over het algemeen vrij achteloos over boord gegooid worden, waardoor er ook nog bruikbare 'theoretische onderdelen' bij het vuil terecht komen. Een renovatie stelt zich ten doel die bruikbare onderdelen te recupereren met inachtneming van kritieken die daar in de loop der tijd tegenin gebracht zijn. De dissertatie betoogt dat deze incorporatie de meeste kans van slagen heeft als het theoretisch kader wordt geherformuleerd in de wetenschapsfilosofische stroming van het kritisch realisme. Deze stroming zoekt oorzakelijkheid in causale mechanismen in plaats van causale wetten die afgeleid worden uit regelmatige samenhangen. Tot slot moet een renovatie er rekening mee houden dat de methoden die de hedendaagse onderzoeker tot zijn of haar beschikking heeft in de jaren zestig nog volkomen *science fiction* waren. Men moest in die tijd grove aannames doen en slimme trucs toepassen om met een beperkte datakwaliteit en computercapaciteit toch tot resultaten te komen. Een renovatie moet de blijvende relevantie van sommige aannames die ontwikkeld zijn in een tijdperk van technische tekortkomingen heroverwegen, zeker nu er veralgemeend computer bezit, grote digitale databestanden en geavanceerde geografische informatiesystemen zijn.

Het renovatiewerk vindt voornamelijk plaats in de hoofdstukken 2 tot en met 5. Hoofdstuk 2 analyseert de theorievorming rondom polycentrische stedelijke systemen. Het doet dit door middel van een extensieve citatieanalyse, die de ambiguïteit van het polycentriciteitsconcept blootlegt. Deze analyse leidt tot de conclusie dat een alternatief conceptueel raamwerk gebaseerd op agglomeratie externaliteiten de voorkeur geniet. Deze richting wordt voortgezet in hoofdstuk 3 waar de begrippen agglomeratie- en netwerkexternaliteiten vergeleken worden en waar wordt ingeschat voor welke toepassingen een netwerkopvatting van stedelijke systemen meer en voor welke het minder geschikt is. Het resultaat is een benadering waarbij netwerkperspectieven idealiter gecombineerd worden met meer klassieke 'territoriale' analyses van de ruimtelijke economie om tot een overkoepelend beeld te komen. Hoofdstuk 4 presenteert vervolgens een methodologische en empirische studie van de grondslagen van centrale-plaatsentheorie. De conclusie van deze analyse is dat ondanks alle kritiek erop, centrale-plaatsen theorie nog prima in staat is om nuttige empirische inzichten te verschaffen over hedendaagse stedelijke systemen.

Hoofdstuk 5 combineert de resultaten van de renovatieoefening die uiteengezet is in de voorgaande hoofdstukken om een relatief open en pluralistische variant van stedelijke systeemtheorie te ontwikkelen: het drie-systemenmodel, dat in eerste instantie in de jaren tachtig aan de universiteit van Amsterdam ontwikkeld werd. Het drie-systemenmodel beschouwt stedelijke systemen als een samenspel van drie relatief autonome subsystemen: het centrale-plaatsensysteem zoals voor het eerst uiteengezet door de Duitse geograaf Walter Christaller, het dagelijks stedelijk systeem, dat geanalyseerd wordt op basis van de inzichten van de Zweedse geograaf Torsten Hägerstrand, en het 'systeem van mondiale waardeketens' waarin de rol van knopen in die waardeketens beschreven wordt met inzichten uit de theorieën van de eveneens Zweedse econoom Gunnar Myrdal. Deze drie, niet geografisch contigue, stedelijke subsystemen beïnvloeden elkaar op co-evolutionaire wijze, waarbij een verandering in een van de drie subsystemen haar weerslag heeft op de andere twee. Alhoewel het het drie-systemenmodel gebaseerd is op 'ouderwetse geografie' concludeert de dissertatie dat het model nog altijd verklarende waarde heeft in de hedendaagse debatten over mondiale verstedelijking.

In de tweede helft van de dissertatie, die de concrete fase behelst, wordt het drie-systemenmodel dat ontwikkeld werd in de abstracte fase toegepast op de Belgische en Vlaamse nederzettingenstructuur. Hoofdstuk 6 vangt aan met een historisch overzicht van de ontwikkeling van het Belgisch stedelijk systeem en analyseert hoe de hedendaagse golf van metropoolvorming zich in België manifesteert. Deze analyse laat zien hoe metropoolvorming agglomeraties die nog vaak als een afzonderlijke stad gezien worden deels integreert, ook over de Belgische gewestgrenzen heen. Hoofdstuk 7 vervolgt met een studie die kijkt in hoeverre een aantal aspecten van het centrale-plaatsensysteem op Noord-België van toepassing zijn. Door een fijnmazige studie van woon-school verplaatsingen in het Nederlandstalig lager onderwijs wordt geconcludeerd dat voorzieningen van het laagste niveau nog steeds centrale plaatsen lijken te articuleren en dat de ruimtelijke structuur keuzes voor voorzieningen nog altijd beïnvloedt. Hoofdstuk 9 brengt tot slot de gerenoveerde stedelijke systeemtheorie terug naar de Vlaamse ruimtelijke planning. Voortbouwend op de literatuur over de 'optimale stadsgrootte' presenteert het de resultaten van een planningatelier dat georganiseerd werd voor de Vlaamse overheid. Hier werden de concepten die in de dissertatie ontwikkeld zijn aan een praktische test onderworpen. Op basis van ruimtelijke analyse en interactie in het planproces werden optimale locaties voor de verdichting van woon en werkgebieden en openbaar vervoersinfrastructuur voorgesteld. Het realiseren van die voorstellen zou kunnen bijdragen aan een economisch en ecologisch robuuster stedelijk systeem.

De dissertatie concludeert met een pleidooi voor de relevantie van 'ouderwetse geografie' voor een pluralistische discipline die zich engageert in het bouwen van bruggen tussen tegengestelde perspectieven. Het ontwikkelde kritisch-realistisch instrumentarium biedt een kader om beweringen over ruimtelijkheid te staven. Dit is ook van nut voor ruimtelijke planning. Immers, gedegen en onderbouwde geografische kennis is een voorwaarde voor het ontwikkelen van adequaat ruimtelijk beleid.

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Michiel van Meeteren (°1979, Leiden, the Netherlands) is a human geographer, educated at the Universities of Amsterdam (BSc, MSc) and Ghent (PhD) and currently working as researcher at the Vrije Universiteit Brussel. Before entering academia, he spent considerable time working as a professional musician and as an applied researcher in spatial economics and urban and regional planning. His research interests are broad, covering urban, economic, financial, and political geography, coupled with a strong dedication to the history of geography as a discipline and methodology. In the last few years, informed by pressing societal issues, his research has increasingly pivoted toward geographies of contemporary Europe, political-economy, the geography of the financial sector and how these phenomena intertwine in the Brussels Capital Region.

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