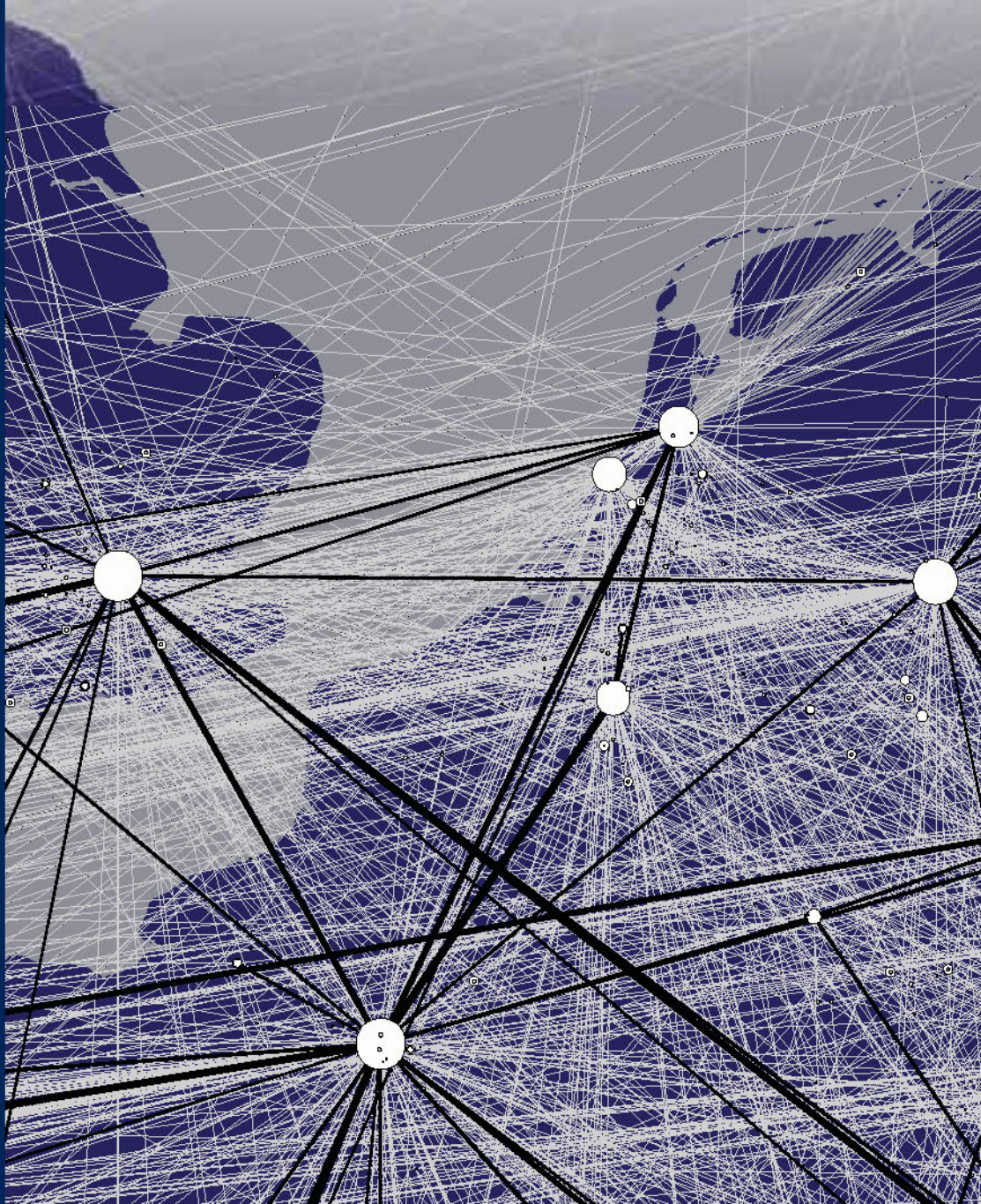
RONALD WALL

Netscape

Cities and Global Corporate Networks



NETSCAPE
Cities and Global Corporate Networks

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(Het netwerklandschap: steden en mondiale bedrijfsnetwerken)

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To Lois, Phoenix and Xavier

Acknowledgements

In the year 2000 I was commissioned by the Dutch National Spatial Planning Agency (RPD) to do a research project on 'Healthy Cities'. In retrospect the foundations for my PhD were laid during this period as it was the first time that I became interested in global economic networks and their impact on the performance of cities. It will therefore not be surprising to many readers that my advisor at the time was Bert van der Knaap who initially introduced me to the field of economic geography and especially city network literature. After completing this study I returned to my original profession of architecture and urban planning, but my interest in city networks grew. Eventually a few years later I decided to pursue my interests in economic geography by doing my PhD at Erasmus University. For these reasons I first and foremost am indebted to my supervisor Bert van der Knaap for inspiration, input and coaching me over the past years.

Furthermore it would have been impossible to write this thesis without the help I received from colleagues. I therefore want to thank these people who either directly or indirectly contributed to the development of my PhD thesis. A special thanks to Martijn Burger for his help and assistance concerning network analysis theories, methods and techniques. Together with Bert our joint collaboration has ensured the success of several papers in scientific journals. In a similar light I want to thank Wilfred Sleegers for his inspiration and help during our research for the Milieu Plan Bureau (MNP) several years ago. I also want to thank Philipp Koellinger, Bas Karreman, Sandra Phlippen, Enrico Pennings, Lambert van der Laan, Wouter Jacobs, Cesar Ducruet, Leo van den Berg and Hans Koster for their inputs during the past few years. Also this thesis would have been impossible without data. Therefore I want to express my appreciation to Imsik Cho, Michiel Raats, Gijsbert Bouw and Suitbert Schmitt who over the years assisted me in collecting and preparing the data used in the analyses.

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During the course of my PhD I have been professor at the Berlage Institute and Rotterdam and Amsterdam Academies of Architecture and Urban Planning and would like to show appreciation to the staff (especially Vedran Mimica, Rob Docter, Zef Hemel and Alejandro Sao Paulo) colleagues and students for their contributions which inspired several concepts found in this dissertation. In this context I want to particularly express my thanks to Duzan Doepel who co-tutored the three year project Edgeless City with me at the Rotterdam Academy.

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Prologue

The central argument and question of this study

The central argument of this thesis is that a new approach to city development is needed which connects knowledge of local processes within a city (place) to knowledge of global processes between cities (network). Although this conception has existed for some time (e.g. Friedmann, 1986, Castells, 1996, Graham and Marvin, 2002, Taylor 2004) most studies remain quite general and little empirical evidence on networks are provided to validate them. Therefore this thesis makes two contributions. The first is that five specific network themes have been theoretically identified, forming the basis for analyses in the rest of this book. The second has been to empirically reveal the importance of worldwide city networks to urban hierarchies and performances. In light of these contributions it is important to be clear to the reader from the start that the networks explored in this thesis concern the corporate relationships between headquarters and their worldwide subsidiaries. It is therefore firms which determine the intercity structures found in this study. In this context, recent literature proposes that the fate of cities has become increasingly tied to their position in international flows of investment and trade (Alderson and Beckfield, 2004) and where the local development of cities has become increasingly complimented by their global positions. From this initial premise it is argued that networks form the essential element between the processes of globalization and urbanization. These processes will now be briefly explored.

The process of globalization

Today the definition of 'globalization' is characteristically defined as the 'international integration' of three types of markets i.e. commodity markets; labour markets; and capital markets (Bordo, Taylor and Williamson, 2005). These three markets are essentially related to expansive corporate activities in our world in which international integration is driven by profit maximization and where national performance is ultimately expressed by GDP per capita. Increases in per capita output are related to technological progress; accumulation of physical and especially technologically embedded capital; the improvement in human skills, education and organization ability; and closer integration of national economies through trade in goods, services, investments and intellectual and entrepreneurial interactions. Furthermore, the fundamental reason behind the development of these three markets is the relative scarcity of natural and human resources (Maddison, 1995) in which the economy is in a continuous process of generating and overcoming scarcity (Achterhuis, 1988). In this sense societies are said to never reach a natural saturation point but instead are perpetually in competition with each other to create new supply and demand. Thomas Hobbes (1651) was one of the first to identify scarcity as the natural state of humanity and from which issues such as the uneven distribution of resources are rooted. In this sense Plato's epigram that 'necessity is the mother of invention' arguably still holds and by which scarcity can be seen as the basis of globalization, urbanization and the social, economic and physical networks that bind these processes (Wall and v.d. Knaap, 2007).

Furthermore, where production processes were until quite recently organized primarily within national boundaries, the increased development of networks has enabled the fragmentation of many production processes and their relocation across different geographical scales (Dicken, 2004). In this way the growing importance of firms in our world has led to an increase in the spatial reach of cities, in which a variety of spatial scales are utilized and where firms tend to occupy different positions within local, regional and global network scales (Van der Knaap 2007). This has led to a move from hierarchical central place structures (Christaller, 1933) to non-hierarchical network structures (Meijers 2007; Taylor et al. 2008), in which a dual system of local and global understanding is possible (Hohenberg & Lees 1985). From this the world has become both a space of places and a place of flows (Castells, 1989). But this does not necessarily mean that the distribution within and between cities is even. In this light the relevance of popular theories concerning the convergence of the world economy is questionable (McLuhan, 1964, O'Brien, 1992; Cairncross, 1997; Friedman, 2005) and where instead it is argued by several authors that globalization is leading to increasingly unequal distributions of technology, capital and labour across different economic and political boundaries (Wallerstein, 1999, Graham and Marvin, 2002, Harvey, 2006). Either way, a new form of capitalism, global order, politics, society and culture are said to be in the making, which are distinct from earlier phases of global progression, and which require a paradigm shift in how we perceive and intervene with the world (Beck, 1992). However, in this thesis it is argued that although today's 'network society' (van Dijk 1991, Castells 1996) certainly holds certain new characteristics, it also bares similarities to previous phases of globalization. In this light, it is important to realize that economic interaction between cities has always existed to some degree (Bairoch, 1988), and that cities should be perceived as both places and processes of global urban interactions over time (Castells, 1996). Considered as processes, cities are in a continuous state of becoming, determined by the changing relationships between dynamic cities (Jacobs, 1969). Hence, today's network society is simply a momentary snapshot in an evolutionary process of global development, and where globalization, urbanization and network formation can be perceived according to the historical progression of economic innovations (Acs, 2002).

The process of urbanization

Today, cities have become more dependent on each other than ever before. Several studies show that they are increasingly dependent on relations to other cities (e.g. Taylor, 2004, Alderson and Beckfield, 2004) and are considerably affected by social, political and market changes within the system. This in turn affects urbanization processes. Therefore, it is arguable that a more effective form of urban development is required that avoids developing cities as 'closed' entities and instead considers them as integral components in an emergent worldwide city network. In this way, municipalities and governments could attempt to understand and intervene with the external 'self-organizing' networks (Portugali, 2000) that influence their cities, and furthermore integrate this knowledge in the future development of these cities. This means learning to operate between global forces of economic production and local ideals of the production of space (Lefebvre, 2003). In this context, cities can be conceived as 'basing points' within the global economy of flows, regulating markets, goods, services and the activities of transnational firms (Sassen, 1998). By better understanding a city's relative importance, interdependencies and functions within global corporate networks, scientists, developers and policy makers can more effectively improve social, economic and spatial development and hereby facilitate a higher probability of improved

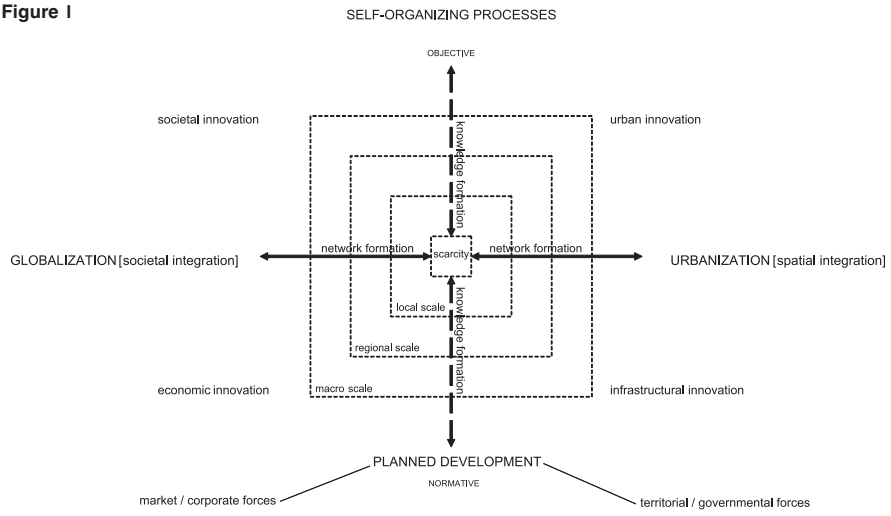
performance and competitiveness of their cities. It is therefore important to unravel why certain cities are more capable of attracting and sustaining global corporations, or as Ann Markusen (1996) terms it, the puzzle of stickiness in an increasingly slippery world. This will have implications for the tradition of planning! Where planning has always been a means of controlling uncertainty and facilitating a desired destiny, a new kind of planning may be required that intervenes within the realm of uncertainty, instead of trying to control it. In this sense, within the increasing complexity and self-organization of our world (Byrne, 1998), where cities are profoundly unstable, chaotic, and unpredictable (Portugali, 2002), it is questionable whether planning still needs the plan (Neuman, 1998). In this light, a new type of urban planning is required at the border between chaos and order, in which the aim is not to control the city by enforcing blue prints, but instead to manage within the system (Teisman, 2005). Order in such a system may be temporarily achieved through interventions at the confluence of global and local forces, operating for instance at the intersection point between multiple social, economic and physical networks.

Networks and development

Based on the above theory I will define my own concept on development, which is explained on the basis of the provided scheme **(figure I)**. This 'development scheme', is in turn divided into two main processes, namely 'societal integration' (globalization) and 'spatial integration' (urbanization). Globalization consists of societal and economic innovation, while urbanization is made up of environmental and infrastructural innovation. Next, it is shown that it is in fact the formation of 'networks' over time which have essentially connected the processes of globalization and urbanization together. At the heart of these networks lies the phenomenon of scarcity, in which forces of supply and demand are continuously challenged. As the scheme further indicates, the gradual development of our 'network society' has coincided with an increased jumping of scales from local to regional to global scales. In this sense, scarcity has been overcome by both an increased exploitation of space and an increased societal system to manage it. Within this developing system, growing complexity and uncertainty are found due to tensions between self-organizing processes and planned interventions. These are in turn challenged by both corporate and territorial forces.

Captured within the above theory and the provided scheme, five central characteristics of networks have been defined, which are empirically explored in the rest of this book, namely: *network temporality*, *network structure*, *network scales*, *network competition* and *network performance*. The first characteristic concerns the evolution of worldwide city networks in which change is evident over time, but also a dependency on future networks structures of the past. In this sense, it is argued that the network's past also affects its future. The second characteristic relates to the structure of today's worldwide corporate network in which particular interest is in the nodal hierarchies of cities and the linkage distribution of the network ties between cities. In this sense, it is also of interest what the skewness of the contemporary system is. Scale forms the third characteristic explored in this book, in which it is questioned what the different roles and interdependencies of cities will be within three different types of corporate network (local, supraregional and global). Also of interest here is the level of horizontal and vertical integration within the network and the degree of interscalar overlap. These datasets and definitions will be clearly explained further on. The fourth characteristic concerns competition, which directly

Figure I



Development scheme. Source Wall/v.d. Knaap, 2009

relates to scarcity as discussed in the scheme. In this investigation, urban competition of cities will be determined by their network linkages and subsequent market overlap. In this sense, it is of interest which cities in the world are truly in competition with each other. The fifth characteristic is performance, which concerns the interdependency of territorial development and network formation. Lastly, based on the above, the general question of this dissertation is what the specific knowledge from these five studies can tell us about development in our world? This question will be answered in the conclusion of this book.

The aim of this study

This thesis is aimed at demonstrating that the corporate networks 'between' cities strongly determine their importance within a globalizing world. Today, the asserted existence of the 'network society' (e.g. van Dijk 1991, Castells 1996), and claims that multinationals are the essential unit of global production and integration, (World Investment Report, 2002), are becoming more evident than ever before. However, although economic networks are said to hold the modern world together, there is a lack of empirical understanding of what these networks actually are (Todeva, 2006), especially where this concerns the corporate networks between cities worldwide (Taylor, 2004). It is said that this is largely due to the fact that city network data is not easily obtainable and therefore extremely scarce (Smith and Timberlake 1995a). In this light, the dissertation makes an empirical contribution to the literature; because it is based on actual 'relational' datasets, so as to reveal the 'netscape' of corporate relations that connect cities worldwide. This type of data specifically concerns the corporate shares between multinational headquarters and their many subsidiaries across the world. Because these firms locate in thousands of cities, the data captures the network intensities formed between them. Besides the empirical problem, it is equally clear that city network theory is still at a relatively new stage of development and that much conceptual confusion exists amongst theories (Derudder, 2006). Therefore, in this thesis, one of the main challenges

has been to empirically test and contribute to the further development of several existing theories. To do this, the book starts off with a historical overview of the conceptual development of city networks, from which five central characteristics have been identified for further analysis, namely the *temporality*, *structure*, *scale*, *competition* and *performance* of city networks. In this way it is argued that the structure of today's inter-city networks has emerged from a long historical process of corporate competition and that the performance of cities and nations are strongly related to their importance at different functional scales within these networks. This argument is further explained in the introductory chapter, as well as a concise description of the data and the specific research questions that relete to the five main chapters.

Networks over time

Although the perception of a globalizing world as a 'network society' is quite common today, the concept of the city as a 'node' in a network and a 'place' in space is not entirely new. Evidence of the city network concept was already evident in the ancient Egyptian hieroglyphic for the city, consisting of a cross (the external networks between cities) within a circle (the place where connections concentrate). (Camagni, 1993). Besides this initial conception, several theories in economic geography have emerged over time (e.g. Christaller, 1933, Friedmann, 1986, Taylor, 2004) leading to the contemporary view of world city networks. Because no clearly structured historical study has been done on the development of city networks, the second chapter makes a theoretical contribution to the literature because the evolution of city networks are investigated, starting with the advent of the Industrial Revolution and proceeding to the contemporary phase of globalization. The aim of this has been to theoretically explore the spatio-temporal development of city networks, as described through five phases of technological innovation. These are the ages of: (1) water power, iron, and textiles; (2) steam power, mechanization, and railways; (3) electricity, steel, and heavy engineering; (4) oil, motorization, and mass production, and finally (5) information and communication technologies. For each period, the related technological and economic innovation has been explored, followed by a study of how this impacted the formation of physical and economic networks between cities. From this, it is posited how the contemporary global network system is the incremental result of an evolutionary process. Each period is illustrated with a geographic information system (GIS) map which is made to represent the specific phase of network formation. Through this approach the subsequent four chapters that are strictly based on actual data, can be considered within a historical context.

The structure of networks

Related to the second characteristic, namely network structure, it is shown in the 3rd chapter that the importance of cities in a globalizing world is strongly associated with their hierarchical positions (centrality) in relation to other cities and the interdependencies (structure) that they exhibit with one another. These properties are empirically explored in this chapter under two separate sections using a dataset on the top 100 global multinationals and their worldwide subsidiaries (2005). In a paper by Ben Derudder (2006) the 'conceptual confusions' that are found in various studies are discussed, where he argues for the necessity for advances in network analysis. One of the identified confusions is the failure to reach agreement regarding which cities are 'world' or 'global' cities. These

theoretical differences stem, on the one hand, from John Friedmann's (1986) analysis of world cities that are based on the power networks derived from corporate headquarters, international finance, transport and communications and producer services. On the other hand, Saskia Sassen (1991) more specifically focused on advanced producer service firms as arguably the most important units of production, situated in what she calls global cities. These studies have resulted in several global or world city research studies (e.g., Beaverstock et al., 2000, Taylor 2004, Alderson and Beckfield, 2004, Carroll 2007) in which results have generally been inconsistent, due to differing theoretical and empirical approaches (Derudder, 2006). Therefore the first section on centrality contributes to the literature by exploring centrality in relation to existing theories of 'world cities' (that feature all industries) and 'global cities' (featuring producer services alone), hereby offering a comparative, contemporary insight into city hierarchies. Furthermore, contemporary globalization, according to Sassen, is generating a new geography of marginality and centrality that cuts across the old core/periphery, North/South, and East/West divisions of the world system (Sassen, 1994). However, research by Alderson and Beckfield (2004) and Carroll (2007) suggest little evidence for the new geography of marginality discussed by Sassen (1991). Within this context, the second section contributes to this discussion by exploring the structure of the contemporary world system, questioning whether it remains consistent with either Sassen's or Alderson and Beckfield's positions. To do this, the linkage distribution of the corporate networks between cities is explored, between cities, nations and supra-regions. In this way, both the volume and flow of corporate connectivity are revealed between developed and undeveloped parts of the world. Furthermore, the statistical distribution of the corporate network is analyzed, so as to identify the degree of skewness in the corporate system.

Networks at different functional scales

Most national planning policies (e.g., 'Randstad 2040') still consider the spatial proximity of cities as decisive to their economic performance, neglecting their transnational networks (Van Oort et al. 2006; Taylor et al. 2008). This is odd, considering the many studies (e.g., Camagni and Salone 1993; Batten 1995; Davies 1998; Carroll 2007) that stress the need for an 'intellectual transition' in the conceptualization of urban external relations (Meijers 2007). Instead, it is argued in the 4th chapter that planning and policy may need to start understanding cities as places of multiple relational assets and resources (Massey 1993; Graham & Marvin 1999). By understanding a city's economic position and linkages to other cities worldwide, future policymakers may start to engage with competitor and collaborator cities that are 'specifically' important to them. To demonstrate this, the study focuses on worldwide intercity networks of multinational corporations and their subsidiaries, because these are said to be central to the development of cities (Rugman 2005). Furthermore, the importance of multinationals to urban development has not only led to an increase in the spatial reach of cities, but a variety of spatial scales are utilized, in which firms operate within local and regional networks, as well as global ones (Van der Knaap 2007). This has apparently led to a theoretical change from hierarchical 'central place' structures (Christaller, 1933) to non-hierarchical network structures (Meijers 2007; Taylor et al. 2008), in which a 'dual system' of understanding is said to be required (Hohenberg & Lees 1985, pp 58-59). Therefore, within this theoretical context, the 4th chapter contributes to the literature by empirically testing the differences of city hierarchies (centrality) and interdependencies (structure), which are derived from three independent worldwide multinational networks. The first concerns the global top 100 multinational headquarters and their subsidiary networks across the globe. The second concerns the top

100 multinational headquarters located in Europe and their worldwide subsidiary relations; and the third network concerns the top 100 multinationals situated in The Netherlands and their worldwide subsidiaries. In this chapter, specific interest is in how the positions of the four Randstad cities (Amsterdam, Rotterdam, The Hague and Utrecht) vary within these networks.

Competition within networks

Today competition between cities is at an all-time high, and local authorities have to put ever more effort into making and maintaining their cities as attractive locations. Furthermore, cost reduction for targeted populations (e.g., tax credits, project financing) is pivotal to attracting and retaining firms and workers, as well as the maintenance of amenities, physical infrastructure, and public transportation networks. As a result, city marketing and city branding have become a 'booming business' (Paddison, 1993; Van den Berg and Braun, 1999), while budgets for urban promotion are ever increasing (Hall and Hubbard, 1996; LeRoy, 2005). This increased interest in 'urban competitiveness' has led to a substantial number of urban ranking lists, in which cities are compared on the basis of their economic performance (Kresl and Singh, 1999; Lever, 1999), global connectivity (Beaverstock et al., 1999; Alderson and Beckfield, 2004), creativity and innovativeness (Florida, 2005), access to and quality of services (Kaufman et al., 2005), or environmental sustainability (Dutzik et al., 2001). This benchmarking of cities takes place not only in academic and commercial research, but has also become engrained within public policy and popular culture. Nonetheless, despite the contemporary plethora of research and policy, empirical evidence on urban competition remains relatively weak. Although most studies on urban competitiveness assume that cities compete vis-à-vis one another, little attention is paid to actually measuring the intensity of competition 'between' cities. However, it is argued in the 5th chapter that in order to validate the concept of urban competitiveness, it is important to understand to what extent cities compete and where this competition comes from. Therefore, the contribution of this study is to shift the focus from 'urban competitiveness' to 'urban network competition'. This supplements the existing literature on competitive cities by providing a method of specifically deriving the strongest competitors, hereby relaxing the stringent theoretical assumption that all cities compete with each other (e.g., Haider, 1992; Markusen and Schrock, 2006). Through this approach, the competitive strength of individual cities is estimated, clusters of competitive cities identified, and the factors of urban competition are analyzed. Drawing on theoretical work by Gordon (1999) and using insights from evolutionary and organizational ecology, a new indicator for estimating the degree of competition between cities is introduced, based on patterns of interaction (networks) between cities. Taking economic competition between world cities as a test case, it is shown in this chapter how the described technique can be utilized.

Networks and national performance

Although the process of globalization is not an entirely new phenomenon, it is clear that in recent decades, significant shifts have occurred in the capacity of firms to produce and export manufactured goods, which have been dispersed throughout an ever-expanding network of peripheral and core nations (Dicken, 2003). Today, the production of these commodities spans more nations than ever before, with each nation performing specific tasks in which it has a comparative advantage (Gereffi, 1994). Facilitated by reduced

transportation costs and advanced communications technologies, this interorganizational system is said to connect firms and states to form the current global economy, resulting in a greater functional interdependence than ever before (Hirst and Thompson, 1996). Within this framework, it is generally accepted that multinational corporations form the basic unit of global production and integration. Furthermore, it has been shown that multinationals are wealthier than most nations in the developing world (United Nations, 2002), and are characterized by their power to coordinate and control the operations of other firms in more than one nation. This trend originated in the 1960s 'golden age' of economic growth, in which foreign direct investment grew at twice the rate of global GNP and 40% faster than world exports (Dicken, 2003). In turn this led to multilateral alliances between firms, which compete to gain access to markets and share increasing costs, risks and uncertainties, but also gain access to new technologies and create economies of synergy by pooling resources and rationalizing production (Kang and Sakai, 2000). In this system, multinational headquarters and their various subsidiaries are strategically situated at specific locations within the global transportation and communication networks, utilizing external services, labor market skills, and proximity benefits (Dicken, 2003). Nonetheless, although international integration is evident, the distribution of multinational networks is said to remain persistently disproportionate (Carroll, 2007), where these firms create a division of labor between nations that corresponds to the division of labor between different levels of corporate hierarchy (Hymer, 1972). Hence, multinationals are said to centralize high-level decision-making and advanced production in only a handful of nations, while the rest of the world is generally confined to lower levels of activity and income (Friedmann, 1986). In this light, the 6th chapter contributes to the literature by empirically investigating the uneven distribution of economic activities in the world and how this relates to the competitive performance and innovation levels of nations and cities (Porter, 1990, Acs, 2002). In this way, a contribution is made by empirically combining Michael Porter's theory on the competitive advantage of nations (GCI index) to corporate network theory and methods. In this context, the corporate connectivity data compiled for this study is defined as a measure of the shareholder relationships that a multinational has with its subsidiary firms. From this it is shown that the developmental differences between nations, in terms of their degree of competitiveness, are strongly associated with the magnitude of their corporate connectivity. The network data used in the various studies in this book are based on headquarters and their worldwide subsidiaries in different cities. However, because competitiveness indicators at the city level (for all global cities) are not readily available, the corporate network data for this last study had to be aggregated to the national level. This explains why the 6th chapter is not executed at the city level. Through this necessary step, transnational 'urban' networks could to some degree be explored in relation to competitiveness.

The relevance of this study

The relevance to architecture and urban planning

This section briefly discusses the initial motivations and goals for this study. Readers may be surprised to know that I have had a career as an architect and urban planner. Before starting my PhD in economic geography, I worked as an architect and urban planner for

several firms and institutions, mainly in the field of urban research. The architecture and urban planning professions espouse a strong conviction that the performance and success of a city depends on how it is planned and designed at the local level. In this way, these professions continuously treat cities as isolated entities, devoid of external influences. The notion that the future of cities might be equally influenced by global forces has received little attention within these fields. Thus, a main goal of this dissertation is to empirically demonstrate the importance of external economic ties to urban development. Fortunately, the awareness of the importance of city networks has been developing for some time in other fields, such as economics and sociology. Originally inspired by Saskia Sassen's book, *Global Cities* (1991) and Manuel Castells, *The Rise of the Information Society* (1996), I gradually became interested in the idea that a city's performance is equally dependent on the connections it has with other cities around the world. In this way, I became interested in how developments 'within' cities are related to that what happens 'between' them.
A few years later, these ideas were reinforced by an inspiring essay by Saskia Sassen, in which she claimed that urban planning and architecture are still 'centered in old traditions of permanence,' which are being 'irrevocably destabilized in cities marked by economic networks, massive infrastructures, and growing estrangement' (Sassen, 2003, pp. 402-403). In her opinion, these spatial disciplines need to confront the 'massiveness of the urban experience.' A few years later, this argument was emphasized by leading architectural authors Rem Koolhaas, Mark Wigley and Ole Bouman (2005) at a conference at Columbia University. They argued that within the context of globalization, architecture is constantly losing ground, becoming increasingly unimportant, and must seek new forms of collaboration and modes of expression. In a sense, these statements have simply confirmed the famous architectural historian Manfredo Tafuri's (1973) prediction in *Progetto e Utopia*, that the architect's hope of creating a better society would eventually be swamped by capitalism.

Today, it is not surprising that the architectural profession is caught in a deadlock (Sassen, 2003). The century's old tradition of highly controlled local space, place and permanence have been exposed to irreversible processes of globalization, in which regional and global forces have become exceedingly influential (Graham and Marvin, 2001). In this way, the lives of ordinary people are increasingly shaped by events, decisions and actions that take place far from where they live or work (Castells, 1992).This is evident in the credit crisis, for example, in which the demise of just a handful of banks and multinationals has led to the world's worst economic recession since the1930s (The Economist, 2008). In this, the detrimental impact on capital and the behavior of consumers, producers and investors is clear. These circumstances reveal how interdependent and vulnerable the world has become and how it is held together by a powerful network of socio-economic activities. Hence, the performance of nations and their cities are strongly related to the transnational networks of multinationals, international trade, and capital flows. Within this context, the dissertation is aimed at empirically revealing the multinational network as a powerful intercity system that spans the globe, hereby exposing the *temporal, structural, scalar, competitive* and *performance* characteristics of these networks.

Furthermore, in light of the planning professions, it is the aim to demonstrate that the development levels of cites are strongly related to corporate connectivity and competition between cities worldwide. If so, then this would contribute towards the theoretical discourse of architecture and planning, because these disciplines have not yet begun to

fully understand and engage with the exogenous forces acting upon cities (Friedmann, 2002). The future of urban development will increasingly depend on an integrated approach connecting dynamic urban issues 'within' particular cities to knowledge of how they interact 'between' one another (Wall, 2005a). As discussed in the book *Splintering Urbanism*, the traditional conception of the city as an object to be controlled and managed is rapidly transforming to a paradoxical understanding of a globally connected but locally disconnected urban landscape (Graham and Marvin, 2001). Hence, it may be more fitting to consider cities as 'basing points' within the economy of global flows, regulating interdependent markets, production and services (Sassen, 1998). The ability of a city to understand and improve its relative performance within the worldwide city network requires the innovation of its social, economic and spatial competitiveness. In this way, it is interesting to study why certain cities are more capable of attracting and sustaining particular corporations (Wall, 2005b) or, as Ann Markusen (1996) calls it, the puzzle of stickiness in an increasingly slippery world. If global interactions do prove to strongly influence the development of cities, then it is conceivable that urban planners will someday program, plan and design cities in relation to the external forces acting upon those cities (Wall, 2008). In this context, planning needs to develop freely across mental and physical borders, leading to a new direction and purpose in defining what urban planning and architecture is (Castells, 1992). Furthermore, it must be a form of planning in which the aim is not to control the city by enforcing blue prints, as in modernist planning, but instead to strategically intervene at multiple internal and external levels of the city (Portugali, 2000). Therefore, one of the contributions of this study is to empirically demonstrate the importance of intercity corporate ties to urban development. However, although this research contributes to the planning discourse, it is principally focused on contributing towards the field of economic geography. Considering that my PhD is strictly in the field of applied economics, the rest of this book will primarily be directed towards knowledge in this particular field.

The relevance to economic geography

Because economic geography is the main focus of this dissertation, I will not delve too far into it in the prologue. The first contribution of this study to this field is that it is based on several unique datasets concerning the worldwide networks of thousands of firms and cities. These data have been compiled over the past years and draw from actual data sources. This kind of dataset is extremely rare, and in fact only a handful of empirical studies exist today that are based on similar datasets. Furthermore, as will be shown later on, this data represents a very large share of world GDP, hereby emphasizing the importance of investigating this system. Because various types of networks can be studied, e.g., commodity chains (Gereffi and Korzeniewicz, 1994) and airline routes (Smith and Timberlake, 2001; Derudder and Witlox, 2004), it is important to point out to the reader that this study focuses specifically on the economic networks between multinational corporations and their many subsidiaries scattered across the globe. Because these firms are strategically located in various types of cities, it is shown in this study that it is the linkages between firms which determine the hierarchic importance of the cities (Pred, 1977). From this a worldwide network of cities of different hierarchic importances can be determined (Friedmann, 1986). Important in this approach is that the boundaries of the network are not known and instead knowledge of all the relationships of a firm are required in order to define its position in relation to all other firms observed (Burt, 1982). The second contribution of this study is that the networks

are analyzed using several distinct methods and techniques. These will be explained later on. Thirdly, specific research questions are explored, concerning: the evolution of networks; the hierarchy and structure of the present worldwide network; the influence of different scales of corporate networks upon cities; how to measure intercity corporate competition in terms of network characteristics; and finally, the relationship between a nation's level of development and its network strength.

The relevance to society

This dissertation makes several societal contributions. The first contribution is to reveal the invisible yet real network of corporate relationships between cities worldwide and hereby empirically contribute to theories concerning the 'network society' (van Dijk 1991, Castells 1996). This because this network is said to represent both economic chains as well as societal webs of economic power (Carroll, 2004), and is thus an interesting object for both scientific and societal inquiry. Furthermore, in the 2nd chapter it is theoretically discussed that today's network society is not an entirely new phenomenon, but a snapshot of an evolutionary process. At a deeper level this study shows that corporate connectivity between cities contributes strongly to their performance and that the vast majority of these connections take place 'between' cities and not 'within' them. In this light, the research may be of interest to governmental policy concerning the importance of international relations to national development. In a report 'Quality and Future' by the Dutch government, these initial incentives have already been made clear, in which it is said that the future of development will depend on an improved understanding of the quality of life in cities and how this is distributed across the globe (MNP, 2004). This dissertation contributes to this insight by exploring the past and present structures, scales and competition of worldwide corporate networks, and how this relates to the performance of cities and nations. In this way, the 'invisible hand' (Smith, 1776) of the economy is partially revealed as a 'visible hand of multinational corporations' (Chandler, 1977), in which the hand appears to be less than fair (Wallerstein, 1999, Harvey, 2006). Therefore, the relevance of popular theories on economic convergence (McLuhan, 1964, O'Brien, 1992; Cairncross, 1997; Friedman, 2005) is questioned. Within this context the dissertation partly contributes to David Harvey's plea for better theoretical representations of the extreme volatility in contemporary economic fortunes across the world economy (Harvey, 2006). This is done firstly by unveiling the corporate system, and secondly by connecting theories on the global competitiveness of nations (e.g. Porter, 1990) to world city network theories (e.g. Friedman, 1986). Lastly, this dissertation may be of interest to Dutch developmental policy, because it will be shown that The Netherlands is one of the most economically connected countries in the world. More importantly, this study will show exactly which cities and nations The Netherlands is connected to, and also the direction of command or subservience that this represents. Because, the study will demonstrate that the majority of Dutch corporate connectivity is to cities and nations beyond its national boundaries; it may be of interest to future urban development policies. In this way, the network analysis techniques demonstrated in this study can be seen as useful devices in which it is possible to become more specific about inter-relational issues, and hereby contribute to future policymaking.

CHAPTER 1

Introduction

1.1 Historical overview of city network theory

1.1.1 Networks within the context of globalization

Before discussing the development of the concept of world city networks, it is important to discuss the context in which this has happened, namely, globalization. At the most elementary level, globalization is seen as a specific geographical scale of activity, namely that between nation-states (Taylor et al, 2008), in which there is a qualitative deepening of the internationalization process. This deepening is said to strengthen the functional and weaken the territorial dimension of development (Stiglitz, 2003). Furthermore, globalization implies the growth of a world market that increasingly penetrates and dominates national and urban economies. Although certain authors will trace globalization back to times before the Industrial Revolution, the nineteenth and twentieth centuries represent an explosive break with the past, through price convergence, scale increase, infrastructural network developments, technological innovation, and declining transport costs (Bordo, Taylor, Williamson, 2005). These two centuries of modern capital movement have been characterized by rapid growth in economic output and international trade, unparalleled accumulation of physical and human capital, and technological progress, which have penetrated all areas of economic activity, hereby creating new patterns of demand, output and employment. Since the Voyages of Discovery, the variety of goods traded between nations has increased, leading to substantial commodity market integration. Rising international trade has enabled countries, by means of transport innovation and cost reduction, to specialize in products that they can produce most efficiently, hereby eliminating the handicap of countries with limited natural resources (Findlay, O'Rourke, 2007). By diffusing new products and technologies, trade has led to strengthened international investment flows, which in turn have led to more diffusion and organizational sophistication. These developments have affected sectoral shifts in the economy, from agriculture and manufacturing to services, and have always been accompanied by increases in physical capital stock, improvements in education and organization, and more openness toward international trade (Maddison, 1995). The international integration of markets is commonly expressed by national GDP per capita. Several causal influences are said to explain increases in per capita output, such as technological progress, the accumulation of physical capital, improvement in human skills, education and organizational ability, and the closer integration of individual national economies through trade (Maddison, 1995). But, until very recently, the production process was organized primarily within national boundaries (Dicken, 2003) in which economies were strongly constrained by geographical distance and political delimitations. Today, however, production processes have become increasingly fragmented, tied together by complex global commodity chains (Gereffi, 1994). Furthermore, there is a shift towards a knowledge-driven economy and global financial system. It is often asserted that the above mentioned processes have led to a homogenous, more integrated 'global village' (McLuhan 1962); captured in terms like 'the end of geography' (O'Brien, 1992), 'the world is flat' (Friedman, 2005)

and the 'the death of distance' (Cairncross, 1997). However, controversy exists in economic theory about whether world development is diverging or converging. On the one hand, several developmental economists argue that because poorer economies tend to grow faster than richer ones, all economies should eventually converge in terms of per capita income and productivity (Friedman, 2005; Matthews, 2006). On the other hand, others stress that economic inequality has not significantly changed over the last forty years, and that the developed world still overwhelmingly dominates global trade (Leamer, 2007; UNCTAD, 2008). In this light, this dissertation studies the geography of corporate globalization, specifically in terms of city networks. This is because today statistics on international trade are no longer sufficient to understand the world economy, because economic interactions have become far less organized by states. Instead, a large proportion of international trade is now organized between multinational corporations beyond the control of the state, thereby transcending boundaries in their global production strategies (Taylor et al, 2008). Nonetheless, even though corporate relations between cities have become more powerful, it is important to realize that economic interaction between cites has always existed (Bairoch, 1988). In this context, a city should be perceived as being 'not a place but a process' of global urban interactions over time (Castells, 1996, pp. 386). Considered as processes, cities are in a continuous state of becoming, determined by the changing relationships between 'dynamic cities' over time (Jacobs, 1969). For this reason, it is interesting to understand today's global networks as a momentary phase in the process of globalization. Therefore the next section will investigate how the conceptual idea of city networks has developed over time.

1.1.2 Early urban economic conceptions

The concept of the city as a node and a network is not new as it was already evident in the ancient Egyptian hieroglyphic of the city, consisting of a cross within a circle (Camagni, 1993). However, the importance of a city has generally mostly been defined by spatial characteristics observed within the boundaries of the city, such as physical size and urban density. One of the first criticisms of this can be seen in Bobek's (1927) statement that geographers are too concerned with the internal geographies of cites, in contrast to the problem of location and support of cites (Harris and Ullman, 1945). Hence, this traditional notion slowly gave way to an understanding of cities as connected entities of increasingly non-spatial networks. In this way, the role of cities has become a function of their cross-border networks, rather than simply one of centers of power in an empire (Sassen, 2002). At the time, scientists such as the geographer Christaller (1933), the sociologist McKenzie (1933) and the historian Gras (1922), already recognized that cities are interdependent systems, linked together to form urban networks. Although opinions may vary on the exact origin of the city network concept, it is certain that research in this vein has escalated over the past few decades. Various scholars have adopted the language of networks to understand the structure and organization of modern urban systems. Nonetheless, although there is a growing body of knowledge concerning city networks, the vast majority of urban research still does not treat cities as interdependent entities. Today, in most urban disciplines, cities are still persistently treated as self-contained nodes, operating in isolation, rather than as components of a larger system.

Although the modern conception of city networks is new, the inquiry into the relationship between space and economic development does have a strong historical tradition. Roughly a century after the introduction of the Westphalia Treaties (1648) and the declaration of

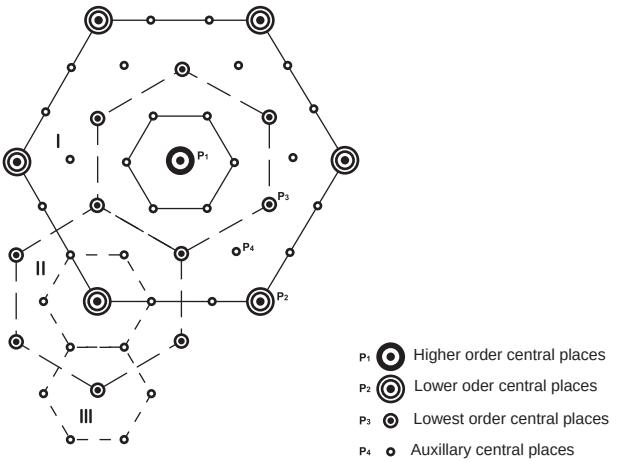
state centered economies, Adam Smith (1776) wrote *The Wealth of Nations*. This book at the time already explained the relationship between capital cities, international trade and national market economies. More importantly, it explained how the state centered system contributed to the transformation of agricultural labor, which set the path towards the Industrial Revolution, which subsequently led to the development of our modern urban system (Bairoch, 1988). Already at the start of the 19th century, 60% of England's labor force was employed in industrial sectors and through which cities started to urbanize more than ever before (Bairoch, 1988). At the time, Johann Heinrich von Thünen (1826) conceptualized the first core-periphery relationship, called the Isolated State. This model was constructed of a central city, sub-centers, transport linkages connecting cities, and the agricultural hinterland, and which was enveloped by the boundaries of the nation state. Interestingly, the added sub-center in the model suggested early competition and hierarchy.

1.1.3 The origin of cities within systems

However, as trade between cities within and between nations proliferated, the simple concept of the 'isolated state' became strained. Around that time, J. Reynaud (1841) promoted the first conception of the systemic spatial and functional regularities of cities within systems in his work *'le systeme general des villes'* (Bretagnolle et al, 1999). This conception is not surprising in a period characterized by steam-powered innovations, intensified network linkages between cities, and internationally expanding markets. Urban populations became denser and economic functions became more diverse, including the emergence of giant firms, cartels and banking and finance services. In fact, as will be shown in chapter 2, many of today's multinationals stem from this period. Approximately a century later, the initial understanding of competing hierarchies of cities at regional and national levels was clearly explained in Walter Christaller's central place theory (Christaller, 1933). He showed in a geometric model how a city's hierarchic importance depends on its centrality, relative to other proximate cities **(Figure 2)**. Furthermore, Christaller assumed that the size of a city's surrounding tributary area, and thus its centrality, increases proportionally with population size. In this model, interlocking sub-national, national and even transnational hexagonal units are incorporated into a network system. The relationships between these units are hierarchic, stemming unidirectionally from the core city to semi-peripheral and peripheral cities. In this sense, these are known to be essentially 'vertical' relationships. Later, as international economies proliferated in the 20th century, the initial concept of city networks became more sophisticated. This can be seen in classic studies such as *The Nature of Cities* by Chauncy Harris and Edward Ullman (1945) and *Cities as Systems within Systems of Cities* by Brian Berry (1964), in which the main premise is that cities are comprised of both internal and external relations, including the intensification of inter-firm and political hierarchies, and widespread strategies of competition and cooperation. Studies by Brian Berry (1960), Larry Bourne (1976), Peter Hall (1980), Ron Johnston and many others posited 'systems thinking' as a prerequisite to understanding how cities develop within themselves and in relation to other cities. Nonetheless, these models were relatively simple and hierarchical, limited within national boundaries and characterized simply by step-up hierarchies (Taylor, 2004).

For a long time, as asserted by Adam Smith (1776), the extent of a city's market has been a function of its size. This was due to the fact that larger cities were convenient central marketplaces that reduced transportation costs and maximized economies of scale.

Figure 2

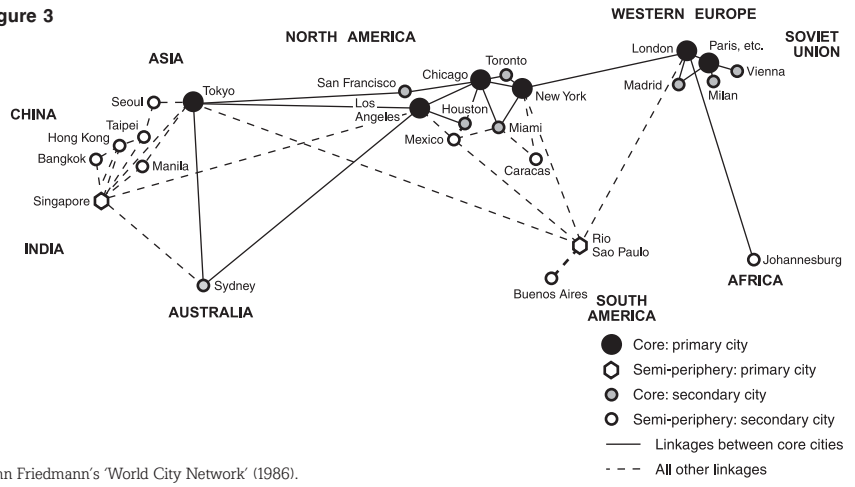


Walter Christaller's 'Central Place' model (1933).

However, new types of goods (e.g., information) and technologies (e.g., telecommunications) have reduced the relationships between both transportation costs and economies of scale on the one hand, and distance and size on the other. As a result, the extent of a city's market has gradually become a function of its connectedness, thus replacing the spatially structured functional urban hierarchy with one that is structured relationally (Neal, 2008). This is evident in the fact that today the most economically powerful cities are not necessarily the most populated. For instance, it will be shown later that cities like Amsterdam and Frankfurt rank among the most economically powerful, but sparsely populated cities, while heavily populated cities like Lagos and Brasilia do not play a very important role in the global corporate network.

In the latter half of the 21st century, new aspects such as infrastructural linkages, corporate coherence to urban development, and how this forms networks started to emerge within the 'city systems' thinking. For instance, Pred (1977) already assumed the importance of 'multilocational' firms as the major source of intermetropolitan and interurban development, together forming a web of services, goods, control and information flows. Furthermore, Pred importantly put forward that urban hierarchy is derived from the presence of firms in cities, and not the cities themselves. In this light, only since the restructuring of the world economy in the 1970s, as 'the international division of labor', has the 'multinational corporations' school of thought made significant progress (Taylor, 2004, pp. 21). Firms were slowly perceived to have 'global reach' (Barnett and Muller, 1974) and to operate in a 'world without borders' (Brown, 1973), forming the first indication that the importance of nation-state's was decreasing. In Stephen Hymer's (1972) work, he already predicted the diffusion of industrialization to developing countries. From this he argued that intermediary corporate activities would be concentrated in middle and low range cities, while high-level planning activities would be concentrated in a limited number of hub cities, such as New York, London, Paris and Tokyo. Furthermore, he argued that the 'multinationalization' of the world economy would mirror the unevenness of labor found within the business structure of firms.

Figure 3

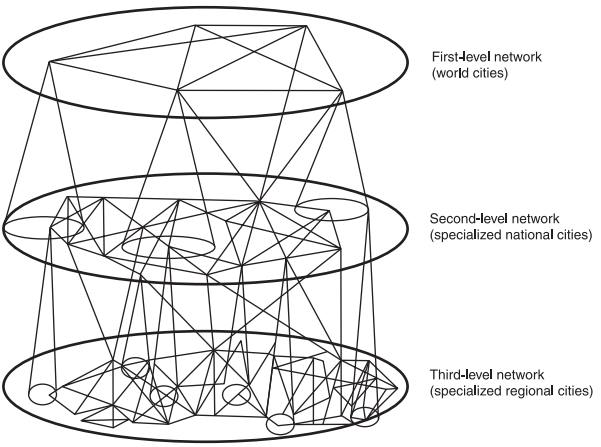


John Friedmann's 'World City Network' (1986).

1.1.4 The modern conception of worldwide city networks

The most influential paper linking world cities to the international division of labor, is Friedmann's (1986) *The World City Hypothesis*, which can be considered the essential gauge of the contemporary network paradigm. In seven theses, Friedmann defines the spatial organization of the new international division of labor. In this he outlined a functional thesis, a hierarchical thesis and a global-local thesis. The *first* shows a city's assigned functional dependence within the world economy. These three functions are headquarters centers, financial centers and articulator cities that link national or regional economies to the global economy **(Figure 3)**. The *second* thesis shows that cities are hierarchically arranged according to their financial centers, corporate headquarters, international institutions, business services, manufacturing centers, transportation networks and population size. This leads to two levels of hierarchy: primary and secondary cities, which in turn are organized into a 'north-south' supra-regional division of core and semi-periphery cities, as well as a 'east-west' division into three continental subsystems (Asia, America and West Europe). In Friedmann's *third* thesis, he states that a city's role in the world economy is directly reflected in the structure and change of the local economy. In this context, cities are seen as centers through which flows of money, workers, information, and commodities' are transmitted, and which articulate the economic relations of their surrounding regions to the global economy (Friedmann, 1986). The outcome is a relatively polarized socio-economic structure, defining global cities (e.g., Tokyo), multinational cities (e.g., Milan), national cities (e.g., Buenos Aires) and sub-national cities (e.g., San Francisco) into a world city hierarchy. In reference to Christaller's central place model, Friedmann shows that world cities are no longer defined by population size and geographic proximity, but rather by the extent of their 'integration with the global system of economic relations' (Friedmann and Wolff, 1982, pp. 310). In this sense, it transcends previously national concepts, by creating city networks between different economic regions of the world. However, although Friedmann's network represents a gigantic conceptual leap forward, it is not effectively based on relational data, concerning real interactions between cities. This network will be empirically explored and mapped in the 3rd chapter.

Figure 4

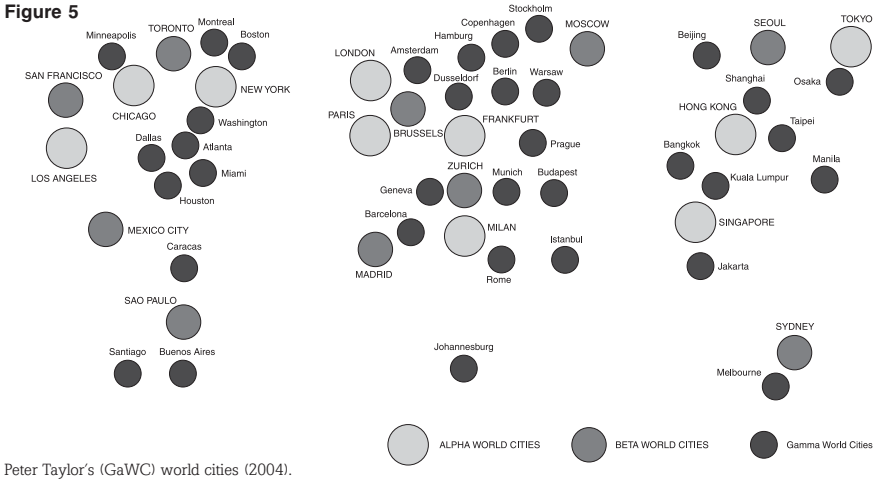


Roberto Camagni's 'nested hierarchies' (1993).

The move from the concept of a 'world city' to a 'global city' is clearly emphasized in Saskia Sassen's book *The Global City* (1991), which compares New York, London and Tokyo with respect to for instance telecommunications and information technologies. According to Sassen, these new technologies demand new types of control and organizational functions, which has led to the emergence of a new type of city: the 'global city'. These cities function differently to others in the following four specific ways: (1) as command points; (2) as key-locations for leading finance and business services; (3) as sites for production and innovation in these sectors; and (4) as markets for these products. According to Sassen, these are the first global service centers in history. Therefore, her approach is similar to Friedmann's, but differs by concentrating on the production of advanced producer services and only briefly touches on the multinational networks and their global integration of subsidiary firms. The 3rd and 5th chapters will explore the differences between, on the one hand, multinational networks and the 'world cities' derived from this; and on the other hand, specific producer service networks and the 'global cities' resulting from this network.

Around the same time, Roberto Camagni (1993) created the most informed conceptual model of the hierarchical structure of cities. This model is interesting because it argues that networks are not flat, mono-layered systems, but instead are comprised of different horizontal and vertical scales of corporate interaction. His diagram of the hierarchy of city networks **(Figure 4)** combines three levels of spatial organization: the territorial (state), competitive (hierarchical) and network (co-operation). Furthermore, he organizes cities in order of regional (bottom), national (middle) and world cities (top). These scales will be empirically investigated in the 4th chapter. In a model, found in *Global City-Regions* (ed. Scott, 2001), Camagni proposes a more sophisticated 'intellectual device', which explores two logical dimensions of global city-regions. The first, the spatial logic, distinguishes between two theoretical approaches: the city as both a territory and a network. The city as a cognitive logic forms the second dimension and includes both functional and symbolic approaches. By crossing dimensions, he arrives at four roles of global cities: the city as a cluster, as an interconnection, as a milieu and as a symbol. In the 6th chapter a partial contribution is made to this understanding, by empirically showing the relationship between local competitiveness and global connectivity.

Figure 5



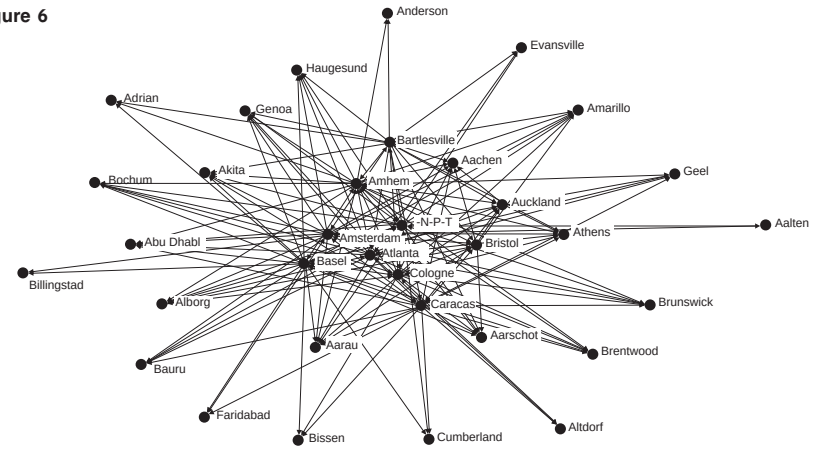
Peter Taylor's (GaWC) world cities (2004).

In *The Rise of the Network Society* (1996), Manuel Castells argues that humanity has transcended into the 'information age', where 'networks constitute the new social morphology of today's societies' and 'reshape the material basis of society.' He shows that in the network society, the dominant form of space as a 'space of places' is reinforced by a new 'space of flows', which occurs through a triad of networked physical and electronic circuits, forming new spaces of social practice and organizational networks. The global 'hub' cities hold strategically important functions, operating as control centers of the world urban system. Castells manages to use the concept of global networks to elaborate on Sassen's global triad, postulating a global network connecting centers with different intensities and scales. Furthermore, he argues that this spatial system of economic activities defines the global city not as a place, but as a process. This is explored in chapter 5 in which competition between cities is measured on the basis of their intercity flows.

In the light of Friedmann, Sassen and Castells – Peter Taylor, in his book *World City Network* (2004), demonstrates how traditional urban service functions have gone global, since the advent of multinational corporations. A new network of major financial and business service firms today provides services to a global network of corporate clients, which Taylor analyzes to reveal the location strategies of leading global service firms in various cities and through which the flows between different metropolitan centers are calculated. Based on this analysis, a classification of the so called *alpha, beta* and *gamma* type cities have been derived **(Figure 5)**. This empirical study serves as the first thorough analysis on worldwide city networks, based on relational data of advanced global producer services. Nonetheless, a limitation of this data is said to be that it is based on indirect evidence, in which the presence of global producer service firms in two or more cities, leads to the assumption that inter-urban connections will exist between these firms, in proportion to their office size (Carroll, 2007). In this way, a set of inferences go beyond what is strictly supported by the available data (Céline Rozenblat and Denise Pumain, 2007).

In a different approach, Arthur Alderson and Jason Beckfield (2004) use concrete data on the economic shares between multinational headquarters and their subsidiaries. This is very similar to the data collected and analyzed in this dissertation. Based on 'network

Figure 6



Arthur Alderson and Jason Beckfield's world city network (2004).

analysis' techniques, borrowed from sociology and graph theory, Alderson and Beckfield demonstrate the pertinent characteristics of the world city network. In their study, they show that the overall morphology of the world city network bears strong resemblance to the 'maximally centralized star' (Borgatti et al, 2002) – networks in which core cities are connected to all the others, but where secondary cities are only partially connected **(Figure 6)**. They show in their analysis that the primary cities of today's economy are Tokyo, New York, Paris and London. Furthermore, they show that powerful cities not only exhibit strong commanding ties with the cities of the world, but also receive strong incoming ties that are extended from less powerful cities. According to Alderson and Beckfield, this is consistent with Friedmann's view that cities at the apex of the world city system are used by other cities as 'basing points' of global capital. However, as will be shown in chapter 3, contradictory evidence is found in this dissertation.

1.1.5 Conclusion

This historical overview of city network theory was aimed at describing the evolution of city network conceptions over time. In this way it has been shown that the development of globalization is shaped largely by economic processes. In an attempt to maximize profits, firms have utilized new technological developments, which have helped them to slowly exploit global space. This competitive process has led to the gradual formation of cost reducing and market expanding activities, manifested in the form of networks of corporate (urban) interaction. These networks are not sporadic structures, but as will be shown in the 2nd chapter, change slowly over time, and instead, to a large degree, follow already established network structures. Hence, change is gradual, but appears to have accelerated since the advent of multinational corporations and their continual utilization of cheaper transport and digital technologies. Furthermore, as explained in the overview, networks are not homogenous structures. Instead, different functional and spatial scales of networks appear to exist in parallel. In this light, intercity competition and the subsequent performance of cities, is strongly related to urban hierarchies, network structures and network scales (Sheppard, 2002). This is evident in the fact that core-periphery relations are age-old entities, in which firms located in cities essentially define the emergent urban

hierarchies and network structures, rather than the cities themselves. Driven by profit maximization, this has led to a unevenly distributed world city network that reflects the disproportionate nature of the internal structures of multinational corporations. Furthermore, an up-scaling of city networks has shifted from city, to nation, to today's global system. This is has strongly influenced global population growth and the expansion of markets (consumption), innovations in transport and communications (distribution), as well as technological and sectoral innovations (production). The importance of various economic sectors has shifted over time, from agriculture, to manufacturing, to service industries. In this light, it is argued that the key sector of today's world economy, and hence the key network, is the advanced producer services sector. These services are said to be situated in a limited number of 'hub' cities, and which control a myriad of other firms across the globe. Lastly, the historical overview has uncovered several general issues concerning network formation, which will now be theoretically explored in more detail, namely: *temporality*, *structure*, *scale*, *competition* and *performance* within networks.

I.2 Specific themes of city network theory

1.2.1 The temporality of city network formation

In the book *The Human Web*, J.R and W.H. McNeill (2003) explain that the history of mankind is related to the incremental formation of worldwide networks, in which trade and communication have accelerated since the dawn of industrialization. This emergent network is due, in particular, to the increased scale of economic interaction, infrastructural development, technological innovation, and declining transport costs (Bordo, Taylor, Williamson, 2005). These changes have penetrated all areas of economic activity, creating new patterns of demand, output, and employment (Maddison, 1995). Innovations over the past few centuries, such as new forms of energy, mechanization, infrastructure, production and communication, have been highly influential on the expansion of city networks. Another important factor has been the development of the nation state. According to Charles Tilly (1994), today's inter-state system is the product of coercive and economic power exercised between the years 1000 and 1800 A.D. The resulting relationship between the state and the city solidified over this 800 year period, inaugurated by the Westphalia Treaties (1648), which gave rise to today's modern nation-states (Kentor, 2005) and led them to become the major political building blocks of modern society (Bairoch, 1988). As a precursor to the Industrial Revolution, this ushered in an alternative political order in which cities, firms and their interactions flourished more than ever before (Taylor, 2004). The importance of nation states has escalated over the last two hundred years. However, in the last few decades of the twentieth century, the state centered system has started to fracture, primarily due to the growing importance of multinational corporations. Beginning in the 1970s, these firms dispersed production across the globe as corporations searched for lower wages, closer proximity to markets and raw materials, and ways to diffuse the power of organized labor (Sassen, 1991). John Meyer et al. (1997) show that the global diffusion of production was facilitated by the emergence of a 'world society', an ideology that legitimates and facilitates the penetration of foreign interests into less developed countries, the development of foreign ownership of private property, and the repatriation of capital that permits multinational corporations to locate and operate around the globe. The corporate

headquarters and foreign subsidiary system that emerged from this process of production and dispersion have formed the basis for a new dimension of economic power, allowing the multinational corporation to increasingly circumvent the regulation of activities formally controlled by the nation-state, hereby making them more dependent on regulation by cities (Kentor, 2005). In this sense, cities are essentially containers of business organizations, and their interactions have led to extremely powerful intercity corporate networks. The hierarchy of these networks is determined by the relative power of the corporations residing within these cities, expressed in terms of their control over the economic activity in other cities (Ross, 1994). The corporate networks that have emerged over the past few decades reflect distinct loci of economic power. Although these firms are not the sole conduits of power in the world economy, they certainly play a momentous, if not primary role in the evolution of the system (Kentor, 2005).

Based on these arguments, Chapter 2 explores how economic networks have developed since the start of the Industrial Revolution, up until the contemporary phase of globalization. In this chapter, the spatio-temporal development of city networks is empirically explored during five succeeding phases of technological innovation, namely: water power, iron, and textiles; steam power, mechanization, and railways; electricity, steel, and heavy engineering; oil, motorization, and mass production; and finally, information and communication technologies. The technological and economic innovation taking place in each of these periods, are examined. This is followed by a study of how this has influenced the formation of economic networks between cities of the world. In this way, the contemporary global network is considered as the incremental result of an evolutionary process. Each period is illustrated with world maps that represent the specific phase of network formation, based on the population size of cities (Chandler, 1987) and the transportation and communication links of that era (van Susteren, 2007.) The conclusion of this chapter then reflects on the developmental characteristics which have led to today's worldwide corporate network. In this way, the remaining empirical chapters, which strictly deal with cross-sectional data, can be placed within a historical context.

1.2.2 The centrality and linkage structure of city networks

World cities refer to those places in which a disproportionate amount of the world's business is conducted (Geddes, 1915) and where the economic power of firms in these cities is similarly large (Gibrat, 1931). In this way, the capitalist world system is spatially uneven, based on the concentration of monopolized high-profit production in a limited number of 'core' zones (Wallerstein, 1979). In Stephen Hymer's (1972) essay *The Multinational Corporation and the Law of Uneven Development*, he showed that as industrialization diffuses to developing countries, where mundane corporate activities concentrate in middle and low range cities. On the other hand, high-level planning activities concentrate in a limited number of hub cities, close to capital, markets, media and government activities, (e.g., New York, London, Paris and Tokyo). Furthermore, Hymer stated that the world economy would be spatially polarized, mirroring the uneven internal structure of labor found within the business structure of multinational corporations. From this Hymer expected that by the close of the 20th century, the already existing uneven patterns of the world economy would simply be reinforced.

Later, Friedmann (1986) discussed the idea that cities function as either power centers of the global economy, subordinate cities defined as national or sub-national economies, or as isolated cities that do not participate in the system at all. Friedmann's hierarchy of world cities illustrated the still common triad of powerful Asian, North American and European cities. The core cities were identified as London, New York, Paris and Tokyo, reflecting the concentration of corporate power in these control centers. Saskia Sassen (1991), in her theory of global cities, focused less on Friedmann's hierarchies of 'power' and more on the functional practice of 'control.' She argued that the rise of specialized producer and financial services in a limited number of cities enabled particular firms to gain high levels of global economic control. Sassen posited that cities with high levels of these specific services are more representative of the contemporary 'global' economy, and that this phenomenon also signifies a new shift in the geography of centrality and marginality. In this sense, cities that were once the 'core' are relegated to the periphery, while peripheral cities shift towards the core.

In their *alpha*, *beta* and *gamma* roster of world cities, Beaverstock et al. (1999) successfully certified Sassen's claim that producer services generate entirely different rankings than the world cities of Friedmann's study. Building on Sassen and Beaverstock et al.'s work, Peter Taylor and the GaWC research group (2004) developed a thorough, more *global city* type analysis, based on relational data for global advanced producer services, and using for instance principal components techniques and clique analysis to determine hierarchic clusters of cities. This revealed the producer service network at the start of the 20th century. In their results, London is said to be the primary city of the world. On the other hand, the *world city approach*, more akin to Friedmann's *World city Hypothesis* (1986), has been developed further by Alderson and Beckfield (2004). Unlike Taylor's approach, Alderson and Beckfield use data regarding intra-firm shareholder ties between multinationals and their subsidiaries. By using 'network analysis' techniques from sociology and graph theory, such as degree and betweenness (explained in chapter 3), these researchers demonstrated the characteristics of the multinational world city network, as it existed at the end of the 20th century. Their results, unlike Taylors, find Tokyo to be the primary world city. Furthermore, in their research, Alderson and Beckfield find little evidence of Sassen's claim of a new geography of centrality in the world. This debate will be further explored in Chapters 3 and 6. They also found that highly ranked GaWC 'global cities' such as Miami and Singapore, do not appear on their list of the top 50 cities. Instead, they find strong consistency between their results and Friedmann's world city rankings. Furthermore, they report that powerful cities not only exhibit strong commanding ties with the other cities of the world, but also that they receive many incoming ties that are extended from less powerful cities. In the third chapter, it will be shown that incoming and outgoing corporate ties are not strongly correlated. Furthermore, unlike Friedmann, Taylor and Alderson and Beckfield's results, it will be shown that another city is the primary city at the beginning of the 21st century.

As seen above, there are very few studies on worldwide city networks. In this light, Smith and Timberlake (1995, 2002) have stipulated the stringent need for a 'relational' analysis of the world city system, instead of merely attribution-based research. As is commonly discussed, this is partly due to the paucity of data (Smith and Timberlake, 1995; Taylor, Walker, and Catalano, 2002) and the fact that only a limited number of papers draw upon original data or test hypotheses. Another recurring issue is the failure to reach an agreement regarding

which cities can be categorized as world or global, a problem that has been underlined in debates regarding world city and global city approaches (Taylor, 2004; Alderson and Beckfield, 2006). As previously discussed, these theoretical differences stem from John Friedmann's 'world city' analysis and Saskia Sassen's 'global city 'analysis. All studies which have emerged in this period prove to be quite inconsistent and incomparative, due to differing theoretical and empirical approaches (Derudder, 2006). In Chapter 3 a contribution is made to improving consistency, by exploring the centrality of 'world cities' (that feature all industries) to 'global cities' (featuring producer services alone), within a single dataset, hereby offering an effective comparison of contemporary city hierarchies.

If the global economy is to be understood as a set of interlocking networks of economic activity, then it is necessary to ask who is excluded from such networks, and why (Sheppard, 2002). In addition, networks have emergent hierarchies and inequalities, referring to privileged spaces and stressing the path-dependency in urban networks (Castells, 1996; Latour, 1999). Colonial economic interdependencies continue to persist (Porter and Sheppard, 1998), and the steamship, airplane, and telegraph have all been applied to the routes along which large shares of commodities and information already flowed, linking major markets together more strongly (Hugill 1999; Mattelart 2000). In this context, economic power is relationally constructed, especially in terms of positionality within the global economy (Sheppard, 2002). A handful of actors (cities) occupy powerful positions at the center, and control networks of relationships that position other actors in present and future states of compliance or dependence (Van Tulder and Ruigrok, 1995). This unequal positionality is equally central to the 'reproduction' of power hierarchies (path dependency) (Galtung, 1971). In light of the above, it is said that the fascination with networks, places too much emphasis on the possibilities of networked spaces, rather than on their relational inequalities (Sheppard, 2002). Therefore, Chapter 3 explores the issue of corporate disproportionality in the world. In this, the key question is whether the world city network has remained unchanged since Hymer's assertion, or whether Sassen is correct that a significant shift has occurred in the world economy over the last twenty years. This question is addressed by investigating the structure of the corporate ties between cities, giving an overview of the world system at the city, national and supra-regional levels. Various centrality techniques (outdegree, indegree and betweenness) are used to define the network structure by means of geographic information system analysis (GIS) and Ucinet network mapping. These terms are explained in Chapter 3.

1.2.3 Differences in the conception of network scale

Contemporary globalization is associated with the construction of scale, especially the increased importance of supra-regional and sub-national scales. Scale theorists have conceptualized how scales come into existence and interact with one another, and how events at a particular scale are shaped by their relationships with other different scales (Smith, 1992; Delaney and Leitner, 1997). The growing importance of the global scale is commonly discussed, in which analysts of multinational corporations have shown that their global reach has not resulted in a loss of either national or local identity (Ruigrok and van Tulder, 1995). Instead, multinationals engage in a strategy of global localization, whereby global competitiveness is rooted in close relationships with particular localities, including headquarter locations, low-cost production sites, industrial districts, and consumer markets (Mair, 1997). In this context, scale theory tends to only indirectly relate geographically distant

localities, by acknowledging local, regional and global scales, without directly examining real interconnections (Sheppard, 2002). Hence, networks are generally discussed at one of two extreme scales. On the one hand, *local*, place-based networks are seen as the key to the formation of economic clusters and to the success of places within the space of flows (Amin and Thrift, 1994). On the other hand, *global* networks of trade, financial transactions, and commodity chains are seen as the defining characteristics of contemporary globalization (Held, McGrew, Goldblatt, and Perraton, 1999).

As discussed in the historical overview, Christaller's 'central place theory' (1933) is one of the milestones in economic geography, in which cities were geometrically categorized into a hierarchic network. Central cities of different sizes and hinterlands are interlocked into a hierarchic hexagonal grid **(Figure 2)** assumed to be proportionate to their urban population size (Neal, 2008). This can be seen as a system of hierarchic vertical relations between an urban place and its immediate hinterland (Taylor et al, 2008). More recently, the conception of the 'network model' as a system comprised of different scale typologies (Camagni and Salone, 1993; Batten, 1995; Davies, 1998; and van der Knaap 2002) has led to a paradigm change in the central place model (Meijers, 2007). In this way, the supra-regional and global relationships of contemporary cities are accounted for. This importance of intercity relations was already stressed by Jacobs (1969), in which she argued that a city's economic development does not depend on servicing its hinterland, but on the economic networks between cities. Thus, the network model is said to service a hinterworld, not a hinterland (Saey, 2008). However, this does not mean that network theory should replace central place theory, but instead is said to compliment it with what has been coined 'central flow theory' (Taylor et al, 2008). An important characteristic of the network model is that unlike central place theory, which only depicts 'vertical', asymmetric relationships between urban places, there is also a two-way, 'horizontal' cooperation between different and similar-sized cities or 'complimentarity' (Meijers, 2007). Therefore, vertical hierarchy and horizontal complimentarity can exist simultaneously in the network model. This requires a dual system of understanding (Hohenberg and Lees, 1985, pp. 58-59) in which it becomes possible to comprehend cities as places of multiple relational assets and resources (Massey, 1993; Graham and Marvin, 2002). In this context, cities can be perceived as linking many types of networks at local, regional and global scales (O'Neill, 1988; Camagni, 1993), in which the ranking of cities may occupy different positions (Van der Knaap, 2007, pp. 13).

Furthermore, the functional roles that firms perform at different scales (economic size or industrial sector, for instance) are decisive for the centrality and structure of networks (Van der Knaap, 2007). Unlike Christaller's model, population size is not assumed to be important to centrality in the network model (Powell, 1990). Hence, because firms are different sizes and have different geographic locations, it can be interesting to analyze the scalar differences of worldwide corporate networks, which has not been empirically demonstrated before. This is another contribution of this dissertation, in which Chapter 4 analyzes the relative importance of top global cities and the four largest Randstad cities (Amsterdam, Rotterdam, Utrecht and The Hague). This is done using three independent, comparative worldwide networks (top 100 global firms, top 100 European firms, top 100 Dutch firms). Network analysis techniques are employed to explore the local, supra-regional and global significance of these cities within the three independent networks. In this way the study questions the relative importance and network structures of these four cities, considering differences in the economic size and locality of the initial headquarters. Another incentive

of this study is to see whether Randstad cities are more internationally oriented than nationally. If so, it is important to consider whether Dutch policies are targeting the correct scale of interventions. Today's instruments of developmental policy are persistently spatially oriented, with little knowledge of functional network relationships beyond proximate cities (Van Oort et al., 2006). In this light, it appears that Dutch planning still follows a Christallian tradition, and has not been particularly influenced by today's literature on global city networks.

1.2.4 Competition within city networks

Different global cities use their comparative advantages in ways that mirror their accumulated resources, where it is their ability to oblige rather than compel others to do business through them that enables some to be the key intersecting points of global networks. As networks transform, some cities will succeed, while many will find themselves weakly positioned, or even completely excluded from the emergent urban exchanges (Allen 1999). In this sense, cities are assumed to be in fierce competition, competing in terms of product markets, inward investments, firms, populations, tourists, hallmark events and government funding (Harvey, 1989; Lever and Turok, 1999). These 'place wars' (Haider, 1992) can occur on local, national, supra-regional, or even global spatial scales (Gordon, 1999). In order to maintain or strengthen their position within the urban hierarchy, and hereby increase their standard of living, cities must work on their ability to successfully compete with other in attracting firms and workers (Porter, 1990; Friedmann, 1995; Storper, 1997). Today, competition between cities is particularly extensive. Local authorities put more and more effort into promoting their cities as attractive locations, employing tools such as tax credits, project financing, social and physical infrastructure, public transportation networks, and amenities. In this way, the marketing of cities has become a 'booming business' (Paddison, 1993; Van de Berg and Braun, 1999), which has led to a substantial number of urban ranking lists, in which cities are compared to each other on the basis of their economic performance (Kresl and Singh, 1999; Lever, 1999); innovativeness (Florida, 2005); access to and quality of services (Kaufman et al., 2005); or environmental sustainability (Dutzik et al., 2001). Today, even local authorities publicize their competitiveness with respect to other places (Malecki, 2002). At the same time, many newspapers and magazines (e.g., Fortune Magazine, Forbes, and Money) are obsessed with the ranking of cities (McCann, 2004; Fisher, 2005).

Urban competition between global financial centers has been the subject of a large body of literature in the field of geography and urban studies (Sassen, 1991; Gordon, 1999; Beaverstock et al., 2002). Despite the plethora of research and policy, empirical evidence on urban competition remains relatively weak, based generally on urban 'attribute data' found 'within' cities, rather than the strengths of their mutual 'relations' (Taylor, 2004). However, as is shown in Chapters 3 and 6, competitive performance is highly dependent on inter-urban relations. In this context, little attention has been paid to measuring the intensity of competition 'between' cities, and there is no systematic and objective measurement of this competition. Therefore, Chapter 5 focuses on defining a new measure to gauge competition relationally and apply this to the real linkages between cities. In this way a new indicator of urban competition has been defined, to deduce different strengths of competitors. This approach therefore challenges the stringent theoretical assumption that all cities compete with each other (Haider, 1992; Markusen and Schrock, 2006). Along these lines, the competitive strengths of individual cities are estimated, clusters of competitive cities are identified, and the factors of urban competition are analyzed.

The new indicator is based on the functional linkages between cities, stemming from work by Gordon (1999) and insights from evolutionary and organizational ecology, e.g. niche overlap theory (MacArthur and Levins, 1967; Field and McFarlane, 1968; Hannan and Freeman, 1977). In this way, competition is operationalized as an attribute of a relationship between two cities (Sohn, 2004). From this it is argued that cities compete to the extent that they serve the same geographical market for particular functions within the urban system. Because there are many dimensions on which cities can compete (Lever and Turok, 1999), this chapter focuses specifically on 'economic competition' between cities, in terms of attracting and retaining firms, which can be regarded as one of the most elementary forms of urban competition (Blumenfeld, 1955). Because most research on urban competition concerns global centers and their advanced producer services, the indicator derived in this study will only be applied to the network of this specific industrial sector. However, the indicator put forward in this chapter is not particularly limited to competition between cities, and can easily be applied to other dimensions of urban competition and supplementary forms of territorial competition, such as competition between regions (see, e.g., Kitson et al., 2004).

The world cities literature assumes that the corporate networks of globally operating advanced business services firms translate into knowledge-based linkages between the cities in which these offices are established (Pain, 2007). Moreover, the corporate network used in this analysis is shown to be highly correlated with the worldwide network of FDI and trade **(Table I)**. Hence, the competitiveness of world cities is generated through their connections to other cities. As Beaverstock et al. (2002) rightly note, the prosperity of thriving world cities is due to their privileged location at the intersection of flows of people, goods, capital and ideas. However, if two cities have exactly the same linkage structure, in the sense that they command the same cities, this means that the same 'external' knowledge can be obtained in both places. World cities linked to the same cities in terms of advanced producer services, are therefore in competition because they serve the same 'hinterworld' (cf. Taylor, 2001), draw on the same resources, and are hence interchangeable with one another. Note that in accordance with the theoretical framework previously presented, the focus here is on the geographic market overlap for the function of global command centers (organizational niche) of advanced producer services (sectoral niche). In order to formally define urban competition, the concept of an urban 'niche' has been introduced, which originally dates back to the first half of the 20th century.

At its inception, this term was mainly used in descriptive biological studies concerning the overlap between the habitats of different species (Grinell, 1904; Elton, 1927). However, the application of the niche concept to urban studies and spatial planning is relatively new (Popielarz and Neal, 2007; Neal, 2008). Analogous to its ecological and organizational counterpart, an urban niche can be regarded as the geographic market of a city, the context in which it executes its economic activities or fulfills its urban functions. In other words, the concept of the urban niche can be decomposed into two parts: 1) a geographic niche (its market area) and 2) a functional niche (its activities). When both the geographic and functional niches of cities overlap, cities are in competition, because they share the same market. In sum, cities that serve the same surrounding area for the same urban functions, expectedly compete for the acquisition of the same subsidiaries. Hence, cities that are not distinctive are likely to be competitors (Neal, 2008). This theoretical framework closely follows the (holistic) Durkheimian view on ecological competition, in which the characteristics of cities (such as hinterland and functions) drive urban competition (Durkheim, 1893; McKenzie, 1933). Hence, cities

are regarded as competitors if they function as substitutes, in the sense that similarities in markets and functions provoke competition.

1.2.5 The impact of urban performance levels on network formation

Alderson and Beckfield stressed that future research should explore ways to combine 'traditional' data concerning the attributes of cities, with relational data. Furthermore, they argue that 'the ultimate aim of all world city research is to say something meaningful about the changing fortunes of cities and their residents' (Alderson and Beckfield, 294, pp. 848). Chapter 6 takes up this challenge by analyzing whether the strength of place-bound attributes is strongly associated with the strength of corporate network connectivity. Because the urban attributes of the many cities in the analyzed global corporate dataset are not readily available, data at the national level has been used instead. As a consequence, the corporate city network data had to be aggregated to the national level as well. However, the use of national data is permissible because although the role of nations has weakened, they have not become insignificant to the world economy (Taylor, 2004). In this light, nations are said to possess key relational assets which create competitive advantages (Sheppard, 2002). This competitive advantage enables nations to channel global economic activities to their advantage (to a certain degree), hereby offering attractive conditions for mobile investment capital (Amin and Thrift, 1994; Storper, 1997; Leyshon and Thrift, 1997). Furthermore, under today's conditions, cities and nations no longer need to be geographically contiguous, and can instead be perceived as fixed places within an undifferentiated space of flows (Castells, 1996, 413), a pure flow economy (Storper, 1997, 28), or a field of transactions of unlimited geographical range (Scott, 2000, 88).

The ties which comprise the networks found in these places are constructed through their available resources and are combined through practices which fix their influence (Amin, 2002; Amin and Thrift, 2003). Therefore, the notion of territoriality is best encapsulated by the embedded, geographical nature of capital, because capital's existence requires the creation of relatively fixed, and largely immobile social and physical infrastructures (Harvey, 1982). Nonetheless, the performance levels located in national networks are far more complicated than simply determining urban assets, such as the stock of service firms, corporate headquarters, cultural capital, or strategic decision makers, inside given municipal or national boundaries (Sheppard, 2002). Instead, the power of places within the globalizing world is more accurately characterized by extensive networks, formed by multinational headquarters (Alderson and Beckfield, 2004). This phenomenon is explained by the fact that multinationals have developed the capacity to produce and export goods to an ever-expanding network of peripheral and core nations (Dicken, 2003), with each nation performing the specific task in which it has a comparative advantage (Gereffi, 1994). Facilitated by reduced transportation costs and advanced communications technologies, this inter-organizational system has resulted in a greater functional interdependence than ever before (Hirst and Thompson, 1996).

Multinationals are responsible for a large portion of international trade and foreign direct investment, much of which is made up of intra-firm transactions. These investments are typically controlled by corporate headquarters that determine the magnitude of foreign investment, the transfer of technology, access to international markets, the repatriation of profits, and the number of employees, etc. Nonetheless, although international investment

has grown exceptionally since the 1960s, the share belonging to developing countries remains limited (Kentor, 2002). This unevenness derives from the fact that only certain nations have the endowment and strategic ability to create the competitive advantage needed to attract investments (Guisinger, 1985). In this manner, nations strive to enhance their international trading position and compete to attract productivity and national development, which in turn enhances their international competitive position. Hence, both firm and state are interlocked in a struggle to capture global market shares, where it is evident that the nation-state remains an important institution of capitalism (Gertler, 1992).

Today, national governance remains a vital attribute for attracting firms, serving as the ultimate guarantor of the rights of global capital and continues to provide the necessary conditions for the global growth of domestic capital (Sassen, 1995; Evans, 1997). Nations are therefore capable of creating national competitive advantages (Porter, 1990). Furthermore, no matter how great the global reach of a multinational becomes, it remains embedded within its country of origin (Stopford et al, 1991), where most of its assets, employment and turnover come from its home country (Hu, 1992). In this sense, both agglomerate and networked space remain fundamental to the production and accumulation of capital (Harvey, 1989; Lefebvre, 1991; Yeung, 1998b), facilitated through transport, communication and production factors. Because corporations typically develop within a domestic context prior to expanding internationally, their home base plays a key role in shaping the identity of the firm, the character of its top management, and its approach towards strategy and organization; and the home country has a continuous influence on the availability and qualities of resources available to the firm (Porter, 1990). Within this context, investors tend to locate their funds in domestic assets far more often than expected, in a phenomenon defined as 'home-bias' (Obstfeld and Rogoff, 2000). Thus, local conventions, rules, practices and institutions prove to be necessary for firms to effectively operate in a world of uncertainty. In this sense, economic and social proximity affect the intensity of interactions in capital markets, at both the national and global levels (Portes and Rey, 1999), and are arguably the cause of the unevenness of corporate connectivity within and between nations. Classical theories on international trade posit that comparative advantage resides in the factor endowments that a country is fortunate enough to inherit, including land, natural resources, labor and the size of the local population (Anderson and Van Wincoop, 2004). However, in his theory on competitive advantage, Michael Porter takes the comparative advantage concept a step further by showing that corporate and national success also depend on the development of unique skills, technology and knowledge in particular industries, and on connecting clusters of internationally successful businesses to particular attributes within their home bases (Porter, 1990). These variables are explained in detail in Chapter 6.

Furthermore, competitiveness also depends on the relative centrality of the nation, the pattern of specialization and differentiation of its activities, and its functional division of labor. According to Porter, only those nations linked to the largest market areas have the ability to provide a foundation for highly specialized functions. In this light, a nation's competitive success is defined as a measure by which a nation can compare itself to the best worldwide competitors. This is measured either by the presence of substantial and sustained exports to a wide array of nations, or by significant outbound investments based on the skills and assets created in the home country. Firms lose competitive advantage in the more price-sensitive industries as they develop towards more capital- and technology-intensive industries. As firms develop into more differentiated industrial segments, they

shift many of their lower-technology activities overseas, while they concentrate on activities that require higher levels of skill and expertise in their home bases. The outsourced activities are then characterized by the corporation's commitment to invest in products, processes, and skills that will reduce costs and improve the firm's competitive advantage.

Based on the global processes discussed above, multinationals are wealthier than most countries in the developing world (United Nations, 2002), characterized by their power to control the operations of other firms in various countries, achieving a degree of control over these dependent firms. In this light, production has enabled a 'world society' that has legitimized the penetration of less developed countries by foreign interests (Meyer, 1997). These powerful firms centralize high-level decision-making and advanced production in only a handful of nations, while the rest of the world is confined to lower levels of activity and income (Hymer, 1972). Thus, contrary to popular literature heralding the emergence of a steadily homogenizing world (Cairncross, 1997; Friedman, 2005), it is questioned in chapter 6, whether the corporate interactions of nations within 'globalized' world of the 21st century are still highly disproportionate. In this sense, it is conjectured that although the corporate reach of multinational corporations will be truly global, the scope and diversity of their transnational interaction will expectedly be particularly limited. This expectation is empirically tested by exploring whether the corporate network data follows a so called 'power-law' statistical distribution, in which only a few hub cities will hold the vast majority of all connections, a common characteristic of self-organized systems (Barabási, 2003). As discussed earlier, multinationals locate their production plants all over the globe, implying that geography has become irrelevant (Cairncross, 2001; Friedman, 2005). However, whether the world economy is 'flattening' is a question that remains under debate (Linders et al., 2008, McCann, 2008). These firms must still be careful in choosing their headquarters and subsidiary locations, based on the qualitative characteristics of the nations in question (Brakman and Van Marrewijk, 2008). Although some countries are clearly larger and geographically less remote than others, economic and geographic differences alone would not justify the disproportionate nature of the corporate control network. Hence, Chapter 6 pays particular attention to the concept of competitiveness as a driver of the disproportionate nature of the global corporate network. In his seminal work, *The Competitive Advantage of Nations*, Michael Porter (1990) showed that corporate and national successes are interdependent. The interdependency was based on the development of skills and knowledge in particular industries, but also on the connections between clusters of internationally successful businesses and particular attributes of their national home bases.

Taking Porter's analysis a step further, this chapter demonstrates how attributes related to competitiveness (such as institutional quality, technological readiness and business sophistication) are coherent with the total relational corporate connectedness within nations and also the number of connections 'between' nations. Using the World Economic Forum's 'Global Competitiveness Index' (Porter et al, 2007) as an indicator of competitiveness (based on institutional quality, technological relatedness and market efficiency), the results aim to show that competitiveness is of critical importance to both headquarters and subsidiary connectivity within the global corporate control network. This is tested on the basis of two central questions. First, why are some nations more connected than others? This is evaluated in terms of total headquarter connectivity (number of outgoing linkages)

and subsidiary relationships (number of incoming relationships). Second, which factors most strongly associate with the strength of the bilateral linkages 'between' nations?

I.3 Empirical setting and methods and techniques used

1.3.1 Data discrepancy

Although theoretical reference is frequently made to cities being part of a network of cities, there is little theoretical concern or empirical evidence concerning the role of cities in such networks (Derudder, 2005). For instance, Peter Taylor has shown that there are 375 references to attribute data within the world city literature, which far exceed the 51 relational data references (Taylor, 2004). Furthermore, of the relational studies, only a small handful analyze city networks at the global level. This is said to be because network data is not readily available. Hence, it is clear that empirical research concerning relational networks is still relatively new (Smith and Timberlake, 1995a; Taylor, Walker, and Catalano, 2002). Because this dissertation is based essentially on relational data concerning corporate ties between cities around the world, it fundamentally contributes to the advancement of network based research.

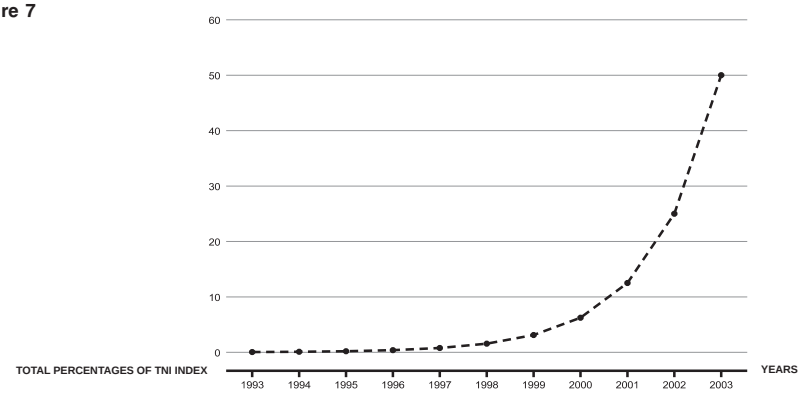
1.3.2 Multinational corporations

As discussed at the start of the introductory chapter, this dissertation is primarily based on databases concerning multinational networks. These worldwide networks represent distinct loci of power that have a significant impact on an increasingly global economy. For instance, the sales of the top 200 global corporations accounted for approximately 30% of world GDP in 1999 (Anderson and Cavanaugh, 2000). Furthermore, in the top 100 of a combined firm-nation list for 2000, 29 economies were multinationals (United Nations, 2002) and the top 500 multinationals accounted for 90% of world FDI and 50% of global trade in 2004 (Rugman, 2005). Also, much of this corporate activity consists of transnational transactions. These investments are typically controlled by corporate headquarters that determine the magnitude of foreign investment, the transfer of technology, access to international markets, the repatriation of profits and the number of employees, etc. This is illustrated below by the rising global reach and the 'transnationality' of multinationals over time **(Figure 7)**. The graph is based on the transnationality index (TNI) defined in the *World Investment Report* (WIR 2005), and represents an indexed score of a firm's foreign assets, foreign employment, and foreign sales. The graph depicts the annual aggregate TNI of the global top 100 multinationals (1993 – 2003), where an exponential increase after 1998 is clearly evident. In this sense an exponential increase in transnationally-based activity is seen.

1.3.3 Main datasets, methods and techniques

The corporate connectivity data compiled for the structural, scalar, competition and performance chapters of this study are based on the shareholder relationships that a multinational has with its subsidiary firms, representing corporate governance or the chain of command as it is passed down from headquarters to various subordinate levels of firms. Three independent datasets (global, European and Dutch) have been compiled for this

Figure 7



Total percentage of transnationality for top World Investment Report firms (1993 – 2003).
Based on WIR data, 2004. Source: Wall/v.d. Knaap, 2009.

dissertation using Fortune®, Lexis-Nexus® and Reach® sources. Each dataset originates with the top 100 headquarters at each of the three scales. For all three datasets, only the top 100 headquarters were used, as these proved to hold over 50% of the total revenue of all firms listed in the sources, and 40% of all employment. Furthermore, the top 100 firms accounted for 27% of OECD revenue, while only 29% was held by the remaining 400 firms. Looking only at the share of revenue held by firms located in New York, London, Paris and Tokyo, it is seen that the top 100 firms in these cities hold 6.7% of OECD revenue, and the remaining 400 firms in the same cities hold an additional 6.7%.

Next, based on their annual year reports, data on subsidiaries and their locations were collected for each network scale. The subsidiaries were classified into five categories of sharehold relationships, starting with headquarter to first subsidiary, continuing with first subsidiary to second subsidiary, and so forth. This is clearly explained in the methodology in the third chapter. Thereafter, all firms were coded according to their standard industrial classification (SIC) codes, such as trade, manufacturing and producer services. In all three independent datasets it was discovered that the division of firms into five industrial sectors, resulted in approximately 4% for basic materials firms, 47% for manufacturers, 16% for trade firms, 18% for producer services, and 16% for consumer services. Aggregating these same industries one level higher, it is seen in all three datasets that both the information and goods industries claim an equal share. Hereby the importance of information firms to the contemporary world economy is evident. This will be discussed in more detail in the second chapter.

Next, the city, national and supra-regional locations of each firm were identified by name and Cartesian coordinates in order to calculate the physical distances between cities or to cluster cities by geographic proximity. To perform this accurately, a benchmark radius was determined through which smaller cities were added to their proximate major city. The resulting networks of all three datasets represent global, regional and local ties between firms. These three datasets were organized into 'adjacency' matrices for further analysis. The final global network holds a total of 9,243 corporate ties, connecting to 2,259 unique cities worldwide. The European corporate dataset holds 8,307 corporate connections

to 2,369 different cities across the globe, while the Dutch corporate dataset holds 9,012 connections to 1,892 cities worldwide. Therefore it is important to stress that the difference between the three datasets lies in the economic size and geographic location of their initial top 100 headquarters. Nonetheless, the extent of the networks derived from these initial characteristics, are worldwide for all three datasets. For instance, the top 100 global headquarters are on average economically stronger than those of the other scales, and are located in cities across the globe. In the case of the top 100 Dutch headquarters; these are relatively less economically powerful and are located only in Dutch cities. However, the networks to subsidiary firms, in both these cases, span the globe. Furthermore, it is important to emphasize that the data collected and analyzed in this study is not a network of firms, but a network of cities produced by the location decisions of firms. Hence, firms constitute cities in this data – i.e. cities literally do not appear in this network unless firms tie them to other cities (Alderson and Beckfield, 2006). In this way the many cities found in these datasets have not been selected beforehand but are ultimately the outcome of thousands of ties between firms.

Finally, it is important to note that all three corporate networks, when aggregated to national level, correlate very well with both foreign direct investment (FDI) and trade data **(Table 1)**. In this case, the resulting coefficients concern the correlation of the actual 'bilateral linkages' between nations. This simply means the degree of coherence of the corporate connectivity, trade and investments, taking place between nations. In the results it is seen that corporate connectivity is most associated with FDI (0.921), imports (0.825), and lastly exports (0.698). Therefore, the corporate governance networks researched in this dissertation arguably reflect global commodity chains and capital flows as well. The advantage being that where trade and FDI data are only available at the national level, the corporate data used in this study can equally reveal interactions between cities worldwide. As argued in the theoretical introduction, intercity networks have become increasingly important to today's globalizing world, hereby representing important objects of scientific inquiry.

1.3.4 Research limitations

The empirical research executed in Chapters 3 to 6 is based on cross-sectional data (2005). This provides a very new perspective on contemporary global economic networks. The limitation of this approach is that little can be said empirically about the past and future of corporate networks. In this sense, the work is particularly descriptive, explorative and explanatory to a lesser degree, but cannot offer empirically projective answers. However, combined with theoretical arguments, this study does offer certain insights into the past and future. Another limitation is that the networks analyzed concern corporate ties. Although these are likely to be one of the most important networks to study, other types of economic, social, cultural and political networks will also play important roles in defining the network society. In this way, the results of this dissertation represent an important, but partial view of the world. Lastly, although this research focuses on intercity linkages, the last chapter on performance had to be executed at the national level. This was unavoidable, as no reliable attribute data exist on the many worldwide cities used in this study. Hence, in the last chapter, city data was aggregated to the national level, so as to make it compatible with the 'Global Competiveness Index' of nations (Porter et al, 2007). Nonetheless, because the network data originate from the urban level, it is arguable that the results, although at the

Table 1

Connectivity	Connectivity	Imports	Exports	FDI
Imports	1	0,825	0,698	0,921
Exports		1	0,975	0,876
FDI			1	0,849
All values 2005				1

Linkage correlations between corporate connectivity, trade (US $) and FDI. Source: Wall/v.d. Knaap, 2009.

national level, also reflect the performance of city networks and urban competitiveness to a certain degree.

1.3.5 Data and techniques used in the temporal study

Chapter 2 addresses the temporal development of corporate networks, and most of this research is based on theoretical studies and empirical results on urban population growth (Chandler, 1987) and trade and communication networks (van Susteren, 2007). Research on the founding years of the Fortune® top 100 multinationals (1955 – 2005) has been collected and analyzed using Fortune®, Wikipedia, Google, Melissa Data® and Lexis Nexis® databases. In addition, a separate analysis was executed concerning the turbulence of firms in the Fortune® 500 list (1955 – 2005). The data used concern 'exiters,' firms that terminated within a specific year, due to mergers and acquisitions or bankruptcy; as well as 'enterers,' or firms that were totally new or established through mergers and acquisitions.

1.3.6 Data and techniques used in the structural study

Chapter 3, concerning centrality and structure within corporate networks, is based on the global dataset. The entire dataset of 9,243 connections is used because these represent all industrial sectors of the contemporary world economy. This allowed for a similar exploration of the concept of 'world cities' as initially characterized by Friedmann (1986) and executed by Alderson and Beckfield (2004). All firms in the datasets have been coded by their industrial (SIC) sectors, allowing for the extraction and analysis of, for instance, the advanced producer service network, so as to investigate evidence on 'global cities', as characterized by Sassen (1991) and executed by Taylor (2004). In the analyses found in Chapter 3, three common centrality measures are used: outdegree, indegree, and betweenness. In these measures, the content of the interaction is the exchanged product, which concerns shareholding from headquarter to subsidiary firms. Therefore, the corporate position of a city can be observed either through the interactions directed towards it (indegree) or the transactions emanating from it (outdegree). Outdegree serves as an expression of the power arising from influence over others (Irwin, Hughes, 1992).

Alternatively, prestige or dependency best characterizes the indegree arising from the accumulation of resources at a given node (Alderson and Beckfield, 2004) (Wall and v.d. Knaap, 2007). In this sense, headquarter cities are dependent on the subsidiary activities in these cities. However, indegree can also be seen the dependency of subsidiary cities on the command functions of a limited number of headquarter cities. Another centrality measure used is 'betweenness,' which is an expression of a city as a 'broker' to others. In the context of this study, this measure is a gauge of a city's intermediary role between the corporate activities of other cities. This is better explained in the methodology of chapter three. To correctly measure outdegree, indegree and betweenness, the 'diagonal' was removed from the 'adjacency matrix'. In this way, intra-urban relations within the cities themselves were eliminated, ensuring that all centrality results are purely inter-urban. Centrality analysis was done using the Ucinet network analysis software (Borgatti, Everett, Freeman, 1999). Ucinet's Mapdraw software package was used to explore the linkage structure of the network, and Mapinfo (GIS) software was used to study the geographic network distributions.

1.3.7 Data and techniques used in the scalar study

In Chapter 4, which relates to analyses concerning differences in global, European and Dutch scales of corporate data, the datasets have been made comparable and compatible. The data was restricted to include only those cities that are found in all three scales of corporate networks. Of the thousands of cities, only 199 fit this criterion. Nonetheless, these 199 international cities proved to be the most important, because they held approximately 90% of the total connectivity found in each of the three datasets. As mentioned before, although the headquarter locations of each scale are restricted to three geographic zones (global, European, The Netherlands), their subsidiary networks are worldwide. In this chapter, the previously defined network measures of outdegree and indegree were used, for each scale. Ucinet network analysis software (Borgatti et al. 2003) was used to analyze the data. Another specific measure, called 'cliqueness,' was used to find sub-groups within the global and European datasets. These 'sub-structures' found in networks, are often of interest in network analysis. For the purpose of this research, the general definition of a clique can be seen simply as the identification of a sub-set of cities that are more closely connected to each other by shareholder interactions, than to other cities that are not part of their subset. This is the strictest and purest definition. For more detail on this technique, see Chapter 4. For this analysis, it has been of interest to find which cities form large, complete sub-graphs, as these are said to reflect stable, completed structures of corporate interdependency and collaboration (Wasserman and Faust 1994, Borgatti, Everett, Freeman, 1999). To measure the statistical nature of the network, a regression analysis was performed on the urban rank and centrality variables. This has been done according to the Zipf regression approach by Gabaix and Ibragimov (2008), through which the data was analyzed to see if it followed a so called 'power-law' distribution, by which cities are seen to occupy relative functional and geographic importances, and where only a handful of hubs are disproportionately connected (Barabási, 2003).

1.3.8 Data and techniques used in the competition study

Urban competition between global financial centers has been the subject of a large body of literature in the field of geography and urban studies (Sassen, 1991; Gordon, 1999; Beaverstock et al., 2002). However, there is no systematic and objective measurement of this competition.

Chapter 5 empirically demonstrates how urban competition can be measured by focusing on economic competition in advanced producer services among 20 world cities. These cities are classified as world cities, based on their level of advanced producer services and the number of commanding linkages (outdegree) that they have in the intercity network of services (See Beaverstock et al., 1999 for the classification). Because the major purpose of this study has been to define a new measurement for competition, the reader should refer to the methodology of Chapter 5 for an elaborate explanation. The data used is based on the advanced producer services subset, mentioned earlier in this section. This subset consists of 3,150 commanding relations between advanced producer services headquarters and their subsidiaries across 684 different cities. By geographically aggregating the data to the city level, a corporate intercity network of advanced producer services was obtained. The twenty strongest cities were selected for the analysis, because these cities accounted for over two thirds of the total number of commanding linkages in the advanced producer service network. Applying the competition measure described in Chapter 5, a matrix of the intensity of competition has been obtained using the Ucinet software (Borgatti et al., 2002). Furthermore, a cluster analysis was carried out to define groups of similar urban clusters.

1.3.9 Data and techniques used in the performance study

Chapter 6 concerns the impact of national performance on the network strengths of nations. This nationally aggregated data has firstly been mapped using GIS software revealing the national network of all industrial sectors. Later this distribution was statistically explored by calculating parameter values according to the Zipf regression approach by Gabaix and Ibragimov (2008). In this way, this data could be analyzed to see if it followed a so called 'power-law' distribution. This corporate unevenness has been shown by Robert Gibrat in 1931, (Sutton, 1997) and, similarly, in Zipf's Law (Axtell, 200), in which cities are assigned relative functional and geographic importance, often characterized by power-law statistical distributions and in which limited cities are extremely connected hubs within the entire city-firm network (Barabási, 2003). Next, the global network of 9,243 corporate connections between cities was aggregated to the national level. This was necessary because national 'Global Competitiveness Index' data (Porter et al, 2007), was used as an indicator of competitiveness (e.g., institutional quality, technological relatedness and market efficiency) so as to analytically measure its relationship to corporate network strengths (as discussed in Chapter 1.2.5). This index employs a specific, integrated view of competitiveness, including twelve variables (institutions, infrastructure, macro-economy, health and primary education, higher education and training, labor market efficiency, capital market efficiency, goods market efficiency, technological readiness, market size, business sophistication and innovation). The index covers over 125 economies at different stages of economic development. The study in Chapter 6 uses a slightly modified version of the original index, in which the qualitative aspects of competitiveness are separated from the more quantitative ones (market size, macro-economy). Most often, countries that score high on one particular variable also score high on the other variables, with a strong statistical correlation between the different variables of over 0.90. Therefore these two groups have been defined using factor analysis. Both groups of variables have been utilized in this research to define the structure of the global corporate control network, to a certain degree. However, it does not explain causality, only association.

The positions of countries in the global corporate control network and the strength of their corporate connections are used as the dependent variables of the study in Chapter 6. The hierarchic position of a country in the network is based on its total headquarter connectivity (the number of outgoing corporate connections, or outdegree) and its total subsidiary connectivity (the number of incoming corporate connections, or indegree). Likewise, the total number of corporate connections between a headquarter country and its subsidiary country is used as an indication of the strength of the corporate connection between the two countries. This measure indicates the network strength 'between' countries. The collected data are then used to test several regression models, relying on the common Poisson regression model, amongst others. For instance, a negative binomial regression model is used to account for the dispersion of the dependent variable and a zero-inflated Poisson regression model to account for excessive zero counts or 'non-Poissonness' in the data. Three separate regressions were performed, first measuring the factors of headquarter connectivity, then the factors of subsidiary connectivity, and finally the factors of the number of corporate connections between countries. Because competitiveness is not the only factors of headquarter and subsidiary connectivity, other variables (covariates) were used as controls. These include covariates of national market size, remoteness, and openness. Furthermore, several bilateral variables measured at the level of country-pairs have been used, such as the geographic, economic and cultural-historical distance between countries. Accounting for both country and bilateral characteristics, including country size and the physical distance between countries, this analysis closely resembles the type of analyses employed in spatial interaction or gravity-based modeling (Fotheringham and O'Kelley, 1989; Sen and Smith, 1995). More detail on data preparation and techniques can be found in Chapter 6. To end this introduction an outline of the book is presented **(Table 2)**.

Table 2

Chapter	Title	Network characterisitics	Central research questions
I	**Introduction**		
2	**The Evolution of Worldwide City Networks**	Temporal	1. How did economic networks between cities evolve since the dawn of the Industrial Revolution up until today? 2. How did this evolution influence the network properties of structure, scale, competiton and spatial performance?
3	**Centrality and Structue within Contemporary Worldwide Corporate Networks**	Structure	1. What is the centrality of cities in the current worldwide corporate network, when (a.) observing all industrial sectors, and (b.) observing only producer services? 2. What is the structure of the contemporary global corporate network, in terms of (a.) the spatial distribution, (b.) the linkage distribution, and (c.) the statistical distribution?
4	**The Relative Importance of Cities within Comparative Worldwide Corporate Networks**	Scale	1. What effect does corporate scale (global, European and Dutch) have on the centrality and structure of (a.) cities worldwide, and specifically (b.) the main cities of the Randstad? 2. Which cities form (a. independent sub-networks or 'cliques' and (b.) which cities are most common to all cliques? 3. Do all three networks hold a 'power-law' distribution, revealing high disprorpotionaltiy?
5	**Measuring Urban Competition on the basis of Flows between Cities**	Competition	1. What is the centrality and geographic structure of the global advanced producer service network? 2. Can corporate competition be novelly measured, based on the producer service ties 'between' cities? 3. What sub-structures of competiton between cities can be derived from the results?
6	**The Coherence of National Competitiveness and the Geography of Global Corporate Networks**	Performance	1. Does the global corporate network, measured at the level of nations, exhibit a highly disproportionate power-law distribution? 2. If so, why are certain nations better connected than others in terms of (a.) outgoing linkages, and (b.) in terms of incoming linkages? 3. Which national factors determine the strengths of linkages 'between' nations?
7	**Conclusions**		

I.4 OUTLINE OF THE BOOK

	Unit of analysis	Methodology
	1. Theoretical 2. Urban population and trade growth 3. Multinational corporations (1800 - 2005)	1. Explorative 2. Descriptive 3. GIS analysis
	1. Global corporate 'worldwide' network (2005) 2. Cities worldwide 3. Nations worldwide 4. Supra-regions worldwide	1. Network centrality (outdegree, indegree, betweenness and diagonal) 2. Ucinet Mapdraw mapping 3. GIS analysis 4. Cluster analysis 5. Zipf regression
	1. Global, European and Dutch 'worldwide' corporate networks (2005) 2. Cities worldwide	1. Network centrality (outdegree, and indegree) 2. Clique analysis 3. GIS analysis 4. Ucinet Mapdraw mapping
	1. Global advanced producer service networks worldwide (2005) 2. Cities worldwide	1. Network centrality (outdegree) 2. Niche overlap model (geographic and functional) 3. Cluster analysis 4. GIS analysis 5. Ucinet Mapdraw mapping
	1. Global corporate network aggregated to the level of nations 2. The 'Global Competitiveness Index' of nations worldwide 3. Various national covariates	1. Network centrality (outdegree, and indegree) 2. Count data models and quasi-Poisson estimation models 3. Zipf regression 4. GIS analysis

CHAPTER 2

The Evolution of Worldwide City Networks

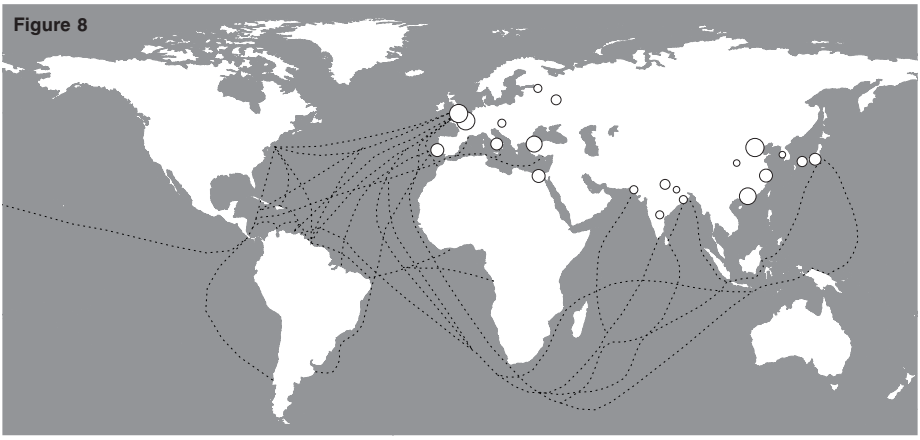
2.1 Introduction

Today, the perception of a globalizing world as a 'network society' is quite common. However, the concept of the city as a 'node' in a network and a 'place' in space is not entirely new. This was already evident in the ancient Egyptian hieroglyphic for the city, consisting of a cross (the external networks between cities) within a circle (the place where connections concentrate). Hence, this character already symbolically captured the dual 'exogenous' and 'endogenous' roles of the city (Camagni, 1993). According to historians J.R and W.H. Mc Neill (2003), authors of the book *The Human Web*, the entire chronology of mankind can be correlated with the gradual formation of worldwide networks, initiated by the development of speech and the invention of archaic technologies. These primordial networks allowed for trade and communication and progressively became more complex, especially after the advent of industrialization. Although several authors trace globalization back to before the Industrial Revolution, the nineteenth and twentieth centuries represent an explosive break with the past. This is mainly due to price convergence, the increased scale of economic interaction, infrastructural developments, technological innovation, and declining transport costs (Bordo, Taylor, Williamson, 2005). These changes penetrated all areas of economic activity, creating new patterns of demand, output, and employment (Maddison, 1995).

Based on these arguments, this chapter begins with the advent of the Industrial Revolution and proceeds to the contemporary phase of globalization. The aim of this chapter is to theoretically discuss the spatio-temporal development of city networks, as described through five phases of technological innovation. These are the ages of: (1) water power, iron, and textiles; (2) steam power, mechanization, and railways; (3) electricity, steel, and heavy engineering; (4) oil, motorization, and mass production, and finally (5) information and communication technologies. For each period, the related technological and economic innovation will be explored, followed by a study of how this impacted the formation of physical, social, and economic networks between cities. In this way, it will be considered how the contemporary global network system is the incremental result of an evolutionary process. Each period is illustrated with a GIS map which is made to represent the specific phase of network formation. These maps display population size of cities (Chandler, 1987) and the transport and communication links of that era (van Susteren, 2007.) The following four chapters, which are based strictly on actual data, can thereby be placed within a sound historical context.

Because the central political units of the contemporary world are still nations, this chapter will briefly start with the Westphalia Treaties (1648), which served as the official confirmation that nation states would at that time become the main political building blocks of society. Thereby, previously city-centered economies became organized into state-centered ones (Bairoch, 1988). This can be seen as a precursor to the Industrial Revolution,

Figure 8



The evolution of worldwide city networks (1770s – 1830s).
Source: Wall/v.d. Knaap, 2009 – based on data Chandler 1987, van Susteren 2007.

ushering in an alternative political order (Taylor, 2004) in which cities and their interactions flourished more than ever before, and the emergence of very large cities ushered in an entirely different type of urban existence than had been experienced before. Urban growth was boosted by increasing urban population, with a subsequent rise of demand and trade. In this era, the Dutch excelled at trade with different parts of the world. This shifted the primary locus from Southern to Northern Europe, whose major cities gradually replaced the previous prime cities of Venice and Genoa (Findlay and O'Rourke, 2007). Because Amsterdam was strongly linked to colonial settlements, the Dutch economy has become regarded as the first modern economy (De Vries, v.d. Woude, 1997).

2.2 Networks within the age of water power, iron and textiles: (1770s – 1830s)

2.2.1 Technological and economic innovation

The period around 1770 represents the start of the Industrial Revolution, driven by early water-powered mechanization and the production of goods such as textiles. The use of coke instead of charcoal and water-driven bellows led to enhanced production, thereby transforming energy demand. This development ushered in a 'Schumpeterian' growth, which replaced the organic 'Smithian' economy of the previous centuries (Wrigley, 1988). Per capita incomes grew as a result of technological change. Cast-iron technology led to the end of an era of wooden, water wheel construction (Floud, McCloskey, 1994), and the rapidly falling price of iron satisfied an important criterion for its universal availability and multiple applications (Freeman and Louçã, 2001). The Industrial Revolution, which took off in Britain in the late eighteenth century, undeniably ushered in a new era in the evolution of the world economy, confirming Britain's dominance as the key technological innovator. By 1810, industry and construction had already overtaken agriculture, justifying the use of the expression 'Industrial Revolution' (Bairoch, 1988). The main incentive for innovators was time-saving in fixed and working capital pursued through mechanization (Supple 1963). Already during this era, it is seen how large-scale infrastructural projects (canals and turnpikes)

required large capital investments, and these improvements benefited all industries and services by widening markets and improving supplies.

2.2.2 Network evolution in the age of water power

The economic explosion at the start of the eighteenth century was initiated by advances in agricultural productivity, a decline in farm labor, and the subsequent Industrial Revolution, which fundamentally transformed the nature of cities and their interactions. Where urban life was previously the exception, it now became the rule, fuelled by a significant rise in international trade to new and old cities, especially in the Americas and Africa (Chandler, 1987). This was mainly due to European demands for new goods, which slowly facilitated the formation of a second primary network-core on the east coast of North America **(Figure 8)**. Although these new cities remained relatively small during the time, their steadily growing populations and markets slowly started to challenge European dominance. Not only did the linkages increase, but improved maritime technology also led to faster and higher volumes of exchange. Furthermore, a shift in Europe's urban hierarchy occurred, where Amsterdam lost its dominance and was gradually replaced by London.

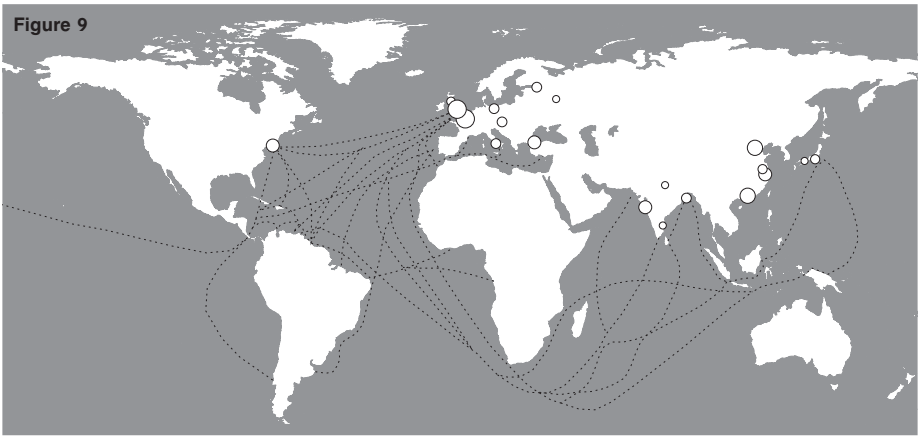
During this period, cities had already started to mature as entities within the developing nation states, thereby creating a new pattern of urbanization. Capital cities served as centers of political administration, bureaucracy, and culture, and they also functioned as important nodes of consumption (Fields, 1999). At that time, economist Adam Smith (1776), in his seminal book *The Wealth of Nations* had already defined the role that cities play in facilitating trade within 'national' market-economies. It is therefore not surprising that at the time, the first core-periphery concept was developed in Von Thünen's (1826) 'Isolated State'. In this model, an initial 'spatial model' of the relationships between core (isolated city market and profit maximization), linkage (navigable canal/transport costs), and periphery (isolated agricultural production in an isolated state) was conceived. This scheme showed a city center (market) with concentric agricultural rings radiating outwards, with land rents highest near the center, and where 'heavy' crops that need fertilizers are placed close to the market. In the model, an added sub-center suggested early competition and hierarchy.

2.3 Networks within the age of steam power, mechanization and railways: (1830s – 1880s)

2.3.1 Technological and economic innovation

At this stage, the 'bourgeois' age of steam power emerged, accompanied by the rapid expansion of the coal and iron industries, through which the regions of Northern Europe and North America boomed (Freeman and Louçã, 2001). Steamships became the key innovation in transport technology, although canals still made a significant contribution to commodity market integration (Slaughter, 1995). Another essential development was the opening of the Suez Canal, allowing steamships to compete on Asian routes. The vastly improved steam engines made it possible to use steam power not only on railways but also in various sectors of industry and agriculture. A major railway network was already constructed in Britain in the 1840s, and the US became the second nation in the world to have its own railroad (Freeman and Louçã, 2001). Although well-endowed in resources and market size, the

Figure 9



The evolution of worldwide city networks (1830s – 1880s).
Source: Wall/v.d. Knaap, 2009 - based on data Chandler 1987, van Susteren 2007.

US did not have the infrastructure in the first half of the nineteenth century to boom. Yet this eventually changed with the advent of railways and new technologies during the second half of the century. By the end of the century, American engineers and scientists had developed new processes and products, leading to greater productivity than in Britain. American managers became experienced in the organization, financing, and operation of large enterprises geared toward creating and exploiting mass markets (Abromavitz, David, 1994).

During this period, transport costs dropped dramatically, leading to price reduction and convergence at an international scale (O'Rourke and Williamson, 1994). By the late nineteenth century, international trade had grown significantly and had a profound impact on income distribution. The world rise in GDP per capita was more impressive than in the twentieth century (Maddison, 1995). Globalization during this period had a dramatic impact on both the world division of labor and the distinction between industrial and primary producing economies. Primary products accounted for 64% of total world export, and minerals accounted for only 14%.

2.3.2 Network evolution in the age of steam power

At this time, the number of international trade links between Europe and America increased rapidly. More importantly, however, New York became the center of a second global economic core, and a new set of trade linkages connected it to the rest of the world **(Figure 9)**. The monolith of previous European dominance split in two, and a bi-centric network was formed. Furthermore, linkages started to sprout on the east coasts of the Americas, South Africa, and Australia, facilitating trans-Pacific and trans-Indian Ocean connectivity. Around 1837, the level of world urbanization surpassed 40%, and London became the first city in European history to exceed a million inhabitants; it was the dominant global city at the time (Chandler, 1987). Other British cities also flourished, such as Liverpool, Manchester, and Glasgow, further marking the dominance of Britain, though St. Petersburg, Berlin, Vienna, and Moscow also ranked within the top 20 world cities (Chandler, 1987). During this age, the primary global cities were port-cities that utilized strategic advantages and accommodated new transport technologies.

Mainly intended to link existing cities together, railroads became a new localizing factor in their own right, joining with natural transport routes and stimulating the growth of cities. Railways linked desolate areas, thereby promoting the urbanization of areas that originally only had marginal economic potential (Bairoch, 1988). By 1840, the population of London had reached two million due to its connection to the British rail system, and it reached the three million mark around 1865. This upsurge was caused by the demand of food, fuel, and raw materials for industry.

The fact that infrastructural networks play a principle role in city location, development, and hierarchy is as true for cities in traditional societies as for those that existed following the Industrial Revolution. It was at this time, as international trade started to flourish, that J. Reynaud (1841, quoted by Robic, 1982), in '*Le système général des villes*,' initially observed and identified systemic spatial and functional regularities of cities as components of urban systems (Pumain, 1999). This framework formed the first conscious conception of systemic, vertical, and horizontal urban linkages between different spatial scales.

2.4 Networks within the age of electricity, steel and heavy engineering: (1880s – 1930s)

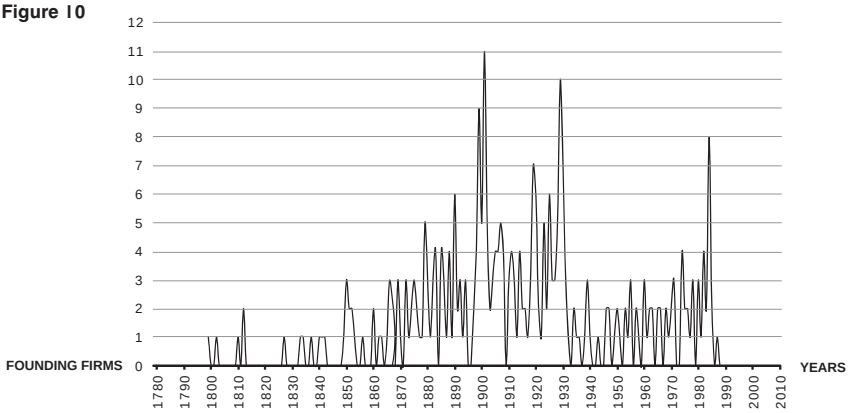
2.4.1 Technological and economic innovation

The age of steel, copper, electricity, and heavy engineering forms the catalyst of this period. In the late 1880s and early 1890s, the threshold was reached for a myriad of new investment opportunities based on cheap steel and electric power. This required huge generators to supply this publicly available 'commodity'. The development of factories was strongly influenced by the new machinery and power tools. The shift in paradigm is comparable to that of information technology or the earlier mechanization of industry based on steam power. However, the Schumpeterian 'gales of creative destruction' did not mean that previous technologies disappeared; instead, they were simply augmented by new innovations.

The fact that coal and steel became available almost everywhere meant that the engineering industry could spread to new centers like Berlin and Paris. Better steam engines were possible because of advances in machine technology and precision engineering. In the 1870s, steam tonnage far exceeded that of sailing ships. Other advances in this period were the first submarine telegraph in 1851, the transatlantic cable in 1858, the first telephone exchanges in Britain in 1878, the formation of General Electric in 1892, and the Marconi wireless telegraph in 1987. Railways and the telegraph brought great transport and communication benefits to American industry and agriculture, most notably in terms of speed and reliability, making it cheaper (Chandler, 1965).

International trade began to outstrip even the rapidly expanding volume of industrial production (Ormerod, 2005). While third-world nations lagged further behind the leading nations, a few, especially in Europe, started to catch up. The US economy was already bigger in 1950 than that of Western Europe as a whole (Maddison, 1995). An important reason for this success was the massive infrastructural investment made to exploit its natural resources and provide urban facilities for its growing populations. Research and

Figure 10



The founding years of Fortune® 100 firms existing between 1995 and 2005.
Source: Wall/v.d. Knaap, 2009 – based on Fortune, Melissa Data and Lexis Nexis.

development were greatly intensified, placing more emphasis on corporate and national investments than on individual efforts. It was not just the US economy that played an active role in standardizing and enlarging markets; more strikingly, the increased role of very large enterprises was also key. These businesses handled large amounts of capital, spreading risks and increasing productivity over a very large range of new industries, especially in consumer goods. They also invested in machinery and equipment, which embodied change more rapidly than did physical structures.

For the first time in history, massive companies emerged, bringing with them entirely new management problems. The firms that survived the turbulent restructuring that took place during this period became the multinational companies so familiar today, such as AEG and Siemens (Hannah, 1983). This was confirmed in a study that was performed concerning the founding years of the Fortune® top 100 multinationals (1955 – 2005). It is interesting to see that many of today's firms were established in the first half of nineteenth century, and especially towards the end of the nineteenth century **(Figure 10)**. This is followed by a decline towards World War I. In the 'Roaring 20s,' there is a sudden boost in the number of firms being founded, followed by a sharp decline during the Great Depression of the 1930s. From the post-war period onwards, there aren't any major fluctuations, except as occurred in the 70s and 80s, when a number of 'information'-type firms were founded. The strong founding activity around the end of the nineteenth century signifies two things. Firstly, it corresponds to Maddison's research that identifies this period as the most affluent ever, a fertile context in which many of today's firms could emerge. Secondly, it signifies that top multinationals generally do not become so overnight. A period of 50 – 100 years is needed for many firms to become strongly established. By further analyzing this dataset within specific industrial sectors, it can be seen that the majority of the firms in the 'transport, communications and energy sector' were established around 1900, and these were strongly facilitated by firms from the finance, insurance, and real-estate sectors, which produced the capital and insurance of many new ventures. The boom in this sector of firms escalated from the early 1870s to peak around 1900 and decline around the early 1920s. Furthermore, many ICT firms were established between the early 80s and mid-90s. Many of the recent consumer service firms were founded during the 'Roaring 20s' and

the 'Golden Age' of the twentieth century. It is interesting that the majority of today's retail trade firms were established between 1877 and 1913, with a peak around 1900.

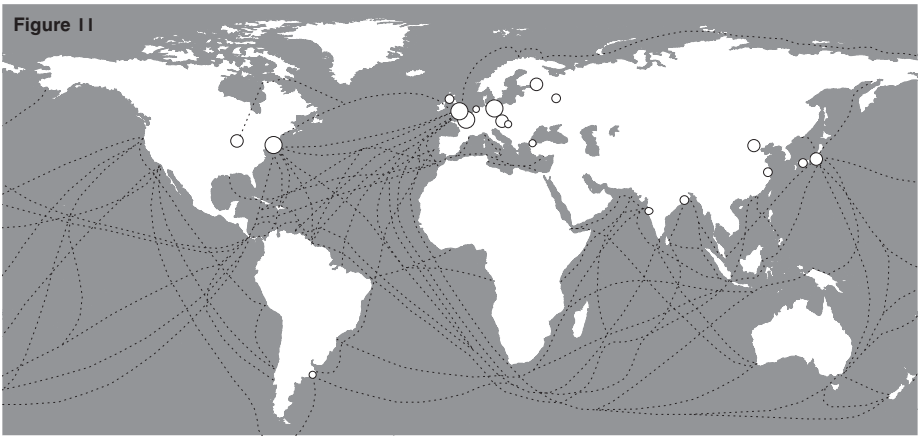
The new giant electrical firms concluded international agreements for the division and re-division of world markets, and they made monopolistic arrangements for the protection of their own domestic markets as well. They pioneered new management techniques to control their vast global operations, such as design, R&D, accountancy, marketing, and personnel (Hannah, 1983). The new communications media greatly facilitated the development of large corporations with more complex management structures that controlled plants in various locations, as well as the production and delivery of materials, components, and machinery from distant lands (Hannah, 1983). With the new infrastructure of world shipping and railways already in place during this period, and the division of the world between the great powers, fierce competition for control of the world market emerged, and the export of capital was greatly facilitated. On the eve of World War I, firms were of an unprecedented size and operated globally. However, only a handful of these firms could survive the fierce competition emerging around the world (Ormerod, 2005).

The sheer scale of multinationals required new management structures in the form of subsidiaries and were controlled by professional managers (Gereffi, Korzeniewicz, 1994). The establishment of a worldwide transport and communications network meant that firms could now operate on a global scale, not only in terms of exports, but also in terms of vertical integration with raw material suppliers, the control of manufacturing facilities and sales agencies in many nations, and the finances to organize such operations. Economies of scale in finance for new investment became increasingly important in the procurement of materials, in the establishment of marketing networks, and in R&D and development. The new electrical technologies also brought with them a revolution in management in the form of expensive equipment, advanced technology, complex maintenance and repair, sophisticated accounting and statistics, and new forms of coordination and political arrangements.

2.4.2 Network evolution in the age of electricity:

In this period, the two core regions, Europe and the US, were firmly established. The development of the Panama Canal opened up these cores' connectivity with the west coast of the US and Australasia **(Figure 11)**. The highest density in trade connections was between the first two cores, but strong linkages with Tokyo were already emerging. There was increasing evidence of the trajectory of the network's shift from a mono-centric system, to a bi-centric one, and then to a tri-centric one. In Europe (circa 1900), London was still the primary city, with 6.5 million inhabitants, followed by Paris with 3.3 million and Berlin with 2.4 million. In the world city top ranks, New York was already the second-largest, with Chicago, Philadelphia, and Boston close at its heels. On the west coast, Los Angeles and San Francisco were already emerging as new giants. By 1905, the United States had caught up with Europe in terms of its level of urban development. This accomplishment stemmed from its huge endowment of resources and adoption of European agricultural innovations (Bairoch, 1988). In the European region, Berlin, Vienna, St. Petersburg, Birmingham, Moscow, Hamburg, Budapest and the Ruhr cities became strong regional contenders. The full dominance of Western development during this era is clearly evident; and the previously dominant Asian cities, which had constituted about 60% of the top 25 world cities, now

Figure 11



The evolution of worldwide city networks (1880s – 1930s).
Source: Wall/v.d. Knaap, 2009 - based on data Chandler 1987, van Susteren 2007.

made up only 15%. Peking shifted from 2nd place in the previous era to 13th place in the new age, though Tokyo rapidly emerged as a new Asian world city contender and claimed 7th place (Chandler, 1987). Amsterdam shifted from 15th place (its highest rank ever, attained in the 1750s) to 40th place in the 1900s.

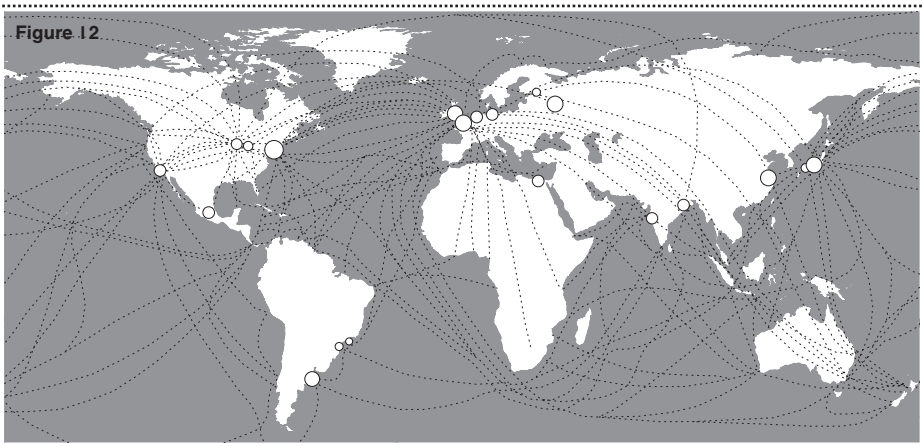
2.5 Networks in the age of oil, motorization and mass production: (1930s – 1980s)

2.5.1 Technological and economic innovation

This period represents the Fordist age of oil, automobiles, and mass production. It emerged out of the crisis of the Great Depression and the two World Wars, which had a more profound social consequence than any previous crisis had wrought (Freeman and Louçã, 2001). It was an 'Age of Extremes,' marked by the first major attempt to establish an entirely alternative economy, namely the Russian Revolution of 1917. Intertwined with these trends of extraordinary political and social change was the rise of a new constellation of technologies based on oil, aircraft, tanks, aviation fuel, machine tools, armaments, and synthetic rubber, as well as the automobile and consumer durables.
During this period, the first true application of mass production techniques by Henry Ford in Detroit replaced the 'craft industry' with the 'moving assembly line'. Detroit in the early 1920s became a place of pilgrimage for top industrialists, engineers, and celebrities from Europe. In the late 1950s, the introduction of the commercial jet aircraft radicalized network formation. The other major development was containerization, which simplified the transshipment of freight, greatly reducing the cost and time involved in transport.

Before this period, the US had become the leading economic power, accounting for 56% of world manufacturing output in 1914. Later, the 1929 recession in the US set in, fuelled by the Wall Street Crash, the end of the housing boom, the rise in interest rates, and contractions in exports in the primary producing nations (Dow, 1998). The key network infrastructures during this period were roads and highways, fuelled by a rising

Figure 12



The evolution of worldwide city networks (1930s – 1980s).
Source: Wall/v.d. Knaap, 2009 - based on data Chandler 1987, van Susteren 2007.

automobile industry. The post-war period indicated a move towards trade liberalization, which started almost immediately in the United States, but did not hit Western Europe until approximately 15 years later (Findlay, O'Rourke, 2007). In the later period, there were also enormous structural changes in the colonies of the world, such as the end of colonial rule and the liberation of these nations, a net inflow of foreign capital and foreign aid to developing nations, buoyant world trade, reduced trade barriers, and catch-up among Asian nations. The price of oil dropped to very low levels in the 1960s, but increased demand and dependence on oil later led to the OPEC crises of the 70s. The Middle Eastern oilfields became the objects of intense power interest.

By 1935, over half of all American families owned an automobile, paralleled by the purchase of household utilities such as washing machines, refrigerators, and dishwashers. This 'Golden Age' of growth saw the biggest increase in GDP per capita consumption ever recorded in capitalist history. The age of mass consumption also influenced service sectors including mass entertainment and tourism. The aircraft industry interacted with social innovation, leading to the advent of the tourist industry. Retail distribution emerged in the form of grocery store self-service, supermarkets and hypermarkets, and this subsequently led to giant firms and the distribution of standardized packaged products (Bluestone, 1980).

2.5.2 Network evolution in the age of oil

In this cycle, it is evident that the American age of world power is fully established, while the entire European economy was eclipsing **(Figure 12)**. Of the world's top 25 cities (circa 1950), six were found in the US during this period, after which this number declined to merely two (circa 2000). New York was ranked at 1st place with a population of 12.3 million, followed by London with 8.9 million. The bi-centric network axis, which had begun to emerge in the previous period, now became fully established, with a growing density of trade between Europe and America. It is also apparent that the further formation of the 'triad' was underway at that time, considering the increase in linkages to a 'rising' Japan. At the time Tokyo already ranked as the 3rd largest world city, with 7.5 million people (Chandler, 1987). The increased emergence of third-world cities with populations above a

million became evident, and connectivity also increased towards cities in the southern hemisphere, such as Buenos Aires (rank 7), Rio de Janeiro (rank 17), Sydney (rank 31), and Johannesburg (rank 40). In the US, a broad regional network is evident between the East Coast cities of New York (rank 1), Chicago (rank 8), Philadelphia (rank 16), Detroit (rank 18), and Boston (rank 23), and it is also seen with the rising West Coast cities of Los Angeles (rank 11) and San Francisco (rank 27). A 'communist' network emerged, forging links to communist nations, and for the first time ever the political division of the world into East and West is seen, with the former demarcated by Berlin (rank 12). Furthermore the emergence of Moscow (rank 6) and Leningrad (rank 19) is evident, which both shifted rapidly into the upper ranks during the heyday of the planned economies.

During this period, with the boom in the US and the slow revival of the European economy, a new era of transcontinental links was forged, where Fordist mass production and the expansion of the network through highways and airlines proliferated and where international economies and nations started to propagate. It is therefore not surprising that city network concepts emerged at that time, as can be seen in the classic studies, *The Nature of Cities*, by Chauncy Harris and Edward Ullman (1945) and *Cities as Systems within Systems of Cities*, by Brian Berry (1964). In these, the main premise was that cities are comprised of both internal relations and external relations to other cities, including the intensification of inter-firm and political hierarchies and widespread strategies of collaboration and competition. Later, Peter Hall (1980) and many others contributed to further 'urban systems thinking'. For instance, Bourne and Simmons' studies (1978) showed that within a set of regional or national cities, a particular city cannot be studied independently; rather, it should be seen as a subset of the overall system (Taylor, 2004).

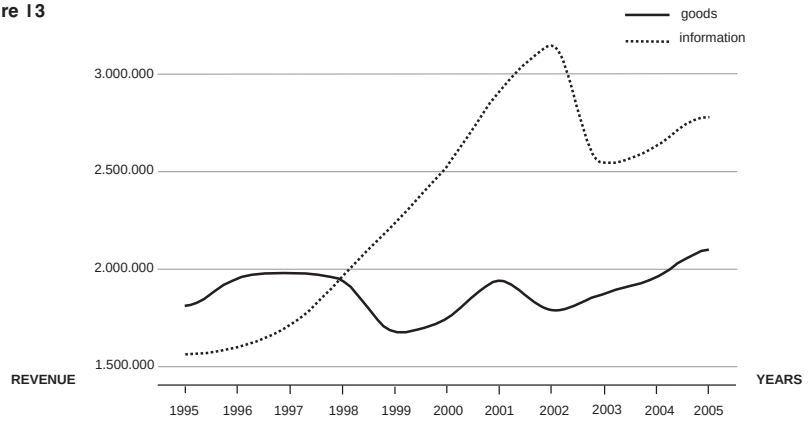
It was also during this period that 'cities in national systems' were analyzed as a relationship between their rank and population size. The reference par excellence on the law of city size distribution is Zipf's Law (1949), which was significant because it introduced statistics to urban studies. After the Industrial Revolution, urbanization became characterized by a considerable rise in the size of cities, but also by a marked increase in the number of very great cities. This was the rise of the megalopolis, developing with London and spreading to New York and Tokyo (Bairoch, 1988). It is interesting to see that although Amsterdam was London's predecessor in terms of economic power, it was never even close to being the largest city. The strength of the Dutch was, and still is, their 'gross' high urban levels and international trade levels.

2.6 Networks within an age of information and communication: (1980s – 2005)

2.6.1 Technological and economic innovation

In the early 1970s, the world economy was overheating. Governments had to cope with strong inflationary pressure, a breakdown of the Bretton Woods fixed exchange rate, and the OPEC oil shock (Maddison, 1995). The momentum of the twentieth century Golden Age decelerated. In the 1950s, the US was the only major centre of capital accumulation. However, in the 1960s, Western Europe became a major centre of capital again, and by the 1970s, Japan had become the third, forming the so-called triad (Wallerstein, 1999). After

Figure 13

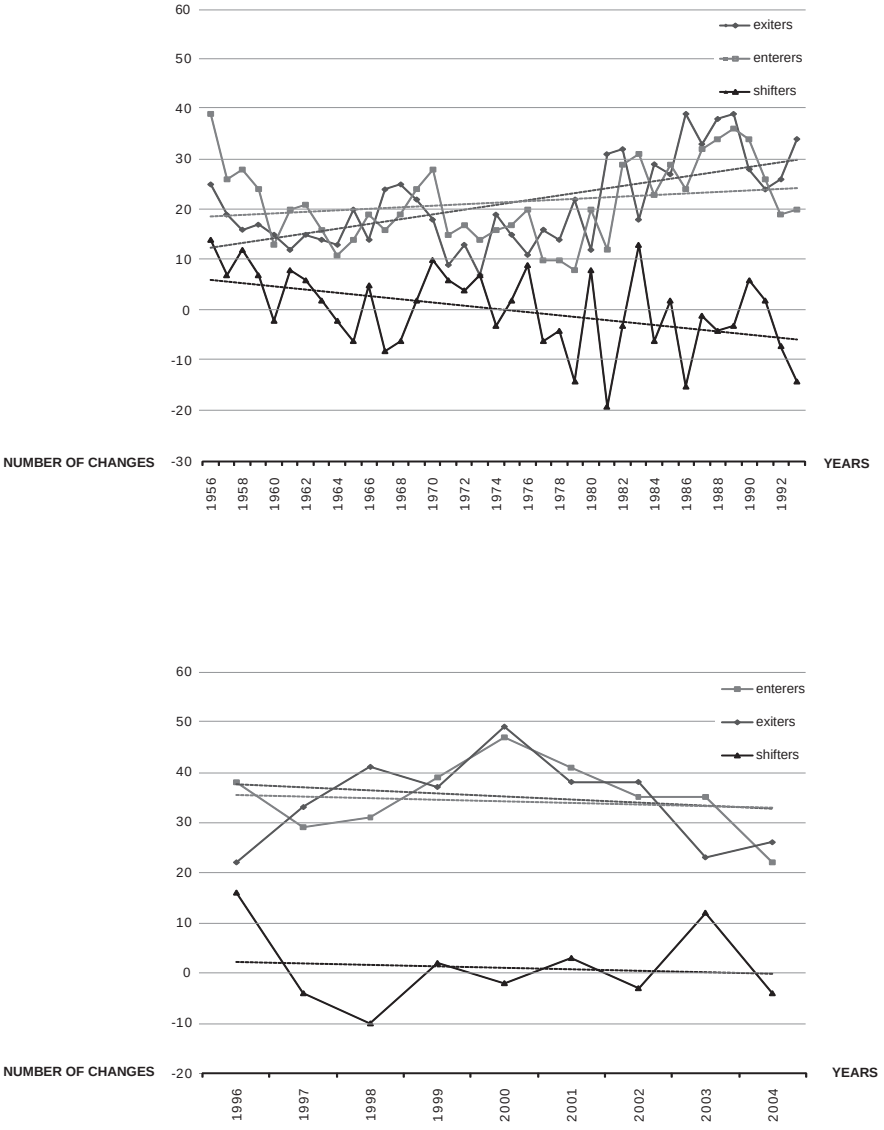


The growth of goods and information firms by revenue.
Source: Wall/v.d. Knaap, 2009 – based on Fortune® 100 firms (1995 – 2005).

1983, these economies managed to squeeze out inflation, and the OPEC oil cartel was broken by the development of new oil resources. Later on, a new shift in the technological paradigm took place. This was most evident in the 1990s, when the US underwent an enormous growth spurt due to ICT technologies, based on electronic computers, software, microelectronics, the Internet, and mobile telephones. The dramatic nature of the technological revolution has been underlined by some of the gigantic mergers that took place in 1999 and 2000, as well as by the internet bubble crash around 2001. Biotechnology and nanotechnology have also grown rapidly and increasingly interact with computer technology. The miniaturization of the 'integrated' circuit chip led to cost reduction and improved performance in consumer computers (McNeill, 1990), and the upscaling of production through miniaturization has proven to be a powerful method of cost reduction (Dicken, 2003).

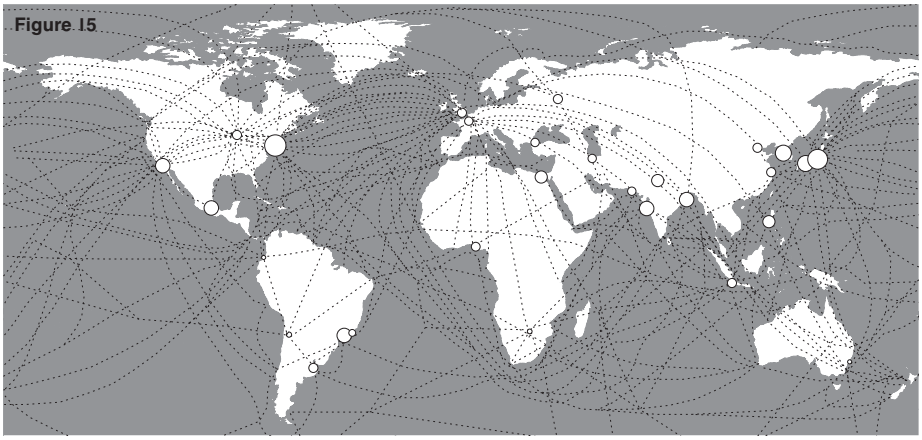
Another vital technological change was in the carrying capacity of communication cables. The development of optical fibers in the 1970s provided the volumetric improvement that would liberate the system from bandwidth constraints. Thus it became possible to transmit huge quantities of data and images instantaneously over an ISDN (Integrated Services Digital network) at rapidly falling costs. Simultaneously, wireless communication transformed as a result of satellite communication and cellular telephone networks. The Internet was introduced in the 1960s and grew exponentially over the last decade (Zook, 2001). To empirically test this, a study was carried out based on the Fortune® 100 multinationals for the period 1995 – 2005. All firms were organized according to their standard industrial codes (SIC) and classified as dealing with either goods or information. These two types were plotted according to their revenues **(Figure 13)**. It can be seen that the information sector overtook goods in the 1990s, becoming the dominant sector. The strong acceleration of information firms after the full establishment of the Internet in 1995 is evident, leading first to the IT bubble in the late 1990s, then to the crash of the IT sector after 2002, and to its recovery around 2004.

Figure 14



Turbulence of firms (mergers, bankruptcy and newly established firms).
Source: Wall/v.d. Knaap, 2009 - based on Fortune® 500 firms (1955 - 2005).

Figure 15



The evolution of worldwide city networks (1980s – 2005).
Source: Wall/v.d. Knaap, 2009 - based on data Chandler 1987, van Susteren 2007.

The internet has enabled the 'horizontalization' of global economic activities. Outsourcing through fiber-optic networks has led to new forms of cost-efficient collaboration between developing and developed areas and the relocation of factories to cheaper nations. The information revolution destroyed the monopolistic power of the former state-owned telecommunication utilities, which have become fragmented and privatized. Important differences between the Fordist and ICT waves are the move from energy-intensive to information-intensive production, from standardized to customized operations, from stable product mixes to rapid changes in product mixes, from automation to systemization, from single firms to networks, from hierarchical structures to horizontal structures, from departmental organizations to integrated ones; products with services to services with products; centralization to distributed intelligence; specialized skills to multi-skilling; government control to government coordination and regulation; planning to vision (Perez, 1989). The pressures to earn profits led to market enlargement, by which firms naturally tended to increase in size. Mergers and acquisitions increased intensively over this period, thereby affecting the stability and hierarchy of multinational firms. A new style of management became widespread that contrasted with the Fordist style in many respects. Networking, both within the firm and through the external relations of the firm, became especially important characteristics of the new organization. The pressure to earn profits during this period led to market enlargement, through which firms naturally tended to increase in size. Large clusters of new firms periodically joined the ranks, basing themselves on new technologies and industries. The relative endurance of these firms, amongst the meteoric rise of new contenders with each revolution, depends on both high levels of profitability and the accumulation of tangible and intangible capital (Freeman and Louçã, 2001).

Because many multinationals originated a century earlier, they possessed the corporate power and strength to make large-scale investments in physical capital to maintain themselves as major global players (Chandler, Hikino, 1997). This in turn enforced an important barrier for new firms hoping to enter the top corporate ranks. Nonetheless, competition between firms is escalating: firms increasingly lose power or are replaced in the top corporate ranks (Audrecht, 1997). The explanation for the turbulence in the list is the periodic

rise of new constellations of industries and technologies and the consequences of their diffusion through the economic system. New entrants to the top echelon need profits to finance their headlong expansion at some point. The need for profitability among leading firms in new technology explains why they try to cement their leadership through patent protection, influencing standards, market power, or scale economies. To explore the turbulence of firms caused through increased competition, an analysis was carried out concerning firm longevity based on the Fortune® 500 firms (1995 – 2005).

This has been done in two separate investigations **(Figure 14)** because the Fortune's criteria for listings were different in the 1955 – 1994 period than that of 1995 – 2005. The former focused primarily on goods and the older service industries, such as transport and communications. The latter, due partly to advances in ICT, but also because the advanced 'service industries' have become less elusive, have recently been included within the Fortune listings. The graphs represent three types of firm activity. The first concerns 'exiters,' which are firms that terminated within a specific year due to mergers and acquisitions or bankruptcy. The second relates to 'enterers' or firms that were totally new or established through mergers and acquisitions. The difference between enterers and exiters leads to the third type: the 'shifters'. A negative difference represents firms that shift upwards into the Fortune® 500 list, from below, implying that there is a lot of competitiveness rising from the lower ranks and challenging the more established firms in the upper ranks.

Recall that the 1950s represent the approximate turning-point of the twentieth century's Golden Age, after which it proceeds towards the oil crisis of the 70s, where a similar decrease in the activities of firms within the Fortune lists is seen (top). Moving from the 70s onwards to the 90s, an evident upsurge of firms is seen entering and exiting the list. In the opposite graph (bottom), this upward trend continues up until the year 2000, after which the system again slips into recession. This study found that the turbulence of firms was almost three times as strong in the period from 1995 – 2005 than in the period from 1956 – 1993. In a study by Audrecht, similar evidence was found. Audrecht computed the time taken to replace one third of the Fortune list of the 500 largest firms, and he concluded that during the 1950s and 1960s this process took two decades. In the 1970s, it took one decade, and in the 1980s, it took approximately half a decade (Audrecht, 1997). In my study, it is obvious that in the latter period there was much more shifting of firms into the Fortune list from below. This indicated that around the end of the twentieth century, there was a significant increase in turbulence as a result of competitiveness. A steady decline is again observed in the period after this peak.

2.6.2 Network evolution in the age of information

In this era, the global triad is fully established by the rapid increase of connectivity in East and Southeast Asia. The triad was first born with the maturation of Japan, then Singapore, and more recently China and India **(Figure 15)**. Tokyo (circa 2000) attained 1st place among world cities and Seoul 3rd place, fully establishing these as megalopolises. The rise of the Asian core is important, seeing that the vast majority of the world's population resides there. Asia, with 11 primary cities, has claimed the lion's share of the world's top 25 cities (Chandler, 1987). The only two US cities left on the list are New York, which has shifted to 2nd place, and Los Angeles (shifted to 8th place). Europe has also seen a major decline in

urban dominance. Top European cities were Moscow (rank 17), London (rank 18), and Paris (rank 22). However, population size no longer serves as a precondition to economic performance, where Europe, although it has relatively smaller cities, re-established itself as the primary core in the world economy due to the development of the European Union and the weakening of the American economy. It is interesting to note that, in this period, third-world cities such as Mexico City (rank 4), Sao Paulo (rank 5), Buenos Aires (rank 14), and Rio de Janeiro (rank 20) emerge as megalopolises. Also, for the first time ever, a sub-Saharan African city, Lagos (rank 24), has risen into the top 25, becoming the second biggest African city after Cairo (rank 10). There is also an evident increase in connectivity to these zones and to other influential megalopolises such as Mumbai (rank 6), Manila (rank 9), Calcutta (rank 11), Delhi (rank 12), Jakarta (rank 15), and Istanbul (rank 23).

More important is the rise of information and service connectivity to cities with less expansive populations but higher human capital, such as Singapore (rank 65) and Bangalore (rank 41). The rise of the service sector had already begun in the 1920s and had risen to levels (in the developed world) of around 65% towards the end of the 1980s (Bairoch, 1988). Ever since, this tendency has been on the rise. The service sector, or 'quaternary sector,' is more closely related to information processing and decision-making than other sectors are. Growth in the service sector is strongly related to higher education and innovation levels.

2.7 Conclusions on the evolution of worldwide city networks

In this chapter, it has been argued that today's network society is the result of a historical process of social and economic interaction between cities. It has been shown that these networks have been motored by specific technological and economic innovations (ACS, 2002) that have had a profound effect on the spatial evolution of intercity networks and especially the relationship between the exogenous and endogenous roles of cities. In this way, it is said, that the fate of any individual city is strongly subjected to its role in the evolution of the worldwide corporate network. Based on the theory of this evolution, the conclusion will be structured according to four main categories that have been identified as being the most significant to network formation, namely (1) the characteristics of the changing network structure; (2) the conception of local, regional, and global scales of networks; (3) competition between cities in the network; and lastly, (4) the relationship between economic networks and the performance of cities and nations.

Centrality and structure of networks

In this study it is clear that within each period of technological innovation, there have been shifts in the hierarchic importance of cities (centrality), as dominance has shifted from Amsterdam to London and then to New York, which is dominant today. It is important to note that since the Industrial Revolution, these strengths have been related to a city's international presence, starting with colonial relations and then shifting to the international relations of today. In each new continent of interaction, new primary cities started to emerge. However, each epoch of innovation is led by only one dominant city. Not only did intercity linkages diversify and strengthen over time, but more efficient technologies also

led to faster and higher volumes of exchange between cities. This has subsequently led to an exponential increase in urban populations over the last two centuries and to the rapid development of cities.

Furthermore, it has been argued that over time, core, semi-peripheral, and peripheral relationships have grown into a more and more complex structure. The cores have been seen to be both the locations of leading technologies and the central markets within each consequent epoch (Europe, US and Japan). Furthermore, geographic changes like the Suez and Panama canals led to strategic changes within the network and influenced market expansion. It is evident in each successive phase of network development that, besides the increase in core market areas, the diversity and intensity of connections between cities also increases, slowly including more and more semi-peripheral and peripheral cities in the system. These relationships are related primarily to the strategic constellations of firms that evolved into the multinational corporate alliances of today. In this way, multinational headquarters locate themselves in the core cities of the system, coordinating efficient production processes in semi-peripheral and peripheral parts of the world. This process is fuelled by the corporate endeavor to maximize profits by reducing costs, which in turn is achieved by relocating certain production processes to less cost-intensives areas. In turn, sped up by cheaper transport technologies and very efficient information and communication systems, competition has become increasingly intense, leading to higher firm turbulence towards the beginning of the twenty-first century.

Different scales of network

Widening regional and international markets led to the formation of new economic cores, starting with the European core and slowly incorporating a North American core and then an Asian core. However, while primary cities of each epoch present an increasingly global reach to distant places, it is evident in the maps that regional and local markets expand simultaneously. This means that interaction also intensifies closer to home, leading to the proliferation of regional and local sub-centers, in which smaller types of firms generally tend to operate. It is also expected that smaller type firms in prime or secondary cities will equally relate to different types of networks between cities. Therefore, it is not only transcontinental networks created by such vehicles as ships and airplanes that influence interactions in societies, but also the advancement of regional and local networks such as railways and highways. These networks have enabled previously isolated areas to become part of the global system, or even completely changed the nature of cities themselves, such as in the development of suburbs, subways, and stations. In this context, an expanding patchwork of local, regional and global corporate networks is conceivable, all interlocking with each other. Hence, it is likely that the type and size of firm defines different types of network structure and urban hierarchy.

Competition within the network

The increased scale of interaction between cities has been influenced not only by more efficient technologies and infrastructures, but also by increased participation of cities within the network and the competition arising from this. Improved technologies have arisen in the form of more available and powerful types of energy (wind, water-power, steam-power, electricity, oil) and efficient infrastructures and vehicles of transport and communication

(wind machinery, steam machinery, electrical machinery, oil driven machinery, and computer driven machinery). Parallel to this process, there has been the subsequent rise of urban populations (demand) and international trade (supply). A periodic shift of industrial sectors is clear, in which agrarian industries were gradually superseded by manufacturing and later by information and advanced services. Nonetheless, this does not eliminate the previous industries; but instead engenders the coexistence and co-development of technologies. These new technologies have been fueled by increased capital investments and the widening of regional and international markets. New markets have led to new core regions and have thereby led to further diversification of the global economy and increased competition between the cores, which in turn have led to cost reduction, higher efficiency, and innovation. Another important factor is that, over time, firms increased in size to become the multinational organizations of today. Through advanced telecom infrastructures, these firms could spread their global reach across the planet and facilitate their subsidiary activities in distant places. This enabled firms to compete more, spread risks and costs, increase productivity, and efficiently transmit capital and information over vast distances.

Competitiveness of nations, cities and networks

In this study it has been discussed that the development of the nation-state played an important role in developing powerful cities and interdependent networks between them. In this way, previously city-centered economies became organized into state-centered ones. Characteristic of this development is the unparalleled increase in urban populations. Technological change and expanding trade have led to per capita income increases over time. Also, new technologies in the cities have led to employment increases and improved living conditions. In a sense, various technologies have incrementally coexisted in cities, leading more to a stacking of different forms of social and physical infrastructure, equipment, and labor. It is the core cities and nations that form the leading markets driving each period, but they are also the areas where politics, science, engineering, and culture thrive. Furthermore, these are also the areas in which land rents are highest and where only highly profitable industries are accommodated. It is the gradual increase of core cities and nations that leads to escalating global competition and the gradual exploitation of more peripheral areas for resources. It is evident that originally, network formation mainly concerns the development of physical networks. Yet slowly, corporate and managerial networks also start to form, leading to higher coordination and efficiency in the overall system. This became an important additional characteristic for businesses to locate in those cities and nations in which a strong climate of business efficiency exists. Coupled with organizational networks, the development of information and communication networks has emerged, which have in turn led to further acceleration in network formation between cities. Research and development intensified through these social and technological advances, in which knowledge could be rapidly exchanged between faraway places.

This chapter has served to theoretically explore the concept of networks between cities. In the next chapters of this dissertation, the four previously discussed components of structure, scale, competition, and performance will be empirically explored, based mainly on a dataset of multinational corporations and their worldwide subsidiaries. In this way, the nature of the contemporary corporate network system will be investigated to see how this coincides with the theoretical evolution of city networks discussed in this chapter.

CHAPTER 3

Centrality and Structure within Contemporary Worldwide Corporate Networks

3.1 Introduction

The importance of cities in a globalizing world s strongly associated with their hierarchical positions (centrality) in relation to other cities and the interdependencies (structure) that they exhibit with one another. These properties are empirically explored in this chapter under two separate sections, using a dataset on the top 100 global multinationals and their worldwide subsidiaries. The first part explores centrality in relation to the existing theories of 'world cities' (that feature all industries) and 'global cities' (featuring producer services alone), thereby offering a more contemporary insight into city hierarchies. In the second part, the structure of the corporate ties between cities is investigated, giving an overview of the world system at city, national and supra-regional levels. To explore this area, various centrality techniques are used (outdegree, indegree and betweenness), and the network structure is represented by geographic information system (GIS) and Ucinet network mapping. Based on a consistent and comparative network dataset, the results confirm the legitimacy of both the 'world city' and 'global city' approaches. Furthermore, despite several popular theories concerning a shifting world economy, the results confirm that the disproportionate structure of the world corporate system remains markedly unaltered.

In a paper by Ben Derudder (2005), a 'taxonomy' of several network research studies is explained, revealing the 'conceptual confusions' that emerge in these studies. From this, he posits the continued need for further advances in network analysis, through which to understand the phenomenon of global urbanization both theoretically and empirically. This follows previous calls, for example by Smith and Timberlake (1995, 2002), for a network-driven empirical analysis of the world city system instead of merely attribution-based research. As is commonly discussed, this is partly due to a paucity of data (Smith and Timberlake 1995a; Taylor, Walker, and Catalano 2002) and the fact that only a limited number of papers draw upon original data or test hypotheses. One way of addressing this dilemma is to develop theoretical formulations that are strongly tied to rigorous empirical research based on relational data (Markusen 1999, Beaverstock et al., 2000), in which important cities derive their status from what flows between them rather than from what remains fixed within them (Amin and Graham, 1999; Castells, 2001). Another recurrent issue is the failure to reach an agreement regarding which cities are world or global cities, an issue that has been underlined in the current debate regarding world city and global city approaches (Taylor 2006 and Alderson and Beckfield 2006).

These theoretical differences stem, on the one hand, from John Friedmann's (1986) analysis of 'world cities,' which are based on the power networks derived from corporate headquarters, international finance, transport and communications and producer services. On the other hand, Saskia Sassen (1991) has more specifically focused on advanced

producer service firms as arguably the most important units of production, situated in what she calls 'global cities.' These studies have resulted in several global or world city research studies (e.g., Beaverstock et al., 2000, Taylor 2004, Alderson and Beckfield, 2004, Carroll 2007) in which results have generally been inconsistent, due to differing theoretical and empirical approaches (Derudder, 2006). Therefore, one of the main contributions of this chapter will be to identify and compare 'world' and 'global' cities within a unique, consistent and comparative dataset. The data concerns the top Fortune® 100 multinationals (2005) and their shares in thousands of subsidiaries around the world. Using this dataset, two central questions will be addressed. The first question concerns the 'nodal' properties or centrality of the corporate network. The second addresses the 'linkage' properties or network structure between the nodes. These terms and data will be clearly defined in due course.

3.2 Questions concerning centrality and structure of networks

3.2.1 The question of centrality

The question of 'centrality' is divided into two parts. In the first part (1a), the centrality derived from the entire network is explored, taking all industrial sectors into consideration. This methodological choice more closely follows the Alderson and Beckfield approach, whereby it is assumed that any new results will best match previous 'world city' approaches. In the second part (1b), only the producer service network are extracted and analyzed, under the assumption that this will better match 'global city'-type research, such as that put forth by the Global and World City (GaWC) study group. The results are unique because the centrality scores of world and global cities are derived from the same dataset, thereby making comparisons more consistent. Furthermore, the study concerns 2005 data, thereby revealing a more contemporary view of the world corporate network than previous studies.

3.2.2 The question of structure

Contemporary globalization, according to Sassen, is generating a new geography of marginality and centrality that cuts across the old core/periphery, North/South, and East/West divisions of the world system (Sassen, 1994, p. 4). Within this context, areas that were once the 'core' are becoming peripheralized (e.g., Detroit, Liverpool and Nagoya) and, in contrast, peripheral cities are shifting towards the core (e.g., Sao Paulo and Mexico City). However, research by Alderson and Beckfield (2004) and Carroll (2007) suggests little evidence for the new geography of marginality discussed by Sassen (1991). Hence, the results appear more consistent with Hymer's (1972) view that globalization mainly reproduces previously existing cross-national patterns of inequality and dependency. Within this context, the second question addresses the contemporary core-periphery structure of the world system (2005) and asks whether it still remains consistent with either Sassen's or Hymer's positions. This question is analyzed in three parts. First, in part (2a), the spatial distribution of the multinational network is investigated by means of GIS software, to reveal the geographic structure of the network in 2005. Mapping this onto the Earth's surface will reveal whether it is true that 'there may be little relationship between proximity in Euclidean geographic space and positionality… in which positionality is not

measured by physical distance, but by the intensity and nature of the inter-connectedness' (Sheppard, 2002 pp 323 – 324).

In the second part (2b), the linkage distribution of the corporate networks between cities is explored, both between nations and between supra-regions. In this way, both the volume and flow of corporate connectivity between developed and undeveloped parts of the world is highlighted. This is possible thanks to the approach of coding all firms according to their city, national and supra-regional locations. Lastly, in part (2c) the statistical distribution of the corporate network is analyzed, so as to identify the degree of skewness in the corporate system. In this it has been expected that only a handful of developed cities will be shown to hold the majority of the connections and that most cities will play an extremely marginalized role in the multinational network. To confirm this, the data will be analyzed through regression techniques to identify so-called power-law characteristics (explained in due course). Before answering the questions above, the next section will discuss city network theory in more detail. This will be followed by the methodological part. In the third section, the empirical results are discussed, before positing the conclusions.

3.3 Theory on the centrality and structure of networks

3.3.1 A brief history of conceptual developments

Patrick Geddes (1915) was first to coin the term 'world cities' to refer to those places in which a disproportionate amount of the world's business is conducted (Beaverstock, Doel, Hubbard and Taylor, 2002). Later, economist Robert Gibrat (1931) showed that the economic power of firms in these cities followed, a similarly uneven distribution (Sutton, 1997). From this, it became apparent that a strong relationship exists between the fate of firms and cities and their related regional configurations (Christaller, 1933). A few decades later, Emmanuel Wallerstein (1979) depicted the capitalist world system as one that is spatially uneven, based on the concentration of monopolized high-profit production in a limited number of 'core' zones. According to him, the division of labor that characterizes this spatial inequality is materialized through a tri-polar system consisting of core, semi-peripheral and peripheral zones. Around the same time, concepts developed concerning the interdependence of cities. Under such frameworks, cities were considered as part of an urban system (Berry, 1964) and as being highly influenced by other cities in the interaction network (Pred, 1977). Today, the concept of globalization as a 'networked phenomenon' is quite common (Beaverstock, Doel, Hubbard and Taylor, 2002); where it is said that an understanding of the structure of urban interaction will be informative about the nature of the world itself (Smith and Timberlake, 1995). In this sense, cities are said to gain their privileged status by virtue of their relational position in a global space of flows (Castells 1996), hereby shifting attention from urban attributes to intercity relationships (Taylor 2006). Nonetheless, much of today's network research is still chiefly based on theoretical reasoning, with a relative lack of direct empirical evidence regarding connections among the world's cities. In many studies, the hierarchies of cities are more often asserted than demonstrated (Short et al., 1996).

Table 3

Rank	Friedmann (1995)	Beaverstock et al (1999)	Taylor et al (2005)	Aldeson/ Beckfield (2004)	Carroll (2007)	Wall/v.d. Knaap (2008)
1	London *	London *	London *	Tokyo *	New York *	New York
2	New York *	Paris *	New York *	New York *	Frankfurt *	Paris
3	Tokyo *	New York *	Hong Kong	Paris *	Munich *	Tokyo
4	Miami	Tokyo *	Paris *	London *	Paris *	London
5	Los Angeles *	Chicago *	Tokyo *	Dusseldorf *	Chicago *	Zurich
6	Frankfurt *	Frankfurt *	Singapore	Amsterdam *	Dusseldorf *	Dusseldorf
7	Amsterdam *	Hong Kong	Chicago *	Zurich *	London *	Munich
8	Singapore	Los Angeles *	Milan	Munich *	Detroit *	Amsterdam
9	Paris *	Milan	Los Angeles *	Osaka *	Stamford *	Houston
10	Zurich *	Singapore	Toronto *	San Francisco	Tokyo *	Ludwigshafen
11	Madrid	San Francisco	Madrid	Frankfurt *	Washington	Frankfurt
12	Mexico City	Sydney	Amsterdam *	Vevey	Montreal	Chicago
13	Sao Paulo	Toronto *	Sydney	Chicago *	Brussels *	Detroit
14	Seoul	Zurich *	Frankfurt *	Stockholm	Bonn	Wolfsburg
15	Sydney	Brussels *	Brussels *	Dallas	Essen	Cincinnati
16	Osaka *	Madrid	Sao Paulo	Detroit *	The Hague *	Osaka
17	San Francisco	Mexico City	San Francisco	Utrecht	Philadelphia *	Omaha
18	Seattle	Sao Paulo	Mexico City	Toronto *	Zurich *	Philadelphia
19	Houston *	Moscow	Zurich *	Saint Louis	Osaka *	Stuttgart
20	Chicago *	Seoul	Taipei	Basel	Dallas	Toronto

Common crossmatch of all studies. Chicago
Dusseldorf
Frankfurt
London
Munich
New York
Paris
Tokyo
Zurich

*** Matching with results Wall/v.d. Knaap's top 50 cities**

City ranking of six different studies.
Source: Wall/v.d. Knaap, 2009 - based on various listings.

Most contemporary research regarding corporate and city hierarchies takes its lead from Stephen Hymer's (1972) essay *The Multinational Corporation and the Law of Uneven Development* and John Friedmann's (1986) *The World City Hypothesis*. At that time, Hymer predicted that there would be a diffusion of industrialization to developing nations, whereby intermediary corporate activities would be concentrated in middle and low range cities, while high-level planning activities would be most concentrated in a limited number of hub cities, close to capital, markets, media and government activities, e.g., New York, London, Paris and Tokyo. Furthermore, he stated that world city formation would reveal the major contradictions of industrial capitalism – among them class and spatial polarization, speculating that the 'multinationalization' of the world economy would mirror the uneven structure of labor found within the firms themselves. Hymer expected that, by the close of the 20th century, the world economy would be held more tightly in the grip of multinationals than ever before, and that the existing patterns of inequality and dependency would be perpetuated. The basic relationship between different nations was predicted to mirror that of superior and subordinate, head office and branch plant.

3.3.2 Conceptual differences: world cities and global cities

However, Friedmann initially derived an empirical ranking of 'world cities'**(Figure 3 and Table 3)** that suggested a network of core and semi-periphery cities, based on indicators such as multinational headquarters, international finance and global transportation (1995 revised version). Under this hypothesis, it was initially shown that the boundaries of world cities were confined not by territorial borders but by international patterns of interaction. From this, it was demonstrated that cities function as either power centers of the global economy, subordinate cities that articulate between national or sub-national economies, or 'isolated' cities that do not participate in the system at all. Using this framework, it was possible to show the extent of a city's integration into the world economy. In Friedmann's hierarchy of world cities, the still common triad of powerful Asian, North American and European cities was illustrated; the core-primary cities were London, New York, Paris and Tokyo, reflecting the concentration of corporate power in these control centers. Furthermore, he demonstrated that the world city network is essentially a North Atlantic formation and that, beyond this heartland, strong marginality continues to exist. Nonetheless, although Friedmann carried out a comprehensive global treatment of world cities using attributional data, there is little empirical (relational) evidence to back up his network arguments (Taylor, 1997), and thus little has been said about the structure of the world cities.

Later, Saskia Sassen (1991), in her book *Global Cities*, focused less on Friedmann's hierarchies of 'power' and more on the functional practice of 'control.' She argued that the rise of specialized producer and financial services in a limited number of cities enabled particular firms to gain high levels of global economic control. Sassen posited that cities with high levels of these specific services are more representative of the contemporary 'global' economy, and that this phenomenon is promoting a new geography of centrality and marginality. Within this context, areas that were once the 'core' are becoming peripheralized (e.g., Detroit, Liverpool and Nagoya), and, in contrast, peripheral cities are shifting towards the core (e.g., Sao Paulo and Mexico City). She also stated that a 'vast territory' exists that is increasingly excluded from the primary economic system (Sassen, 2002). Nonetheless, although her research marshaled much evidence through her three case

studies, it had little to say about other world cities and how they fit into the bigger picture (Taylor, 2004).

Even Beaverstock et al.'s (1999) alpha, beta and gamma roster of world cities **(Table 3)**, which relates to Sassen's work, did not show evidence of the relational structures that are formed between cities. Nevertheless, these researchers successfully showed that producer services generate an entirely different ranking of cities than that indicated by world city research. In comparison to Friedmann, it is evident in the table that only the apex matches well, decreasing towards the base. Thus, it should be clear that these studies are based on attributional data in which comparative results have been developed but relational ones have not. However, several studies do exist that explore ties between cities. Building on Sassen and Beaverstock et al.'s work, Peter Taylor and the GaWC research group (1999 – 2009) have probably developed the first 'world city' network analysis based on relational data for global advanced producer services **(Figure 5 and Table 3)**. It has been argued that the GaWC approach measures 'a cutting-edge economic activity within globalization, but deals with only a small part of the world economy' (Taylor, 2006 pg 892). The specific focus on only producer services in Taylor's as well as in Beaverstock's studies leads to different types of centrality than in world city approaches (for instance the strong rankings of cities like Hong Kong, Singapore and Los Angeles). However, a limitation of their method is said to be that it is based on indirect evidence in which the presence of global producer service firms in two or more cities leads to the assumption that interurban connections will exist between these firms in proportion to their office size (Carroll, 2007). Thereby creating a set of inferences that goes beyond what is strictly supported by the available data (Céline Rozenblat and Denise Pumain, 2007).

On the other hand, the 'world city' approach has been further studied by individuals like Arthur Alderson and Jason Beckfield (2004) and William Carroll (2005). Unlike in Taylor et al.'s global city network, Alderson and Beckfield use concrete data regarding intra-firm shareholds between Fortune® 500 headquarters (2000) and their subsidiaries. Furthermore, they do not start with a chosen, predefined roster of cities to study corporate relations, but they instead include all cities that are derived from the headquarter-subsidiary relationships. This leads to more elaborate datasets. According to these studies, firms knit cities together, so that cities should be treated as actors embedded in networks of corporate relationships. By using 'network analysis' techniques from sociology and graph theory, the researchers demonstrate the characteristics of this network. Through this the 'positionality is mapped, by depicting the relationships between different agents, in different places' (Sheppard, 2002, pp. 323). It their study, the overall morphology of the world city network bears a strong resemblance to the 'maximally centralized star' (Borgatti and Everett 1999), networks in which core cities are connected to all the others, but where secondary cities are disconnected from each other. In their case, the core cities are Tokyo, New York, Paris and London **(Figure 6 and Table 3)**.

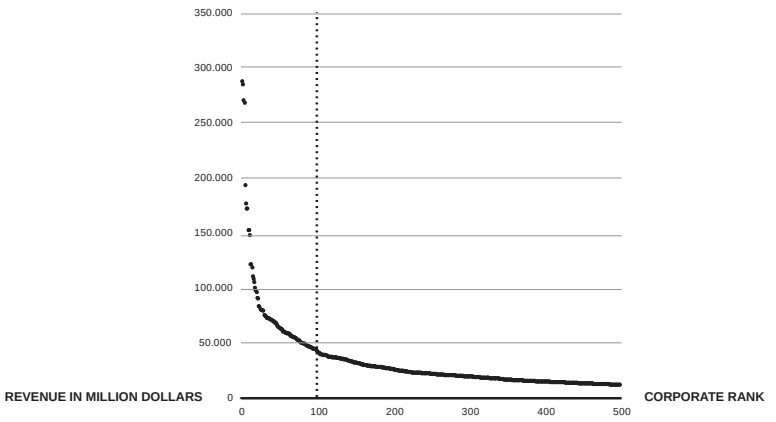
3.3.3 Conceptual differences: a shifting or reinforcing world system

Furthermore, Alderson and Beckfield state that they find little evidence of Sassen's new geography of centrality. If this were so, they would have expected to observe substantial slippage between the map of the contemporary world city system and the map of the world system at the national level (Wallerstein 1974, Chase-Dunn and Grimes 1995). They also found that highly ranked GaWC cities, such as Miami, Singapore, Mexico City, Sao Paulo, and Sydney, do not appear within their top 50 list **(Table 3)**. They did however find strong consistency between their results and Friedmann's world city rankings. Furthermore, they report that powerful cities do not only exhibit strong commanding ties with the other cities of the world, but also receive many incoming ties that are extended from less powerful cities. This is consistent with Friedmann's view that cities at the apex of the world city system are used by other cities as 'basing points' of global capital. In this dissertation, contradictory evidence is shown, which will be discussed shortly. In a similar light, Carroll (2007) explores the managerial structures of firms by analyzing the inter-firm directorate interlocks between multinationals. His data is based on 350 of the Fortune® 500 listings (1997) from which directorate interlocks were assembled. In this way, the managerial structures of firms were explored instead of the shareholding relations between them, hereby giving a perspective on elite managerial networks. This study concluded that in terms of the degree of intercity relations, New York, Frankfurt, Munich and Paris are most central. Tokyo and London play a more marginal role as sites for transnational intercity elite connections. Furthermore, Carroll shows that Paris plays the prime role in Europe, with its strongest ties to Brussels and Montreal, but also exhibits sparse ties with American cities. His work shows that the primary linkages fall between the European and North American regions and that connectivity with the Asian region is less strong. Furthermore, results from Alderson, Beckfield and Carroll are all shown to be more consistent with Hymer's view that globalization largely reproduces existing cross-national patterns of inequality and dependency, whereby the interurban corporate-elite network does not subvert the dominance of the developed capitalist core – in contrast, it reinforces it (Carroll, 2007). This issue is similarly addressed in this study.

3.3.4 Multinational corporations, nations and cities

Akin to the approach of the last two studies, this research is also based on a database of global multinationals, because their worldwide networks represent distinct loci of power that have a significant impact on an increasingly global economy. It has been shown, for instance, that the sales of the top 200 global corporations (1999) accounted for approximately 30% of world GDP (Anderson and Cavanaugh, 2000). In addition, in the top 100 of a combined firm-nation list for 2000, 29 economies were multinationals (United Nations, 2002). These firms are richer than many nations; for example, the revenue of General Motors was greater than the GDP of more than 148 nations (2004). Furthermore, these firms have the ability to coordinate production from within a centralized strategic decision-making framework, such that the coordination takes the firm across national boundaries (Cowling and Sudgen, 1987). These cross-border operations lead to a complex organization of economic activities at different geographic scales. One may include in this list decisions to centralize or decentralize, or to cluster or distribute a firm's functions. These are aspects that will be addressed by the first research question concerning centrality (both global and world cities) within the corporate dataset.

Figure 16



Fortune® 500 firms ranked by revenue.
Source: Wall/v.d. Knaap, 2009 – based on Fortune® 500 (2005).

Multinationals are responsible for a large portion of international trade and foreign direct investment (FDI), and much of this consists of intra-firm transactions. These investments are typically controlled by corporate headquarters that decide on the magnitude of foreign investment, the transfer of technology, access to international markets, the repatriation of profits, the number of employees, etc. International investment between firms have been growing markedly since the 1960s, but although there has been an intensification of cross-investment between the industrialized economies, the share claimed by developing nations and their cities remains very low (Kentor, 2002). This unevenness derives from the fact that only certain locations possess the endowments and the strategic ability to create the competitive advantage needed to attract corporate FDI (Guisinger, 1985). This notion points to the statistical skewness of corporate networks, a fact already discovered by Robert Gibrat in 1931 (Sutton, 1997) and similarly found in Zipf's Law, in which each city is assigned a relative functional and geographic importance. It is often characterized by a power-law statistical distribution, in which a few cities are extremely connected hubs within the entire city-firm network (Barabási, 2003). In this sense, it is expected that city positionality will prove to be an asymmetric relationship in which core agents exert more influence over peripherally positioned locations than vice-versa (Sheppard, 2002). These issues will be explored in the second question concerning the structure of the global corporate network.

3.4 Data, methodology and techniques

3.4.1 Data and methodology

The connectivity data compiled for this study concerns of the sharehold relationships that a multinational has with its subsidiary firms. This intra-firm network represents corporate governance or the chain of command as it is passed down from headquarters to various subordinate levels of firms. The corporate network data has been compiled from the global Fortune® 500 (2005). Only the top 100 of these firms were used, as these firms account for over 50% of the total revenue of all 500 firms and for 40% of all employment **(Figure 16)**.

Figure 17

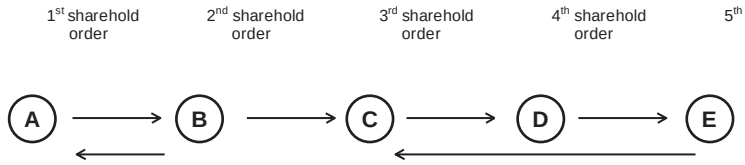
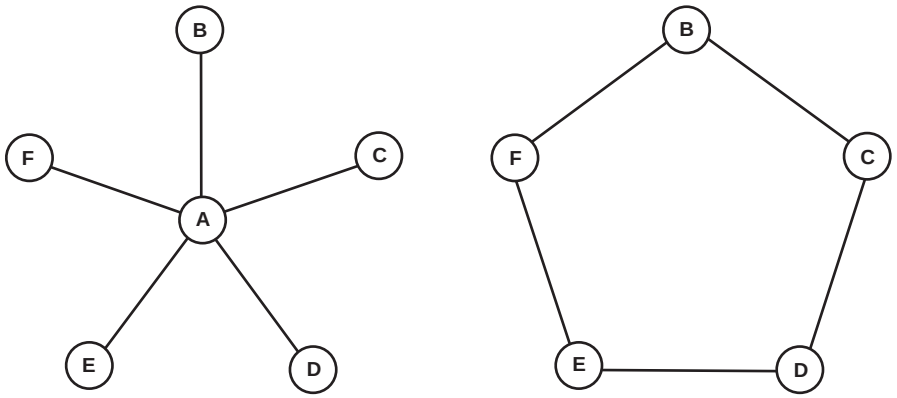


Diagram showing the five levels of multinational sharehold relationships in the dataset.
Source: Wall/v.d. Knaap, 2009.

Based on LexisNexis® and Thomson Reuters® databases, the subsidiaries of the top 100 headquarters were identified for each dataset. These were classified into five categories of sharehold relationships, starting with headquarter to first subsidiary, continuing with first subsidiary to second subsidiary, and so forth. Thereafter, all of the firms were labeled according to their industrial codes, such as trade, manufacturing and producer services. Next, the city, national and supra-regional locations of each firm were identified by name and Cartesian coordinates, in order to calculate the physical distances between cities or to cluster cities by geographic proximity. To perform this accurately, a benchmark radius of 25 km was calculated and smaller cities within this radius were combined with their proximate major city. In the diagram **(Figure 17)** the five subsidiary orders are illustrated so as to explain the classification of both headquarter and subsidiary relations. In this way, the problem of only taking first order headquarter relations into consideration was avoided (Godfrey and Zhou, 1999), but instead include several lower 'regional' levels of firm. From this there are far more derived headquarters than the initial 100. Imagine, for example, that a Fortune® 100 headquarter is situated in City A and has an outward connection to a subsidiary in City B. In this case, City B is a subsidiary to headquarter City A. However, the same firm in City B has an outward connection to a sub-subsidiary in City C, and so forth. In this case, City B is the headquarter city and City C is the subsidiary city. These relationships represent global, regional and local ties organized into an adjacency matrix of 9243 sharehold ties. To present a rough comparison, the 100 multinational headquarters link 2259 unique cities, whereas Alderson and Beckfield derive 3692 cities with all 500 multinationals. This means that roughly 60% of all unique cities result from the upper echelon of the Fortune list. This observation further substantiates the choice to use only the top 100 headquarters.

In the analysis, three common centrality measures have been used, namely outdegree, indegree, and betweenness. Fundamental to these measures is the notion that interaction between nodes in a graph has an effect on the network position of each node. However, interactions that define this position can vary greatly in scope and content (Irwin, Hughes, 1992). In essence, the content of the interaction is the product exchanged, which in the case of this study concerns shareholding from headquarter to subsidiary firms **(Figure 17)**.

Figure 18



Simplified network structure to explain centrality measures.
Source: Wall/v.d. Knaap.

Therefore, the corporate position of a city can be observed through either the interactions directed towards it (indegree) or the transactions emanating from it (outdegree). Outdegree serves as an expression of the power arising from influence over others (Irwin, Hughes, 1992); where alternatively, prestige best characterizes the indegree arising from the accumulation of resources at a given node (Alderson and Beckfield, 2004). Another centrality measure used is 'betweenness,' which is an expression of a city as a broker of other cities. It is a gauge of a city's intermediary role as a connecting point between other cities. To measure outdegree, indegree and betweenness correctly, the 'diagonal' was removed from the adjacency matrix. The result was that all intra-urban relations within the cities themselves were eliminated, ensuring that all centrality results are purely inter-urban. All centrality analysis was done using the Ucinet network analysis software (Borgatti, Everett, Freeman, 1999).
Next, the Mapdraw software package was used to explore the linkage structure of the network, and Mapinfo (GIS) software to study the geographic network distributions.
To measure the statistical nature of the network and to test for power-law distributions, a regression analysis was performed on the urban rank and centrality variables.

3.4.2 Network techniques

There are various measures of centrality in the field of network analysis to measure the relative importance of a node in a graph. Some of the best known are outdegree, indegree, and betweenness. Fundamental to the application of network analysis is the notion that interaction between nodes in the graph has an effect on the network position of any individual node, independent of the effects of other characteristics. However, the interactions that define this position can vary greatly in scope and content (Irwin, Hughes, 1992). In essence, the content of the interaction is the actual product exchanged. In the case of this analysis, it concerns shareholds from parent headquarters to different levels of subsidiary firms. Because these investments have directions, the data is said to be 'directed' and 'asymmetric.' The asymmetry arises because not every shareholding relationship is reciprocated. It is therefore important to know whether the corporate position of a city (node) results from interactions directed towards it, or from transactions emanating from it. Again the former is known as the 'indegree' and the latter the 'outdegree.' It is generally

hypothesized that outdegree is an expression of power which arises from exercising influence over others (Irwin, Hughes, 1992). The notion of prestige (Alderson and Beckfield, 2004) best expresses the indegree arising from the accumulation of resources at a given node. However, it could also be regarded as a measure of 'dependency'. Another commonly used measure is 'betweenness' which is an expression of the brokerage.

Based on an explanation offered by Robert Hanneman, the various available centrality measures can be explained. In the diagram **(Figure 18)**, the applied centrality measures are explained using a simple 'star-shaped' and 'pentagon-shaped' figure. The nodes are cities in which firms are located, and the linkages represent shareholding between the firms. For simplicity, the directions of each exchange will not be considered. Immediately it is instinctively clear that city A within the star shape is more privileged than the others, but what are the reasons for this?

Degree centrality

Firstly City A has more alternatives than the other cities. For instance, if City F were to no longer provide subsidiaries to City A, then City A would still be able to benefit from sharehold transactions that involve the other four cities. However, City F would not participate at all. The more linkages that a city has, the more power it has because it has more choices. This makes it more independent of the other actors and hence more powerful. In this case, City A is of degree 5 and all others are degree 1. Looking at the pentagon network, it is clear that each city has an equal number of alternative city partners, and all are therefore equally advantaged. If firms in City F were to disconnect from City B, then City F would still have access to an alternative, namely City E. There would now be two cities of degree 1 and three cities of degree 2. However, when using directed data, degree is defined in terms of outdegree and indegree. In the star diagram, if headquarters in City A had single shareholding ties to cities B, C and D, then City A would have an outdegree of 3. If cities E and F had a single sharehold into City A, then this central city would have an indegree of 2. City A would, in this case, be the dominant city with both the strongest commanding power and the most prestige. This example represents a simple unvalued graph, in which each city only sends one tie. However, the actual corporate data used in the analysis is valued. This means for instance that City A can exhibit 6 ties to City C and only 2 to City D etc. Nonetheless, whether valued or not, cities that send more ties have claimed a higher share of global corporate activity and can thus be actively represented as 'world cities' (Friedmann, 1987). Alternatively, cities that receive the highest shares of linkages are basing points for global capital (Sassen 1991). In the formula **(I)**, the indegree C_I of city n_i is where the number of ties received by city I, is represented by $X+i$. Similarly, $g - 1$ represents the maximum number of ties linking i to j (Wasserman and Faust, 1994). The outdegree C_O of city n_i is where $Xi +$ represents the number of ties sent from city i, and $g - 1$ is the maximum number of possible ties linking i to j.

$$C_I(n_i) = \frac{x+i}{g-1} \qquad C_O(n_i) = \frac{xi+}{g-1} \tag{1}$$

Indegree and outdegree formulas

Betweenness

Another reason why City A is advantaged in the star diagram, is because this city lies between the paths of all other cities and consequently has direct access to all of the cities. This gives City A a 'brokerage' position in which it can intervene in the exchanges between cities and benefit from this. Looking at the pentagon diagram, it is quite clear that no city has a similar special intermediary position. In this sense, cities that are situated on many shortest paths between other cities may exhibit higher betweenness than those that do not. Again, the valued, asymmetric data must first be transformed into a dichotomous, symmetrical matrix. The formula **(2)** shows how to calculate the betweenness C_B of each city n_i where $g_{jk}(n_i)/g_{jk}$ represents the probability that the geodesic g linking cities j and k include city i. To standardize this it can be written as $(g-1)(g-2)/2$ to guarantee that $C_B(n_i)$ will be between 0 and 1 (Wasserman and Faust, 1994).

$$C_B(n_i) = \frac{\sum_{j<k} \frac{g_{jk}(n_i)}{g_{jk}}}{(g-1)(g-2)/2} \tag{2}$$

Betweenness formula

Other techniques

In the analyses to represent the core semiperiphery and periphery, cluster analysis on the four centrality scores (outdegree, indegree, and betweenness) is executed. In this way, hierarchic clusters are defined. To show whether the networks follow a power-law distribution, a simple linear regression was used in which degree centrality served to estimate the rankings of cities in both networks. Furthermore, Ucinet Mapdraw was used to visualize the functional structures of the networks, and the Mapinfo geographic information system (GIS) was used to map the geographic distribution of the networks.

3.5 Analysis results

3.5.1 Results on centrality

To recapitulate, research question (1a) concerns centralities in the dataset and how this corresponds to other research. To answer this question, the outdegree, indegree and betweenness centrality techniques have been applied and listed. **(Table 4)** In the results, there are 7781 corporate connections (shares) 'between' cities, plus an additional 1462 ties 'within' cities themselves (diagonal), totaling 9243 connections. Interesting is that only 16% of interaction is intra-urban (inside the city), which supports the view that important cities derive their status from what flows between them, rather than what remains fixed within them (Amin and Graham 1999, Allen 1999, Castells 2001). In the results, New York prevails as the dominant city in terms of 'outdegree,' followed by Paris, Tokyo and then London. Consistent with Carroll, it is shown that Paris is a prime world city and not merely a city of national importance. This is also discussed by Friedmann (1986). Below these, Zurich, Dusseldorf, Munich and Amsterdam claim a more secondary role in terms of outdegree. Furthermore, despite differences in rank, it has been discovered that an 80% match exists between the outcomes of this study and Alderson and Beckfield's (2004) top ten cities.

Of the 2259 cities, only 397 (17%) have outdegree scores, underlining one of Hymer's (1972) points: that vital corporate activity generally becomes most concentrated in a limited number of cities close to capital markets, media and government activities. New York claims 9% of all outdegree, Paris 6%, Tokyo 5% and London 4%. Thus, in total, these four cities claim 25% of global command activity. The strong skewness of outdegree can be seen in the descriptive table **(Table 5)** where variance and standard deviation are highest; this is similar to what is seen in Alderson and Beckfield's (2004) results, where cities that send more ties are cities that have captured more of the control functions of the world economy. Where outdegree expresses the command or power that cities wield over others, indegree can be seen as an expression of the acquired resources (subsidiaries) in cities, upon which other cities are dependent. In this sense, it is agreed with Taylor's suggestion that cities with high indegree are 'strategic places where it is necessary to be' (Taylor, 2006 pg. 890). In the centrality results **(Table 4)**, it is seen that New York, London, Singapore and Hong Kong are strongest in indegree. These cities offer high numbers of goods and services subsidiaries. From the results, it is clear that semi-peripheral and peripheral cities also play a vital role; for instance, Singapore and Hong Kong are insignificant in terms of outdegree but important in terms of indegree. This matches the global city list proposed by Taylor et al. **(Table 3)**. It supports Hymer's point that a strong diffusion of industrialization to developing nations will exist and that intermediary activities are concentrated in middle-range cities. This is underlined by the fact that out of 2259 cities, almost all exhibit some level of indegree. Although Taylor (2006) objects that the two-stage model proposed by Alderson and Beckfield 'misses out on regional headquarters,' it is clear from the similarity of the indegree rank to Taylor's producer service network results, that this analysis has authentically included a 5-stage corporate chain (as discussed in the methodology). In this manner, regional headquarters are equally incorporated into the matrix of this study. For this reason, the measures of outdegree are consistent with Alderson and Beckfield, and also support the GaWC findings (Taylor et al., 2002).

Table 4

Rank	OutDegree		InDegree		Diagonal		nBetweeness	
1	New York	692	New York	165	NewYork	186	New York	28,67
2	Paris	491	London	115	Tokyo	113	Paris	13,40
3	Tokyo	367	Singapore	101	Paris	90	Tokyo	11,74
4	London	326	Hong Kong	93	Dusseldorf	64	Dusseldorf	9,43
5	Zurich	293	Paris	92	Houston Texas	63	London	7,25
6	Dusseldorf	259	Tokyo	85	London	55	Munich	7,23
7	Munich	253	Brussels	80	Zurich	45	Houston	7,15
8	Palo Alto	218	Madrid	76	Brussels	43	Palo Alto	6,37
9	Amsterdam	204	Milan	75	Atlanta Georgia	33	Zurich	5,12
10	Lausanne	191	Houston	66	Dearborn Michigan	28	Irving	4,54
11	The Hague	165	Toronto	62	Munich	25	Amsterdam	4,23
12	Irving	148	Mexico City	59	Amsterdam	25	Chicago	3,83
13	New Brunswick	146	Buenos Aires	57	OmahaNebraska	18	The Hague	3,62
14	Houston Texas	134	Dublin	55	Turin	17	Lausanne	3,45
15	Ludwigshafen	131	Jakarta	50	StamfordConnecticut	13	Brussels	3,24
16	Frankfurt	116	Amsterdam	49	Vienna	13	New Brunswick	2,99
17	Brussels	109	Vienna	49	MexicoCity	12	Calgary	2,83
18	Gerlingen	85	Bangkok	49	Madrid	12	Detroit	2,77
19	Stamford	79	Frankfurt	48	NewBrunswick NewJersey	11	Cincinnati	2,74
20	Chicago	78	Zurich	47	CincinnatiOhio	11	Ludwigshafen	2,72
21	Detroit	74	Barcelona	47	Toronto	11	Gerlingen	2,60
22	Toyota	71	Sao Paulo	47	Osaka	11	Philadelphia	2,40
23	Wolfsburg	71	Sydney	40	Seoul	11	Northfield	2,29
24	Northfield	69	Hamburg	39	DetroitMichigan	10	Greenwich	1,99
25	Cincinnati	64	Montreal	36	GlendaleCalifornia	10	Toronto	1,94
26	Calgary	59	Taipei	36	Hamburg	10	Portland	1,80
27	Cupertino	55	Atlanta	35	FrankfurtamMain	9	Atlanta	1,78
28	Osaka	54	Munich	34	Wolfsburg	9	Auburn Hills	1,77
29	Alpharetta	54	Chicago	34	Minneapolis Minnesota	9	Stamford	1,75
30	Dearborn	54	Seoul	34	HongKong	9	Omaha	1,67
31	Auburn Hills	46	Luxembourg	34	CulverCity California	9	Barcelona	1,45
32	Greenwich	43	Mississauga	33	HonoluluHawaii	8	Cupertino	1,36
33	Portland	43	Prague	33	LosAngeles California	7	Los Angeles	1,33
34	Chesterbrook	42	Istanbul	32	Singapore	7	Toyota	1,32
35	Omaha	41	Budapest	32	Milan	7	Naperville	1,30
36	Philadelphia	40	Lisbon	32	Schaumburg Illinois	7	DallasTexas	1,28
37	Edinburgh	40	Los Angeles	31	Bloomington Illinois	7	Mexico City	1,28
38	Stuttgart	40	Dusseldorf	30	Lausanne	6	Frankfurt	1,22
39	Glendale	39	Melbourne	30	Northfield Illinois	6	Mississauga	1,17
40	Toronto	38	Johannesburg	29	Greenwich Connecticut	6	Wolfsburg	1,17
41	San Ramon	37	Kuala Lumpur	29	Barcelona	6	Louisville	1,15
42	Naperville	36	Warsaw	29	Louisville Kentucky	6	Cleveland	1,12

Cities ranked according to the four centrality measures. Source: Wall/v.d. Knaap, 2009.

Table 4 (continued)

Rank	OutDegree		InDegree		Diagonal		nBetweeness	
43	Stavanger	36	Berlin	27	Richmond Virginia	6	Saint Louis	1,11
44	Morristown	34	Dallas	26	Hartford Connecticut	6	Madrid	1,11
45	Swindon	33	Caracas	26	Nicosia	6	Saint Paul	1,11
46	Atlanta	32	Bogota	26	TheHague	5	Osaka	1,07
47	Los Angeles	31	Shanghai	25	Calgary	5	Alpharetta	1,04
48	Saint Paul	30	Rome	24	AuburnHills Michigan	5	Edinburgh	1,01
49	East Hanover	30	Auckland	24	SaintLouis Missouri	5	Singapore	1,00
50	Southfield	29	Beijing	24	Edinburgh	5	Vienna	0,99
TOTAL LINKS		7781		7781		1462		
ACTIVE CITIES		397		2545		221		533
N		2559						

Cities ranked according to the four centrality measures.
Source: Wall/v.d. Knaap, 2009.

One area where the results of this study differ from those of Alderson and Beckfield is in respect of correlation. Firstly, Alderson and Beckfield report a weak correlation between outdegree and betweenness, but in the case of this research, strong positive correlation has been found **(Table 6)**. This means, in the case of this study, that a city with high command will also generally be a strong mediator or 'broker' to other cities. Secondly, they report strong cohesion between indegree and outdegree ranks, while in this research a very weak relationship is depicted. In this sense, it is not agreed with Alderson and Beckfield's claim that there is strong coherence between the ties sent from a city and the ties received by that city. The interpretation of indegree in this study is that it is a measure of the dependency of a handful of powerful cities upon various subordinate cities. Furthermore, it is noted that New York, Paris, Tokyo and Dusseldorf claim 26% of betweenness, meaning that a vast amount of corporate investment passes through these intermediary cities, which allows them to claim a strong brokerage role within the global system.

To answer the question of how these results match the rankings proposed by similar research studies, the resulting centrality measures have been compared to those of other ranking lists **(Table 3)**. This table is only a top-twenty sample of the complete lists. These studies have been discussed previously in the theoretical part of this chapter and have been matched with the top 50 list of total outdegree ties in this study. Additionally, a table of percentage scores signifies the extent of overlap between certain other studies and the results of this research **(Table 7)**. In respect of all three centrality measures, it has been found that agreement between lists is highest towards the apex of the system. Considering outdegree, it is discovered that the city list matches Friedmann's cities in 47% of the cases.

Table 5

	Minimum	Maximum	Mean	Std. Deviation	Variance
OutDegree	0	692,00	3,04	24,40	595,40
InDegree	0	165,00	3,04	8,00	63,98
InBetweeness	0	28,67	0,10	0,80	0,65

Descriptive statistics of the three centrality scores.
Source: Wall/v.d. Knaap, 2009.

or the Beaverstock et al. and Taylor et al. results, this is 29%, indicating a weaker correlation with the results in this research. This clearly shows the mismatch between a world-city type network in which all industrial sectors are included and one where only producer services are taken into account. The best match is with Carroll's list, at 76%, but a match rate of only 44% is found with Alderson and Beckfield's ranking. Furthermore, cities that Friedmann identifies as important, such as Singapore, Miami, Mexico City, Sao Paulo and Sydney, do not appear in the outdegree list of this study, a finding that is consistent with Alderson and Beckfield's results. Cities like Hong Kong, Singapore and Milan, as identified by Beaverstock et al., are not powerful in terms of outdegree. Neither are cities like Washington and Montreal, as Carroll found. It is striking that in terms of indegree, Carroll's results correspond least strongly with the derived results (60%), possibly meaning that corporate directorate cities are less associated with subservient firms than with power wielding ones. Lastly, by cross-matching all lists, it has been discovered that New York, London, Paris, Tokyo, Chicago, Dusseldorf, Frankfurt, Munich and Zurich are common to all lists. This means that there is general consensus about the importance of these cities.

In the next part, question (1b) is answered using only producer service ties from the dataset used in this study. In the percentage match data **(Table 7)**, it is seen in parentheses that the match rate increases from 29% to 42%. This is true for both Beaverstock et al.'s and Taylor et al.'s results. Furthermore, the top ten from their list match 100% of the producer service network results in this study (not shown). Hence, although Hong Kong, Singapore and Milan do not prove to be strong world cities, they do appear in the top ten global cities. These results show that when looking at the network of all industrial sectors, the match with world city research is highest. In contrast, the selection associated with the producer service network corresponds better with global city research. In this sense, global cities are simply a specific subset of world cities, confirming that the hierarchy of world or global cities is the result of selection criteria. These outcomes are original, firstly because they are derived from one unique dataset and should therefore be more readily comparable, and secondly because the results are not based on attribute data, but instead serve as centrality scores derived from inter-firm relationships between cities.

Table 6

			OutDegree	InDegree
Spearman's rho		OutDegree	1,00	0,33
		InDegree	0,33	1,00
		nBetweeness	0,72	0,65

All correlations significant at the 0.01 level (2-tailed). n = normalized.

Correlations of the three centrality scores.
Source: Wall/v.d. Knaap, 2009.

A comparison is provided to show how world and global city hierarchies differ **(Table 8)**. Because Friedmann (1986) defines world cities by the power they exert over other cities, outdegree is of most interest to this issue. Similarly, because Sassen (1991) defines global cities as basing points for global capital, especially in respect of advanced producer services, the indegree is of interest. This is confirmed by the fact that there is only a 28% match of global cities in the world cities outdegree list, but 74% match with the global city indegree list. In the case of this study, outdegree represents outward investments (shareholds) to firms in other cities, while indegree represents inward investments from other cities. From the perspective of world cities, it is clear that New York, Paris, Tokyo and London wield considerable power over other cities. It is also evident that all these cities are from the developed world. The same is seen in Alderson and Beckfield's rankings **(Table1 3)**. From the perspective of global cities, it is clear that cities from developed, and developing nations (Johannesburg, Bangkok, Mexico City and Jakarta) appear in this list. This is very similar to the list by Beaverstock et al. Although Hong Kong and Singapore are less important in outbound power relations, they prove to be as important as London and New York in their role as centers for advanced producer services and as basing points for inward-bound capital. It is also evident in the table that the total links of advanced producer services (3312) claim 48% of the total network of all five industrial sectors (7781), underlining how important this industry is.

In Table 8, it is clear that far fewer cities are global cities than world cities (in terms of both outdegree and indegree), confirming Sassen's statement that specialized producer services will be concentrated in relatively few sites. This is also evident in the Ucinet network diagrams **(Figure 19)**. For both networks, only corporate linkages greater than or equal to five are shown. Again it is clear that the global city network includes far fewer cities than does the world city network, indicating that the control exercised by producer services over other industries occurs higher up in the commodity chain. Because world cities include other multinational industries, such as basic resources, manufacturing, trade and consumer services, it is not surprising that this network features higher density and diversity. The fact that the cores of both networks are very similar arguably shows how advanced producer services can strongly facilitate the activities of other industries.

Table 7

	Friedmann	Beaverstock	Carroll	Alderson and Beckfield
Outdegree	47%	29% (42%)	76%	76%
Indegree	77%	76% (76%)	60%	60%
Betweeness	60%	38%	80%	80%

Rank matching of the three centrality scores.Source: Wall/v.d. Knaap, 2009.

3.5.2 Results on structure

In this part, the second question will be answered – namely the question that concerns network structure and that asks whether the more actual dataset used in this study will reveal results similar to those of Alderson, Beckfield and Carroll. In this sense, it is questioned whether the core and periphery of the world system, as defined by Hymer (1971), continues to persist. This question is first answered by analyzing the geographic distribution of the data between cities, and then through an analysis concerning the share of connections between core cities and the nations to which they connect, after which the share of multinational connections between supra-regions of the world is shown. Because this analysis follows a methodology similar to that of world city research, all industrial sectors will be included in the analysis. In the first analysis (2a), the corporate data was mapped using GIS software, so as to reveal the geographic distribution of shareholding between multinational headquarters and their subsidiaries **(Figure 23)**. In this map, it is clear that the distribution of shareholds is polarized into three core regions, namely North America, Europe and Asia Pacific; it is evident that although there is East-West connectivity, the highest intensity prevails in the transatlantic zone between Europe and North America. Furthermore, it is evident that a North-South divide still exists, such that Africa for instance is clearly marginalized. This map also confirms that interconnectedness in today's globalizing world bears a moderate relation to physical proximity (Sheppard, 2002). The intensity of this skewness is made clearer in the graph in which city indegree and outdegree are plotted against their Cartesian coordinates **(Figure 20)**. It is evident here that developing cities play a higher role in terms of indegree than in terms of outdegree.

Because all firms in the network are also coded by the nations in which they are located, it was possible to answer question (2b), concerning the linkage distribution between cities and nations. In the results, only four core cities are shown **(Table 9)**; it is evident that New York, with 692 ties, has the highest outdegree of these four cities. Nonetheless, this is deceiving, since 60% of these ties are within the US. Of the four cities, New York is in fact the least internationally connected, followed by Tokyo. This is an outcome similar to what Carroll found, where New York's centrality derives substantially from its prominence

Table 8

Rank	World cities All industrial sectors	Links	World cities All industrial sectors	Links	Global Cities Advanced producers services	Links	Global Cities Advanced producers services	Links
	OutDegree		InDegree		OutDegree		InDegree	
1	*New York*	692	*New York*	165	*New York*	453	*New York*	157
2	*Paris*	491	*London*	115	*Paris*	247	*London*	106
3	*Tokyo*	367	*Singapore*	101	*London*	244	*Paris*	68
4	*London*	326	*Hong Kong*	93	*Zurich*	143	*Singapore*	60
5	*Zurich*	293	*Paris*	92	*Amsterdam*	102	*Hong Kong*	57
6	*Dusseldorf*	259	*Tokyo*	85	*Tokyo*	100	*Tokyo*	57
7	*Munich*	253	*Brussels*	80	*Frankfurt*	92	*Zurich*	52
8	Palo Alto	218	*Madrid*	76	*The Hague*	89	*Brussels*	49
91	*Amsterdam*	204	*Milan*	75	*Brussels*	84	*Amsterdam*	43
10	Lausanne	191	*Houston*	66	*Dusseldorf*	75	*Atlanta*	43
11	The Hague	165	*Toronto*	62	Lausanne	59	*Dusseldorf*	34
12	Irving	148	*Mexico City*	59	PaloAlto	57	*Toronto*	34
13	New Brunswick	146	*Buenos Aires*	57	*Houston*	50	*Houston*	31
14	Houston Texas	134	Dublin	55	*Atlanta*	48	*Milan*	31
15	Ludwigshafen	131	*Jakarta*	50	*Munich*	48	*Madrid*	30
16	*Frankfurt*	116	*Amsterdam*	49	*Chicago*	46	*Mexico City*	28
17	*Brussels*	109	*Vienna*	49	Omaha	42	*Bangkok*	26
18	Gerlingen	85	*Bangkok*	49	Wolfsburg	35	*Seoul*	24
19	Stamford	79	*Frankfurt*	48	Edinburgh	33	*Jakarta*	23
20	*Chicago*	78	*Zurich*	47	*Osaka*	30	*Frankfurt*	22
21	Detroit	74	*Barcelona*	47	Dearborn	29	*Chicago*	21
22	Toyota	71	*Sao Paulo*	47	*Dallas*	25	*Sao Paulo*	21
23	Wolfsburg	71	*Sydney*	40	*Singapore*	25	*Buenos Aires*	20
24	Northfield	69	Hamburg	39	Calgary	24	Dublin	19
25	Cincinnati	64	*Montreal*	36	Chesterbrook	24	*Luxembourg*	19

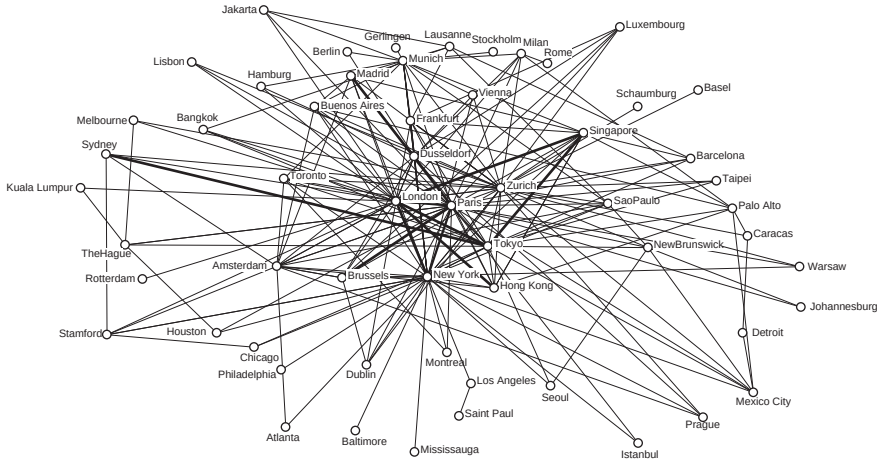
Cities in italics represent alpha, beta and gamma cities of Beaverstock et al's city list.

World cities according to all industries, and global cities according to producer services.
Source: Wall/v.d. Knaap, 2009.

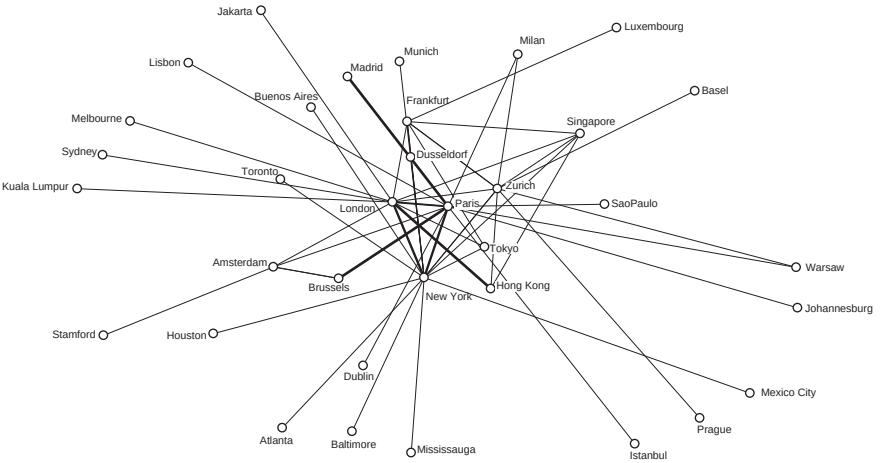
Table 8 (continued)

Rank	World Cities All industrial sectors	Links	World Cities All industrial sectors	Links	Global Cities Advanced producers services	Links	Global Cities Advanced producers services	Links
	OutDegree		InDegree		OutDegree		InDegree	
26	Calgary	59	*Taipei*	36	Northfield	24	Saint Helier	18
27	Cupertino	55	*Atlanta*	35	*Toronto*	24	*Vienna*	18
28	*Osaka*	54	*Munich*	34	Toyota	23	*Boston*	17
29	Alpharetta	54	*Chicago*	34	*Madrid*	22	*Los Angeles*	17
30	Dearborn	54	*Seoul*	34	*Philadelphia*	22	*Melbourne*	17
31	Auburn Hills	46	*Luxembourg*	34	*Berlin*	21	*Sydney*	17
32	Greenwich	43	Mississauga	33	*Boston*	21	*Barcelona*	16
33	Portland	43	Prague	33	Ludwigshafen	20	*Munich*	16
34	Chesterbrook	42	*Istanbul*	32	Providence	20	Budapest	14
35	Omaha	41	Budapest	32	Stamford	18	*Johannesburg*	14
36	Philadelphia	40	Lisbon	32	Aachen	17	Kuala Lumpur	13
37	Edinburgh	40	Los Angeles	31	Auburn Hills	17	Prague	13
38	Stuttgart	40	*Dusseldorf*	30	Cincinnati	17	*Taipei*	13
39	Glendale	39	*Melbourne*	30	Irving	17	Wilmington	13
40	*Toronto*	38	*Johannesburg*	29	Moulineaux	17	Honolulu	12
41	San Ramon	37	Kuala Lumpur	29	Turin	17	*Istanbul*	12
42	Naperville	36	Warsaw	29	Detroit	16	Lisbon	12
43	Stavanger	36	*Berlin*	27	East Hanover	16	Mississauga	12
44	Morristown	34	*Dallas*	26	Louisville	16	*Montreal*	12
45	Swindon	33	Caracas	26	Cupertino	15	Athens	11
46	*Atlanta*	32	Bogota	26	Edina	15	*Berlin*	11
47	Los Angeles	31	Shanghai	25	*Los Angeles*	14	*Geneva*	11
48	Saint Paul	30	*Rome*	24	Saint Louis	14	*Hamburg*	11
49	East Hanover	30	Auckland	24	Saint Paul	14	Moscow	11
50	Southfield	29	*Beijing*	24	*Hong Kong*	13	San Francisco	11
TOTAL LINKS		**7781**		**7781**		**3312**		**3312**
ACTIVE CITIES		**397**		**2545**		**264**		**1143**
MATCH BEAVERSTOCK		**28%**		**68%**		**48%**		**74%**

Figure 19



All industrial sectors



Advanced producer services

Ucinet core-periphery network diagrams.
Source: Wall/v.d. Knaap, 2009.

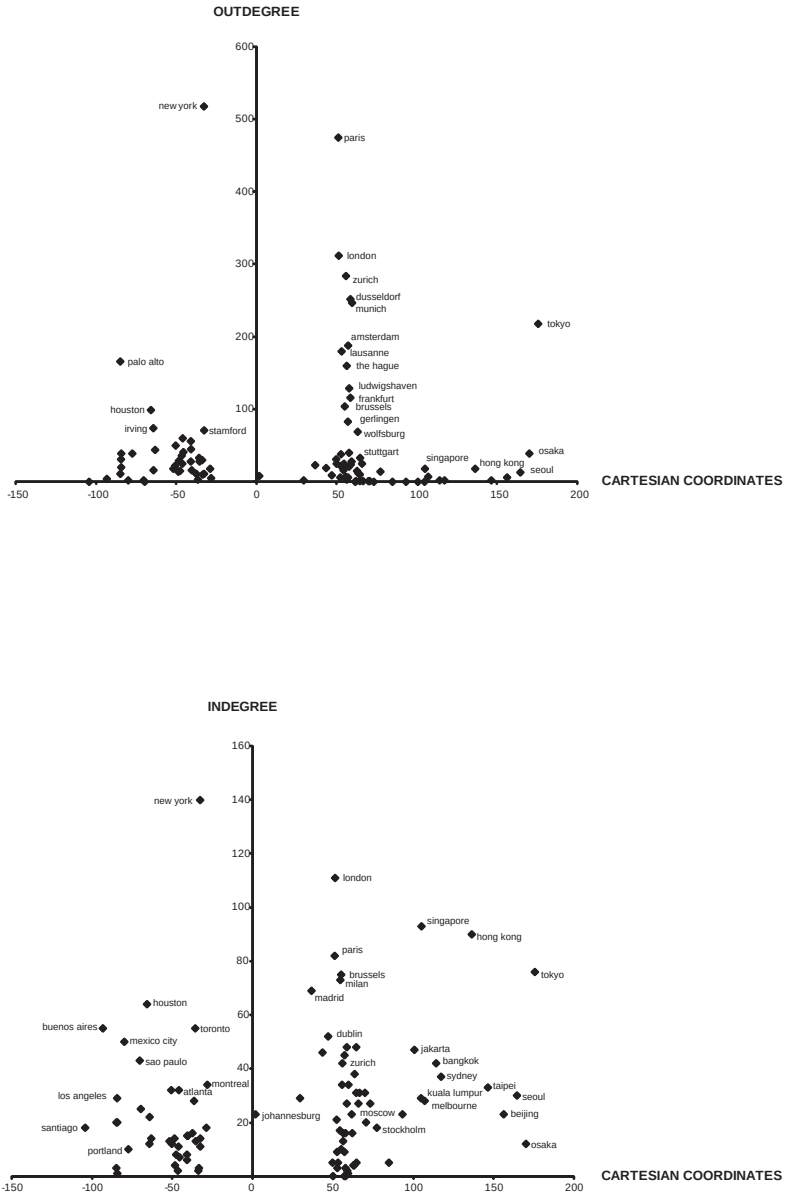
with corporate America, and where Tokyo is quite marginal as a site for transnational elite connections, yet it is absolutely central to the Japanese national network (Carroll, 2007). Tokyo also has the weakest diversity of connections to other nations (36); it exhibits a preference for more proximate nations such as China, Singapore, Thailand, Taiwan and Malaysia. Surprisingly, not only is Paris second in total ties (581), but it also proves to be the second most internationally connected city, with only 20% of its ties to France. It also features the highest diversity of nations to which it connects (87), meaning that it is more integrated with the world than the other cities are.

These results are in stark contrast to Friedmann's suggestion that Paris is merely a nationally connected city and not a world city (Friedmann 1996). Although London proves to have the lowest outdegree (381), it also proves to be only 12% connected within the UK, making it the most internationally oriented of the four cities. However, London's diversity of connections (66) is lower than New York's (82) and Paris's (87), but higher than Tokyo's (36). It is interesting that its highest share of non-UK connections is with Canada (17%). London also has a relatively strong relationship with China due to its strong history with Hong Kong. Most importantly, the table shows that the majority of ties held by these core cities are almost entirely with developed nations. Next, an analysis was carried out at the supra-regional level to identify the share of investments between these areas **(Table 10)**. The rows indicate outdegree shares and the columns the indegree. In the table, it is evident that North America, Europe and Asia Pacific together claim 98% of all outdegree relations and 82% of all indegree. Hence, these areas have a disproportionate share of global economic power, while at the same time the world is highly dependent on them.

Nevertheless, in terms of outdegree, Europe claims 43.9%; North America 46.6% and Pacific Asia only 7.3%. For indegree this is 41.4% for North America, 35% for Europe and 5.9% for Pacific Asia. Therefore, the West still holds the vast majority of all investments. Furthermore, these supra-regions tend to be more connected within themselves than with other regions. For instance, Europe is 27.5% connected with itself, whereas it is only 5.1% connected to North America. The same is seen for North America at a rate of 35.0% versus 6.4%. Furthermore 82% of all outdegree ties are evidently between the three core regions and only 0.5% go to the more peripheral regions. For peripheral regions, 1.6% of the outdegree is accounted for, while15.9% is sent from the periphery to the three core regions. Similar to those of Carroll and Alderson and Beckfield, these results confirm that the world system is still highly disproportionate and also confirm Hymer's assumption that the previous world city hegemony is being perpetuated. This means that according to the world city approach, the system has not changed much. However, caution should be taken in stating that there is no evidence for Sassen's theory, that a new geography of marginality and centrality is being generated. This is first because, as shown in this research, world city and global city networks are entirely different entities; and secondly this is because this research, as with previous research, is cross-sectional.

Lastly, to answer the question regarding statistical distribution (2c), three rank-size graphs were developed **(Figure 29)**. The first graph shows the total number of outbound headquarter linkages 'within' cities (outdegree) in the global dataset. In this graph, it is evident that the log distribution is roughly linear, representing high disproportionality within the world corporate system[1].

Figure 20



Outdegree and indegree in terms of Cartesian coordinates.
Source: Wall/v.d. Knaap, 2009.

3.6 Conclusions

Firstly, it has been demonstrated that on a methodological level the top 100 of the Fortune® 500 organizations (2005) claim a disproportionate share of the total revenue of all firms and subsequently contribute much more to world GDP than do firms in the lower 400 rank. Hence, a network analysis has been executed, based on the network of sharesbetween the top 100 multinational headquarters and their subsidiaries around the world. Because all of the firms were classified in terms of their physical location, the corporate strengths between the 2259 cities could be empirically shown. This research contributes to 'relational' types of analysis, offering a more actual view of the corporate centralities of cities and the structure of this network. In terms of centrality, it has been firstly discovered that intra-city ties form a relatively small part of total corporate connectivity, confirming that important cities derive their status from what flows between them rather than from what remains fixed within them (Amin and Graham 1999, Castells 2001), and that the boundaries of world cities are not confined by territorial borders but rather by international patterns of interaction (Friedmann, 1986). It is also reported that only 17% of all 2259 cities in the dataset exhibit outdegree linkages – New York, Paris, Tokyo and London rank highest and together claim 25% of all outdegree ties. This confirms the belief that most corporate activity is conducted by only a handful of cities (Geddes 1915, Hymer 1972, Wallerstein 1979) and is therefore consistent with Alderson and Beckfield in the sense that cities that send more ties are cities that have captured more of the control functions of the world, so that the distribution of power is highly skewed. Below the top four, Zurich, Dusseldorf, Munich and Amsterdam are reported as important secondary cities.

While outdegree expresses the power of a limited number of developed cities over others, indegree is instead found to be highly dispersed over many cities. Of the 2259 cities in the dataset, all prove to exhibit some level of indegree. Furthermore, the top ranks are not only claimed by cities in developed nations – Singapore and Hong Kong, for instance, claim 3rd and 4th place. This confirms Hymer's point that a strong diffusion of industrialization to developing nations will exist and that intermediary activities will also be concentrated in middle-range cities. Furthermore, it is reported that unlike Alderson and Beckfield's results, outdegree and indegree correlate weakly, indicating that cities with high 'command' do not necessarily have high 'prestige.' Therefore, in the case of this research, indegree expresses connections between the headquarters in a handful of powerful cities and a wide range of subsidiaries within cities further down the production chain. Indegree therefore expresses the dependencies of powerful cities on these places. In addition, unlike Alderson and Beckfield, a strong correlation between outdegree and betweenness is found. This suggests that cities with strong control (power) over others are also likely to play a strong intermediary role in the investments taking place between other cities (brokerage). Additionally, it has been found that when observing the outdegree network generated by all industries, one sees a superior match with the rankings of three previous world city studies, and far poorer matching between these results and global city research. In fact,

1 The parameter values were estimated using the Zipf regression approach by Gabaix and Ibragimov (2008).

Table 9

Top 10	headquater city	subsidiary country	links	%
1	NewYork	US	406	59
2	NewYork	Canada	43	6
3	NewYork	Germany	25	4
4	NewYork	UK	18	3
5	NewYork	Switzerland	10	1
6	NewYork	China	8	1
7	NewYork	NL	8	1
8	NewYork	Belgium	7	1
9	NewYork	France	7	1
10	NewYork	Ireland	6	1
	TOTAL LINKS		692	
	TOTAL DESTINATIONS		82	
1	Paris	France	122	21
2	Paris	US	68	12
3	Paris	Spain	34	6
4	Paris	Canada	33	6
5	Paris	Belgium	27	5
6	Paris	Germany	25	4
7	Paris	UK	21	4
8	Paris	NL	19	3
9	Paris	Switzerland	17	3
10	Paris	Italy	15	3
	TOTAL LINKS		581	
	TOTAL DESTINATIONS		87	
1	London	Canada	64	17
2	London	UK	44	12
3	London	China	24	6
4	London	US	22	6
5	London	Australia	19	5
6	London	Germany	19	5
7	London	Singapore	16	4
8	London	NL	16	4
9	London	France	11	3
10	London	Switzerland	10	3
	TOTAL LINKS		381	
	TOTAL DESTINATIONS		66	

Outdegree of four core cities to various nations.
Source: Wall/v.d. Knaap, 2009.

Table 9 (continued)

Top 10	headquater city	subsidiary country	links	%
1	Tokyo	Japan	224	47
2	Tokyo	US	71	15
3	Tokyo	China	27	6
4	Tokyo	Canada	21	4
5	Tokyo	Singapore	13	3
6	Tokyo	Thailand	13	3
7	Tokyo	Taiwan	11	2
8	Tokyo	Australia	9	2
9	Tokyo	Malaysia	9	2
10	Tokyo	UK	9	2
	TOTAL LINKS		**480**	
	TOTAL DESTINATIONS		**36**	

Outdegree of four core cities to various nations.
Source: Wall/v.d. Knaap, 2009.

despite slight differences in the positions of specific cities within the rankings, it is found that the results matched 80% of Alderson and Beckfield's top ten cities. Furthermore, in a final cross-match between all lists including this one, a general consensus was found that New York, London, Paris, Tokyo, Chicago, Dusseldorf, Frankfurt, Munich, and Zurich, are the most important cities within the world economy.

To answer the second part of the first question, the advanced producer service network was extracted from the complete network to examine whether this sub-network would correspond better to global city research, which itself is based on advanced producer services. The results confirmed that the match between the producer service data of this study and Taylor et al.'s or Beaverstock et al.'s lists increases significantly, with a 100% match for their top ten cities. Furthermore, London, as in other global city research, proved to be the primary city in terms of advanced producer services. In this manner, it is shown how the classification of global or world cities is strongly related to industrial specifications, from which it is clear that global cities are simply a subset of world cities. Moreover, the centrality scores for the entire network (world cities) have been compared to those of only the producer services (global cities). It is clear in the former that only a few powerful cities from developed nations invest in other cities around the world (outdegree), while, in the case of the latter, a large number of cities in developed and developing nations receive investments (indegree). Therefore, it is seen that cities like Hong Kong, Singapore, Jakarta, Johannesburg and Mexico City, play a significant role in producer services. It is also reported that far fewer cities count as global than as world cities – confirming Sassen's statement that specialized producer services are concentrated in relatively fewer sites. This is also evident from the Ucinet network diagrams, where both global and world city networks strongly resemble a 'maximally centralized star' (Borgatti and Everett 1990).

Table 10

	Austral Asia	Central America	Pacific Asia	East Europe Central Asia	Europe	North Africa Middle East
Austral Asia	0,15	0,00	0,01	0,00	0,00	0,00
Central America	0,01	0,25	0,01	0,00	0,08	0,00
Pacific Asia	0,18	0,18	3,45	0,04	0,97	0,03
East Europe Central Asia	0,00	0,00	0,00	0,05	0,00	0,00
Europe	1,07	1,27	1,71	1,05	27,49	0,91
North Africa Middle East	0,00	0,01	0,00	0,02	0,10	0,05
North America	0,67	0,96	0,70	0,40	6,38	0,41
South America	0,00	0,01	0,00	0,00	0,01	0,00
South East Asia	0,01	0,03	0,09	0,01	0,03	0,00
Sub Sahara Africa	0,00	0,00	0,00	0,00	0,00	0,00
TOTAL INDEGREE	**2,10**	**2,72**	**5,97**	**1,58**	**35,06**	**1,41**
CORE	**1,9**	**2,4**	**5,9**	**1,5**	**34,8**	**1,4**
PERIPHERY	**0,17**	**0,30**	**0,11**	**0,09**	**0,22**	**0,05**

North America, Europe and Pacific Asia claim 98% of all outdegree and 82% of all indegree.
82% of all outdegree relations are within the tri-core region, and 0,5% between the the tri-core and the peripheral regions
1,62% of outdegree is amongst the peripheral regions themselves, and 15,9% is between periphery and tri-core.
82% of all indegree relations are within the tri-core, and 15,9% between the tri-core and the remaining regions.
1,62% of indegree is amongst the peripheral regions themselves, and 0,53% is between periphery and tri-core.

Percentage share of multinational connectivity between supra-regions.
Source: Wall/v.d. Knaap, 2009.

	North America	South America	South East Asia	Sub Sahara Africa	TOTAL OUTDEGREE	CORE	PERIPHERY
	0,00	0,00	0,02	0,00	**0,18**	0,00	0,2
	0,06	0,00	0,01	0,00	**0,42**	0,00	0,3
	1,32	0,13	0,98	0,04	**7,35**	0,03	1,6
	0,00	0,00	0,00	0,00	**0,05**	0,00	0,1
	5,07	1,47	2,00	1,86	**43,90**	0,91	9,6
	0,00	0,01	0,00	0,01	**0,21**	0,05	0,1
	34,86	0,75	0,98	0,48	**46,60**	0,41	4,7
	0,00	0,30	0,00	0,03	**0,36**	0,00	0,3
	0,14	0,00	0,39	0,00	**0,70**	0,00	0,4
	0,00	0,04	0,00	0,18	**0,23**	0,00	0,2
	41,46	**2,70**	**4,39**	**2,61**	**100**	**1,41**	**17,5**
	41,3	**2,3**	**4,0**	**2,4**	**97,8**	**1,4**	
	0,21	**0,36**	**0,42**	**0,23**	**2,15**	**0,05**	

This shows that the overall system is still strongly hierarchical, and that vertical ties still largely dominate over horizontal ones. This is further confirmed in the next chapter. To answer the first question, it has been asserted that the comparisons between global and world city rankings in this study are exclusive; firstly, because they are derived from a unique and topical dataset, making them more comparative; and secondly, because the results are not based on attribute data, but are instead derived from real corporate relationships between cities. In this way, it has been attempted in this research to try to establish a more consistent comparison, and in this way a contribution is offered to the question of how global and world cities can be better defined (Derudder, 2005).

In this paragraph, the conclusions are summarized regarding the second question, which pertains to the structure of the world city network. First, a GIS analysis has shown that the spatial distribution of the multinational network is highly disproportionate. Hence, the distribution of corporate shares is clearly polarized into three core regions, namely North America, Europe and Asia Pacific. Furthermore, it is clear that, although East-West connectivity exists, the highest intensity prevails in the transatlantic zone between Europe and North America, consistent with the results of Carroll's study (2007). It is also seen that a North-South divide still exists, where Africa for instance is clearly marginalized, claiming only 1% of all investments. This result was further confirmed in a rank-size analysis, where outdegree, indegree and linkage strengths between cities all proved to follow a power-law statistical distribution, characterized by the fact that only a few hubs hold the majority of all connections (Barabási, 2003). This particular statistical structure is interestingly a universal characteristic of many self-organized systems. Furthermore, the linkage strengths between cities proved to be the most disproportionate, meaning that only a few privileged hubs claim the highest volume of investments between cities, and that the strongest ties are almost entirely between developed cities. Therefore, although many cities participate in the global corporate network, the majority of their ties are weak, while the core of the world corporate network remains restricted to a few privileged cities. To further verify this observation, an analysis concerning the distribution of ties from New York, Paris, Tokyo and London to various nations around the world was carried out.

It was evident that New York, although claiming the highest outdegree of all cities, only has 40% of its ties to cities outside the US. Hence, of the four cities, New York is in fact the least internationally connected, followed by Tokyo. This is an outcome similar to Carroll's, in which New York's centrality derives substantially from its prominence within corporate America, and where Tokyo's role is more modest than was claimed by Alderson and Beckfield. Yet, as the results in this study also confirm, Tokyo is absolutely central to the Japanese national network. Tokyo also has the weakest diversity of connections to other nations, and it has a preference for in-region nations such as China, Singapore, Thailand, Taiwan and Malaysia. Surprisingly, not only is Paris second in total ties, but it also proves to be the second most internationally connected city. It also has the highest diversity of nations to which it connects, meaning that it is more integrated with the world than are other cities. Again, these results contrast with Friedmann's suggestion that Paris is merely a nationally connected city and not a world city. Although London proves to have the lowest outdegree of the four cities, it is the most internationally oriented city. However, London's diversity of connections is lower than those of New York and Paris are, but higher than those of Tokyo. Most importantly, the results of this analysis show that the majority of ties held by these core cities are almost entirely with developed nations.

To answer the last part of the second question, an analysis was carried out at the supra-regional level to see what the share of investments is between these areas. In these results it was evident that North America, Europe and Pacific Asia together claim 98% of all outdegree relations and 82% of all indegree. Hence, these areas claim a disproportionate share of world economic power (Harvey, 2006), while at the same time the world is highly dependent on them – Europe and North America claim the majority of these multinational investments. Furthermore, 82% of all outdegree ties are strictly between these three core regions, meaning that the vast majority of the world is marginalized from the corporate system. This is in agreement with Sassen that a 'vast territory' exists that is increasingly excluded from the primary economic system (2002). It has also been shown that the three major supra-regions are far more connected internally than with other regions – in the case of peripheral regions, only 2% of the outdegree is internal, while 16% is sent from the periphery to the three core regions. Hence the periphery is more dependent on the core than vice versa. Therefore, these results agree with Carroll's, and Alderson and Beckfield's, in suggesting that the world system is still highly disproportionate, verifying Hymer's assumption that the previous world city hegemony is being perpetuated. This means that according to the world city approach, the system has not changed much. Nonetheless, caution should be taken in stating that there is no evidence for Sassen's theory that a new geography of marginality and centrality is being generated. This is firstly because, as shown in this research, world city and global city networks are entirely different entities; and secondly because this research, as with previous studies, is cross-sectional. Or, China and other emerging markets might be ushering in a new geography of marginality, while on the other hand the recent collapse of financial markets in the developed world shows that emerging markets remain extremely dependent on the core. Nonetheless, this remains speculative. This will depend on longitudinal research and further work regarding the types of networks being analyzed. Hence, a contribution has been made to the literature, but the need for improved conceptual clarity remains urgent (Derudder, 2005).

CHAPTER 4

The Relative Importance of Cities within Different Scales of Worldwide Corporate Network[2]

4.1 Introduction

Today, the importance of the Randstad agglomeration is often discussed in terms of the economic coherence between its four largest cities. This is remarkable when several leading authors argue that the economic importance of cities is strongly related to the economic networks between cities worldwide. This discrepancy stems from the fact that limited empirical research exists on corporate networks. Furthermore, the relative importance of cities within various studies is based on different functional types and spatial scales of data, making the results incomparable. Therefore, in this chapter, the relative importance of the four largest Randstad cities is explored within three independent, comparative networks (top 100 global firms, top 100 European firms, top 100 Dutch firms). Employing network analysis techniques, this study evaluates the local, supra-regional and global importance of the four Randstad cities within the three independent networks. The results show that the relative importance and network structures of these four cities are highly dependent on the economic size and locality of the initial headquarters and that Amsterdam proves to be the most important Randstad city in all three scales of corporate networks.

The Dutch Randstad region is a poly-centric metropolitan region in the Netherlands comprised mainly of Amsterdam, Rotterdam, The Hague and Utrecht and forms one of the largest agglomerations in Europe (OECD 2007). The Randstad generates approximately 50 percent of Dutch business interactions, though it has been found that the economic activity within the urban regions of these cities is much larger than that between these regions (Van der Knaap 2002). Hence there is no true integration between these cities regions (Van Oort et al. 2006). Furthermore, economically speaking, these cities operate more internationally than nationally (Wall & Van der Knaap, 2008). Nonetheless, most national planning policies (e.g., 'Randstad 2040') still consider the proximity of cities as decisive to their economic performance, neglecting their transnational networks (Van Oort et al. 2006; Taylor et al. 2008). This is odd, considering the many studies (e.g., Camagni and Salone 1993; Batten 1995; Davies 1998; Carroll 2007) that stress the need for an 'intellectual transition' in the conceptualization of urban external relations (Meijers 2007). In place of such an approach, planning and policy could begin to understand cities as places of multiple relational assets and resources (Massey 1993; Graham & Marvin 1999). By understanding a city's position and its linkages to other cities worldwide, policymakers can start to engage with competitor and collaborator cities that are specifically important to them. But what type of networks should be taken into account?

2 This chapter is published in the the Journal of Economic and Social Geography (2009), issue 100 (2).

Most world city network research focuses on corporate relations between cities as a vital factors of urban performance (Friedmann 1987; Taylor 2004; Alderson & Beckfield 2004). Similarly, this study focuses on worldwide intercity networks of multinational corporations and their subsidiaries, as these are said to be central to the development of cities (Rugman 2005). This idea has been empirically demonstrated in a study by Wall et al. (2007), which found that the total corporate connectivity of cities correlates highly with economic indicators such as GDP, global competitivity, technology, innovation, and business sophistication. Evidence of this correlation was found in the global, European and Dutch corporate networks.

The importance of multinationals to city development has led to an increase in the spatial reach of a city: a variety of spatial scales are utilized, and firms operate on local and regional networks as well as global ones (Van der Knaap 2007). This leads to a move from hierarchical 'central place' structures to non-hierarchical network structures (Meijers 2007; Taylor et al. 2008), in which a 'dual system' of understanding is required (Hohenberg & Lees 1985, pp 58-59). Furthermore, cities link many types of network together at the local, supra-regional and global scales, and, in terms of rankings, cities 'may occupy different positions' on each of these network scales (Van der Knaap 2007, pp. 13). In this context there is a strong need to account for various scales that may affect the competitiveness of a city (Asheim and Isaksen, 2002) and where many geographical scales can simultaneously influence a city's innovation processes (Malmberg and Maskell, 2002).

Although all multinationals have global reach, they differ by economic size and geographic location, which subsequently determine the total number of corporate connections and the strengths of the ties between cities. Accordingly, the research question is what the scalar differences of intercity corporate networks will be, which are derived from three size categories of multinational headquarter and their geographic localities. The first concerns the global top 100 multinational headquarters and their subsidiary networks across the globe. The second concerns the top 100 multinational headquarters located in Europe and their worldwide subsidiary relations; and the third network concerns the top 100 multinationals situated in The Netherlands and their worldwide subsidiaries. Specific interested is in how the positions of the four Randstad cities (Amsterdam, Rotterdam, The Hague and Utrecht) vary within these networks. Furthermore, a clique analysis will be carried out to identify different subsets within these networks.

4.2 Theory and aims concerning city ranking and network scales

4.2.1 Scale theory

Multinationals are central agents in the development of the world city system, where it has been shown that multinationals are wealthier than most nations (United Nations, 2002) and that the top 500 multinationals (2004) account for 90% of world FDI and 50% of global trade (Rugman 2005). However, research on worldwide networks is scarce (Smith and Timberlake, 1993), and most research has been based on attribute data, in which comparative results are shown but not relational ones (Taylor 2004). Nonetheless, a few studies on worldwide city networks do exist, such as analyses on global advanced producer service networks (Beaverstock et al. 2000), the corporate ties of the world's 500 largest multinationals (Alderson &

Beckfield 2004) and worldwide inter-corporate directorships (Carroll 2007). This type of analysis is unique because cities obtain relative importance because of their relationships to other cities (Harvey 2006). The results of these studies, however, cannot be easily compared to each other, and they do not show nuances in networks generated by different corporate typologies. Therefore this chapter is aimed at showing the differences in networks generated by three independent, but highly comparable levels of corporate network, in which variations in the relative importance of the main Randstad cities will be assessed.

Since the 2nd World War, the Dutch national government has demonstrated a constant concern with the spatial development of the nation. Out of this concern, a national planning policy has been designed, aimed at strengthening the social, economic and spatial structure of the Randstad. It is only recently, however, that the concept of city networks has been incorporated, e.g., in the preliminary *5th report* (VROM 2001) and the *Economic Strategy Randstad* (Regio Randstad 2006), whose goal is to turn the Randstad into an internationally competitive network metropolis. In these studies, it is argued that this will be achieved by strengthening the spatial integration of the region. According to research by the Netherlands Institute for Spatial Research (RPB), however, the degree to which the Randstad forms a coherent system of complimentary cities is questionable (Van Oort et al. 2006). Instead, these cities interact more with their direct proximate environments and in international networks (Wall & Van der Knaap 2008). It is therefore uncertain whether policy is targeting the correct scale of interventions, and it appears that their instruments are essentially spatially oriented with little knowledge of functional network relationships (Van Oort et al. 2006). The persistence of thinking in terms of geographic proximities is odd considering the amount of literature today that indicates how advances in transport and communication technology and the growth of multinational networks have had a significant impact on the spatial economic structure of cities and regions (Camagni and Salone 1993; Batten 1995). Hence, planning and urban policy practice may need to start representing cities as multiple layers of relational assets and resources (Massey 1993; Graham and Marvin 1999).

4.2.2 Research aims

Although past studies have focused mainly on attribute data (economic performance, creativity, innovativeness, and access and quality of services) to measure the relative importance of cities, today the economic development of cities is essentially related to interaction between cities (Taylor 2004), and is less dependent on what remains fixed within them (Amin and Graham 1999; Castells 2001). Hence, the network positions of cities in worldwide corporate networks is focused on in this study, so as to identify changes in their relative importance. The significance of intercity relations was already stressed by Jacobs (1969), who argued that a city's economic development does not result by servicing its hinterland, but by economic networks between cities. In this sense, central place theory (Christaller 1933) is complimented by a 'central flow theory' in the form of an interlocking network model (Taylor et al. 2008). Yet, the relative importance of cities may differ across hierarchic scales (Van der Knaap, 2007); accordingly, this study examines the relative importance of the Randstad cities in worldwide corporate networks at different corporate scales. In light of this, a clique analysis will be carried out to also identify horizontal and vertical network formations.

Figure 21

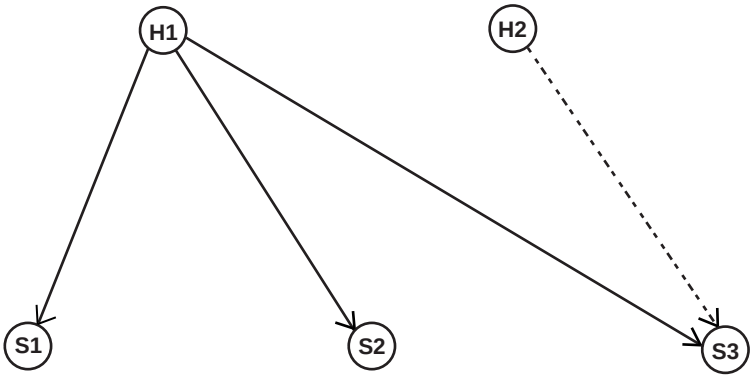


Diagram to explain headquarter and subsidiary relations.
Source: Wall/v.d. Knaap, 2009.

Lastly, it is shown in various studies that corporate headquarters locate in limited, centralized cities (Friedmann 1987, Sassen, 2001, Alderson and Beckfield, 2004), from which their power is exercised upon subsidiary firms in an array of more peripheral type cities. This corporate unevenness was already shown by Robert Gibrat in 1931, (Sutton, 1997), and similarly in Zipf's Law (Axtell, 200), in which cities are assigned relative functional and geographic importance, often characterized by power-law statistical distributions, – 'in which limited cities are extremely connected hubs' within the entire city-firm network (Barabási, 2003). In this context, it becomes interesting to see the hierarchical significance of Randstad cities within the three corporate network scales. Based on this theory, the last part of the analysis is aimed at revealing evidence of power-law distributions within the three datasets.

4.3 Data, methodology and techniques

4.3.1 Data

The data used in the analyses concern corporate shares or investments from multinational headquarters to their many subsidiaries. Three independent datasets have been compiled using Fortune®, Lexis-Nexus® and Reach® sources. Each dataset originates with the top 100 headquarters at a given scale (global, European and Dutch). Next, data on all subsidiaries and their locations were collected for each network scale. For a more detailed explanation on the data see chapter 3.4.1. Aggregating the data on interactions between multinational headquarters and their subsidiaries to the city-level, the worldwide corporate networks between cities were obtained. To make the three scales comparable, the data was restricted to include only those cities that are found in all three scales of corporate networks. Of the thousands of cities, only 199 fitted this criterion. Nonetheless, these 199 international cities proved to be the most important, because they held approximately 90% of the total connectivity found in each of the three datasets. It is important to note that, although the headquarter locations of each scale are restricted to three geographic zones (global, European, The Netherlands), their subsidiary networks are worldwide.

Figure 22

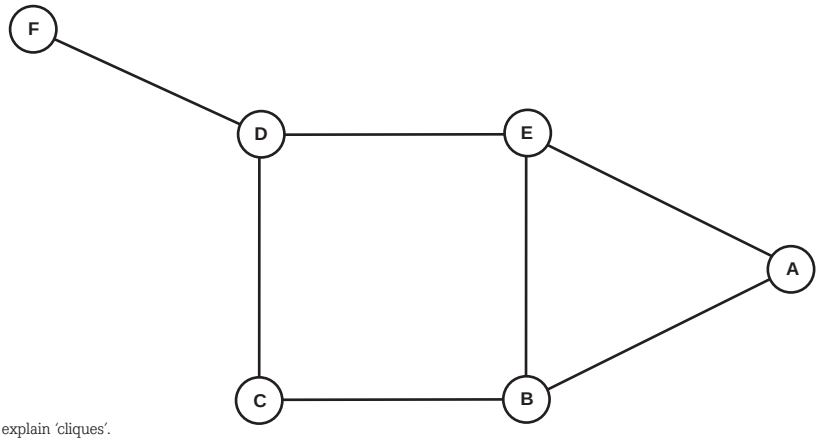


Diagram to explain 'cliques'.
Source: Wall/v.d. Knaap, 2009.

4.3.2 Methodology and techniques

Two network measures have been used in this study, namely outdegree and indegree. These are measures signifying the directionality of corporate investments between firms and can be best explained by means of the provided network diagram **(Figure 21)**. In this it is evident that a multinational headquarter (H1) is situated in a particular city, with three subsidiaries (S1, S2, and S3) in other cities. The arrow direction indicates that (H1) owns shares in these three subsidiaries, which in network terminology is called the 'outdegree' (Wasserman and Faust 1994). In this case, headquarter city (H1), has an outdegree of three. It is a measure of how much economic power or command a city exerts over others. Conversely, the three subsidiary cities each have an incoming sharehold from (H1), called the 'indegree' (Wasserman and Faust 1994). This can be seen as a measure of the dependency of other cities upon a particular city. Furthermore, looking at subsidiary city (S3), it is clear that it also has an inward sharehold from (H2), meaning that it has a total indegree of two, hereby showing that indegree is also dependent on the number of headquarter cities that connect with a particular subsidiary city. The three corporate datasets have been organized into adjacency matrices of headquarter cities and subsidiary cities. UCINET network analysis software (Borgatti et al. 2003) was used to analyze the data. For a more concise description of these measures and their formulas, see chapter 3.4.2.

One specific measure however does need further explanation. This concerns the measure of cliqueness, which has been used to find sub-groups within the global and European datasets. Often of interest to network analysts are the 'sub-structures' that can be found in a network. It is often the exercise to compound highly dense networks into sub-groupings or 'cliques'. For the purpose of this research, the general definition of a clique can be seen as simply the identification of a sub-set of cities that are more closely connected to each other by sharehold interactions, than to other cities that are not part of their sub-set. This is the strictest and purest definition, but there are other looser definitions such as N-cliques and K-plexes which can be used. In the diagram **(Figure 22)** it is seen that smallest clique possible is city F - D, called a 'dyad'; followed by the 'triad' A-B-E. It is clear that every city has to be connected to each other, whereas in the case of quadrant E-B-C-D this is not a

clique, because all cities are not connected to each other. In network analysis, researchers are mostly interested in the largest types of cliques derived from the algorithm used. In this research it is interesting to find which cities form large, complete subgraphs, as these are said to reflect stable, completed structures of corporate interdependency and collaboration. Of these largest cliques, it is also of interest to reveal which cities are most common, as these act as bridges or vertical connectors between the horizontal cliques. The more that cliques overlap in this way, the higher the possibility of mobilization and diffusion throughout the entire network. To find a clique a 'brute force' algorithm is used to explore each subgraph.

4.4 Analysis results

4.4.1 Network characteristics of global firms

In the provided lists it is shown what the centrality scores of the top 100 headquarter networks aare, within the three corporate scales **(Table 11)**. Each subsequent scale represents the outdegree and indegree and related city ranking. In the global sample it is clear that, globally, New York is 1st in terms of both headquarter and subsidiary relations, and that its dominance is in command functions. Düsseldorf is 2nd, Munich 3rd and Zurich 4th, proving to be the top global headquarter cities, where London at 6th position, Paris 7th and Tokyo 22nd are weaker than expected. The global centrality strengths of moderately populated cities like Düsseldorf, Munich and Zurich, confirm Powell's (1990) conception of network organization, holding that networks offer cities greater economic flexibility and stability than a system of unidirectional, spatially embedded ties to a central place. By capitalizing on the positive externalities associated with cooperative linkages, small cities can specialize in the provision of higher-order services, thereby elevating their status in the functional urban hierarchy and lifting them from the Christallerian shadow of the nearest larger city. Tokyo, although an Asian regional powerhouse, is evidently not entirely the global contender it is often claimed to be. However, in subsidiary relations, London is 2nd, showing that many individual cities are highly dependent on it. Concerning the Randstad (G4) cities, it is seen that, in terms of outdegree, Amsterdam claims 9th position and The Hague 11th position in the global economy. The Hague's position is strongly related to Shell's presence in this city. Furthermore, it is observed that Rotterdam and Utrecht do not have headquarter functions within the global dataset. However, considering subsidiary relationships, Rotterdam ranks 21st and Utrecht 31st. In terms of subsidiaries, The Hague drops down to 32nd place, meaning that it is not so important to other cities at this scale. Furthermore, even if summing up the connections of the four Dutch cities, the relative strength of the combined Randstad only reaches 5th position. Hence, the Randstad's global position is highly attributed to on the corporate activities of Amsterdam. Regarding linkage strengths **(Table 12)**, Amsterdam has strong outdegree or command over subsidiaries in Paris, Brussels and Hong Kong, while, alternatively, Amsterdam has indegree relations with headquarters situated in Brussels, Paris, Dusseldorf and London. This reveals the often two-way flow or cooperation between cities, which characterizes 'central flow theory, 'in contrast to 'central place theory' (Taylor et al. 2008).

4.4.2 Network characteristics of European firms

The second dataset provides similar results concerning worldwide networks generated by the top 100 European multinational headquarters **(Table 11)**. It is evident that Paris and London have risen, relative to the ranking in the global network, to 1st and 2nd position, in both headquarter and subsidiary functions, followed Zurich. The most important non-European subsidiary cities are Singapore 6th, Hong Kong 8th and Buenos Aires 10th. Looking at ranks of Randstad cities, a higher ranking is evident than at the global scale. Amsterdam now ranks 4th as a headquarter city, meaning that it is more important to the European network than the global one. Furthermore, Utrecht ranks 30th and Rotterdam 38th, while The Hague's headquarter status has become relatively less important, arguably because its petroleum operations (Shell) are more important to the world than to Europe. In this dataset, Amsterdam, for instance, has strongest outdegree relations with London, Zurich and Tokyo **(Table 12)** and is alternatively highly controlled by headquarters in Paris, Vevey, Munich, Brussels and London.

4.4.3 Network characteristics of Dutch firms

At the next scale, networks generated by The Netherlands top 100 headquarter network are shown, where it is evident that in terms of outdegree, Amsterdam ranks 1st, Utrecht 2nd, Rotterdam 3rd and The Hague 4th **(Table 11)**. In terms of indegree, Dutch subsidiaries at this network level are far more important to international cities like London 2nd, and Paris 3rd, than to other Dutch cities. This shows that the main corporate relations of the Randstad are strongly related to cities outside The Netherlands. Looking at which cities are most connected to the Randstad top four **(Table 13)**, it is clear that Amsterdam's strongest outdegree linkages are to subsidiaries within Amsterdam, and its second strongest connection is to Paris. Rotterdam is primarily connected to London, secondly to Walton on Thames and thirdly to The Hague, before being connected within itself. Utrecht is mostly oriented towards Amsterdam, but also strongly connects to other tertiary type cities like Luxembourg and Brussels. It is also highly connected to Willemstad (Dutch Antilles), possibly due to offshore banking. The Hague is firstly linked to Wilmington, due to Wilmington's importance in petroleum insurance. Looking at the internal relations between Dutch cities, it is evident that Amsterdam and Utrecht are strongly connected, while Rotterdam and The Hague have moderate ties to each other (Wall & Van der Knaap, 2008). Nonetheless the former two cities are poorly connected to the latter two cities, verifying that Randstad cities are only weakly connected to each other (Van Oort et al., 2006).

4.4.4 Network structures at different corporate scales

By analyzing the global and European top 100 networks, the geographic and structural configuration of the corporate networks is revealed. This is done on the one hand by mapping the networks using GIS **(Figure 23 – 25)**, and on the other hand, by using UCINET and Mapdraw network analysis software **(Figure 26 – 28)**.

Through GIS, it was possible to observe the exact distribution of corporate shareholds in geographic space. The white dots depict the presence of firms within cities, and are scaled accordingly. The black lines illustrate corporate sharehold ties greater or equal to five, while the light grey lines show ties less than five. The thicker a line is between

Table 11

Global headquarter city	outdegree	outdegree rank	Global subsidiary city	indegree	indegree rank
New York	**473**	**1**	New York	**135**	**1**
Dusseldorf	**234**	**2**	London	**82**	**2**
Munich	**206**	**3**	Dusseldorf	**80**	**3**
Zurich	**192**	**4**	Brussels	**66**	**4**
PaloAlto	**162**	**5**	Paris	**65**	**5**
London	**147**	**6**	Houston	**59**	**6**
Irving	**110**	**7**	Frankfurt	**54**	**7**
Paris	**110**	**7**	**Amsterdam**	**49**	**8**
New Brunswick	**109**	**8**	Milan	**47**	**9**
Amsterdam	**102**	**9**	Zurich	**47**	**9**
Brussels	**88**	**10**	Madrid	**40**	**10**
The Hague	**68**	**11**	Vienna	**40**	**10**
Frankfurt	**67**	**12**	Tokyo	**39**	**11**
Chicago	**63**	**13**	Singapore	**38**	**12**
Houston	**60**	**14**	Atlanta	**37**	**13**
Atlanta	**55**	**15**	Toronto	**36**	**14**
Wolfsburg	**54**	**16**	Mexico City	**34**	**15**
Detroit	**52**	**17**	Munich	**30**	**16**
Calgary	**49**	**18**	Bangkok	**28**	**17**
Gerlingen	**48**	**19**	Hamburg	**28**	**17**
Lausanne	**43**	**20**	Dublin	**27**	**18**
Stuttgart	**43**	**20**	Hong Kong	**27**	**18**
Toyota	**40**	**21**	Barcelona	**26**	**19**
Tokyo	**37**	**22**	Buenos Aires	**26**	**19**
Cincinnati	**36**	**22**	Luxembourg	**24**	**20**
Schaumburg	**35**	**23**	**Rotterdam**	**23**	**21**
Stavanger	**34**	**24**	Berlin	**22**	**22**
Philadelphia	**32**	**24**	Taipei	**22**	**22**
Chesterbrook	**31**	**25**	Montreal	**20**	**23**
Trieste	**28**	**26**	Turin	**20**	**23**
Rotterdam	**n/a**	**n/a**	**Utrecht**	**12**	**31**
Utrecht	**n/a**	**n/a**	**The Hague**	**11**	**32**
199 cities	**N = 3618**				

Outdegree and indegree of global corporate networks (data 2005/2006).
Source: Wall/v.d. Knaap, 2009.

Table 11 (continued)

European headquarter city	outdegree	outdegree rank	European subsidiary city	indegree	indegree rank
Paris	**376**	**1**	Paris	**154**	**1**
London	**302**	**2**	London	**117**	**2**
Zurich	**232**	**3**	Madrid	**70**	**3**
Amsterdam	**87**	**4**	New York	**67**	**4**
Basel	**83**	**6**	Brussels	**55**	**5**
Oslo	**77**	**7**	Singapore	**47**	**6**
Frankfurt	**71**	**8**	Munich	**45**	**7**
Vevey	**71**	**8**	Hong Kong	**42**	**8**
Espoo	**62**	**9**	Milan	**42**	**8**
Munich	**59**	**10**	Vienna	**41**	**9**
Dusseldorf	**53**	**11**	Buenos Aires	**40**	**10**
Chicago	**47**	**12**	Zurich	**39**	**11**
Berlin	**45**	**13**	Dublin	**37**	**12**
Brussels	**42**	**14**	Frankfurt	**36**	**13**
Edinburgh	**38**	**15**	**Amsterdam**	**33**	**14**
Tampere	**38**	**15**	Tokyo	**33**	**14**
Santa Monica	**36**	**16**	Barcelona	**23**	**15**
The Hague	**31**	**17**	Mexico City	**23**	**15**
Wolfsburg	**31**	**17**	Bangkok	**22**	**16**
Gothenburg	**30**	**18**	Dusseldorf	**22**	**16**
Leverkusen	**29**	**19**	Johannesburg	**22**	**16**
La Courneuve	**27**	**20**	Luxembourg	**22**	**16**
Saint Paul	**27**	**20**	Prague	**22**	**16**
Rome	**22**	**21**	Budapest	**21**	**17**
Trieste	**21**	**22**	Jakarta	**21**	**17**
Stuttgart	**20**	**23**	Lisbon	**21**	**17**
Bochum	**19**	**24**	Oslo	**21**	**17**
Gerlingen	**19**	**24**	Toronto	**21**	**17**
Voorhees	**18**	**25**	Hamburg	**20**	**18**
Utrecht	**12**	**30**	Athens	**19**	**19**
Rotterdam	**3**	**38**	**The Hague**	**10**	**27**
			Rotterdam	**9**	**28**
			Utrecht	**9**	**28**
199 cities	**N = 2820**				

Outdegree and indegree of European corporate networks (data 2005/2006).
Source: Wall/v.d. Knaap, 2009.

Table 11 (continued)

Dutch headquarter city	outdegree	outdegree rank	Global subsidiary city	indegree	indegree rank
Amsterdam	**2787**	**1**	**Amsterdam**	**884**	**1**
Utrecht	**2087**	**2**	London	**452**	**2**
Rotterdam	**1223**	**3**	Paris	**258**	**3**
The Hague	**1155**	**4**	Utrecht	**238**	**4**
Arnhem	**734**	**5**	Wilmington	**213**	**5**
Eindhoven	**484**	**6**	Brussels	**192**	**6**
Heerlen	**294**	**7**	Dublin	**190**	**7**
Ritthem	**90**	**8**	**The Hague**	**188**	**8**
Rijen	**61**	**9**	**Rotterdam**	**178**	**9**
Nijkerk	**26**	**10**	Luxembourg	**172**	**10**
Meppel	**14**	**11**	Hong Kong	**161**	**11**
Den Bosch	**12**	**12**	Delaware	**107**	**12**
Breda	**12**	**12**	Singapore	**105**	**13**
Best	**11**	**13**	Walton	**87**	**14**
Bergen op Zoom	**10**	**14**	Milan	**85**	**15**
Sittard	**5**	**15**	Madrid	**83**	**16**
Tilburg	**4**	**16**	Hamburg	**73**	**17**
Rijssen	**1**	**17**	Zurich	**68**	**18**
Veenendaal	**1**	**17**	Stockholm	**66**	**19**
Zwolle	**1**	**17**	Dover	**63**	**20**
New York	**n/a**	**n/a**	Shanghai	**63**	**20**
Paris	**n/a**	**n/a**	Eindhoven	**62**	**21**
London	**n/a**	**n/a**	New York	**62**	**21**
London	**n/a**	**n/a**	Lisbon	**59**	**22**
			Melbourne	**58**	**23**
			Houston Texas	**55**	**24**
			Vienna	**55**	**24**
			Buenos Aires	**54**	**25**
			Bunnik	**54**	**25**
			Warsaw	**54**	**25**
			Mexico City	**50**	**26**
			Arnhem	**49**	**27**
			Budapest	**49**	**27**
199 cities	**N = 9012**				

Outdegree and indegree of Dutch corporate networks (data 2005/2006).
Source: Wall/v.d. Knaap, 2009.

Table 12

Global Corporate Network			
To City	**Outdegree**	**From City**	**Indegree**
Paris	**12**	Brussels	**7**
Brussels	**8**	Paris	**6**
Hong Kong	**7**	Dusseldorf	**3**
London	**7**	London	**3**
Atlanta	**6**	Dearborn	**2**
Madrid	**5**	Frankfurt	**2**
Toronto	**5**	Munich	**2**
Velizy	**5**	New York	**2**

European Corporate Network			
To City	**Outdegree**	**From City**	**Indegree**
London	**13**	Paris	**16**
Zurich	**8**	Vevey	**7**
Tokyo	**8**	Munich	**5**
Madrid	**8**	Brussels	**3**
Paris	**7**	London	**3**
Frankfurt	**6**	Aachen	**2**
Dublin	**6**	Auburn Hills	**2**
Toronto	**5**	New York	**2**

Global Corporate Network			
To City	**Outdegree**	**From City**	**Indegree**
Paris	**130**	Utrecht	**357**
London	**99**	The Hague	**18**
Dublin	**66**	Rotterdam	**13**
Singapore	**49**	Heerlen	**7**
Brussels	**42**	Arnhem	**5**
Milan	**42**	Eindhoven	**4**
Redfern	**41**	Breda	**3**
Hong Kong	**35**	Nijkerk	**1**

Amsterdam's linkage strengths with other cities at global, European and Dutch network scales.
Source: Wall/v.d. Knaap, 2009.

Table 13

Rank	Amsterdam		Rotterdam		Utrecht		The Hague	
1	Amsterdam	474	London	120	Amsterdam	357	Wilmington	167
2	Paris	130	Walton	87	Utrecht	21	London	105
3	London	99	The Hague	68	Willemstad	118	Dover	51
4	Dublin	66	Rotterdam	62	Brussels	116	The Hague	51
5	Singapore	49	Dublin	58	Luxembourg	110	Houston	48
6	Brussels	42	Paris	51	London	86	Melbourne	32
7	Milan	42	Hamburg	22	Rotterdam	83	Cedar Rapids	22
8	Redfern	41	Epping	21	Hong Kong	80	Delaware	21
9	Hong Kong	35	Jerusalem	20	Tortola	49	Amsterdam	18
10	Sydney	35	Mexico City	19	Paris	45	Edinburgh	18

Outdegree strengths of Randstad cities, within top 100 Dutch corporate network.
Source: Wall/v.d. Knaap, 2009.

two cities, the more ties that exist. First of all, it is obvious that the strongest ties in both maps are between North America (east-coast), Europe and Pacific Asia, showing that the supra-regional East/West triad still prevails. The incidental linkages towards the south are mainly to Australasia and South America. Africa is primarily bound through Johannesburg, Abidjan, Lagos and Cairo, but the relative share of connectivity to this continent is very sparse. The grey lines indicate a lot of inter-regional activity, but this generally concerns weak ties. Interesting is that both networks generate a similar overall distribution **(Figure 23 and 24)**. Both maps reveal the prominence of North Atlantic ties between North America and Europe, underlining Carroll's results that the interurban corporate elite network is essentially a North Atlantic formation. One strong difference between the two maps is that the global network around Pacific Asia and North America is more completed, where cities in these regions also connect together; whereas the European network reveals a more star-shaped system. Another difference is that the European network has generally stronger network ties (thickness) and is more strongly linked to South America. Australasia is also apparently less strongly connected to the European corporate system. In the zoom-in, the global and European corporate networks are shown in more detail **(Figure 25)**. Here it is again evident that the ties of the global network (top) are less dense than the European network (bottom). Furthermore, it is evident that European cities in the European corporate network are far more connected to each other than in the global system, hereby forming a more horizontally connected and completed network of cities.

In the Mapdraw diagrams, we see also the apex of the network generated by global top multinationals **(Figure 26)**. Note: only connections of five and above are shown. In the image, the 'star diagram' discussed by Robert Hanneman **(Figure 18)** is evident, in which New York, Paris, London and Tokyo form the centre of the network. The arrow direction represents the command or prestige of the linkages, where for instance Paris primarily wields command over other cities. Paris has strong outdegree towards New York, but this is not reciprocated. Paris has strong ties with Brussels and places like Montreal, as has

been shown in Carroll's results as well. London has strong command over New York. Furthermore, London has strong outdegree towards Hong Kong and Singapore. Tokyo proves to be moderately connected to London and New York, but besides this it is entirely connected to Asian cities, such as Taipei, Bangkok and Hong Kong. It is also evident that its strongest ties are nationally directed to Kawasaki and Osaka, indicating that Tokyo is especially important to Japan. Furthermore, an interesting sub-network is found between Hamburg, Dusseldorf and Munich. It is evident that both Amsterdam and The Hague play a secondary role in the global system, both strongly connected to Paris and London.

In the bottom second diagram **(Figure 27)**, the core of the European corporate system is represented strongly by Paris and London. Not only is Paris stronger than London in total degree, but as is seen in the diagram, also by diversity of connections. In this manner, it is evident that Paris is well integrated with cities across the globe. Its strongest links are with London, then Brussels. However, unlike the global network, it has no connection to Montreal, but is connected to Hong Kong and Tokyo. Similarly, within this network London is not connected to Hong Kong and Singapore, while this is the case within the global network. Similar to the global network, Amsterdam and The Hague both play a secondary role within the European corporate network. From this analysis, it is evident that the structures of the two multinational systems are dissimilar. So, while centrality measures towards the apex of the system are similar, the structures of the linkages are not.

4.4.5 Clique formation within different network scales

In the Ucinet analysis on clique formation **(Table 14)** it is depicted that for the global system (top); there are 680 cliques with members 5 – 11, grouped into seven classes of cliques. In clique analysis, the largest clique is of most interest to researchers, because there are relatively few of them, and these represent the largest units of completed 'horizontal' network. Hence, there are 16 cliques of 11 members in the global network, and the combination cities of these cliques are specified in the table. By analysing these combinations it was verified which cities are most common to all. These important cities connect different cliques and can be seen as 'vertical' connectors or 'intermediaries'. In the global system, it is found that cities, for instance, Amsterdam, Brussels, Dusseldorf, Frankfurt and The Hague serve as prime intermediaries between cliques. In the European corporate system, there are 677 cliques with members ranging from 5 to 14. These can be subdivided into ten classes. The largest clique consists of 14 members and there are 10 of them, and there specific city combinations are represented in the table. In the European network, London, Munich, Paris and New York form the prime intermediaries, followed by Amsterdam, Frankfurt, Tokyo and so forth. The European network proves to have much larger cliques, and more intermediaries than the global network, hereby revealing a more integrated and completed structure than the global one. This might imply a more robust and reliable system of corporate collaboration.

4.4.6 Disproportionality within different network scales

In the global multinational network, regions claim 98% of all outwardly directed relations (outdegree) over other nations, displaying a disproportionate amount of power over the world. Furthermore, these areas claim 82% of all incoming relations (indegree), showing how dependent the world is on these cores **(Table 10)**. It is evident that a clear North-

South divide still exists; Africa, for instance, holds only approximately 1% of multinational relations. It is also evident that although there is a clear degree of East-West connectivity, the highest intensity prevails in the transatlantic zone between Europe and North America. The Randstad cities clearly fall within the primary economic zone of the world **(Figure 23 and Figure 24)**. Zooming in onto Europe in the same map, the detailed ties within the European region are seen **(Figure 25 top and bottom)**. Amsterdam and The Hague are evidently important, but they are subordinate to larger cities like Paris and London, while Rotterdam and Utrecht play a moderate rolein these networks.

To answer the last part, the statistical distributions of the three databases were analyzed. In this way the data was tested to see if it follows a power-law distribution. To recapitulate, in power-law networks a few nodes act as 'highly connected hubs' while the majority of nodes have low connectivity (Barabási, 2003). In the global, European and Dutch scatterplots **(Figure 29)** it is shown that prime connectivity (y-axis) is held by a limited number of cities while the majority falls into the 'long-tail' of weak connectivity. The city ranks of these three graphs can be seen in the results **(Table 11)**. The regression coefficient in all three graphs is approximately -1 which is characteristic of a power-law. According to economist Axtell, 'the stability of this distribution makes it the most robust statistical regularity in all the social sciences' (Ball, 2005 pg. 321), in which the more connected a city is, the higher its future probability of gaining new connections, known as the law of 'preferential attachment'.

This means the higher in rank a city is, the higher its stability in the network. Within this context, the four Randstad cities rank quite high, indicating good levels of stability. Amsterdam proves to be the most connected hub within all three datasets, signifying its global supra-regional and national importance. Amsterdam's dominance in all three corporate scales reveals its hinge function between networks, hereby vertically integrating the three networks. Hence, its overall stability is related to its network strength in Dutch, European and global networks, which consequently 'reinforce its position in each of these networks and leads to agglomeration advantages' (Van der Knaap, 2007 pp 13). Furthermore, in comparison to Amsterdam, the other three Randstad cities have weaker connectivity across scales – although their importance does increase when dropping corporate scales, from global to local networks.

4.5 Conclusion

It has been shown in this study that different sizes and localities of multinational headquarters will reveal different types of networks at different corporate scales. From the structures of the different network scales, it can be shown that the relative importances of Randstad cities differ across the global, supra-regional and local scales. Amsterdam turns out to be relatively important at all three corporate scales, The Hague ranks high at the global and local scale, while Utrecht and Rotterdam only show importance at more local corporate scales. Furthermore, it has been shown that other Dutch cities have little relative importance in global, European and Dutch networks, and that the four Randstad cities prove to operate more with international cities than with other Dutch ones. This study clearly shows the importance of studying different scales of corporate networks, in which it can be easily seen from the results, that no individual network can give complete

Table 14

Cliques overall result of global dataset
Sixteen cliques of eleven members (horizontal connections)

clique	**1**	Amsterdam	Beijing	Frankfurt	Hong Kong	London	Munich	New York
clique	**2**	Amsterdam	Beijing	Frankfurt	Hong Kong	Jakarta	London	Munich
clique	**3**	Amsterdam	Beijing	Chicago	Frankfurt	London	Munich	New York
clique	**4**	Amsterdam	Barcelona	Buenos Aires	Dusseldorf	Frankfurt	London	Munich
clique	**5**	Amsterdam	Buenos Aires	Dusseldorf	Frankfurt	London	Munich	New York
clique	**6**	Amsterdam	Buenos Aires	Dublin	Dusseldorf	Frankfurt	London	Munich
clique	**7**	Amsterdam	Dusseldorf	Frankfurt	Hong Kong	London	Munich	New York
clique	**8**	Amsterdam	Dusseldorf	Frankfurt	London	Milan	Munich	New York
clique	**9**	Amsterdam	Frankfurt	Hong Kong	Jakarta	London	Munich	New York
clique	**10**	Amsterdam	Frankfurt	Hong Kong	London	Munich	New York	Paris
clique	**11**	Amsterdam	Chicago	Frankfurt	London	Munich	New York	Paris
clique	**12**	Amsterdam	Chicago	Frankfurt	London	Munich	New York	Paris
clique	**13**	Amsterdam	Barcelona	Buenos Aires	Dusseldorf	Frankfurt	London	Madrid
clique	**14**	Amsterdam	Buenos Aires	Dublin	Dusseldorf	Frankfurt	London	Madrid
clique	**15**	Amsterdam	Brussels	Dusseldorf	London	Milan	Munich	New York
clique	**16**	Brussels	Dusseldorf	London	Milan	Munich	New York	Palo Alto

Cliques overall result of Europe dataset
Ten cliques of fourteen memebrs (horizontal connections)

clique	**1**	Amsterdam	Brussels	Chicago	Dusseldorf	Frankfurt	Hong Kong	Houston
clique	**2**	Amsterdam	Brussels	Buenos Aires	Chicago	Dusseldorf	Frankfurt	Hong Kong
clique	**3**	Amsterdam	Brussels	Chicago	Dusseldorf	Frankfurt	Hong Kong	London
clique	**4**	Amsterdam	Brussels	Chicago	Dusseldorf	Frankfurt	Hong Kong	London
clique	**5**	Amsterdam	Brussels	Buenos Aires	Chicago	Dusseldorf	Frankfurt	Hong Kong
clique	**6**	Amsterdam	Brussels	Chicago	Dusseldorf	Frankfurt	Hong Kong	London
clique	**7**	Amsterdam	Brussels	Chicago	Dusseldorf	Frankfurt	Hong Kong	London
clique	**8**	Amsterdam	Brussels	Chicago	Dusseldorf	Frankfurt	Hong Kong	Houston
clique	**9**	Amsterdam	Brussels	Buenos Aires	Dusseldorf	Edinburgh	Frankfurt	London
clique	**10**	Amsterdam	Brussels	Buenos Aires	Dusseldorf	Edinburgh	Frankfurt	London

Networks cliques and vertical connecting cities (top = global dataset; bottom = European dataset).
Source: Wall/v.d. Knaap, 2009.

Paris	Seoul	Singapore	Tokyo		
New York	Paris	Singapore	Tokyo		
Paris	Seoul	Singapore	Tokyo		
New York	Paris	Tokyo	Zurich		
Paris	SaoPaulo	Tokyo	Zurich		
New York	Paris	Tokyo	Zurich		
Paris	Taipei	Tokyo	Zurich		
Paris	Tokyo	Vienna	Zurich		
Paris	Singapore	Tokyo	Zurich		
Singapore	Taipei	Tokyo	Zurich		
Singapore	Taipei	Tokyo	Zurich		
Singapore	Sydney	Tokyo	Zurich		
Munich	New York	Paris	Zurich		
Munich	New York	Paris	Zurich		
Paris	Tokyo	Vienna	Zurich		
Paris	Tokyo	Vienna	Zurich		

London	Luxembourg	Munich	New York	Paris	The Hague	Zurich	
London	Luxembourg	Munich	New York	Paris	The Hague	Zurich	
Luxembourg	Munich	New York	Paris	The Hague	Tokyo	Zurich	
Luxembourg	Munich	New York	Paris	The Hague	Toronto	Zurich	
London	Milan	Munich	New York	Paris	The Hague	Zurich	
Milan	Munich	New York	Paris	Singapore	The Hague	Zurich	
Milan	Munich	New York	Paris	The Hague	Toronto	Zurich	
London	Munich	New York	Paris	Singapore	The Hague	Zurich	
Luxembourg	Madrid	Munich	New York	Paris	The Hague	Zurich	
Madrid	Milan	Munich	New York	Paris	The Hague	Zurich	

Table 14 (continued)

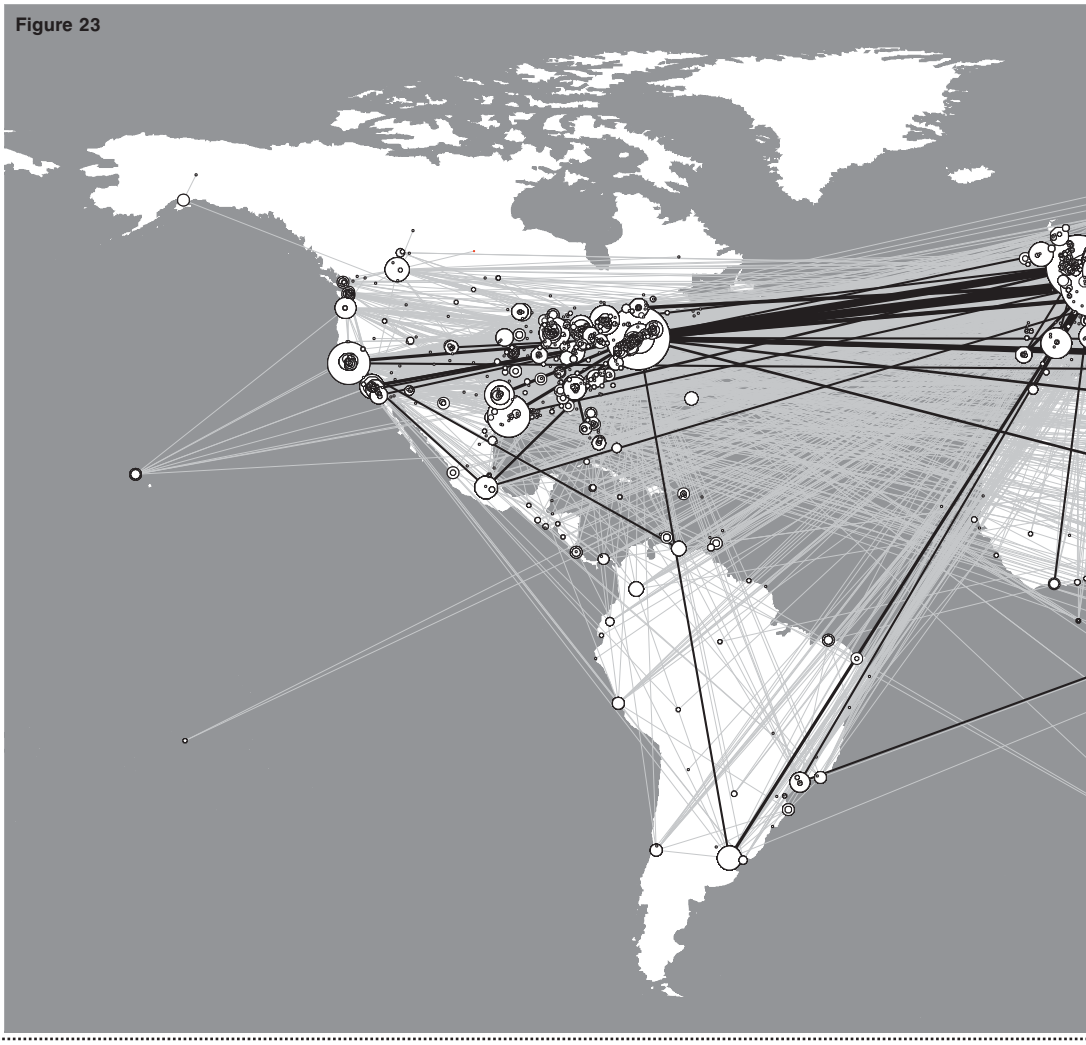
Most common city to the global ten cliques (vertical connectors)	
Amsteram	10
Brussels	10
Dusseldorf	10
Frankfurt	10
London	10
Munich	10
New York	10
Paris	10
The Hague	10
Zurich	10
Chicago	8
Hong Kong	8
Luxembourg	5
Buenos Aires	4
Milan	4
Edinburgh	2
Houston	2
Singapore	2
Toronto	2
Tokyo	1

Most common city to the European sixteen cliques (vertical connectors)	
London	16
Munich	16
Paris	16
New York	16
Amsterdam	15
Frankfurt	14
Tokyo	14
Zurich	13
Dusseldorf	9
Singapore	7
Buenos Aires	5
Hong Kong	5
Beijing	3
Chicago	3
Milan	3
Taipei	3
Vienna	3
Brussels	2
Barcelona	2
Dublin	2
Jakarta	2
Seoul	2
Palo Alto	1
Sao Paulo	1
Sydney	1

Vertical connecting cities (left = global dataset; right = European dataset).
Source: Wall/v.d. Knaap, 2009.

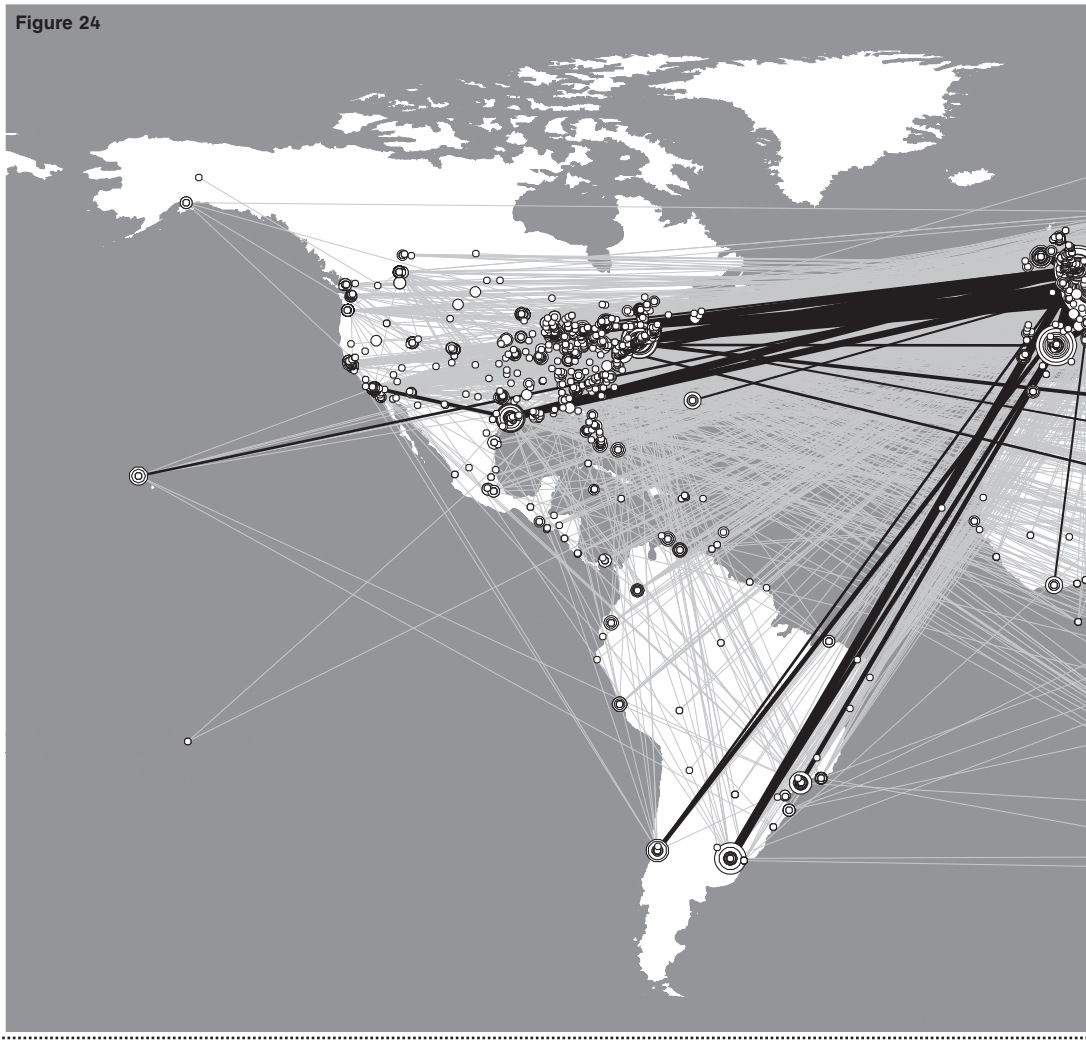
insight into the nature of cities. The fact that the three datasets reveal different knowledge about the roles of Randstad cities in corporate networks can be interesting to different levels of governmental policy. For local policy, for example, the strengthening of ties between Randstad cities can be of interest, as well as the reinforcement of existing ties to other international cities e.g., London and Paris. At the global scale, the powerful role of Amsterdam and The Hague in the world economy can be of interest to Dutch international policy. The Hague's strength, however, appears to be highly attributable to the presence of Shell and related subsidiaries. Furthermore, the power-law found within all three networks proves that regardless of scale, corporate networks are self-organized, highly disproportionate systems. Lastly, because Randstad cities prove to be far more dependent on international cities than on local ones, it is interesting to reconsider, in this light, policy concerning the future of the Randstad: the usual view that local cohesiveness is essential to strengthening the Randstad's economic performance might need to be revised.

Figure 23



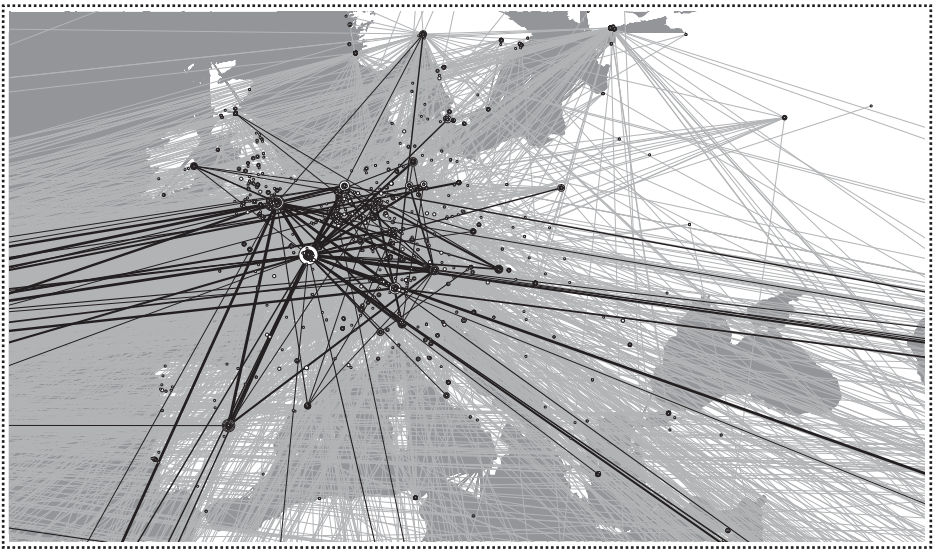
GIS map of top 100 global multinational headquarters and their subsidiary networks.
Source: Wall/v.d. Knaap, 2009.

Figure 24



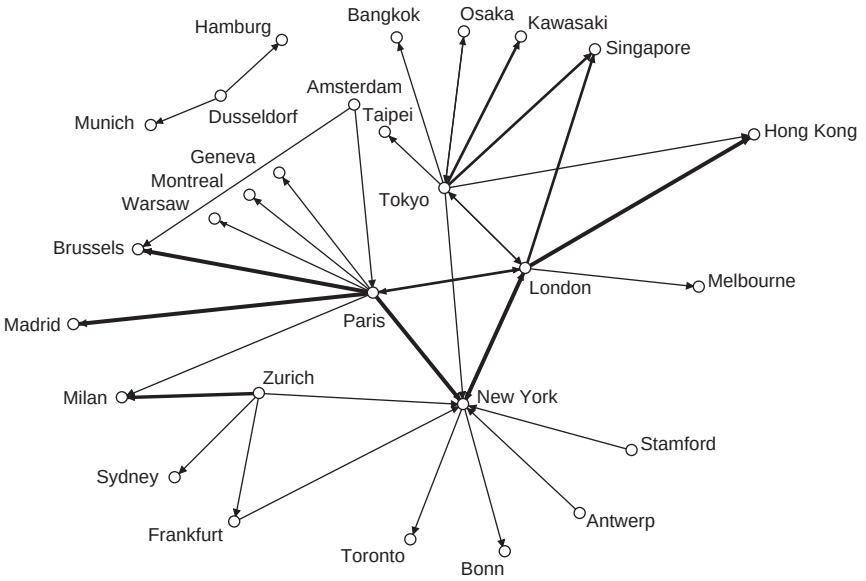
GIS map of top 100 European multinational headquarters and their subsidiary networks.
Source: Wall/v.d. Knaap, 2009.

Figure 25



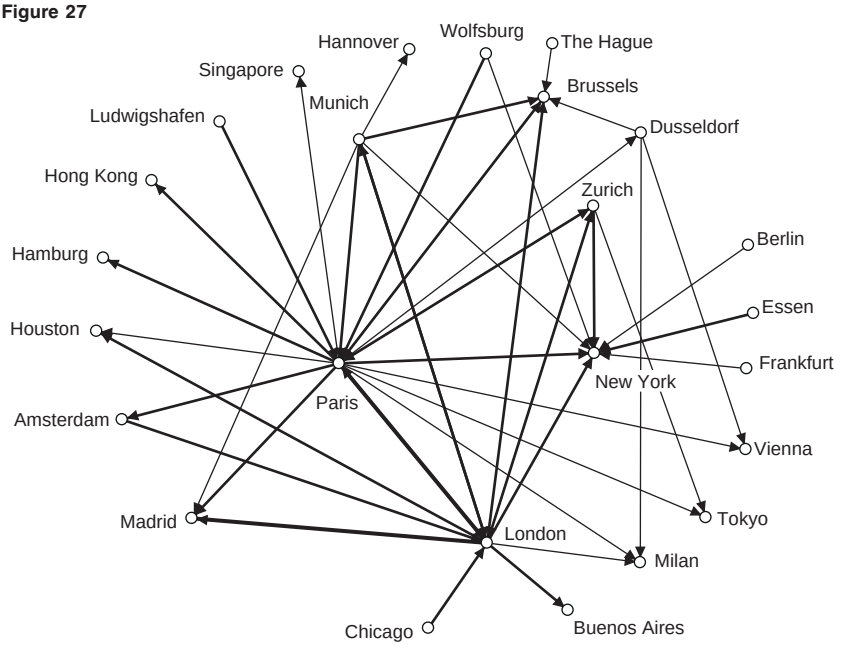
Zoom in on figure 23 (top) and figure 24 (bottom).
Source: Wall/v.d. Knaap, 2009.

Figure 26



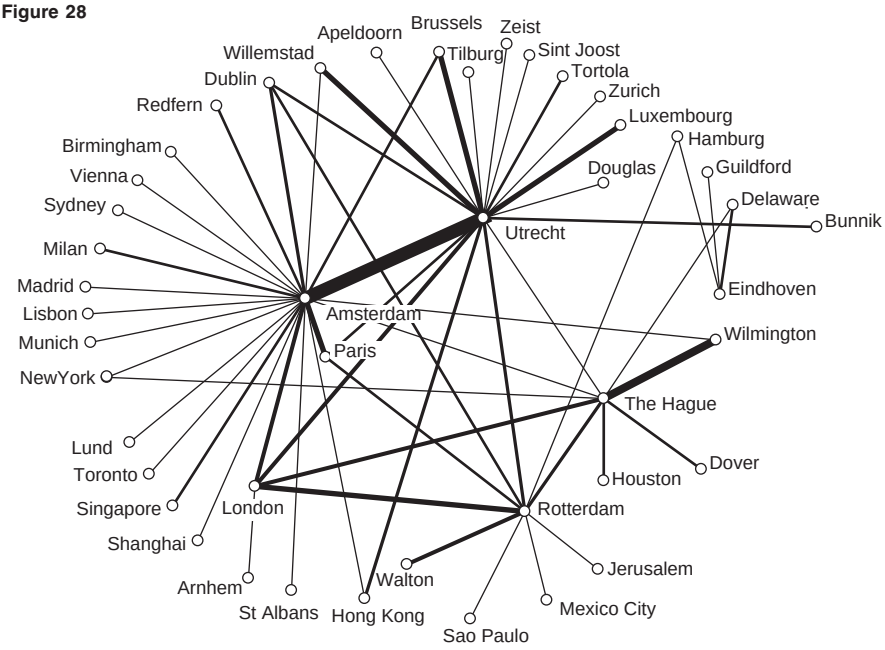
Connectivity of the top 100 global multinational headquarters and subsidiary networks (>5)
Source: Wall/v.d. Knaap, 2009.

Figure 27



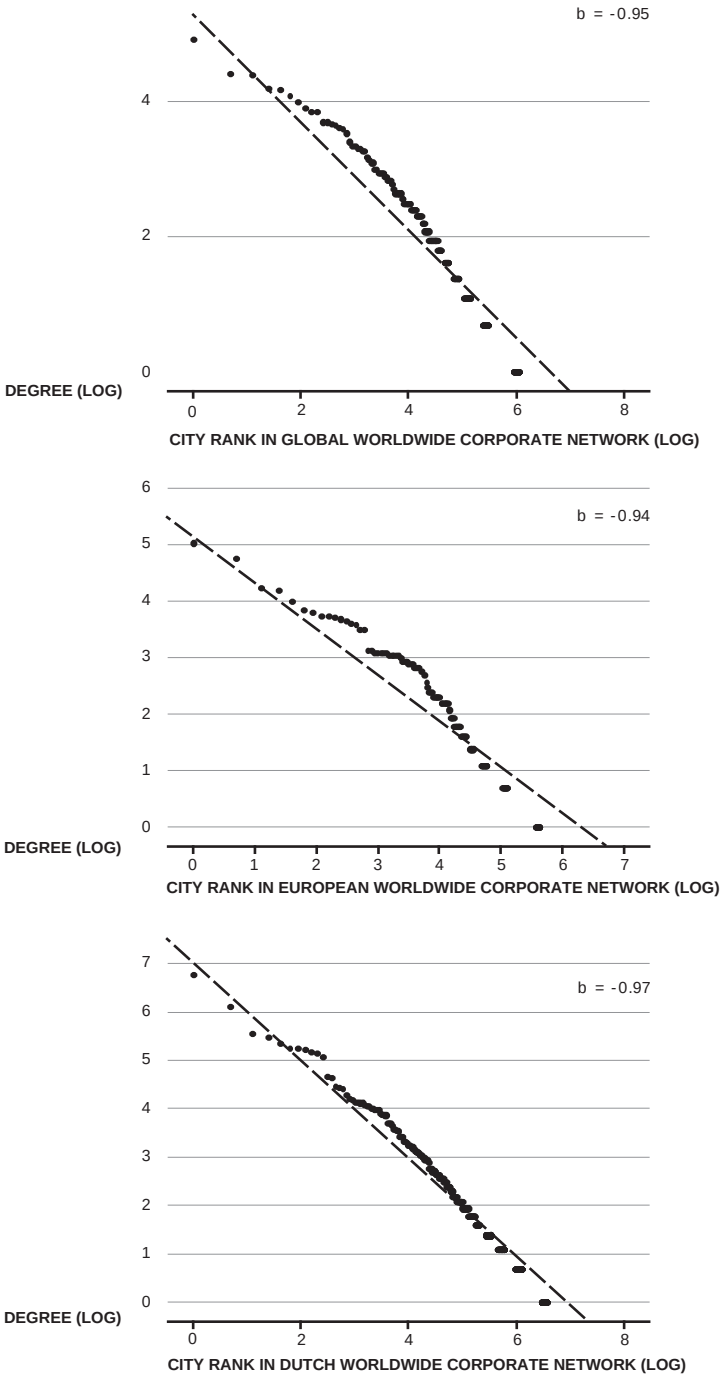
Connectivity of top 100 European multinational headquarters and subsidiary networks (>5).
Source: Wall/v.d. Knaap, 2009.

Figure 28



Connectivity of top 100 Dutch multinational headquarters and subsidiary networks (>5).
Source: Wall/v.d. Knaap, 2009.

Figure 29



Power-Law Distribution in Global, European and Dutch Corporate Networks.
Source: Wall/v.d. Knaap, 2009.

CHAPTER 5

Measuring Urban Competition on the Basis of Flows between Cities[3]

5.1 Introduction

In the modern economy, cities are assumed to be in fierce competition. Despite the rich theoretical discourse on these 'place wars,' little attention has been paid to measuring the intensity of competition between cities. Drawing on theoretical work by Gordon (1999) and using insights from evolutionary and organizational ecology, an indicator for estimating the degree of competition between cities is introduced, based on patterns of interaction (networks) between these cities. Taking economic competition between world cities as a test subject, it is shown how the described technique can be utilized.

In recent decades, the urban studies and planning literature has strongly acknowledged that cities compete in terms of product markets, inward investments, the establishment of firms, population, tourists, hallmark events and government funding (Harvey, 1989; Lever and Turok, 1999). These intercity 'place wars' (cf. Haider, 1992) in various 'markets' can take place on local, regional, national, continental, or even global spatial scales (Gordon, 1999). In a world in which the role of physical distance is apparently declining (Cairncross, 2001; Friedman, 2007), cities have to work on their 'competitiveness,' or their ability to successfully compete with other cities in attracting firms and workers, in order to maintain or strengthen their position within the urban hierarchy and hence increase their standard of living (Porter, 1990; Friedmann, 1995; Storper, 1997). Competition between cities is at an all-time high, and local authorities have to put ever more effort into making and maintaining their cities as attractive locations of residence. Today, cost reduction for targeted populations (e.g., tax credits, project financing) is pivotal to attracting and retaining firms and workers, but so is the maintenance of amenities, physical infrastructure, and public transportation networks. As a result, city marketing and city branding have become a 'booming business' (Paddison, 1993; Van de Berg and Braun, 1999), while budgets for place promotion are ever increasing (Hall and Hubbard, 1996; LeRoy, 2005). This increased interest in the concept of 'urban competitiveness' has led to a substantial number of urban ranking lists, in which cities are compared on the basis of their economic performance (Kresl and Singh, 1999; Lever, 1999), global connectivity (Beaverstock et al., 1999; Alderson and Beckfield, 2004), creativity and innovativeness (Florida, 2005), access to and quality of services (Kaufman et al., 2005), or environmental sustainability (Dutzik et al., 2001). This benchmarking of cities is taking place not only in academic and commercial research, but it has also become engrained within public policy and popular culture. Today, local authorities increasingly publicize their relatively competitive stance toward other places (Malecki, 2002), while at the same time many newspapers and magazines (e.g., Fortune

3 This chapter is under revision for the journal Urban Studies and available as GaWC Research Bulletin 273. It is authored by Burger M.J., Wall, R.S., and v.d. Knaap. G.A., under the title of Measuring Urban Competition on the Basis of Flows between Cities.

Magazine, Forbes, Money) seem to be obsessed with rankings of how cities compare to each other (McCann, 2004; Fisher, 2005).

Despite the contemporary plethora of research and policy, empirical evidence on urban competition remains relatively weak. Although most studies on urban competitiveness assume that cities compete vis-à-vis one another, little attention is paid to actually measuring the intensity of competition 'between' cities This is arguably an important step to be taken as there are limitations to enhancing the competitiveness of cities and regions within a globalizing world. It is therefore important that empirical analyses start to decide at what scales competitive processes take place and to what extent urban regions are relevant in this respect (Boschma, 2004). In this context various scales can influence the competitiveness of cities (Asheim and Isaksen, 2002). Therefore, in order to validate the concept of urban competitiveness, it is important to understand to what extent cities compete and where this competition comes from. Shifting the focus from urban competitiveness to urban competition can enrich the literature on competitive cities by providing a method of deducing the strongest competitors, thereby relaxing the stringent theoretical assumption that all cities compete against each other (see, e.g., Haider, 1992; Markusen and Schrock, 2006). Along these lines, the competitive strength of individual cities is estimated, clusters of competitive cities identified, and the factors of urban competition, analyzed.

5.2 The question of measurable competition between cities

Using insights from niche overlap theory (MacArthur and Levins, 1967; Field and McFarlane, 1968; Hannan and Freeman, 1977), this study aims to put forth a straightforward yet elegant indicator for measuring the intensity of competition between cities, based on the functional linkages that these cities have to other cities. More specifically, competition is operationalized as an attribute of a relationship between two cities, which can be regarded as the lowest unit of analysis at which competition can be measured (Sohn, 2004). This study argues that cities are in competition to the extent that they serve the same geographical market for particular functions within the urban system. As there are many dimensions in which cities can compete (Lever and Turok, 1999), the focus will predominantly be on economic competition between cities in terms of attracting and retaining firms, which can be regarded as the one of the most elementary forms of urban competition.[4] Although the focus is on economic competition between cities, the indicator proposed in this chapter is not particularly limited to competition between cities and can without difficulty be applied to other dimensions of urban competition and other forms of territorial competition, such as competition between regions (see, e.g., Kitson et al., 2004).

The remainder of this chapter is structured as follows: Firstly there is a focus on the conceptualization of economic competition between cities using different dimensions of urban systems outlined by Gordon (1999). The next part is devoted to the measurement of economic competition between cities using niche overlap theory, followed by a part in

4 In particular, attention is drawn here to firms in basic sectors (manufacturing, wholesale and producer services), which have a non-local export market and are considered most important for local economic growth according to Economic Base Theory (Blumenfeld, 1955).

which this method is applied to urban economic competition within the worldwide city network. Finally, the last section of this chapter concerns discussion and conclusions.

5.3 Theory on competition between cities in the network economy

5.3.1 Cities within the network economy

Recently, there has been increased interest in the role and nature of the dynamics of urban systems. This literature contends that the rise of the network economy is exemplified by recent advances in transport and communication technology, ongoing globalization, rising common markets, the individualization of production and the growth of multinational firms, with a significant impact on the spatial economic structure of cities and regions (see, e.g., Batten, 1995; Anas et al., 1998). Meanwhile, the monocentric city is simultaneously transforming into a polycentric urban network, and social and economic processes are taking place on ever larger geographical scales, increasingly larger than those of the 'traditional' city itself (Kloosterman and Musterd, 2001; Van Oort et al., 2008). Hence, physical and administrative boundaries have become insufficient to characterize spatial entities, where cities are no longer confined by territorial delineations but are instead defined by patterns of interaction (Friedmann, 1986).

Hence, the competitiveness of cities is primarily related to what flows through them instead of what is fixed within them (Castells, 1996; Derudder et al., 2007). Today, cities are known to gain their privileged status in the global network economy by virtue of their position within a 'global space of flows' (Castells, 1996). This change shifts attention away from traditional developments such as internal urban properties and towards an understanding of external relations between cities, such as trade or business activities, with the implication that this knowledge will better define a city's prosperity. Thus, 'urban competitiveness' should be considered as a 'networked phenomenon' (Beaverstock et al., 2002) dependent on a 'society of cities' in which 'no city develops in isolation' (Storper, 1997), but rather, each is part of a system of cities (Berry, 1964), where interaction between cities is an essential component of the dynamics of urban systems (Rozenblat and Pumain, 2007). Thus, cities are relatively autonomous entities whose evolution is highly influenced or disturbed by other cities in the interaction network (Pred, 1977), and where 'urban development can no longer be understood without considering the networks and systems to which cities belong' (Rozenblat and Pumain, 2007).

5.3.2 A worldwide web of competition

However, when the networks of cities show an ever-increasing amount of overlap, urban competition will likely intensify. When cities expand the geographic scope of their markets, it is quite plausible that they will increasingly serve the same geographic markets and thus start to function as substitutes to each other. Today, cities compete to attract businesses,

5 On a more general note, it can also be argued that cities are in competition because firms are in competition and firms have to make an effort to warrant a favorable balance between costs and benefits in their theoretically free choice of location (cf. Madig, 2004). In other words, urban competition can be perceived as an unintended consequence of goal-directed behavior of firms. As some locations of residence yield potentially more benefits

investments, and economic growth, while success in these endeavors is largely dependent on the successful exploitation of a city's competitive advantage. However, in the network economy, even the sources of urban competitiveness have changed (Ordway, 2003): whereas in the 'old economy', competitiveness was mainly based on immobile and controllable factors such as resource availability, labor costs and the institutional context; the focus in the new economy is on knowledge, unique skills and maximizing networking opportunities (Porter, 1990; Ordway, 2003). These new sources of competitiveness are not only more 'footloose' than their predecessors but are also less controllable by local authorities. According to Gordon (1999), the increased 'footlooseness' and uncontrollability of competitive assets further induces economic competition between cities.[5] Examples of increased urban competition are numerous, but the most well-known are unquestionably the urban rat race between the large financial centers of London, New York, Paris and Tokyo (Sassen, 1991; Alderson and Beckfield, 2004), the fierce rivalry between cities in the European Union as a result of the creation of the common market (Lever, 1999), and the tax wars between American states seeking to attract businesses (Enrich, 1996).

However, geographic market overlap itself does not necessarily constitute urban competition. On the contrary, if the various cities in an urban system specialize in different sectors or perform different organizational functions, they in fact complement each other by fulfilling different economic roles (Meijers, 2005; Van Oort et al., 2008). Two cities within the same urban system that produce different goods or services for which the other city has an effective demand are likely to establish an exchange. For example, a city that specializes in financial services can provide these services to a city that specializes in manufacturing, and vice versa. Hence, cities do not have to be specialized in all possible sectors but can instead benefit from specializations elsewhere in the urban network (Meijers, 2005). In this vein, Gordon (1999) mentions the delegation of routine administrative tasks to places offering this blue-collar labor at lower pay rates. In such cases where cities' networks (or action radiuses) overlap, but where spatial labor division exists, cities are considered to be complementary (Beckham, 1973; Van Oort et al., 2007).

Along these lines, two conditions for the existence of economic competition between cities can be identified, broadly covering different dimensions of urban systems distinguished by Gordon (1999): 1) geographic market overlap and 2) functional overlap. The next section explains these concepts in more detail.

5.4 The definition and measurement of urban competition

In order to formally define urban competition, the concept of urban niche is introduced. The theoretical concept of niche dates back to the first half of the 20th century and at its inception mainly concerned descriptive biological studies on the overlap of the habitats of different species (see, e.g., Grinell, 1904; Elton, 1927).[6] In its original context, a niche is defined as the set of environmental states in which a species thrives (Popielarz and Neal, 2007), and

(in terms of tax benefits, project financing, accessibility, available human capital, access to knowledge) and fewer costs (in terms of housing prices, congestion) than other locations, urban competition emerges, whether cities like it or not (see also Ho, 2000). An overview of the history of the niche concept in the ecological and social sciences can be found in Popielarz and Neal (2007).

typically consists of the resources on which a species depends for its survival, such as the natural habitat from which it collects food. From the 1970s onwards, the concept of niche has been present in the social sciences, most notably in organization studies (Hannan and Freeman, 1977; Podolny et al., 1996) and social network analysis (Burt and Talmud, 1993; Sohn, 2004). The application of the niche concept to urban studies and spatial planning is relatively new (e.g., Popielarz and Neal, 2007; Neal, 2008). Analogous to its ecological and organizational counterpart, an urban niche can be regarded as the geographic market of a city, the context in which it executes its economic activities or fulfills its urban functions. In other words, the concept of the urban niche can be decomposed into two parts: 1) a geographic niche (its market area) and 2) a functional niche (its activities).

5.4.1 Dimension 1: geographic niche overlap

Cities are in competition to the extent that they serve the same geographic market or have at least considerably overlapping geographic niches. As outlined in the previous section, geographic niche overlap does not necessarily have to be based on physical proximity. On the contrary, cities are in competition to the extent that they have linkages related to the physical movement of goods, people, and services with similar cities. In other words, urban competition is defined by overlapping patterns of interaction, and in this fashion, competition between cities can take place on various geographical scales, where cities in competition on a local scale do not necessarily have to be in competition on a national or international scale. For example, the Dutch cities Amsterdam and Rotterdam may compete locally, sharing as they do the same hinterland (Randstad Holland), but they may differ in their functional linkages to the rest of the world. Likewise, London and Paris may compete on a global scale but not on a local scale. Hence, the same rules do not necessarily apply to all spatial scales (Martin, 1999).[7]

5.4.2 Dimension 2: functional niche overlap

Cities are in competition to the extent that they perform the same function within their respective urban systems. Differentiation is made between 1) sectoral or product niche overlap and 2) organizational niche overlap. First of all, this is related insofar as cities are in competition, to the extent that they specialize in the same sectors or produce the same products. Competition is therefore conceptualized as the lack of inter-urban industrial differentiation, in which cities have overlapping sectoral and product niches. In this respect, Markusen and Schrock (2006) explicitly point to the mimicking of legendary success cases such as Silicon Valley or the Cambridge cluster as drivers behind this overlap. Today, most cities endeavor to be clusters of high-tech or creative industries. As a result, cities become less distinctive and competition intensifies. Secondly, cities are in competition to the extent that they perform the same organizational function (Gordon, 1999). Here, one can think of the traditional division between white-collar and blue-collar work, but also of a division between headquarter and subsidiary (production plant) functions. In the absence of functional differentiation of labor, these cities are more likely to be in competition.

6 An overview of the history of the niche concept in the ecological and social sciences can be found in Popielarz and Neal (2007).

7 In other words, one can speak here of non-perfect aggregation across spatial scales.

Figure 30

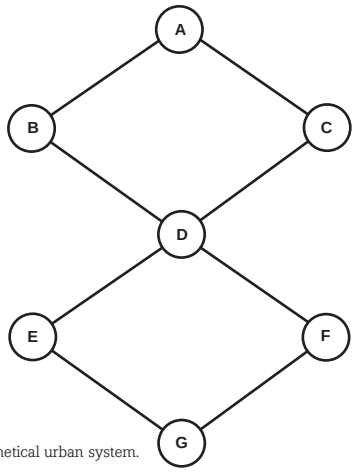


Figure 28 Functional linkages in a hypothetical urban system.
Source: Wall/Burger/v.d. Knaap, 2009.

When both the geographic and functional niches of cities overlap, cities are in competition because they have to share the same 'part of the pie.' It is argued that cities that serve the same surrounding area for the same urban functions are expected to compete for the acquisition of the same firms. In other words, cities that are not distinctive and are interdependent are most likely to be in competition (Neal, 2008). This theoretical framework closely follows the (holistic) Durkheimian view on ecological competition, in which the characteristics of cities (hinterland, functions) drive urban competition (Durkheim, 1893; McKenzie, 1933). Cities are regarded as competitors if they function as substitutes to each other.

5.4.3 Measuring urban competition using niche overlap

Although the existence of urban competition is recognized in urban studies and the spatial planning literature, few attempts are made to explicitly measure the extent of competition between cities or within a sub-system of cities. By employing the two dimensions of urban competition discussed in the previous section, the measurement of competition is now discussed. Over the years, several indicators of niche overlap have been developed in the field of statistical ecology to measure the intensity of competition between members of a population. Consider the following urban structure for a particular function in the diagram **(Figure 30)**.

In this urban system, for this particular urban function:

- Cities A and G are linked to different cities (to cities B and C and cities E and F, respectively). For this reason, the similarity between their geographical markets is 0%, meaning that there is no urban competition between cities A and G.
- Cities B and C have exactly the same linkage structure, as both cities are only linked to cities A and D. Hence, the similarity between their networks is 100%, meaning that the geographical markets of cities B and C maximally overlap.
- Cities A and D have a partly overlapping linkage structure. Although cities A and D are both linked to cities B and C, city D is also linked to cities E and F. Hence, the intensity of competition between cities A and D is intermediate, as their geographical markets only partly overlap.

In line with the theoretical concept of niche overlap, two cities are in competition to the extent that they are linked to the same other cities with regard to the same functions. In contrast to the artificial urban system above, real urban systems usually differ in size, and the functional linkages between cities can simultaneously differ in intensity. Hence, in order to facilitate comparisons of the degree of urban competition between cities, the strength of the linkage between two cities should be expressed as the relative dependence of a city on another city. For example, if city A has two linkages with city B and one linkage with city C, the geographical market (niche) of city A for the urban function under consideration consists of a 2/3 linkage to city B and a 1/3 linkage to city C. Hence, two cities are in competition to the extent that they are relatively linked to the same other cities for those particular urban functions.

Over the years, several statistical approaches have been developed for formally measuring overlap between members of a population. Among these methods, the alpha-coefficient, Euclidean distance, Manhattan distance, cosine, and standardized versions of these similarity indices are noted (e.g., Bray-Curtis, Kulczynski, Gower metric).[8] Notwithstanding their computational differences, a central element of these measures is that they look at the dissimilarity or ecological distance between the members of a given population. If one approaches competition by looking at the absence of structural equivalence, competition is conceptualized as an attribute of the relationship between cities.

Based on comparative research in ecological statistics (e.g., Bloom, 1981; Beals, 1984; Faith et al., 1987; McCune and Grace, 2002) and interest in compositional overlap (rather than absolute overlap)[9], the relative Manhattan distance to measure ecological distance is used, or as in this case the absence of overlap between the geographical markets of cities for a particular function. The relative Manhattan distance is desirable in that it uses the value zero when there is a maximum niche overlap and a constant maximum value (e.g., 1) when there is no niche overlap (Beals, 1984). Second, the relative Manhattan distance shows a low discrepancy between the predicted and observed similarity. Third, the relative Manhattan distance has a robust linear relationship with true ecological distance when tested with simulated data (Faith et al., 1987).

The relative Manhattan distance, also known as the relative Sørensen or relative city block distance, measures the relative distance or dissimilarity in niche between two species i and j for a particular urban function k, here expressed as the non-overlap in geographical markets between two cities i and j. More formally **(3)** which can be written as **(4)** in which $a_{ih,k}$ is the strength of the urban linkage (e.g., the number of business interactions) between cities i and h for urban function k, and $a_{jh,k}$ is the strength of the urban linkages between cities j and h for urban function k. Linkages between cities i and j are excluded, as are linkages that remain within a city, in order to measure genuine competition between the cities under consideration and not urban complementarities.

8 See McCune and Grace (2002) for an overview of all basic measures of niche overlap.

9 For this reason, we do not use the Bray-Curtis or Kulczynski coefficients to measure ecological distance. However, from a mathematical point of view, both the Bray-Curtis and the Kulczynski coefficients equal the Relativized Manhattan distance when standardized to equal totals (see Faith et al. 1987).

$$RDISTANCE_{ijk} = 1 - \left[\sum_{h=1}^{p} MIN \left(\frac{a_{ih,k}}{\sum_{h=1}^{p} a_{ih,k}}, \frac{a_{jh,k}}{\sum_{h=1}^{p} a_{jh,k}} \right) \right], i \neq j \neq h, \quad (3)$$

$$RDISTANCE_{ijk} = \frac{1}{2} \sum_{h=1}^{p} \left| \frac{a_{ih,k}}{\sum_{h=1}^{p} a_{ih,k}} - \frac{a_{jh,k}}{\sum_{h=1}^{p} a_{jh,k}} \right|, i \neq j \neq h \quad (4)$$

The distance measure is relative because it gives the absolute difference between the cities divided by their absolute sum. In other words, in standardizing the absolute difference to sample totals, the total non-overlap of the geographical markets for the two cities i and j is converted into a percentage non-overlap for the geographical markets of two cities. This allows for a comparison of the cities based on the relative distribution of urban linkages across space (Legendre and Legendre, 1998). The degree of similarity between two cities or the competition coefficient can then be expressed as **(5)**:

$$COMPETITION_{ijk} = 1 - RDISTANCE_{ijk} \quad (5)$$

The competition coefficient COMPETITIONijk typically ranges between 0 and 1. If the competition coefficient equals zero, the geographical markets of cities i and j are totally different and the intensity of competition between the two cities is at a minimum. If the competition coefficient equals one, the geographical markets of cities i and j completely overlap and the intensity of competition between the two cities is at a maximum.

Equations 4 – 6 present a method of estimating the intensity of competition between cities for one particular urban function. This function can range from that of the global command center in the advanced producer services sector (Taylor, 1999; see below) to that of the production site in the textiles and apparel commodity chain. The total intensity of competition between two cities for a number of urban functions can be estimated by weighting the competition coefficients for the different urban functions k with the overall importance of these urban functions in the two cities.

5.5 Application: urban competition in the worldwide city network

5.5.1 Empirical setting: producer services in the worldwide city network

In order to show how the described techniques in the previous section can be utilized, economic competition between leading world cities are used (Taylor, 1999) as a test case. Literature on world cities typically identifies the multinational enterprise as a central agent in the generation of the world city system, and generally, the economic and political power of such corporations symbolizes the predicaments of globalization. These multinational entities are the primary movers and shapers of the global economy because they have the ability to control and coordinate production networks across different nations so as to take advantage of geographical differences in factor distributions, as well as to switch and re-switch resources globally. In particular, attention is drawn here to the advanced producer services firms (financial and business services) 'as command points in the organization of the world economy' (Sassen, 1991) and as 'the key agents of global city formation' (Taylor, 2005). In the world cities literature, the assumption is made that the corporate networks of globally operating advanced business services firms translate into knowledge-based linkages between cities in which these offices are established (Pain, 2007). Moreover, the corporate network of advanced producer services shows itself to be highly correlated with the worldwide network of FDI and trade (Wall et al., 2007). Hence, the competitiveness of world cities is generated through their connections to other cities. As Beaverstock et al. (2002: 111) rightly note: 'the prosperity of successful world cities is due to their privileged location at the intersection of all that matters in global economic terms – flows of people, goods, capital and ideas.' However, if two cities have exactly the same linkage structure, in the sense that they command the same other cities, this means that the same 'external' knowledge can be obtained in both places. World cities linked to the same other cities for advanced producer services are in competition because they serve the same 'hinterworld' (cf. Taylor, 2001), draw on the same resources and are hence interchangeable with one another. Note that in accordance with the theoretical framework, the focus here is on geographic market overlap for the function as global command centre (organizational niche) and for advanced producer services (sectoral niche).

Urban competition between global financial centers has been the subject of a large body of literature in the field of geography and urban studies (see e.g., Sassen, 1991; Gordon, 1999; Beaverstock et al., 2002). However, no systematic and objective measurement of this competition has yet been provided. This section demonstrates how urban competition can be measured by focusing on economic competition in advanced producer services among 20 world cities **(see Table 15)**. These cities are classified as world cities based on their level of advanced producer services and the number of commanding linkages they have in the intercity network of advanced producer services (Beaverstock et al., 1999 for the classification). It is acknowledged that this scope is rather limited (see also Robinson, 2005). However, the major purpose of this example is to show how the competition coefficient estimation described in the previous section can be utilized.

5.5.2 Data used in the analysis

In order to measure urban competition, a dataset on corporate networks of global advanced producer services firms has been used, using the sources Fortune® 500, Lexis-Nexus® and Reach® and containing the annual reports of large companies. From these sources, information on the top 100 headquarters according to the Fortune® 500 listing were selected, because these businesses claim disproportionate shares of revenue. The top 100 of the Fortune® 500 firms in 2005 claimed 27% of OECD revenue, while it took the remaining 400 firms to claim an additional 29%. These top firms held over 50% of the total revenue and offered 40% of the employment of all 500 firms. All subsidiaries of these headquarters were found and classified into five orders of shareholder relations, starting with headquarter to first subsidiary, first subsidiary to second subsidiary, and so forth. Next, only the advanced producer services that originated a commanding relation were selected, and the city locations of every firm (headquarter and subsidiary) were identified, where smaller cities within a discontinuity break of 25 km were added to the proximate major city.

The derived subset consists of 3150 commanding relations between advanced producer services headquarters and their subsidiaries across 684 different cities. By geographically aggregating the data to the city level and mapping it using GIS, a corporate intercity network of advanced producer services was obtained **(Figure 31)**. From this network, it appears that cities in North America and Europe have the strongest advanced producer service relationships with the world. This is not surprising, since much of their manufacturing activities take place in third-world nations but are financed, insured and facilitated by producer services headquarters within developed zones (Wall et al., 2007). The 20 world cities in the sample and their outward connectivity to the corporate intercity network of advanced producer services are listed **(Table 15)**. These cities account for over two thirds of the total number of commanding linkages in the corporate intercity network of advanced producer services. Most strikingly, the four most prominent cities in the network (New York, London, Paris and Zurich) claim over one third of the total number of linkages.

5.6 Urban competition in advanced producer services at a global scale

This analysis focuses on urban competition between 20 of the most prominent cities in the world city network, examining to what extent their linkage patterns of commanding relations to all other cities in this network are similar. Applying the competition measure described previously, a matrix of the intensity of competition between 20 financial centres in the world city network was obtained using the UCINET software (Borgatti et al., 2002). Overall, the competition coefficient ranged from 0% (e.g., Berlin – Osaka) to 41% (Frankfurt – Zurich). A graphical representation of this matrix is presented in the a network diagram **(Figure 32)**. The network diagram consists of nodes and linkages. The nodes in the network represent the different world cities, where the colour of the node represent the continent on which the city is situated (Europe, North America, or Asia). The node sizes represent the position of a city in the corporate intercity network of advanced producer services based on the total number of outward linkages the city has. This position can range from that of a primary world city (London, New York, Paris) to that of a world city with relatively few commanding relations to other cities (Hong Kong, Madrid, Toronto).

Figure 31

GIS map of the global advanced producer service network (headquarters and subsidiaries).
Source: Wall/v.d. Knaap, 2009.

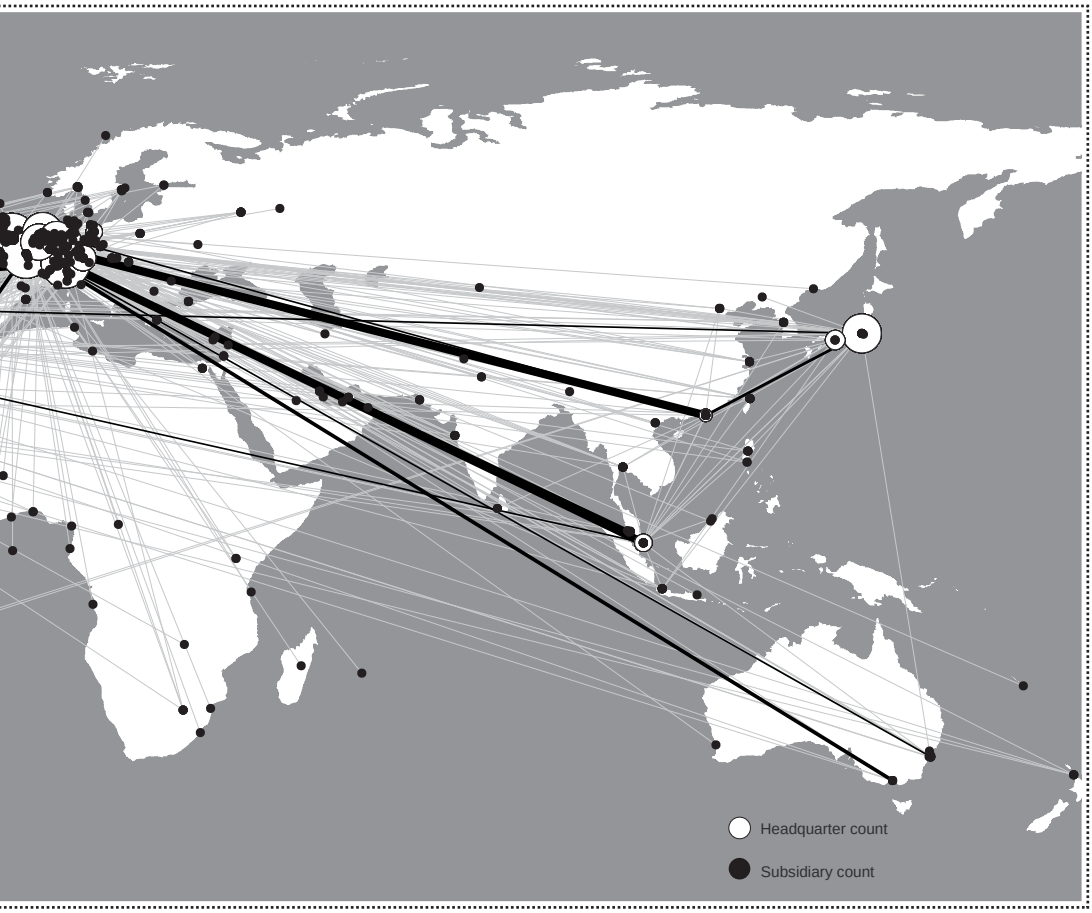

Headquarter count
Subsidiary count

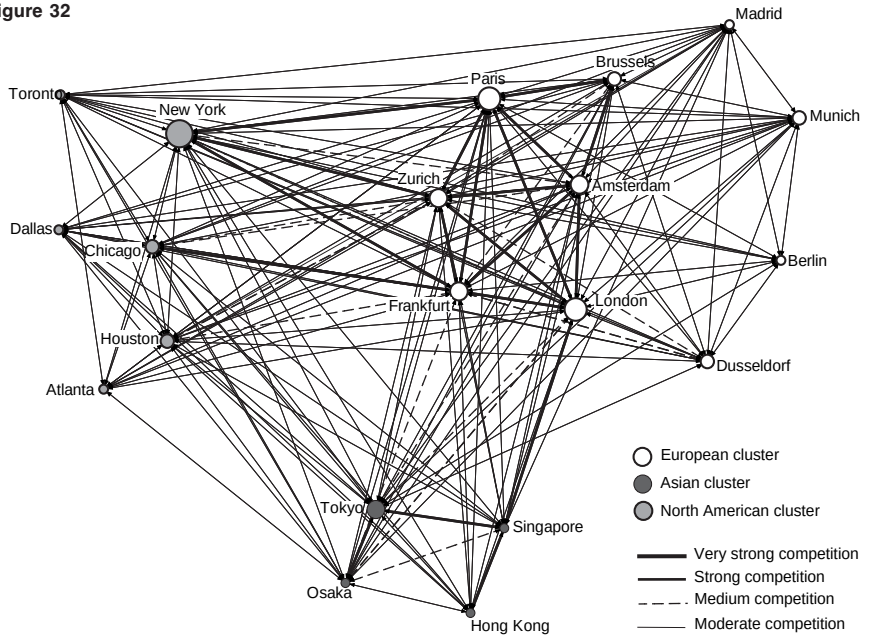
Table 15

Rank	City	Commanding Linkages
1	New York	368
2	Paris	218
3	London	204
4	Zurich	116
5	Frankfurt	89
6	Amsterdam	87
7	Tokyo	74
8	Brussels	58
9	Düsseldorf	51
10	Munich	46
11	Chicago	43
12	Houston	41
13	Dallas	24
14	Osaka	23
15	Berlin	20
16	Atlanta	19
17	Singapore	18
18	Toronto	17
19	Madrid	15
20	Hong Kong	8

Connectivity of the top 20 world cities within the corporate intercity network of advanced producer services.
Source: Wall/Burger/v.d. Knaap, 2009.

The linkages between the cities in the network diagram represent the nature of the relationship between cities in the world city network, where the line style of the linkages represent the intensity of competition between the different cities. If there is no linkage drawn between two cities (e.g., Toronto – Madrid), the competition coefficient is lower than 5%. This means that there is hardly any geographical market overlap between the two cities for the urban function under consideration. In other words, both cities command totally different cities in the intercity advanced producer services network. A thin intercity linkage (e.g., Munich – Amsterdam) indicates that the competition coefficient ranges between 5% and 15%, which means that the degree of geographic market overlap between the two cities ranges from low to average for this urban function. A dotted intercity linkage (e.g., London – Tokyo) indicates an average degree of geographical market overlap between the two cities with a competition coefficient that lies between 15% and 25%. A thick linkage (e.g., Amsterdam-Brussels) signifies that the competition coefficient falls between 25% and 35%, which indicates an average-to-strong degree of geographical market overlap. Finally, a very thick intercity linkage (e.g., Frankfurt – Paris) indicates that the competition coefficient is over 35%, which points to a strong degree of geographic market overlap for advanced producer services between these two cities, and indicates that both cities command similar cities to a large extent. For this reason, the intensity of competition between these cities is fiercest.

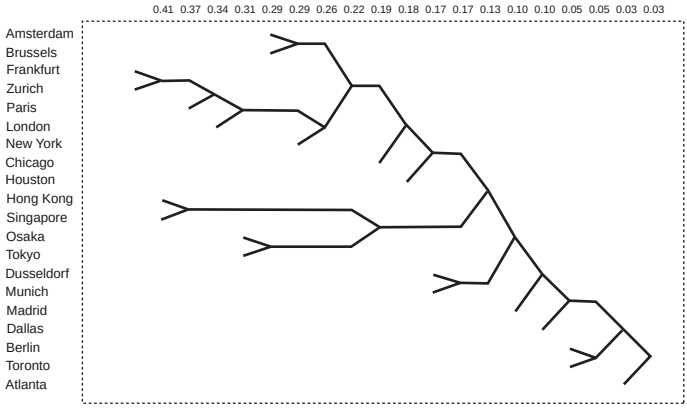
Figure 32



Competition in the corporate intercity network of advanced producer services.
Source: Wall/Burger/v.d. Knaap, 2009.

Looking at the overall pattern of competitive relations, a number of empirical observations can be made. First of all, competition between cities for advanced producer services has a strong geographical dimension. The intensity of competition between cities that are geographically proximate tends to be stronger than competition between cities that are geographically distant. In general, the intensity of competition between cities situated on different continents is low to average. Moreover, if there is a strong intensity of competition between cities situated on different continents, there is also at least one primary world city (London or New York) involved in most instances. This is not surprising, as these primary world cities serve a more diverse geographical market with a larger geographical scope than do other cities in the world city network (see also Derudder and Witlox, 2008). Applying a hierarchical cluster analysis (Johnson, 1967) to the competition coefficients, two major clusters of contending cities can be identified **(Figure 33)**, namely (1) Northern Transatlantic Seaboard (London, Frankfurt, Zurich, Paris, Amsterdam, Brussels, New York) and (2) Pacific Asia (Tokyo, Osaka, Hong Kong, Singapore). From this, it can be inferred that the intensity of competition that Tokyo receives from the other large world cities (London, New York, Paris) as command centre (of advanced producer services) is rather limited. Whereas Tokyo's commanding intercity relations are primarily directed toward Asian cities (for over 70%), the commanding intercity relations of New York and Paris are predominantly directed at European and North American cities. London is in this respect the most globally oriented city, as it is not only strongly connected to cities in Europe and North America, but also has linkages to cities in Pacific Asia (particularly Hong Kong and Singapore). These findings once more stress that not all world cities serve the same 'hinterworld' (cf. Taylor, 2001; Taylor and Walker, 2004).

Figure 33



Hierarchical cluster analysis of competition between cities.
Source: Wall/Burger/v.d. Knaap, 2009.

Moreover, competition is fiercer between cities at the top of the urban hierarchy. Smaller world cities such as Atlanta, Berlin, Toronto, Dallas, and Madrid face relatively little economic competition from the other world cities in the sample. This related to the fact that the commanding relations of these cities have a primarily regional scope. In other words, such cities have a relatively 'regionally oriented' hinterworld. For example, over two thirds of the commanding relations of Madrid remain within Southern Europe and go to cities like Barcelona and Milan. Likewise, over 90% of the commanding linkages of Toronto do not leave Canada. This is in line with the research conducted by Derudder and Witlox (2008), who find that the intercity relations of the most important world cities in terms of network connectivity are predominantly global in scope, while the intercity relations of the less well-connected cities in the world city network have a more regional scope.

5.7 Conclusions

Using niche overlap theory, this chapter introduces an indicator used to measure the intensity of competition between pairs of cities, which can be considered the most fine-grained level at which competition can be measured. Cities are considered to be in competition to the extent that they are linked to the same other cities, pending the same functions. Using individual competition coefficients as building blocks, it is possible to derive the amount of competition that a city receives from all other cities, to identify clusters of competing cities, and to define the extent of cities' markets. In addition, the competition coefficient can easily show that not all cities are in competition with each other and that some cities receive more competition than other cities do. This study used the example of competition between (commanding) global financial centers that use the corporate intercity network of advanced producer services. Naturally, this is only a small amount of the competition that the cities in this network receive from all other cities, and preferably, the intensity of competition between cities should be measured across a full spectrum of urban functions. Nonetheless, when urban niches are fully specified in terms of geography and functions, the resulting niche overlap measure can accurately indicate

the amount of competition that a city experiences as a result of the other cities in the urban network.

The main limitations of measuring urban competition on the basis of flows between cities are the computational demands that occur when including many dimensions of urban competition, and not surprisingly, data availability. First of all, the proposed indicator of urban competition could be further improved by including multiple dimensions of urban competition and by introducing an asymmetric competition coefficient. Such an asymmetric competition coefficient should take into account that city A does not necessarily receive as much competition from city B as city B receives from city A (see, e.g., Pianka, 1983; Sohn, 2004). In the measure, city size is neutralized using proportions when estimating the competition coefficient; hence, the coefficient does not allow the detection of unequal patterns of niche overlap. However, most importantly, the present lack of spatially detailed data on economic linkages hampers empirical research efforts to accurately measure the intensity of competition between cities. Although the past 10 years have witnessed an increasing availability of geo-coded datasets, the amount of urban network data with global or continental coverage is still rather limited (Taylor, 1999). Notable exceptions are corporate networks (e.g., Beaverstock et al., 1999; Alderson and Beckfield, 2004) and airline data (Derudder et al., 2008). However, there is still a lack of spatially and sectorally specified trade data that measures tangible economic relations between cities. Future research should not only concentrate on further fine-tuning the measurement of urban networks in general and urban competition in particular, but should also invest in spatially detailed data on connections between cities. Furthermore, the competition coefficient is not meant to replace other, more qualitative accounts of urban competitiveness and urban competition; instead, the competition coefficient should be perceived as complementary to qualitative approaches to studying competition between cities, in the sense that they should reinforce each other. For example, having identified the most important competitors of a particular city, it becomes easier for individuals like urban planners to recognize which aspects of urban competitiveness a city should concentrate on in order to surpass its competitors.

This clears the way for more goal-directed and effective strategic urban planning and policy-making with regards to urban competitiveness (Ho, 2000, Van Dijk, 2006). In this sense, planning and policy could become manifest in an interactive understanding between cities and not only within cities. On a similar note, city rankings may still be useful as indicators of urban competitiveness. However, it is important to recognize that not all cities are in competition and that for this reason, not all of them should be put on the same ranking lists. Future research should not only measure the intensity of competition between cities but also examine factors of competition. For instance, are cities of similar size and close proximity more likely to be in competition? Besides giving an indication of the intensity of competition between cities, (aggregated) competition coefficients can also be utilized in a regression framework to link competition to urban performance. Accordingly, the focus shifts from urban competition as an independent variable ('causes of urban competition') to urban competition as an independent variable ('consequences of urban competition'). Naturally, new questions arise. How does urban competition affect urban performance? Are cities that receive less competition from other cities more likely to grow and strengthen their position within the urban system? Can urban competition explain the decline of cities? These questions should be addressed in future research.

CHAPTER 6

The Coherence of National Competitiveness and the Geography of Global Corporate Networks[10]

6.1 Introduction

6.1.1 Multinationals and global production networks

The gradual integration of nations within the globalizing world is strongly characterized by economic networks formed by multinational headquarters and their various subsidiaries located across the globe. Although the corporate reach of multinational corporations is clearly global, the scope of their transnational interaction remains limited. Hence, contrary to popular literature heralding the emergence of a steadily homogenizing world, transnational corporate networks are mostly restricted to interactions between developed nations, revealing a disproportionate statistical distribution. By focusing on the transnational corporate network of shareholder relationships between the global Fortune® 100 multinational headquarters and their many subsidiaries, it is shown that the developmental differences between nations, in terms of their degree of competitiveness, importantly relate to the unevenness of the distribution of the corporate system. Although the process of globalization is not an entirely new phenomenon, it is clear that in recent decades, significant shifts have occurred as the capacity to produce and export manufactured goods has been dispersed throughout an ever-expanding network of peripheral and core nations (Dicken, 2003). Today, the production of commodities spans more nations than ever before, with each nation performing specific tasks in which it has a comparative advantage (Gereffi, 1994). Facilitated by reduced transportation costs and advanced communications technologies, this inter-organizational system connects firms and states to form today's global economy, resulting in a greater functional interdependence than ever before (Hirst and Thompson, 1996).

Within the framework of contemporary globalization, it is generally accepted that multinational corporations form the basic unit of global production and integration. Furthermore, it has been shown that multinationals are wealthier than most nations in the developing world (United Nations, 2002). Multinationals are characterized by their power to coordinate and control the operations of other firms in more than one nation, which is the result of direct cross-border investment of one firm in another, in which a degree of control over the latter firm is achieved. This trend originated in the 1960s 'golden age' of economic growth, in which foreign direct investment grew at twice the rate of global

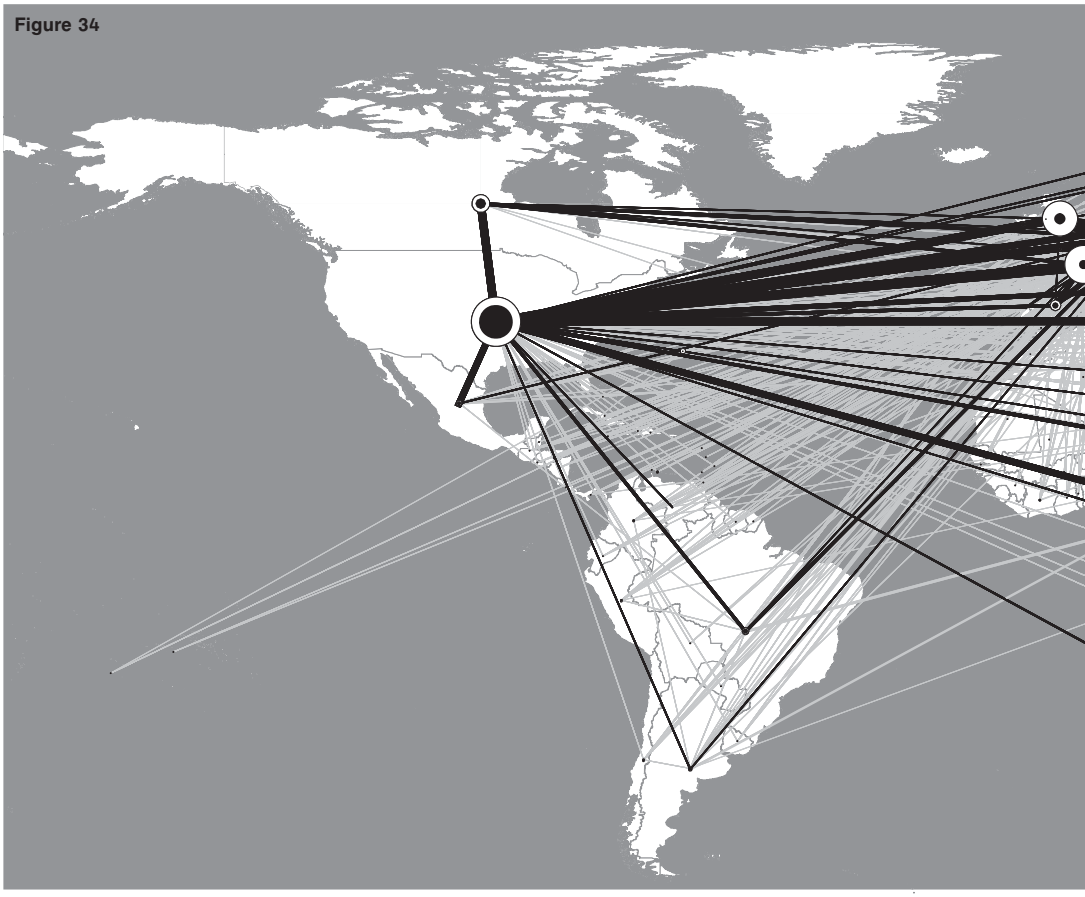
10 This chapter is under revision for the journal Environment and Planning A, and is available as GaWC Research Bulletin 285. It is authored by Wall, R.S., Burger M.J. and v.d. Knaap G.A., under the title National Competitiveness as a Determinant of the Geography of Global Corporate Networks.

GNP and 40% faster than world exports (Dicken, 2003). This led to multilateral alliances between firms, which compete to gain access to markets and share increasing costs, risks and uncertainties, but also gain access to new technologies and create economies of synergy by pooling resources and rationalizing production (Kang and Sakai, 2000). In this system, multinational headquarters and their various subsidiaries are strategically situated at locations within the global transportation and communication networks, utilizing external services, labor market skills, and proximity benefits (Dicken, 2003).

The worldwide diffusion of production has been facilitated by the emergence of a 'world society' that has legitimized the penetration of less developed nations by foreign interests (Meyer, 1997). Nonetheless, although international integration is evident, the distribution of multinational networks remains persistently disproportionate (Carroll, 2007), where these firms create a division of labor between nations that corresponds to the division of labor between different levels of corporate hierarchy (Hymer, 1972). Multinationals centralize high-level decision-making and advanced production in only a handful of nations, and the rest of the world is generally confined to lower levels of activity and income. Therefore, the notion of territoriality is best encapsulated by the geographical embeddedness of capital, because capital's existence requires the creation of relatively fixed, secure and largely immobile social and physical infrastructures (Harvey, 1982). In this light, it is interesting to investigate the uneven distribution of clustered economic activities in the world and how these places are interconnected. To better understand the world economic system in this way, it becomes less necessary to understand how each component part works in detail and more important to explore how these components are connected (Ormerod, 2005). Hence, network analysis is a unique method capable of revealing the nature of the multinational system, in which 'objects obtain significance as a consequence of their relationships to other objects' (Harvey, 2006).

It has been said that there is a strong need for studies which analyze the impact of different geographic contexts on the performance of firms (Cooke, 2001). Today, several studies exist that empirically explore worldwide economic networks – for instance, the corporate ties of the world's largest multinationals (Alderson and Beckfield, 2004) and worldwide inter-corporate directorships (Carroll, 2007). Both of these studies are successful in showing the unevenness of the world economic system, but they stress that future research should investigate the relationship between attribute data and corporate network data. In this way, network research can become meaningful to development studies. This is the main contribution of this chapter, in which the strength of corporate connectivity will be associated with Porter's concept of the competitiveness of nations. The corporate connectivity data compiled for this study is defined as a measure of the sharehold relationships that a multinational has with its subsidiary firms. This intra-firm network represents corporate governance or the chain of command as it is passed down from headquarters to various subordinate firms. Corporate network data was compiled using the global Fortune® 500 (2007), where only the top 100 headquarters were selected since in the analysis of this study these 100 were responsible for over 50% of the total revenue and provided 40% of the employment accounted for by all 500 firms. Furthermore, these multinationals claimed 27% of all OECD revenue. Next, by reviewing the annual reports of these firms, their subsidiaries were extracted and classified according to various levels of sharehold relations and national location (Wall, Sleegers and v.d. Knaap, 2007). This resulted in a dataset of 9243 sharehold relationships.

Figure 34



Geographic information system (GIS) map representing transnational corporate shareholds.
Source: Wall/Burger/v.d. Knaap, 2009.

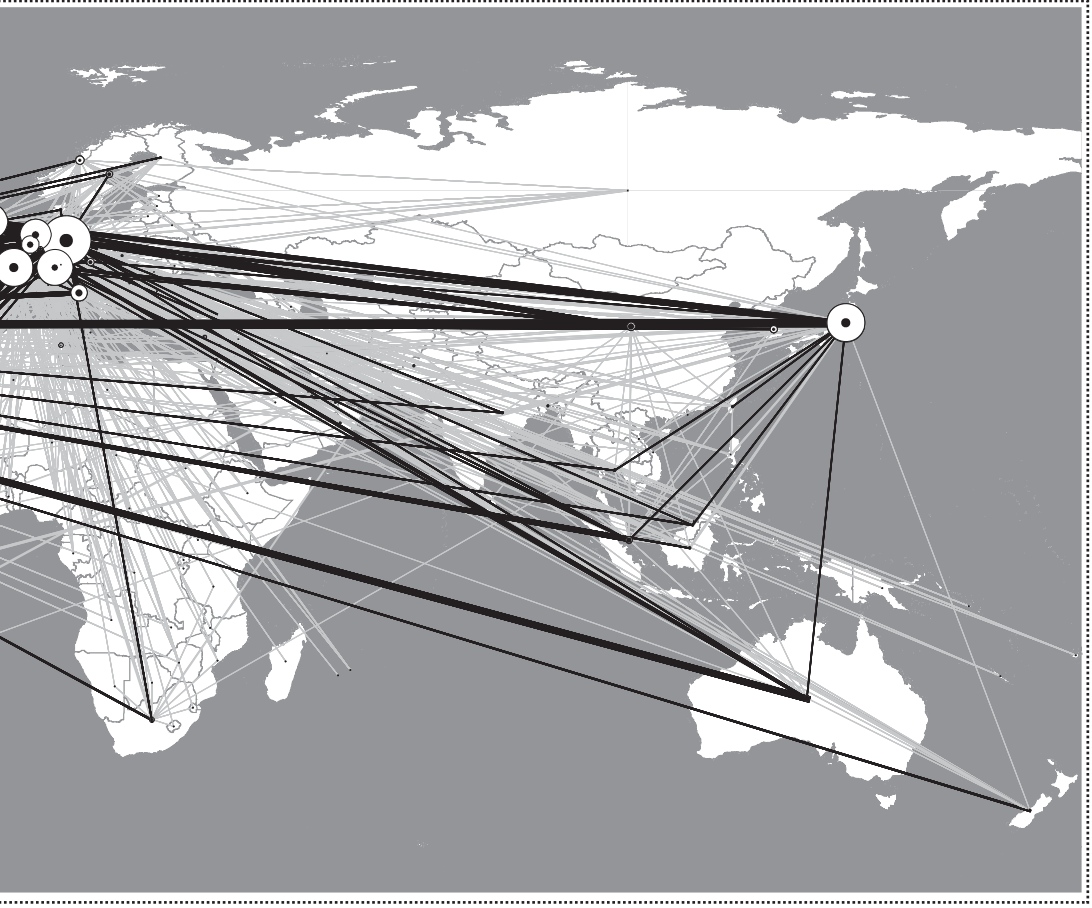


Figure 35

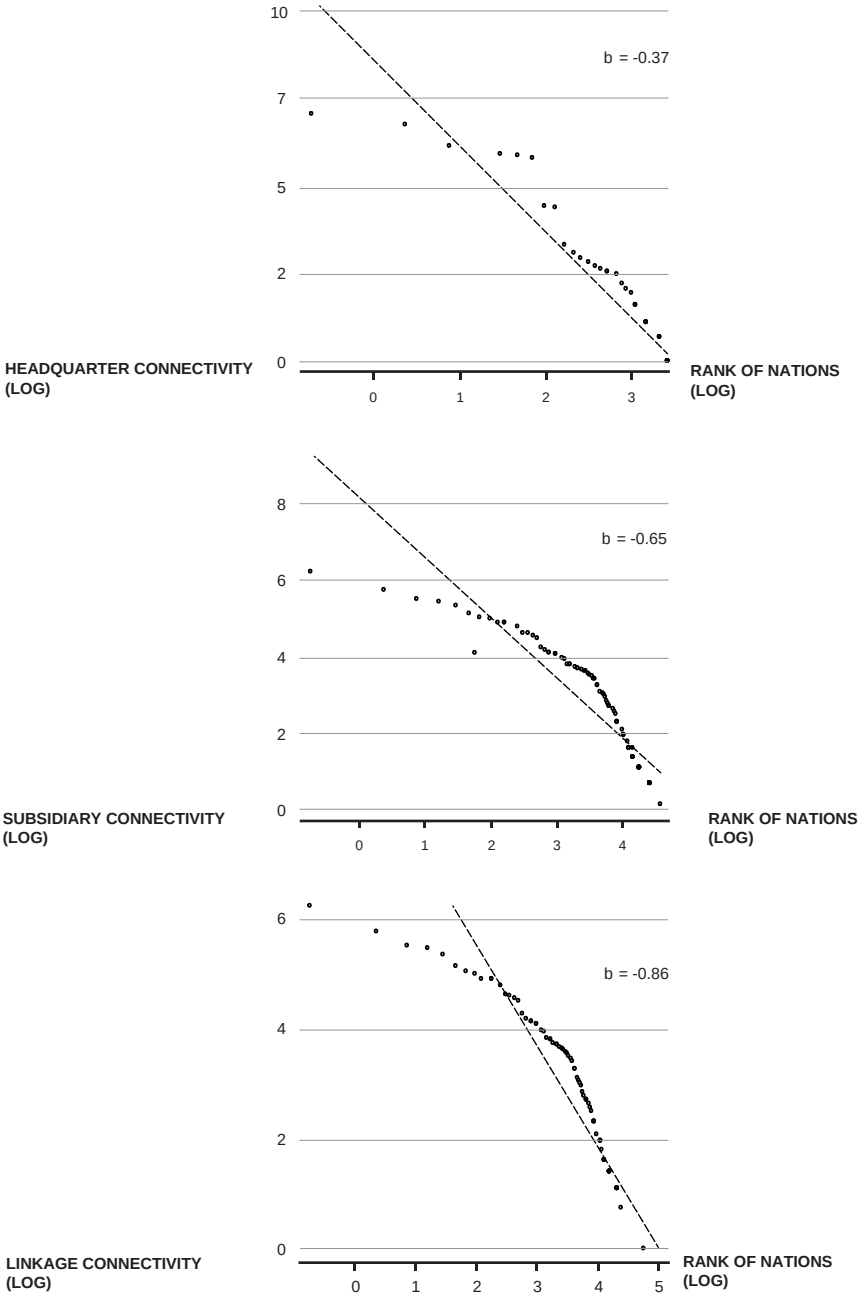
Geographic information system (GIS) map representing a zoom-in on Europe. of the global transnational system.
Source: Wall/Burger/v.d. Knaap, 2009.

6.1.2 Evidence of a highly disproportionate corporate system

In mapping this data, the global configuration of corporate networks at the national level was revealed **(Figure 34)**. The distribution of corporate shareholds among nations is clearly polarized, with the three core regions as North America, Europe and Pacific Asia. In fact, these regions claim 98% of all outwardly directed relationships with other nations, displaying a disproportionate power over the world. Furthermore, these areas claim 82% of all incoming relationships, showing how dependent the world is on these cores. It is also evident that a clear North-South divide still exists, where Africa, for instance, only holds approximately 1% of multinational relationships. It is also evident that although there is clear East-West connectivity, the highest intensity prevails in the transatlantic zone between Europe and North America. In the zoom-in onto Europe it is evident what the supra-regional interaction between nations is and who the major players are **(Figure 35)**. The disproportionality of the world's economic backbone is further exemplified in the three graphs **(Figure 36)**. The top graph shows the number of multinational headquarters (outdegree) located in particular nations; the middle graph depicts the number of subsi-diaries (indegree) of multinationals per nation, while the bottom graph illustrates the bilateral linkages between nations. All of these images show that the log distribution is roughly linear, representing the high disproportionality within the world corporate system[11].

11 The parameter values have been estimated using the Zipf regression approach by Gabaix and Ibragimov (2008).

Figure 36



Disproportionality of the global corporate control network: Zipf regressions for (1) the total headquarter connections of nations; (2) the total subsidiary connections of nations; and (3) the bilateral connections between nations.
Source: Wall/Burger/v.d. Knaap, 2009.

6.1.3 *Questions concerning connectivity within and between nations*

Given the disproportionality of the global corporate control network, two central research questions are posited, which will be further explored in this chapter. First, why are some nations better connected than others? This can be seen in terms of (a) the total headquarter connectivity (number of outgoing linkages) of nations; and (b) subsidiary relationships (number of incoming relationships) of nations. Second, which factors are related to the strengths of linkages 'between' nations? The differences explored by these questions can be best explained using the provided network diagram **(Figure 2I)**. In this figure, a multinational headquarter (H1) is situated in a particular nation, with three subsidiaries (S1, S2, and S3) in other nations. The arrow direction indicates that (H1) owns shares in these three subsidiaries, which in network analysis terminology is called the 'outdegree.' In this case, the headquarter nation (H1) has an outdegree of three. This is a measure of how much economic power a nation exerts over others, which relates to research question 1a. Conversely, the three subsidiary nations each have one incoming share from (H1), called the 'indegree.' This, in turn, is a measure of the dependency of other nations upon a particular nation, and relates to research question 1b. Furthermore, subsidiary nation (S3) also has an inward share from (H2), meaning that it has a total indegree of two, hereby showing that indegree is also dependent on the number of headquarter nations that connect with a particular subsidiary nation. Hence, questions 1a and 1b concern the total connectivity of nations. This is very different from research question 2, which instead aims to show the strengths of linkages between nations. For this, a more complex statistical model is required, as explained later. Lastly, national indicators of competitiveness are used in this analysis to statistically define the various network strengths.

6.1.4 *The Global Competitiveness Index*

In popular discourse, it is often argued that in this day and age, multinationals can locate their production plants all over the globe and geography has become irrelevant (Cairncross, 2001; Friedman, 2007). However, in truth, the world is certainly not 'flattening' (Linders et al., 2008, McCann, 2008): multinationals still carefully choose their headquarter location and subsidiary locations based on the qualitative characteristics of the nations in question (Brakman and Van Marrewijk, 2008). Although some nations are clearly larger and geographically less remote than others, economic and geographic differences alone would not justify such disproportionality in the corporate control network. This study draws particular attention to the concept of competitiveness as a driver of this disproportionality. In his book *The Competitive Advantage of Nations*, Porter (1990) showed that corporate and national successes are interdependent, based on the development of skills and knowledge in particular industries, and on the connections between clusters of internationally successful businesses and particular attributes of their national home-bases. Therefore, taking this analysis one step further, an important contribution of this study is the empirical demonstration of how attributes related to competitiveness (such as institutional quality, technological readiness and business sophistication) relate to the corporate connectedness of nations and the number of connections 'between' nations. Using the World Economic Forum's 'Global Competitiveness Index' (Porter et al, 2007) as an indicator of competitiveness (based on institutional quality, technological relatedness and market efficiency), the results of this study aim to show that competitiveness is of critical importance for the headquarter

connectivity of nations and, though to a lesser extent, for the subsidiary connectivity of nations in the global corporate control network.

6.2 Theoretical framework concerning firms and nations

6.2.1 Firms and nations within a globalizing world

The contemporary global economy can be regarded as a state of competition that is continuously subjected to major shifts of competitive advantage in the global marketplace (Cerny, 1991). These shifts are not new, as the world has been episodically subjected to similar spurts throughout the history of capitalism (Harvey 1989; Castells 1996), However, it is clear that this process has intensified over the last three decades, driven primarily by competitive market mechanisms, technological change, and space-time compression – which has subsequently resulted in the increased global reach of multinationals (UNCTAD, 1996). Since the 1970s, the global dispersion of production has proliferated as corporations increasingly sought lower wages, proximity to markets and resources, and ways to redistribute their labor (Sassen, 1991). This process has led to the geographic dispersion of headquarters and their subsidiaries, and to the further expansion of global commodity chains. In pursuit of cost reduction and profit maximization, these firms utilize their commodity chains in order to organize value-added production stages, coordinate various levels of distribution, and employ a governance structure that controls the allocation of resources, and facilitate an institutional framework that coordinates between national and international policies (Gereffi, 1994).

Nonetheless, although corporate networks are evidently increasing in reach, it is equally apparent that investments are only becoming more concentrated within and between particular nations (Dicken, 2003, Driffield and Love 2005). In this sense, it appears that global corporate networks are only integrating particular nations into the world economy, resulting in a higher relative polarization between nations. Consequently, this process leads to increasing uncertainty concerning the future of nations within the globalizing economy (Kentor 2005). This raises questions about why certain nations claim higher shares of corporate connectivity, and why the highest interdependency is found only between particular nations. To contextualize these questions, it is necessary to further consider the interdependence of firms and nations, and how competitiveness leads to disproportionate shares of economic exchange.

6.2.2 The multinational corporation

A multinational is a firm that has the ability to coordinate production from a central point of strategic decision-making, but that operates across national boundaries (Cowling and Sudgen, 1987). These cross-border operations lead to a complex organization of economic activities at different geographic scales, such as decisions to centralize or decentralize, or to cluster or disperse a firm's functions. multinational networks therefore represent distinct loci of power that have a significant impact on an increasingly global economy, where it has been shown, for instance, that the sales of the top 200 global corporations (1999) accounted for

approximately 30% of world GDP (Anderson and Cavanaugh, 2000). Furthermore, of the top 100 entities on a combined firm-nation list for 2000, 29 economies were multinationals (United Nations, 2002). These firms are richer than many nations; for example, the revenue of General Motors was greater than the GDP of more than 148 nations (2004).

Furthermore, multinationals are responsible for a large portion of international trade and foreign direct investment (FDI), with much of this made up of intrafirm transactions. These investments are typically controlled by corporate headquarters that establish the magnitude of foreign investment, the transfer of technology, access to international markets, the repatriation of profits, the number of employees, etc. International investment between firms has grown exceptionally since the 1960s, but while cross investment between the industrialized economies has intensified, the share claimed by developing nations remains very low (Kentor, 2002). This unevenness derives from the fact that only certain nations have the endowment and strategic ability to create the competitive advantage needed to attract corporate FDI (Guisinger, 1985). In this manner, nations strive to enhance their international trading position and compete to attract productivity and national development, which in turn enhances their international competitive position further. Hence, both firm and state are interlocked in a struggle to capture global market shares, where the nation-state remains an equally important institution of capitalism (Gertler, 1992).

When firms are more porous, nations differentiate themselves using artificially-erected territorial boundaries made to distinguish and formalize their spatiality. These geographic units contain different forms of power and legitimacy with which to spatially organize people and institutions. Where nations traditionally were restrictive, today the changing role of nations can be witnessed, which have transitioned from merely having a policing role to having a more proactive engagement with global competition. In this way, national governance remains a vital attribute for attracting firms, as it serves as the ultimate guarantor of the rights of global capital and continues to provide the necessary conditions for the global growth of domestic capital (Sassen, 1995; Evans, 1997). Therefore, nations are capable of creating national competitive advantages (Porter, 1990). The core interaction between the state and multinationals is the control of the production system and the relative distribution of benefits and costs related to its operation. This relationship consists of a complex mixture of collaboration and conflict (Gordon, 1988), in which the multinational seeks to optimize its chain of production by operating in the most advantageous locations. Similarly, the nation endeavors to maximize its share of value-added activity and profits. For this reason, the relationships between nations and firms are inevitably awkward (Pitelis, 1991), leading not to the decline of the state (Evans 1997, Weiss 1997), but instead to a transformation in which the state continues to participate in the internationalization of capital[12]. In this sense, the state depends on the legitimizing power derived from its citizens, but also on the extent to which power can be derived from collusion with corporate capital. States are thus continuously asked to reform and reformulate their national policies to meet the challenges of globalization.

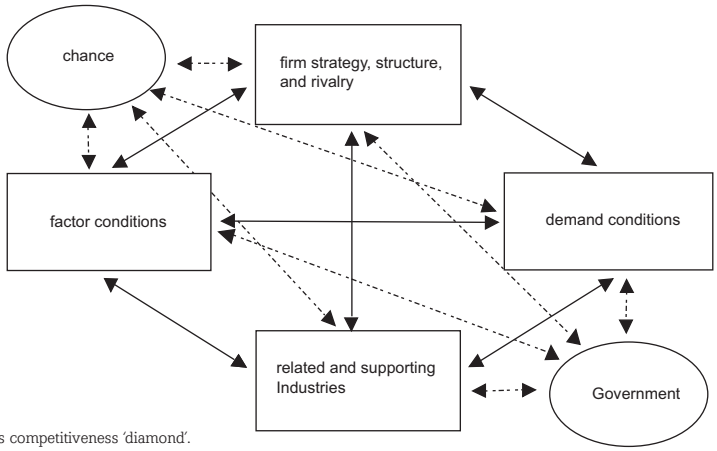
12 Ultra-globalists like Ohmae (1995) believe that this process will lead to a breakdown in the territoriality of the global economy, which will become borderless, and they claim that a firm's of origin does not matter.

Furthermore, no matter how great the global reach of an multinational becomes, it remains embedded within its nation of origin (Stopford and Strange 1991), and generally most of its assets, employment and turnover comes from its home nation (Hu 1992). In this sense, both agglomerate and networked space remain fundamental to the production and accumulation of capital (Harvey 1989, Lefebvre 1991, Yeung 1998b), facilitated through transport, communication and production factors. Because corporations typically develop within a domestic context prior to expanding internationally, the home base plays a key role in shaping the identity of the firm, the character of its top management, and its approach to strategy and organization, and the home nation has a continuous influence on the availability and qualities of resources available to the firm (Porter, 1990). Within this context, investors tend to locate their funds in domestic assets far more often than expected (Wojcik), in a phenomenon defined as the 'home-bias' (Obstfeld and Rogoff 2000). One of the main reasons for this is the reliability of domestic information (Merton 1987). Similarly, the technological activities of corporations also remain firmly rooted in their nations of origin (Cantwell 1995) because of the reliable infrastructure, resources, business networks and labor processes available in that context. Local conventions, rules, practices and institutions therefore prove to be necessary for firms to effectively operate in a world of uncertainty. In this sense, economic and social proximity affects the intensity of interactions in capital markets at both the national and global levels (Portes and Rey 1999), and is therefore arguably a cause of the unevenness of corporate connectivity within and between nations. The growing perception of the interdependence created by internationalization and urban competition leads to the increasing recognition that geography matters to economic performance. The issue of national performance will now be discussed.

6.2.3 Corporate and national competitive advantage

Classical theories on international trade posit that comparative advantage resides in the factor endowments that a nation is fortunate enough to inherit, including land, natural resources, labor and the size of the local population (Anderson and Van Wincoop, 2004). In Michael Porter's theory on competitive advantage, he takes the comparative advantage concept a step further by showing that corporate and national success is now also dependent on the development of unique skills, technology and knowledge in particular industries, and also by connecting clusters of internationally successful business to particular attributes within their home city regions (Porter, 1990). Competitiveness and development are intensified through the urban clustering of these advanced factor endowments within their respective nations. Furthermore, competitiveness also depends on the relative centrality of the nation, the pattern of specialization and differentiation of its activities, and its functional division of labor. Also, according to Porter, only those nations that are linked to the largest market areas have the ability to provide a foundation for highly specialized functions. Nonetheless, for nations to establish greater international integration, they need to optimize their endowments. In this light, a nation's competitive success is defined as a measure by which a nation can compare itself to the best worldwide competitors. This is measured either by the presence of substantial and sustained exports to a wide array of nations, or by significant outbound FDI based on skills and assets created in the home nation. Firms lose competitive advantage in the more price-sensitive industries as they develop towards more capital- and technology-intensive industries. As firms develop into more differentiated industrial segments, they shift many of their lower-technology activities overseas, while in their home bases they concentrate on

Figure 37



Michael Porter's competitiveness 'diamond'.
Source: Wall/Burger/v.d. Knaap, 2009 – based on Porter, 1990.

activities that require higher levels of skill and expertise. The outsourced activities are then characterized by the corporation's commitment to invest in products, processes, and skills that will reduce costs and improve the firm's competitive advantage.

Porter's conceptualization of competitive advantage is represented by a 'diamond' consisting of four categories of variables that influence a firm's ability to establish and sustain competitive advantage within international markets **(Figure 37)**. First, this concerns 'factor conditions,' basic factors such as natural resources, climate, location and demographics, and 'advanced factors' such as communications, infrastructure, sophisticated skills, and research facilities. Porter argues that the latter are more fundamental to competitiveness, as they tend to be specialized rather than generalized. Second, 'demand conditions' emphasize the role of home demand in providing the impetus to upgrade competitive advantage. In this sense, firms are typically most sensitive to the needs of their closest customers; as a result, the characteristics of home demand are particularly important. 'Related and supporting industries' form the third category, which are likely to stimulate an industry's investments in advanced factors of production, and conversely to create spill-over benefits beyond the confines of that particular industrial sector. This in turn facilitates the potential to innovate. Lastly, firm 'strategy, structure and rivalry' are identified as systematic differences in the characteristics of business sectors of different nations that are important factors of the industrial pattern of competitive advantage within each nation. These characteristics include national strategies, structures, goals, managerial practices, individual attitudes, and the intensity of rivalries within the business sector. Again, these properties stimulate corporate innovation.

6.2.4 Disproportionate multinational networks

In light of the above discussion, corporate networks and their relationship to various nations are essential to the analysis of this study, as this is expected to reveal diverse concentrations of economic activity within various nations as well as the interdependencies between them. This approach is interesting, as it reveals differential power relationships within the corporate network, transcending simple atomistic descriptions of individual

actors (e.g., firms), and revealing the centrality, hierarchy, and strength of associations between actors in the system (Bridge, 1997). From this approach, the existence of unequal relationships between the core and periphery can be empirically identified (Storper and Salais, 1997). However, because these structural measures cannot reveal much about the qualitative nature of the relationships (Pratt, 1997), it is important to explain the measures in relation to the competitive characteristics of nations, in a convergence of different streams of knowledge (Sunley, 2008). This will be implemented in the analysis using the Global Competitiveness Index.

Although conceptualizations of networks are not entirely new, most contemporary research takes its lead from John Friedmann's (1986) and Stephen Hymer's (1972) work on multinationals and uneven development. At the time, Hymer predicted that there would be a diffusion of lower levels of industrialization to developing nations, that intermediary activity would be concentrated in middle-range places, and that the highest-level corporate activities would be concentrated in only a limited number of nations that are close to capital markets, media activities and governmental institutions. Later on, Friedmann posited that world cities (nations) can be sorted into a networked hierarchy based on the economic power that they command. According to Friedmann, those that rank first in connectivity are those that function as the 'command and control centers of the global economy,' and that there are subordinate cities that articulate between the economies of various nations into the world economy. Friedmann also showed that the level of city (nation) integration into the world economy will depend on the functions assigned to it, in which the cores will be platforms for global capital and serve as points for the spatial organization and articulation of production and markets, resulting in a complex, uneven spatial hierarchy.

Today, several studies have empirically explored global economic relationships between cities/nations – such as the Global and World Cities (GaWC) study group's analysis of worldwide advanced producer service networks (Taylor, 2004), an exploration of the corporate ties of the world's 500 largest multinationals (Alderson and Beckfield, 2004), considerations of worldwide inter-corporate directorships (Carroll, 2007), and three scales of worldwide corporate shareholds (Wall and v.d. Knaap, 2008). These studies are linked by their illustration of how the fates of cities and nations are tied to their positions within international flows of investment and trade. Furthermore, these empirical studies indicate that contrary to popular theory concerning the emergence of a shifting geography of corporate centrality and marginality (Sassen 1995), the disproportionate structure of the worldwide corporate system in fact remains strongly persistent. This has also been shown through the initial investigation of the data of this research, as expressed earlier in the introduction. In the words of Alderson and Beckfield, 'we find little evidence for the new geography of centrality and marginality discussed by scholars such as Friedmann and Sassen.' Similarly, Carroll concludes that 'in the structure of global corporate power, the interurban corporate-elite network does not subvert the dominance of the developed capitalist core – it reinforces it.' Also, these two studies reveal that cities located in core nations are more powerful and prestigious than those in non-core nations.

Hence, there is a strong positive cohesion between cities with high corporate connectivity and the strength of their respective national connectivity. According to Carroll, this 'uneven network' is shaped by factors such as transnational political-economic structure, nationally specific legal and business systems, linguistic and cultural affinities, the political

Table 16

Nation	Headquarter and/or Subsidiary Nation	Outdegree	Indegree	GCI 2007
Albania	Subsidiary	0	1	3.35
Algeria	Subsidiary	0	4	3.50
Angola	Subsidiary	0	3	2.52
Argentina	Headquarter and Subsidiary	4	59	3.62
Australia	Headquarter and Subsidiary	6	134	5.35
Austria	Headquarter and Subsidiary	14	65	5.38
Azerbaijan	Subsidiary	0	1	3.78
Bahrain	Subsidiary	0	3	4.47
Bangladesh	Subsidiary	0	3	3.26
Barbados	Subsidiary	0	3	4.59
Belgium	Headquarter and Subsidiary	83	132	5.23
Bolivia	Subsidiary	0	3	3.18
Bosnia & Herzegovina	Subsidiary	0	2	3.41
Brazil	Headquarter and Subsidiary	7	93	3.89
Bulgaria	Subsidiary	0	6	3.76
Burkina Faso	Subsidiary	0	1	3.26
Burundi	Subsidiary	0	2	2.73
Cameroon	Subsidiary	0	7	3.10
Canada	Headquarter and Subsidiary	11	245	5.47
Chad	Subsidiary	0	2	2.62
Chile	Subsidiary	0	20	4.63
China	Headquarter and Subsidiary	12	167	3.97
Colombia	Subsidiary	0	26	3.85
Costa Rica	Subsidiary	0	4	4.18
Croatia	Subsidiary	0	5	4.17
Cyprus	Subsidiary	0	3	4.53
Czech Republic	Headquarter and Subsidiary	4	40	4.56
Denmark	Headquarter and Subsidiary	2	41	5.78
Dominican Republic	Subsidiary	0	7	3.53
Ecuador	Subsidiary	0	12	3.31
Egypt	Subsidiary	0	21	3.75
El Salvador	Subsidiary	0	5	3.90
Estonia	Subsidiary	0	3	4.84
Ethiopia	Subsidiary	0	2	3.18
Finland	Subsidiary	0	30	5.68
France	Headquarter and Subsidiary	457	206	5.26
Gambia	Subsidiary	0	1	3.60
Germany	Headquarter and Subsidiary	850	230	5.55
Greece	Subsidiary	0	34	4.20
				3.74

Nations included in the analysis and their number of outdegree connections, indegree connections and Global Competitiveness. Index (GCI). Source: Wall/Burger/v.d. Knaap, 2009.

Table 16 (continued)

Nation	Headquarter and/or Subsidiary Nation	Outdegree	Indegree	GCI 2007
Guatemala	Subsidiary	0	7	3.66
Honduras	Subsidiary	0	3	4.37
Hungary	Headquarter and Subsidiary	1	37	4.24
India	Subsidiary	0	44	4.16
Indonesia	Subsidiary	0	52	5.13
Ireland	Headquarter and Subsidiary	12	70	5.30
Israel	Headquarter and Subsidiary	1	8	4.28
Italy	Headquarter and Subsidiary	78	132	4.09
Jamaica	Subsidiary	0	3	5.41
Japan	Headquarter and Subsidiary	365	99	4.27
Jordan	Subsidiary	0	3	3.91
Kazakhstan	Subsidiary	0	2	3.71
Kenya	Subsidiary	0	10	4.41
Kuwait	Subsidiary	0	1	4.36
Latvia	Subsidiary	0	5	4.44
Lithuania	Subsidiary	0	1	3.29
Libya	Subsidiary	0	2	3.28
Madagascar	Subsidiary	0	1	3.10
Malawi	Subsidiary	0	1	5.10
Malaysia	Subsidiary	0	61	3.24
Mali	Subsidiary	0	2	4.47
Malta	Subsidiary	0	2	3.15
Mauritania	Subsidiary	0	1	4.24
Mauritius	Subsidiary	0	3	3.98
Mexico	Subsidiary	4	89	3.45
Moldova	Subsidiary	0	1	3.84
Morocco	Subsidiary	0	14	2.90
Mozambique	Subsidiary	0	3	5.25
New Zealand	Subsidiary	0	39	3.31
Nicaragua	Subsidiary	0	2	3.48
Nigeria	Subsidiary	0	15	5.38
Norway	Headquarter and Subsidiary	21	44	4.26
Oman	Subsidiary	0	4	3.56
Pakistan	Subsidiary	0	15	4.14
Panama	Subsidiary	0	15	3.13
Paraguay	Subsidiary	0	4	3.73
Peru	Subsidiary	0	19	3.79
Philippines	Subsidiary	0	33	4.09
Poland	Subsidiary	0	38	4.65
Portugal	Headquarter and Subsidiary	2	51	4.65

Nations included in the analysis and their number of outdegree connections, indegree connections and Global Competitiveness. Index (GCI). Source: Wall/Burger/v.d. Knaap, 2009.

Table 16 (continued)

Nation	Headquarter and/or Subsidiary Nation	Outdegree	Indegree	GCI 2007
Qatar	Subsidiary	0	3	3.84
Romania	Subsidiary	0	10	3.87
Russia	Subsidiary	0	26	4.21
Saudi Arabia	Subsidiary	0	16	3.44
Senegal	Subsidiary	0	4	5.71
Singapore	Headquarter and Subsidiary	16	100	4.43
Slovakia	Subsidiary	0	17	4.64
Slovenia	Subsidiary	0	4	4.28
South Africa	Headquarter and Subsidiary	2	45	5.38
South Korea	Headquarter and Subsidiary	18	40	4.70
Spain	Headquarter and Subsidiary	27	146	3.96
Sri Lanka	Subsidiary	0	7	3.37
Suriname	Subsidiary	0	2	5.68
Sweden	Headquarter and Subsidiary	8	61	5.78
Switzerland	Headquarter and Subsidiary	448	119	3.62
Syria	Subsidiary	0	2	3.49
Tanzania	Subsidiary	0	2	4.51
Thailand	Headquarter and Subsidiary	2	59	5.52
The Netherlands	Headquarter and Subsidiary	330	153	4.59
Tunisia	Headquarter and Subsidiary	13	10	4.09
Turkey	Subsidiary	0	35	3.31
Uganda	Subsidiary	0	2	3.76
Ukraine	Subsidiary	0	3	4.69
United Arab Emirates	Headquarter and Subsidiary	1	22	5.48
United Kingdom	Headquarter and Subsidiary	351	311	5.61
United States	Headquarter and Subsidiary	1172	499	3.93
Uruguay	Subsidiary	0	10	4.01
Uzbekistan	Subsidiary	0	1	3.37
Venezuela	Subsidiary	0	31	3.74
Vietnam	Subsidiary	0	13	3.24
Zambia	Subsidiary	0	2	3.15
Zimbabwe	Subsidiary	0	5	3.05

Nations included in the analysis and their number of outdegree connections, indegree connections and Global Competitiveness. Index (GCI). Source: Wall/Burger/v.d. Knaap, 2009.

structure of nations and the physical limitations of geographic space such as distance. In this sense, these practices generate a strongly embedded national network resulting from the hierarchical management and control of corporate activities, and from the exercise of strategic and allocative power within particular contexts (Scott, 1997). Lastly, these studies conclude that in the future, corporate network analysis needs to transcend merely structural studies and instead must start to engage with more explanatory types of variables. In this context, by combining network data with readily available national and regional data, researchers can say more about how nations and cities gain central positions within worldwide networks (Alderson and Beckfield, 2004). Therefore, the following section aims to contribute to this goal.

6.3 Data, methodology and techniques

6.3.1 Data on competitiveness and corporate connectivity

The remainder of this study analyzes the influence of national competiveness on (1) the position of a nation in the global corporate control network and (2) the strength of the corporate connection between two nations. In this research, the competitiveness of a nation is based on the Global Competitiveness Index (GCI), which was developed by Michael Porter and Xavier Sala-i-Martin, amongst others, for the World Economic Forum. This index was initially presented in the 2004 – 2005 Global Competitiveness Report and employs a specific, integrated view of competitiveness, including twelve pillars (institutions, infrastructure, macro-economy, health and primary education, higher education and training, labor market efficiency, capital market efficiency, goods market efficiency, technological readiness, market size, business sophistication and innovation. These variables are particularly focused on the qualitative aspects of national economies, and it is important to note that none of these aspects can individually ensure competitiveness. In this light, the most competitive economies are those that score highest on a broad array of factors. Today, GCI covers over 125 economies at different stages of economic development, and GCI scores range from 2.52 (least competitive nations) to 5.78 (most competitive nation) on a scale of 1 to 7. This research uses a slightly modified version of the original index, in which the qualitative aspects of competitiveness are separated from the more quantitative ones (market size, macro-economy). Based on the modified GCI, Denmark, Switzerland, Singapore, Sweden, and Finland are the top five most competitive nations, followed closely by the United States and Germany. Angola, Chad and Burundi were among the least competitive nations. A complete overview of the GCI scores of the nations in the analysis can be found in **(Table 16)**.

The Global Competitiveness Index was originally developed by the Spanish economist Xavier Sala-i-Martin and aims to measure 'the set of institutions, policies and factors that relate to the level of productivity of a nation' (Sala-i-Martin et al. 2007). In this respect, the index is an indicator for the relative attractiveness or competitive advantage of nations. From 2004 onwards, the index has appeared in the World Economic Forum's yearly Global Competitiveness Report. This research uses the index scores from the 2007 – 2008 report, which contains competiveness scores for 131 nations.

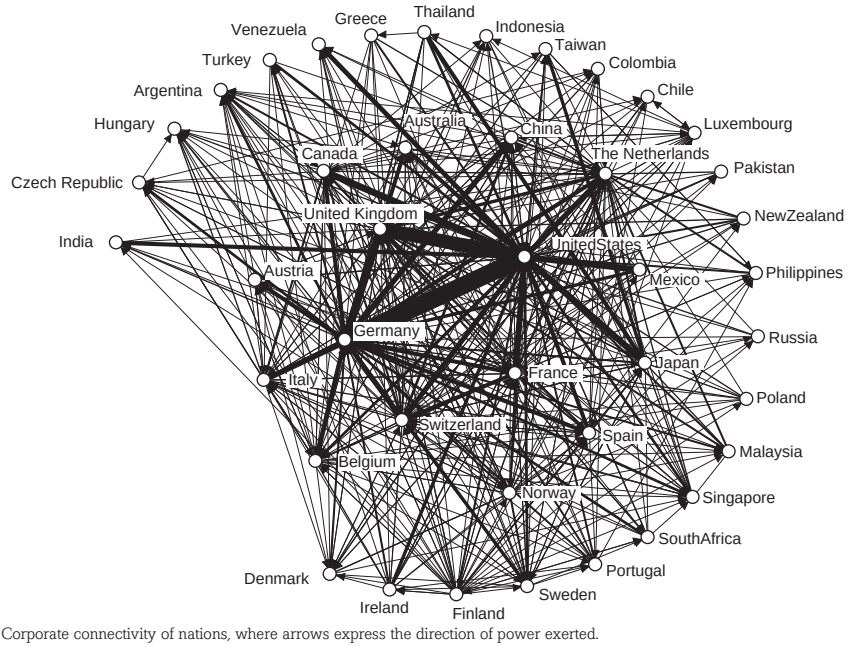
In total, the Global Competitiveness Index is made up of over 100 variables organized into 12 pillars, representing different factors of a nation's competiveness. Most often, nations that score high on one particular pillar also score high on the other pillars, with a strong statistical correlation between the different pillars of over 0.90. Exploratory factor analysis is then used to identify two groups of pillars. The first group, consisting of two pillars, is related to the market size of a nation. The second group, consisting of 10 pillars, is related to the qualitative elements of competitiveness. Both these groups of pillars have been utilized in the research as factors of the structure of the global corporate control network, except that these multiple variables have been condensed into two clear factors. Hence, the definition of competitiveness is narrower than the broad definition of the World Economic Forum.

The pillars included in this second group are: institutions, infrastructure, health and primary education, higher education and training, goods market efficiency, labor market efficiency, financial market sophistication, technological readiness, business sophistication, and innovation. For each pillar, the Global Competitiveness Index provides a subindex. The competitiveness variable in this study is an unweighted average of the sub-indexes of the 10 pillars of the second group. A more detailed account of the Global Competiveness Index and the variables included in each pillar can be found in Chapter 1.1. of the Global Competiveness Report 2008 (Sala-i-Martin et al. 2007).

With respect to the dependent variable, the position of nations in the global corporate control network is focused on, and the strength of their corporate connections between nations. The hierarchic position of a nation in the network is based on its total headquarter connectivity (the number of outgoing corporate connections, or outdegree) and its total subsidiary connectivity (the number of incoming corporate connections, or indegree). Likewise, the total number of corporate connections between a headquarter nation and its subsidiary nation has been used as an indication of the strength of the corporate bilateral connection between the two nations. In this manner, the total network strength 'within' a nation and corporate connectivity 'between' nations is defined on the basis of the intra-firm linkages of Fortune's top 100 multinationals (2007) and their subsidiaries. Next, by reviewing the annual reports (2006 – 2007) of these multinationals using the Lexis Nexis® and Thompson One Banker® databases, their subsidiaries were extracted and classified according to various levels of sharehold relationships and national location. This resulted in a dataset of 9243 sharehold relationships, of which 4638 prove to be domestic linkages and 4605 transnational. By strictly focusing on only transnational corporate connections and excluding those linkages to subsidiary nations for which GCI scores are unavailable, a dataset of 4322 sharehold relationships was attained.[13] In aggregating the data to the national level, a global corporate network between nations was constructed between 43 headquarter nations with at least one outgoing corporate connection and 111 subsidiary nations that have at least one incoming corporate connection, as listed **(Table 16)**.

13 These mainly included islands in the Caribbean, Indian Ocean, and South Pacific and some nations in Sub-Saharan Africa with only a few connections in total. For Angola and Malawi, the 2006 score was used because the 2007 score was unavailable.

Figure 38



Corporate connectivity of nations, where arrows express the direction of power exerted.
Source: Wall/Burger/v.d. Knaap, 2009.

As already indicated in the First Section **(Figure 36)**, the global corporate control network is disproportionate in many respects. First, most outgoing corporate connections are held by only a few headquarter nations. Here, the United States (1192 outgoing connections), Germany (850), France (457), Japan (448), Switzerland (365), the United Kingdom (351), and the Netherlands (330) are most prominent. This is also clearly evident in the Ucinet centrality analysis on national connectivity **(Figure 38)**. Overall, these nations hold about 93% of all outgoing connections, indicating that multinationals are very particular about where their headquarters are located. Furthermore, a similar yet less disproportionate pattern can be seen with respect to subsidiary connectivity, where the top 10 nations (United States, United Kingdom, Canada, Germany, France, China, Netherlands, Spain, Australia and Italy) hold approximately 50% of all incoming relationships. In general, African and South American nations are obviously underrepresented in the network, with hardly any outgoing connections and only a few incoming connections. Also, with respect to linkage connectivity, or the number of connections between nations, the global corporate network reveals similar unevenness, since only 1% of the nation pairs hold roughly 45% of all corporate connections. The United States is involved in each of the top five strongest transnational connections, either as a headquarter nation or as a subsidiary nation: Germany-United States (150 corporate connections), United States-Canada (136), United States-United Kingdom (112), Japan-United States (106), and United States-Germany (84). Furthermore, there is no corporate connectivity between over 85% of nation pairs.

Table 17

	Mean	Standard Deviation	Minimum	Maximum	N
Headquarter connectivity	38.94	157.2	0	1172	111
Subsidiary connectivity	38.94	71.59	1	499	111
Competitiveness	4.14	0.80	2.52	5.78	111
Market size	3.79	1.15	1.43	6.86	111
ln Remoteness	-1.68	0.24	-2.02	-0.98	111
ln Openness	0.26	0.20	0.03	1.14	111

Summary statistics of variables in the analyses on headquarter and subsidiary connectivity.
Source: Wall/Burger/v.d. Knaap, 2009.

6.3.2 Count data models and quasi-Poisson estimation

Both the headquarter and subsidiary connectivity of nations and the number of corporate connections between nations can be perceived as count data, as these variables 'count' the number of times that something has occurred. In this case, it concerns the number of incoming or outgoing linkages, or flow frequencies between nations. Although count data is often treated as if it were continuous, estimation by Ordinary Least Squares in a linear regression framework often results in inefficient and biased estimates of these parameters (Long, 1997). A more extensive discussion of this issue can be found in Flowerdew and Aitkin (1982) and Burger et al. (2008).

Hence, the use of alternative regression techniques would be more appropriate. Probably the most common regression model applied to count data is the Poisson regression. Applying a Poisson regression, it can (for example) be conjectured that a nation's i headquarter connectivity H_i has a Poisson distribution with a conditional mean (μ) that is a function of a number of independent variables, including competitiveness **(6)**. As H_i is assumed to have a non-negative integer value, the exponential of the independent variables is taken, so that μ_i is compelled to be zero or positive. More formally, **(7)**. in which the conditional mean μ_i is linked to an exponential function of a set of independent variables X_i

$$\Pr[H_i] = \frac{\exp(-\mu_{ij})\,\mu_{ij}^{H_i}}{H_i!}, \left(H_i = 0,1...\right) \qquad \textbf{(6)}$$

where α_0 is a proportionality constant, and X_{ij} is a 1 x k row vector of explanatory variables (including the competitiveness indicator) with corresponding parameters β.

Table 18

	Mean	Standard Deviation	Minimum	Maximum	N
Link connectivity	0.91	5.52	0	150	4730
Competitiveness HC	4.74	0.69	3.26	5.78	4730
Market Size HC	4.74	0.91	2.72	6.83	4730
ln Remoteness HC	-1.62	0.25	-1.95	-1.02	4730
ln Openness HC	0.30	0.18	0.07	0.77	4730
Competitiveness SC	4.13	0.80	2.52	5.78	4730
Market Size SC	3.79	1.15	1.43	6.86	4730
ln Remoteness SC	-1.68	0.24	-2.02	-0.98	4730
ln Openness SC	0.26	0.20	0.03	1.14	4730
ln Geographic distance	8.66	0.84	4.00	9.89	4730
Adjacency dummy	0.03	0.16	0	1	4730
ln Economic distance	2.50	1.76	0	10.05	4730
Free trade agr. dummy	0.10	0.30	0	1	4730
Common language dummy	0.11	0.18	0	1	4730
Common history dummy	0.03	0.18	0	1	4730

HC and SC refer to Headquarter Nation and Subsidiary Nation, respectively.

Summary statistics of variables in the analyses on headquarter and subsidiary connectivity.
Source: Wall/Burger/v.d. Knaap, 2009.

$$\mu_i = \exp(\alpha_0 + \beta' X_i) \quad (7)$$

An important condition of the Poisson regression model is that it assumes equi-dispersion, which means that the conditional variance should be equal to the conditional mean. However, the conditional variance is most frequently higher than the conditional mean, which suggests that the dependent variable is over-dispersed. A related problem concerns excessive zero counts or 'non-Poissonness' in the data, meaning that the incidence of zero counts is greater than would be expected from the Poisson distribution (Long, 1997). In order to correct this, a negative binomial regression model (in the case of over-dispersion), a zero-inflated Poisson regression model (in the case of excess zeros) or a zero-inflated negative binomial regression (in the case of over-dispersion and excess zeros) can be employed. These quasi-Poisson regression models are extensions or modifications of the original Poisson regression model.[14] Not correcting for over-dispersion and/or excess zeros normally results in an inefficient estimation of the dependent variable, exemplified by spuriously large z-values and spuriously small p-values, due to downward-biased standard errors (Gourieroux et al., 1984). A more technical discussion of modifications of the Poisson regression model can be found in Greene (1994) and Long (1997). Although this example

Table 19

	Competitiveness	Market Size	ln Remoteness	ln Openness
Competitiveness	1.00			
Market size	0.53	1.00		
ln Remoteness	0.18	0.29	1.00	
ln Openness	0.26	0.01	0.12	1.00

Correlations of independent variables used in the analyses on link connectivity.
Source: Wall/Burger/v.d. Knaap, 2009.

uses aggregate headquarter connectivity, the same models can be applied to subsidiary and link connectivity. Hence, three separate regressions are run using count data methods; and subsequently analysis is made of (1) the factors of headquarter connectivity, (2) the factors of subsidiary connectivity, and (3) the factors of the number of corporate connections between nations.

6.3.3 Covariates

Naturally, competitiveness is not the only factors of headquarter and subsidiary connectivity. In fact, there are other variables (covariates) that affect the relationship between connectivity and competitiveness, which should be controlled for in the analysis. While the analysis of aggregate headquarter and subsidiary connectivity only involves variables measured at the national level, the analysis of link connectivity (the number of connections between nations) also includes bilateral variables (for instance, the distance between nations). The summary statistics of the variables included in the models has been provided **(Table 17)**.

At the national level, market size, remoteness, and openness are included as control variables for both headquarter and subsidiary nations. Larger nations generally tend to be more attractive to multinationals, as these firms are then able to serve a larger market. In the analyses, the market size of a nation is based on the GCI's market size pillar, which, as explained earlier, is a composite measure of domestic market size (accounting for 75%) and foreign market size based on international trade (accounting for 25%). Similar to the national GCI described above, nations are ranked on a scale of 1 to 7. Remoteness is included in these analyses to control for the geographical position and accessibility of a nation, and is measured as the average distance between that nation and all other nations in the world. Furthermore, in order to control for the fact that some nations are

14 The likelihood ratio test of over-dispersion can be used to test whether the negative binomial specification is favored over the Poisson specification. Likewise, the Vuong statistic (Vuong, 1989) can be employed to test whether a zero-inflated model is favored over its non-zero inflated counterpart by examining whether there is significant evidence of excessive zero counts.

Table 20

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Competitiveness HC (1)	1.00						
Market Size HC (2)	0.09	1.00					
ln Remoteness HC (3)	-0.20	0.29	1.00				
ln Openness HC (4)	0.37	-0.48	-0.34	1.00			
Competitiveness SC (5)	0.00	0.00	0.00	0.00	1.00		
Market Size SC (6)	0.00	-0.01	0.00	0.00	0.53	1.00	
ln Remoteness SC (7)	0.00	0.00	-0.01	0.00	0.18	0.29	1.00
ln Openness SC (8)	0.00	0.00	0.00	-0.01	0.31	0.00	0.11
ln Geographic distance (9)	-0.14	0.12	0.43	-0.19	-0.15	-0.06	0.33
Adjacency (10)	-0.03	0.01	-0.03	-0.01	0.06	0.09	0.00
ln Economic distance (11)	0.18	0.43	0.07	-0.24	-0.34	-0.49	-0.17
Free trade agreement (12)	0.05	0.08	0.09	-0.03	0.24	0.26	0.16
Common language (13)	0.03	0.02	0.02	-0.02	-0.02	-0.05	0.01
Common history (14)	0.03	0.07	-0.09	0.00	0.03	0.04	-0.01

	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Competitiveness HC (1)							
Market Size HC (2)							
ln Remoteness HC (3)							
ln Openness HC (4)							
Competitiveness SC (5)							
Market Size SC (6)							
ln Remoteness SC (7)							
ln Openness SC (8)	1.00						
ln Geographic distance (9)	-0.05	1.00					
Adjacency (10)	0.02	-0.35	1.00				
ln Economic distance (11)	-0.14	0.09	-0.07	1.00			
Free trade agreement (12)	0.08	-0.29	0.28	-0.17	1.00		
Common language (13)	0.00	-0.09	0.16	0.03	0.13	1.00	
Common history (14)	-0.01	-0.15	0.23	0.03	0.04	0.28	1.00

HC and SC refer to Headquarter Nation and Subsidiary Nation, respectively.

Correlations of independent variables used in the analyses on headquarter and subsidiary connectivity.
Source: Wall/Burger/v.d. Knaap, 2009.

Table 21

	Model 1 Headquarter Connectivity	Model 2 Subsidiary Connectivity
Competitiveness	2.72 (0.33)**	0.62 (0.09)**
Market Size	2.08 (0.27)**	1.02 (0.07)**
ln Remoteness	-2.86 (0.75)**	0.21 (0.22)
ln Openness	-0.28 (1.20)	0.26 (0.29)
Constant	-25.4 (2.64)**	-3.57 (0.51)**
Observations		
Maximum likelihood R2	111	111
Log pseudo likelihood	0.625	0.862
Likelihood ratio test of	-165.5	-387.3
overdispersion	1.833**	714.7**
AIC	3.091	7.086

**** p<0.01, *p<0.05. Robust standard errors between parentheses.**

Negative binomial pseudo maximum likelihood of headquarter and subsidiary connectivity.
Source: Wall/Burger/v.d. Knaap, 2009.

more protectionist and domestically oriented than others, thereby having less transnational linkages, a variable for the openness of a national economy is included. This variable is measured by a nation's exports divided by its GDP.

To analyze the number of corporate connections between nations, several bilateral variables have been included that are measured at the level of pairs. These bilateral variables reflect the distance between two nations, where distance is interpreted as a multi-faceted concept (Boschma, 2005) that keeps nations separated, hereby resulting in transaction costs that themselves result from transnational corporate interdependence (see also Linders et al., 2008). More specifically, the focus has been on geographic, economic and cultural-historical distance between nations. A large body of literature on world trade and foreign direct investment has shown that these barriers (Anderson and Van Wincoop, 2003; Bergstrand and Egger, 2007) still generally tend to obstruct the creation of economic linkages between nations. By accounting for both national and bilateral characteristics, including size and the physical distance between nations, this analysis closely resembles the type of analyses employed in spatial interaction or gravity-based modeling (Fotheringham and O'Kelley, 1989; Sen and Smith, 1995).

Physical distance between headquarters and subsidiaries creates transaction costs in terms of transportation (of goods and people) costs, communication costs and time costs (Head, 2004). In line with previous research, geographic distance is measured as the straight distance between nations ('as the crow flies'), using the capital of each nation as its center of gravity. However, as this also implies that the distance between the two centers of

gravity of neighboring nations is likely to overestimate the average distance between them, an adjacency dummy variable has been included.[15] This variable captures not only measurement error, but also historical relationships between adjacent nations, including the value of only one nation if the two nations are neighbors. The economic distance between nations is measured by differences in per capita GDP and indicates whether two nations have similar preferences and a similar output mix (Linder, 1961), which in turn would stimulate the formation of corporate connections between these nations. Moreover, as there is a high level of internal trade between headquarters and their subsidiaries, tariff and non-tariff barriers to trade may obstruct the creation of corporate linkages between nations. The Free Trade Agreement (FTA) dummy indicates whether nations are both members of the same free trade area and is defined on the basis of OECD data on major regional trade agreements. Finally, cultural-historical distance is measured by whether nations have the same official language and a historical relationship. To assess whether two nations have the same official language, a database collected by Haveman has been used[16] that distinguishes fourteen languages. These data have been expanded using the CIA's World Factbook to cover even more nations and languages. Hence, a language dummy variable reflects whether or not two nations have a common official language. Similarly, the history dummy variable takes the value of only one nation, if two nations had (or have) a colonial relationship, or if they were once part of the same nation. This variable is constructed on the basis of CEPII data[17].

6. 4 Empirical results

6.4.1 Initial model tests

This section analyzes to what extent national competiveness influences the headquarter connectivity (the number of outgoing corporate connections), subsidiary connectivity (the number of incoming corporate connections) and link connectivity (the number of corporate connections between nations) between nations. Regarding the analysis of headquarter and subsidiary connectivity, the negative binomial regression model proved to be more appropriate than its Poisson and zero-inflated counterparts. Similarly, for the analysis of linkage connectivity, the zero-inflated negative binomial model regression model fit the data best.[18] Concerning the potential problem of multicollinearity, the correlation matrices in **(Table 19 and Table 20)** indicate that all variables show sufficient independent variation, as the correlations between the explanatory variables are below 0.55. Furthermore, all regression models below are calculated using the Huber/White/sandwich estimator (robust standard errors) to account for unobserved heterogeneity (Santos Silva and Tenreyro, 2006).

15 Adjacency requires either a land border or a small body of water separating the two nations.
16 www. macalester. edu/research/economics/PAGE/HAVEMAN/Trade
17 www.cepii.fr
18 Models were compared on the basis of information criteria (AIC, BIC), the likelihood ratio test of overdispersion and the Vuong statistic.

Table 22

	Model 3 **Link Connectivity**	
Negative Binomial Part		
Competitiveness Headquarter Nation	1.83	(0.14)**
Market Size Headquarter Nation	1.01	(0.11)**
ln Remoteness Headquarter	-2.11	(0.31)**
ln Openness Headquarter	-0.42	(0.15)**
Competitiveness Subsidiary	0.42	(0.07)**
Market Size Subsidiary	0.77	(0.07)**
ln Remoteness Subsidiary	0.55	(0.23)*
ln Openness Subsidiary	0.08	(0.07)
ln Geographic distance	-0.11	(0.07)
Adjacency dummy	0.36	(0.16)*
ln Economic distance	-0.20	(0.04)**
Free trade agreement dummy	0.18	(0.14)
Common language dummy	0.50	(0.11)**
Common history dummy	-0.02	(0.12)
Constant	-21.8	(1.47)**
Zero-Inflated Part		
Competitiveness Headquarter	-2.19	(0.31)**
Market Size Headquarter	-2.48	(0.28)**
ln Remoteness Headquarter	3.49	(0.69)**
ln Openness Headquarter	-1.04	(0.26)**
Competitiveness Subsidiary	0.04	(0.17)
Market Size Subsidiary	-0.18	(0.14)
ln Remoteness Subsidiary	-1.34	(0.65)*
ln Openness Subsidiary	0.14	(0.19)
ln Geographic distance	0.84	(0.07)**
Adjacency dummy	-16.6	2.06)**
ln Economic distance	0.35	(0.11)
Free trade agreement dummy	0.80	(0.51)
Common language dummy	0.12	(0.39)
Common history dummy	-2.70	(0.79)**
Constant	20.6	(1.47)**
Observations	4730.	
Maximum likelihood R2	0.416	
Log pseudolikelihood	-2262	
Likelihood ratio test of overdispersion	1083**	
Vuong test (z)	6.36**	
AIC	0.969	

Zero-inflated negative binomial pseudo maximum likelihood of the number of corporate connections between nations.
Source: Wall/Burger/v.d. Knaap, 2009.

6.4.2 *Headquarter connectivity and national competitiveness*

Model 1 in **(Table 21)** presents estimates for the negative binomial regression model for headquarter connectivity. In general, it can be inferred that in line with theory, most variables fit expectations and are statistically significant. Only the openness of a nation's economy does not apparently affect the headquarter or subsidiary connectivity of a nation within the global corporate network. With respect to headquarter connectivity, a highly positive and significant effect of competitiveness has been found on the number of outgoing linkages that a nation has. If the competitiveness of nations is increased by one standard deviation, the number of outgoing linkages is multiplied by a factor of 8.88.[19] However, besides competitiveness, a nation's market size and remoteness also appear to be important factors of a nation's headquarter connectivity. In this case, the number of outgoing corporate connections is multiplied by a factor 11.17 when increasing the market size of a nation by one standard deviation. On a similar note, if the remoteness of a nation in terms of its average distance to all other nations increases by 1%, then the number of outgoing connections for that nation will drop by 2.86%, as expected.

6.4.3 *Subsidiary connectivity and national competitiveness*

Model 2 in **(Table 21)** presents the estimates for the negative binomial regression model on subsidiary connectivity. As expected, competitiveness has a positive and statistically significant effect on a nation's number of incoming corporate connections. However, this effect is smaller when compared to a nation's outbound headquarter connectivity. Increasing competitiveness by one standard deviation only multiplies the subsidiary connectivity by a factor of 1.62. Similarly, with respect to market size, it has been found that the number of incoming linkages is multiplied by a factor of 3.23 if the market size of a nation is increased by one standard deviation. Striking enough, neither the openness of a nation's economy nor its remoteness has an effect on the number of incoming corporate connections.

Comparing the factors of headquarter and subsidiary connectivity, two important observations can be made with respect to multinational location preferences. First, a nation's competitiveness is important for attracting headquarter and subsidiary multinational offices. However, the market size of a nation (in terms of both the domestic and the foreign market that it serves) seems to matter most for both the headquarter and subsidiary connectivity of nations to the global corporate control network. Second, the estimated effect of competitiveness, market size and the remoteness of nations on the number of outgoing linkages is much greater than the estimated effect of these variables on the number of incoming linkages. This indicates that (not surprisingly) multinationals are much more demanding with respect to the characteristics of their headquarter locations than with respect to the locations of their subsidiaries.

19 The coefficients on competitiveness and market size are semi-elasticities. To interpret the impact of these variables on headquarter, subsidiary and link connectivity, we assume that these variables decrease by one standard deviation. The probability of trade is then multiplied by a factor $e^{b_x * s_x}$, where b_x is the unstandardized coefficient and s_x is the standard deviation of the corresponding variable. In this example, $e^{2.72*0.80} = 8.88$.

6.4.4 Competitiveness and connectivity between nations

Model 3 of **(Table 22)** presents the estimates for the zero-inflated negative binomial regression model on link connectivity. The zero-inflated model (Greene, 1994; Long, 1997) consists of two parts. The first part of the model contains a logit regression of the probability that there is no corporate connection between nations at all. The second part contains a negative binomial regression of the probability of each count for the group that has a non-zero probability, or interaction intensity other than zero. Hence, the zero-inflated negative binomial model generates two sets of parameter estimates: one set for the logit model, which identifies members of the pairs of nations that always have zero values (pairs of nations that never have a corporate connection); and one set for the negative binomial part, which predicts the probability of a count belonging to the group of nations that have theoretically non-zero corporate connections. Because it is concurred that the factors of the probability of link formation do not significantly differ from the factors that predict the number of links that are created, the same variables are included in both parts of the regression model.

Model 3 includes variables measured at the level of the headquarter , the subsidiary and bilateral variables. The majority of variables included in this analysis have the expected properties and are statistically significant. As can be derived from these results **(Table 22)**, the coefficients in the logit model are usually in opposition to those in the negative binomial part. With respect to the bilateral variables, it is found that geographical distance, adjacency and common history particularly affect the probability of corporate connectivity, which can be derived from the logit part of the model. Hence, if the geographical distance between nations increases by 1%, the probability of pairs belonging to the corporate connection group increases by 0.84%. Being neighbors and having a common history decreases the odds of never having a corporate connection by 99% and 93%, respectively. Despite the fact that geographic distance and common history both affect the probability of corporate connections; these variables nonetheless tend not to have an effect on the expected number of corporate connections between the nations. Examining the negative binomial part of the model, it appears that in particular, economic distance, adjacency, and sharing a common official language increase the expected number of connections when all other variables are held constant. Hence, the likelihood of two nations' having a corporate connection and the probability of a certain number of corporate connections between nations have different factors.

The discussion can now focus on the impact of national characteristics on the number of corporate connections between nations. Compared to the subsidiary characteristics, the headquarter characteristics appear to have a much stronger effect on the probability of link formation between two nations and the number of linkages that are created between two nations. This is exemplified by the smaller effect size estimates of the subsidiary variables. This is in line with the findings related to headquarter and subsidiary connectivity in Models 1 and 2. More specifically, the competitiveness of a headquarter has a strong effect on both the probability of a corporate connection and the number of corporate connections between the two nations under observation. Increasing headquarter competitiveness by one standard deviation multiplies the probability of a corporate connection by a factor of 4.5, and the number of corporate connections by a factor 3.6, assuming that all other variables remain constant. Hence, the competitiveness of a subsidiary does not have an

effect on the probability of a corporate connection between the two nations. In this case, the number of corporate connections between two nations is only multiplied by a factor of 1.3 if the competitiveness of a subsidiary is increased by one standard deviation. In line with this, the market size of the headquarter appears to be a more important factors of the structure of the global corporate control network than the market size of the subsidiary. With respect to remoteness, it is seen that pairs that connect to remote headquarter nations generally have a lower probability of link formation and a smaller number of corporate connections. Strikingly, it is seen that pairs with remote subsidiary nations generally have a higher probability of linkage formation and a larger number of corporate connections. This can be explained by the fact the remote nations (e.g., Australia, New Zealand) face less competition from other nations when serving as subsidiary locations for multinationals that wish to serve their local markets. Furthermore, it is also found that the openness of the headquarter has a positive effect on the probability of link formation, but a negative effect on the number of linkages created, resulting in a net effect of approximately zero. By comparing the national factors of the global corporate control network to each other, it can be concluded that national competitiveness, market size and the remoteness of the headquarter and subsidiary nations significantly relates to the structure of the global corporate network. Nonetheless, the overall characteristics of headquarter nations tend to be much stronger factors of the probability of corporate connectivity between two nations, as well as of the number of corporate connections created, than those characteristics of the subsidiary.

6.5. Conclusion

This study has investigated transnational corporate networks based on intra-firm shareholds In this way, differential economic power relationships have served to transcend atomistic descriptions of individual actors, hereby enabling empirical knowledge of the interdependence between nations (Alderson and Beckfield, 2004). These networks represent almost one third of all OECD revenue and are almost entirely based in developed nations in North America, Europe and Pacific Asia, particularly in the transatlantic zone between Europe and North America. Furthermore, besides attaining structural insight into the disproportionality of the contemporary global corporate system, its skewness has been associated with specific variables, namely the competitiveness and market size indices of the world's nations, while controlling for other national (openness, remoteness) and bilateral (geographical, cultural, and economic distance) characteristics. This has been executed by considering two research questions focused on understanding the structure of the corporate network, first in terms of national headquarter centrality (headquarter outdegree and subsidiary indegree) and secondly in terms of corporate connectivity between nations. Concerning headquarter connectivity, the results show that both the level of competitiveness and the market size of nations are highly influential in the total number of 'outdegree' headquarter linkages. In this manner, the competiveness indicator has served to capture the more 'qualitative' aspects of national economies, while market size has been used to represent the more 'quantitative' aspects. In this way Porter's (1990) observation that the endowment of an multinational's headquarter home base plays a vital role in its success, has been validated. These clustered endowments include infrastructure, resources, effective business systems and labor processes, and also the reassurance of a

more predictable and sizeable market (Cantwell, 1995), which are all variables captured in the independent variables that we have used.

As with outgoing headquarter connectivity, the results have shown that the total subsidiary 'indegree' connectivity of nations reveals outcomes analogous to that of headquarters, except that the effect proves to be smaller in all cases. Although competitiveness and market size do matter to the strength of headquarter and subsidiary connectivity alike, the impact of a nation's competitiveness and market size is apparently far more influential for headquarters than for subsidiaries. This is arguably because multinational headquarters are situated in only a handful of highly developed nations, while subsidiaries are more abundantly found in well-developed, developed and developing nations. This means that their variance is far greater than that of headquarters, as they are more likely to be located in nations with lower qualitative levels of competitiveness and smaller market sizes.

Regarding the second question, in which the linkage strength 'between' nations is shown to be strongly related to national performance indicators, similar results are found. The national competitiveness and market size of both headquarter and subsidiary nations prove to be important factors of the contemporary global corporate structure. However, the overall characteristics of headquarter nations prove to be much stronger factors of the probability of corporate connectivity between two nations and the volume of their linkages than is the case for subsidiary nations. In other words, the competitiveness and market size of a headquarter nation is evidently more important to the structure of the global corporate network than the competitiveness and market size of a subsidiary nation. As explained in theory, this unevenness derives from the fact that only particular nations are well endowed enough and have the strategic ability to ensure the competitive advantage needed to attract multinational headquarters.

The structural findings regarding the corporate network show that the world has not changed much since 1972 when Hymer postulated the corporate unevenness of nations: today, the same handful of persistent headquarter nations still tend to dominate the global arena. These results have shown that the majority of shareholds remain between developed nations, which still serve as the primary command and control centers of the world economy. This network structure, as shown in this research, is related to the fixedness and persistence of largely immobile social and physical infrastructures (Harvey, 1982), as has been captured in the competitiveness index. In this way, the structure of global corporate power does not subvert the dominance of the developed capitalist core, but instead reinforces it (Carroll, 2007).

CHAPTER 7

Conclusion

7.1 General conclusion

Today the asserted existence of the 'network society' (e.g. van Dijk 1991, Castells 1996), and claims that multinationals are the essential unit of global production and integration, as stated in the *World Investment Report*, 2002, have become more evident than ever before. Although economic, social, political and technological networks are said to hold the modern world together, there is a lack of empirical understanding of what business networks actually are (Todeva, 2006), especially where this concerns the economic networks between cities worldwide (Taylor, 2004). As previously discussed, this is because city network data is not easy to obtain and therefore extremely scarce (Smith and Timberlake 1995a; Taylor, Walker, and Catalano 2002). In this light, the dissertation makes an empirical contribution, because it is based on unique 'relational' datasets to reveal the 'netscape' of corporate relations that connect cities worldwide.

Before concluding on the specific questions related to the five themes of this dissertation, a conclusion will be given to the general question stated in the prologue. In this, the question was asked, what the specific knowledge of the five studies can tell us about development in our world. Firstly, this study has empirically shown that corporate networks occurring between cities greatly contribute to their hierarchic importance within the world. By aggregating this data to the national level, it has also been shown that there is a strong relationship between national global competitiveness indicators and their transnational connectivity. In this light, it is arguable that the fate of cities is strongly related to their level of integration with other cities within the economic world system. This does not mean that local developments within municipal boundaries are unimportant but that policymakers and developers should compliment and integrate these developments with knowledge concerning the external relationships of cities. Furthermore, because the developers of most cities and nations do not acknowledge or understand the ties that bind them to other cities and nations, underlines the fact that policy and development might be missing a part of the puzzle. In this context there is a strong need to account for various scales that may affect the competitiveness of a city (Asheim and Isaksen, 2002).

The dependency of cities on supraregional and global networks emphasizes the uncanny complexity of the knowledge needed to effectively engage with development. In this context, in a time when sustainable development has become paramount, it is advisable that policymakers and developers start to engage with empirical knowledge concerning the external relationships of their cities and nations. Naturally this means dealing with complex issues and the uncertainty manifested in this. Actions happening far away can detrimentally affect local developments, which to some degree is clear in the recent global recession. In this light, the extreme interdependency of many cities and nations, but also the evident exclusion of most cities and nations from the global corporate system, blatantly challenges the future approaches that will be taken by politicians. The study on different

corporate scales makes a small contribution to this approach in which it is clear that different functional scales of corporate network (local, regional and global) may require parallel scales of policy and intervention. However, the universal disproportionality found in all three scales of network also challenges us to question what the network distribution of a sustainable world might be and whether this would be economically viable in a world which appears to have always been subjected to this unevenness. Naturally this brings us back to the heart of the matter discussed in the development scheme in the prologue, namely scarcity. If it is true that scarcity is the natural state of humanity (Hobbes, 1651) and that the economy is a continuous process of generating and overcoming scarcity (Achterhuis, 1988), then it is questionable whether a more 'fair' distribution is possible at all. These are essential questions that cannot be scientifically tested within the constraints of this study. However, the approach, methods and techniques used in this thesis can arguably someday contribute to answering this problem.

Evident in the five studies is that urban and national performances are strongly related to corporate interdependency. However, this connectivity is largely held by and between a handful of developed cities and nations. Hence, although our corporate system has evidently achieved a higher level of global reach, it has not reached a higher global scope. The hegemony of the system clearly emphasizes the strong competition between corporations, as shown in the studies, in which they struggle for markets. As seen, this competition is not generic, but instead highly selective. Not all cities and nations are contenders! The corporate competition between cities (network) and nations is strongly related to the development and competitivity levels of cities and nations (place). In this light, the study contributes to a new vision on development because it shows how cities and nations have a relative, highly specific understanding of their positions (centrality) and interdependencies with other cities and nations (linkages). To developers and politicians this means learning to operate between global forces of economic production and local ideals on the production of space (Lefebvre, 2003). In this way, it is important for cities to unravel why certain cities are more capable of attracting and sustaining global headquarters and subsidiaries (Markusen, 1996).

Furthermore, the complexity of such networks (Byrne, 1998) already suggests the virtual impossibility of fully controlling them (Portugali, 2002). Hence, planning may need to drop blue-print type plans and instead work more on the basis of adaptive scenarios (Neuman, 1998), in which planners are superseded by managers of development (Teisman, 2005). In a world where inter-corporate activities between cities have strongly transcended the previous constraints of nations, the roles of cities have evidently become more important to urban innovation and development (Acs, 2002), in which it is imperative that cities take more responsibility for their own actions, and start to depend less on national governance. For example, this is clear in the development policies of Rotterdam, which nurtures strong reliance on national interventions. However, as the results show, Rotterdam although a significant international port, has limited importance within global and European corporate networks. This is reflected in its lesser prestige amongst the other main Randstad cities. In this context, it is advisable that cities start to comprehend their network relationships to other cities and utilize this knowledge in their development policies. This means strengthening collaborations with existing and future partner cities, even if those cities are also competitors. Cities like Eindhoven have already demonstrated that this is possible, with good effect! Strengthening corporate networks means improving existing relationships

between industries in different locations, but equally means developing innovative new industries which compliment the existing ones. This is important when considering that many geographical scales simultaneously influence a city's innovation processes (Malmberg and Maskell, 2002). By revealing the functional and geographic nature of the external environment, network analysis can serves as a useful tool for urban development.

Finally, the studies on the five characteristics of networks, as captured in the scheme **(Figure I)**, contribute to a possible new theory on development, in which it is proposed that development in a globalizing world, can only be effectively achieved through a global approach. This means a view where the network society is seen as being embedded within a continuous historical process, in which temporality, structure, scale, scarcity and performance are eternally interlocked within networks.

7.2 Specific conclusions

As conferred in the first chapter, the 'network society' is not a recent occurrence, but instead a snapshot in a historical process. This means that the network characteristics investigated in this dissertation i.e. *structure, scale, competition* and *performance,* are momentary results within a *temporal* trajectory. These five characteristics have been investigated, each under a separate chapter. In the 2nd chapter, the temporal development of global city networks and how this has gradually undermined the power of nations, has been explored. This is followed by the 3rd chapter which explores the centrality and structure of contemporary worldwide corporate networks, at city, national and supra-regional levels. The 4th chapter has investigated the relative importance of cities within comparative global corporate networks, while the 5th chapter focused on a new analytical model to measure urban competition on the basis of corporate ties taking place between cities. Lastly, the 6th chapter investigated national competitiveness in relation to the geography of global corporate networks. Conclusions derived from these six chapters will now be briefly discussed. Following this, the last part of this chapter will reflect on how the dissertation contributes to society and more specifically my previous profession 'urban planning', as has been discussed in the prologue.

In the introductory chapter an overview has been made of how geographic models have conceptually transformed from the end of the 18th century to our current phase of globalization. It has been argued in this study that this period has represented an explosive break with previous times, due to fundamental economic transformations such as price convergence, expansive trade, the unparalleled accumulation of physical and human capital, plus technological innovations and declining transport and communication costs. Increased trade has allowed cities to specialize in commodities in which they are most efficient, hereby leading to an increased diffusion of products, services and technologies, and the subsequent integration of international markets. This fragmentation of production processes and geographical reorganization and relocation of firms has weakened the age-old limiting factors of physical distance and political boundaries. Nonetheless, bold assertions stating that this process has led to 'the end of geography' (O'Brien, 1992), 'the world is flat' (Friedman, 2005) or 'the death of distance' (Cairncross, 1997) have been contested in chapter 3 and 6 of this dissertation. This will be stressed in more detail later on.

Furthermore, it has been discussed that the emergent network of trade relations has slowly transformed the world from what was previously a political map of states, that simply premised international relations, to a network of multinational corporations operating between various cities, and largely beyond the confines of the state (Taylor et al, 2008). In this way, it has become clear that multinationals have become the central actors of today's world. Therefore, it has been of interest in this study to empirically reveal what today's transnational and intercity corporate networks are. For this reason the first part of the introductory chapter starts with the inauguration of the nation-state (1648) and discusses how the influence of multinational corporations has grown ever since. Based on this period, it has been shown how economic geography models have transformed from Von Thünen's notion of the 'Isolated State' (1826) to today's more sophisticated models of global urban networks. At the time, the model of the Isolated State already held most of the characteristics common to modern geography, such as core and periphery cities, transport linkages, national boundaries and land price variations. Because of improved transport innovations and growing trade this isolated model started to transform to a network model connecting various cities and nations. The key change over time has been the awareness of increasing interdependencies and the growing scale of networks, plus the subsequent variation of urban centrality and structure within these networks. For instance, Christaller's 'central place' model was oriented towards regional and national scales, while later on, Friedmann's 'world city' model emphasized the entire scale of today's urban system. Leading from these studies, the introductory chapter has shown how the conceptions of global city networks have become more and more sophisticated and measurable over time. In this manner, one of the major changes has been that network conceptions have transformed from simple hierarchic models, with one-way 'vertical' connectivity; to reciprocative models in which there is an increased two-way 'horizontal' relationship between headquarter and subsidiary cities (Taylor et al, 2008). These structural changes are strongly related to improved transport and communications that have enabled multinational corporations to take advantage of markets and production sites across the world. It is these powerful firms which strongly define the hierarchy of cities and not the cities themselves (Pred, 1977). The international division of labor resulting from these firms has led to increased global reach. Nonetheless, as discussed by Hymer (1972), the emergent structure of the world economy also mirrors the uneven distribution of labor found within the organizational structure of firms themselves. In this sense, cities have been organized into core, semi-peripheral and peripheral functions, according to the types of firms they accommodate (Friedmann, 1986). Unlike Christaller, Friedmann showed that world cities are no longer defined by population size and spatial proximity, but instead by the extent of their integration within the global economic system.

In the introduction it is also shown that the importance of the more generically defined world cities of Friedmann have been contested by Sassen (1991) and Beaverstock et al (1999), emphasizing the specific importance of advanced producer service companies to the world economy, because these firms control, coordinate and facilitate global production processes. These specific networks have been explored in chapter 3 and 5. The introductory chapter also discusses the importance of different scales of network, distinguishing regional, national and worldwide systems (Camagni, 1993). This emphasizes that the hierarchy of a city can vary within different 'horizontal' orders of relationships, but also that certain cities can 'vertically' intermediate between horizontal networks. These conceptual ideas are investigated in the fourth chapter, which is unique because no

empirical research exists that compares different scales of worldwide corporate network. However, as discussed in the introduction, several studies do exist that empirically explore individual corporate networks. For instance, Taylor (2004) investigated the global network of advanced producer services; while the entire world city network based on all industrial sectors, has been explored by Alderson and Beckfield (2004). However, these studies utilize different types of data and methodology, hereby resulting in different opinions concerning the nature of intercity networks. Therefore chapter 3 effectively compares these studies within a consistent dataset, allowing for results that are more comparative than usual. Based on these more general conclusions, the next section will more specifically conclude the five main chapters of this dissertation, namely temporality, structure, scale, competition and performance.

7.3 Conclusions on temporality

Unlike the 1st chapter, which aimed at investigating how conceptions and models in economic geography have changed over time, the 2nd chapter firstly questioned the historic development of intercity networks over time in relation to specific technological and economic innovations, which took place since the advent of the Industrial Revolution up until today. Secondly, it has been questioned how these innovations have affected the emergent structure of worldwide city networks. In this way, the temporal chapter argues that the importance of any individual city is strongly related to its role in the changing worldwide network. In this way the second chapter has made a theoretical contribution to literature because the evolution of city networks have been consistently investigated, starting with the advent of the Industrial Revolution and proceeding to the contemporary phase of globalization. The has been shown by exploring the spatio-temporal development of city networks within five phases of technological innovation: (1) water power, iron, and textiles; (2) steam power, mechanization, and railways; (3) electricity, steel, and heavy engineering; (4) oil, motorization, and mass production, and finally (5) information and communication technologies. For each period, the related technological and economic innovation has been explored, followed by a study of how this impacted the formation of physical and economic networks between cities. From this, it has been argued that the contemporary global network system is the incremental result of an evolutionary process. Furthermore, each period has been illustrated with a geographic information system (GIS) map to represent the related phase of network formation. Through this approach the subsequent four chapters could be considered within a historical context. In this study it was discussed that not only did intercity linkages diversify and strengthen over time, but more efficient technologies have led to faster and higher volumes of exchange between cities, leading to an exponential increase in urban populations over past centuries. Furthermore, core, semi-peripheral, and peripheral relationships have developed over time into an increasingly complex structure. The cores have become locations of leading technologies and central markets, revealing the diversity and intensity of connections that they have with semi-peripheral and peripheral cities. By mapping these different industrial epochs the evolution of economic networks over time has been demonstrated, showing that corporate interaction has become increasingly intense. Furthermore, in this study it is shown that firm turbulence (mergers and bankruptcies) have escalated towards the beginning of the twenty-first century, after which it has again declined up until 2005.

It has been argued in the temporal chapter that expanding markets have led to the proliferation of new economic cores, starting with the European core, then North American core, and more recently the Asian core. However, it is also seen that although primary cities in these cores have always displayed increasing global reach to distant places; it is also evident in the GIS maps that regional and local markets have expanded as well. From this it is asserted that increased transnational interaction has simultaneously led to the propagation of regional and local sub-centers, consisting of networks of generally smaller types of firms. In this way, previously isolated areas have slowly integrated with the global system. Hence, the maps have served to illustrate an expanding patchwork of local, regional and global corporate networks. Furthermore, it is seen in this chapter that a periodic shift of industrial sectors has occurred over time, in which agrarian industries have gradually been complimented by manufacturing, information and service industries. Therefore it is also argued that different industrial sectors will lead to different types of network structure and urban hierarchy. This has been empirically explored in chapters three and four. Furthermore, the temporal chapter also discusses that increasing scales of urban interaction have also led to a rising number of cities which collaborate and compete within the network. This has been thoroughly explored in chapter 5. Furthermore, it is discussed that improved transport and communication technologies have facilitated capital investments and the widening of regional and international markets. This has led to further diversification of the global economy and increased competition. Over the centuries we see that primate cities gradually shift in position. This has been Amsterdam, London and currently New York. Furthermore, more cities appear to join the system over time in which the density of competing cities increases. Previously established technological networks are conditional to the establishment of future networks and technologies such as shipping and airline routes and ICT cables. In a sense, a stacking of network technology is evident. Besides already established networks, new expansions are also found to previously unconnected regions. In this sense, new nodes and hubs also appear to proliferate, for instance in South American and SE Asian regions.

Furthermore, this study has shown that the development of nation-states has played a vital role in developing powerful cities and urban networks. In this light, previously city-centered economies have gradually organized into state-centered ones. Characteristic of this development is the unparalleled increase in urban populations, for example Europe's population since the 19th century which more than quadrupled and became more prosperous than ever before (Bailey, 1999). In this context, it is has been the core cities and nations that have formed the primary markets driving each period and which have consequently served as areas where politics, science and culture can thrive. Furthermore, as discussed in this chapter, network formation initially concerned the development of physical networks, while later this was complimented by corporate and managerial networks, leading to higher coordination levels and efficiency of the urban system. In this context it is arguable that over time the number of factors determining the locational choices of firms may have grown. This relates to the competitiveness of cities and nations. The relationship between national developmental indicators and corporate network strengths has been thoroughly investigated in chapter 6.

7.4 Conclusions on structure

Leading from the conclusions of the temporal chapter, the 3rd chapter argues that the importance of cities in a globalizing world should be defined by their hierarchical positions (nodal centrality) in relation to other cities, and their interdependence (linkage structure) with one another. This has been empirically explored, based on a dataset concerning the top Fortune® 100 global multinationals and their worldwide subsidiaries. Firstly, it has been shown that these firms claim a disproportionate share of the total revenue of all firms listed in the Fortune® 500 list, and that this contributes far more to world GDP than the remaining 400 firms. Furthermore, in terms of centrality, it has been discovered that the economic ties found within the municipal boundaries of cities, form a remarkably small part of overall corporate connectivity found in the dataset. This confirms that today important cities obtain relative importance by what flows between them, rather than from what remains fixed within them (Amin and Graham 1999, Castells 2001), and underlines that the boundaries of world cities are not confined by territorial borders, but by international patterns of interaction (Friedmann, 1986). It has also been reported in this chapter that only 17% of all 2259 cities in the dataset, exhibit outdegree (outbound) linkages, in which New York, Paris, Tokyo and London are shown to rank highest, together claiming 25% of all outdegree ties. The study confirms that most corporate activity is conducted by only a handful of cities (Geddes 1915, Hymer 1972, Wallerstein 1979). Moreover, the results are consistent with Alderson and Beckfield's observation that cities that send more ties capture more of the world's control functions, by which the distribution of power is highly skewed. Furthermore, this study has reported Zurich, Dusseldorf, Munich and Amsterdam as important secondary cities.

Where outdegree has been shown, to express the economic power of a limited number of developed cities over others, indegree (inbound relations) is shown to be highly dispersed over many cities. In fact, of the 2259 cities found in the dataset, all hold some level of indegree. Furthermore, in terms of indegree, the top ranks are also claimed by cities in developing nations, such as Singapore and Hong Kong. This confirms Hymer's supposition (1972) that a strong diffusion of industrialization to developing nations will exist and that intermediary activities will concentrate in middle-range cities. Furthermore, it is shown that unlike Alderson and Beckfield's results, outdegree and indegree in fact correlate weakly, hereby indicating that cities with high 'command' do not necessarily have high 'prestige.' Therefore, in the case of this research, indegree more likely represents the dependencies of powerful commanding cities upon a wide array of subsidiary cities. Also, unlike Alderson and Beckfield (2004), a strong correlation is found between outdegree and betweenness. This suggests that cities with strong control (power) over others are also likely to play strong intermediary roles in the relationships taking place between other cities (brokerage). Additionally, it has been found that when observing the outdegree network generated by all industrial sectors, a superior match is found with the rankings of other 'world city' studies, while a far poorer matching is found with 'global city' research. In a final cross-match between the lists of all six observed studies, a general consensus was found that New York, London, Paris, Tokyo, Chicago, Dusseldorf, Frankfurt, Munich, and Zurich are the most important cities today.

Next, by focusing on only the producer service network, it was shown that this sub-network corresponded better to global city types of research, which similarly frelate to producer services. The results have confirmed that the match between the producer service data of this study and the lists of other studies increases significantly, with a 100% match for the top ten cities. London, as in other global city studies, proved to be the primary city of the advanced producer service network. Based on these analyses, it is shown that the classification of global or world cities is simply a matter of industrial specification. Hence, global cities are simply a subset of world cities. This finding is particularly interesting to the theoretical discussion stated in chapter 3, concerning global city and world city approaches. By comparing these approaches on the basis of one dataset, a contribution has been made to improving conceptual and empirical consistency within such studies (Derudder, 2005).Furthermore, it has been shown that cities like Hong Kong, Singapore, Jakarta, Johannesburg and Mexico City play a significant role in the worldwide networks of producer services. Also, it is verified that far less cities count as being global (in terms of producer service ties) than as world cities (in terms of all ties), hereby confirming Sassen's (1991) statement that specialized producer services will be concentrated in relatively fewer sites. It is also shown in this chapter that although reciprocated ties between cities are allowed for in the analysis, today's corporate system remains particularly hierarchical, where vertical ties still largely dominate over horizontal ones.

Answering the second question, concerning network unevenness, it has been empirically shown that the spatial distribution of today's multinational network is clearly disproportionate, polarized into three core regions, namely North America, Europe and Asia Pacific. Furthermore, it is shown that the highest intensity of corporate activity prevails within the transatlantic zone between Europe and North America. It is shown that a North-South divide still persists, in which Africa proves to be particularly marginalized, claiming a mere 1% of all corporate ties. In turn, this corporate network is seen to follow a power-law statistical distribution, characterized by the fact that only a few hub cities hold the majority of all connections, a feature common to many self-organized systems (Barabási, 2003). Furthermore it is shown that the strongest ties are almost entirely between developed cities. Therefore, although many cities participate in the global corporate network, the majority of their ties are particularly weak, while the core of the world corporate network remains restricted to a few privileged cities.

To further verify the above observation, an analysis was carried out concerning the distribution of ties from New York, Paris, Tokyo and London to various nations around the world. From this it became evident that New York, although claiming the highest outdegree of all cities, only has 40% of its ties to cities outside the US, making it the least internationally connected of the four hub cities, followed at second place by Tokyo. In this sense, it was asserted that New York's centrality is primarily derived from its prominence within corporate America. Of the four hubs, Tokyo discloses the weakest diversity of connections to other nations, and moreover it has a preference for in-region nations such as China, Singapore, Thailand, Taiwan and Malaysia. Paris on the other hand proves to be not only second in the total number of corporate ties, but also is shown to be the second most internationally connected city in the world. It also has the highest diversity of nations to which it connects, meaning that it is the most integrated of the four hub cities. This is an interesting finding seeing that Paris is often sdepicted as being a weaker global city, even regional type city (Friedmann, 1986). Furthermore, although London holds the lowest outdegree

of the four hubs, it does prove to be most strongly connected to other international cities. However, London's diversity of connections is lower than those of New York and Paris, but higher than those of Tokyo.

Next, by observing the distribution of connectivity over supra-regions, it has become evident in this study that North America, Europe and Pacific Asia together claim 98% of all outdegree relations and 82% of all indegree. Hence, these areas claim an extremely uneven share of world economic power, while simultaneously the world appears to be highly dependent on them. Furthermore, 82% of all outdegree ties are strictly between these three core regions, again showing, but at a higher level of aggregation, that the majority of the world is marginalized from the global corporate system. These findings confirm Carroll's (2007) claim that the hegemony of cities in the 20th century is simply being perpetuated. This means that the system has not changed much over the past few decades. Nonetheless, as argued in chapter 3, caution should be taken in stating that this disproves the existence of a new geography of marginality and centrality (Sassen, 1991), because, as with previous studies, this research is based on cross-sectional data. Instead, answers to such questions will depend on longitudinal research and more thorough network specifications.

7.5 Conclusions on scale

The 4th chapter reveals the different types of networks formed by multinational headquarters of different sizes and geographic localities (global, European and Dutch firms). In this way the study has contributed to related literature by empirically confirming the theoretical assumptions that cities are today strongly dependent on their transnational networks (Van Oort et al. 2006; Taylor et al. 2008) and that firms obtain different meanings within local, regional and global networks (Van der Knaap 2007). Furthermore, based on the study on 'cliques' in the different datasets, it has been confirmed that both hierarchical 'central place' structures (Christaller, 1933) and non-hierarchical network structures exist (Meijers 2007; Taylor et al. 2008), in which a 'dual system' of understanding has been demonstrated (Hohenberg & Lees 1985, pp 58-59).

Furthermore, because all three datasets represent exactly the same worldwide cities, the comparisons are methodologically consistent. By analyzing the centralities and structures of the three network scales it has been shown how the relative importance of cities differ in each network. This study reveals a different perspective on cities, considering that most developmental policy places emphasis on the spatial proximity of cities. For instance, the importance of the Randstad agglomeration is often discussed in terms of the economic coherence between its four largest cities (Van Oort et al, 2006). Instead, this study has revealed the importance of urban hierarchies, when only considering functional relationships between cities – and at three separate scales of corporate data.

In the global dataset it has become clear that New York is 1st in terms of both headquarter and subsidiary relations, and that its dominance is in command functions. However, as shown in chapter 3, most of this connectivity is found within the boundaries of the US. Düsseldorf proves to be 2nd, Munich 3rd and Zurich 4th, forming together with New York the top global headquarter cities. Furthermore, London at 6th place, Paris 7th and Tokyo 22nd

proves to be weaker than often claimed. Concerning the Randstad cities, it has been shown that in terms of outdegree, Amsterdam ranks 9th and The Hague holds 11th position in the global corporate network. Furthermore, it is seen that Rotterdam and Utrecht do not play an important headquarter role within the global system. However, in terms of subsidiary relationships, Rotterdam and Utrecht do claim moderate importance. It has also been shown that when summing up the connections of these four Dutch cities, their combined strength only reaches 5th position. Hence, the Randstad's position within the global dataset is predominated by the corporate activities of Amsterdam! Regarding linkage strengths within the global dataset, Amsterdam proves to have strong command (outdegree) over subsidiaries in Paris, Brussels and Hong Kong, while alternatively Amsterdam reveals indegree relations with headquarters in Brussels, Paris, Dusseldorf and London. This evidence demonstrates the two-way flow or interdependence between cities, discussed in Taylor et al's (2008) 'central flow theory'. Regarding the structure of the linkages between cities it has been shown that Paris, for example, principally commands over other cities. For instance, Paris has strong outdegree ties with New York. Similarly, London has strong command over New York. Furthermore New York proves to have strong national but moderate international presence. London proves to have strong command over Hong Kong and Singapore. Tokyo is seen to be well connected to London, but besides this is entirely connected to Asian cities, such as Taipei, Bangkok and Hong Kong. It is also evident that Tokyo's strongest ties are particularly directed to Kawasaki and Osaka, indicating that Tokyo is essentially important to Japan. In terms of the Randstad, it is evident that both Amsterdam and The Hague play secondary roles in the global system, each specifically connected to Paris and London. In a specific analysis on the formation of network cliques (see chapter 4 for further explanation), it is shown that in the global system there are 680 unique cliques of different sizes. However, in clique analysis, the largest clique is of most interest to researchers, because there are relatively few of them, and these arguably represent the largest units of completed 'horizontal' network. Hence, there are 16 large cliques in the global networks. Important cities prove to be, Amsterdam, Brussels, Dusseldorf, Frankfurt and The Hague. These sub-networks together hold the majority of all global corporate activity. Furthermore, these networks are regarded to be 'horizontally connected' because each city is connected to every other city. Because some cities are common to different large cliques, they serve as intermediaries.

In the European corporate network, it is shown that the importance of Paris and London increases to 1st and 2nd position, relative to their ranks in the global network. This is evident in both headquarter and subsidiary functions. Similarly, the hierarchic positions of Randstad cities within the European network reveal higher rankings than in the global dataset. In this it is clear that Amsterdam ranks 4th as a headquarter city, showing that it is stronger within the European network than the global one. Furthermore, it is shown that Utrecht and Rotterdam have achieved moderate headquarter status within the European network, while The Hague's headquarter status has become relatively less important. This is possibly because its petroleum operations (Shell) are more important within the global network than that of Europe corporations. In this dataset, Amsterdam, for instance, proves to have strong outdegree ties with London, Zurich and Tokyo, but is at the same time controlled by headquarters in Paris, Vevey, Munich, Brussels and London. Regarding the structure of linkages in the European corporate system, it is seen that not only is Paris stronger than London in terms of total connectivity, but it also has a much higher diversity of connections to other cities. Therefore, Paris is well integrated with various global cities

and its strongest links are with London and Brussels. However, unlike the results of the global network, Paris appears to have no connection to Montreal, although it is well connected to Hong Kong and Tokyo. Similarly, within the European network, London is not connected to Hong Kong and Singapore, although this is so within the global network. Similar to the global network, Amsterdam and The Hague both play a secondary role within the European corporate network. Similar to the global dataset, a clique analysis was carried out, in which London, Munich, Paris, New York Amsterdam, Frankfurt and Tokyo form the prime cities. Furthermore, the European network proves to contain much larger cliques than the global network, hereby revealing more integrated and completed structures than was the case of the global network.

Within the third dataset, the Dutch worldwide network, it has been demonstrated that in terms of headquarter relations, Amsterdam ranks 1st, Utrecht 2nd, Rotterdam 3rd and The Hague 4th. Furthermore, in terms of indegree, Dutch subsidiaries in this network prove to be far more important to international cities like London and Paris than to their proximate Dutch cities. This shows that the main corporate relations of the Randstad are with cities outside The Netherlands. Within this network, Amsterdam's strongest outdegree linkages are to Paris, while Rotterdam is shown to be primarily connected to London. The results reveal that Utrecht is particularly connected to Amsterdam, although it also strongly connects to cities like Luxembourg, Brussels and Willemstad. In turn, The Hague (particularly due to Shell) is seen to be firstly linked to Wilmington, owing to Wilmington's importance in the world of petroleum insurance. Looking at the internal relations between Dutch cities, it is clear that Amsterdam and Utrecht are powerfully connected; forming a strong northern region, while Rotterdam and The Hague hold very moderate ties with each other. More importantly, the former two cities are weakly connected to the latter two cities, verifying that contingency between Randstad cities is relatively weak (Van Oort et al., 2006).

Observing the overall results of Randstad cities within the three datasets, Amsterdam's importance at all scales is obvious. The Hague proves to rank high at global and Dutch network scales, while Utrecht and Rotterdam only obtain importance in the European, but particularly Dutch, corporate scale. Furthermore, it is seen that other Dutch cities show little importance within global, European and Dutch networks, although this does increases the Dutch corporate scale. Furthermore, the four Randstad cities tend to operate more with international cities than with other Dutch ones. Hence, by studying urban hierarchies within different scales of corporate networks it has become clear that no individual network can give complete insight into the nature of cities. The fact that all three datasets reveal entirely different knowledge about the roles of Randstad cities in corporate networks can be interesting to different levels of governmental policy. For local Dutch policy, for instance, the strengthening of ties between Randstad cities can be of interest, as well as the reinforcement of ties to other international cities e.g., London and Paris. At the global scale, the powerful role of Amsterdam and The Hague within the world economy can be interesting to Dutch international policy. However, it is stressed that The Hague's strength is essentially due to the presence of Shell in this city. In light of this study the different meanings of cities in different functional datasets can lead to specific policies tailored to corporations of a certain type. From this knowledge, policy could be aimed at strengthening already existing ties to national and international cities or facilitating the emergence of new ties to unconnected places. By understanding Randstad city's economic position and linkages to other cities worldwide, future policymakers may start to engage with competitor

and collaborator cities that are 'specifically' important to them. In this way, not only the strengths but also diversity of corporate relationships can be developed. From this the ultimate challenge would be to understand the relationship between the agglomeration economies of cities and their relationships to distant hinterworlds. Furthermore, an important finding is that the three independent networks all prove to hold almost identical power-law distributions. This shows that regardless of scale, corporate networks are highly disproportionate, 'self-organized' systems (Axtell, 2001, Barabási, 2003). It seems that the disproportionality amongst firms, originally discovered by the economist Gibrat (1931) still persists. From this apparently universal tendency it becomes questionable whether the unevenness of corporate systems can be changed, and if so, what the statistical distribution of a more evenly spread network might be? This question can be interesting to policy concerning sustainability in The Netherlands, Europe and the world. Lastly, because Randstad cities prove to be far more dependent on international cities than on local ones, it is interesting to reconsider, in this light, policy concerning the future of the Randstad. Hence, the usual view that local cohesiveness and geographic proximity are essential to strengthening the Randstad's economic performance might need to be revised. Seeing that approximately 70% of Dutch corporate connectivity is transnational, it appears important that governmental policy equally starts to address the improvement of corporate relationships with cities and nations beyond Dutch political boundaries.

7.6 Conclusions on competition

In the 5th chapter it is discussed that in the modern economy, cities are generally assumed to be in fierce competition with each other. In recent decades, the urban studies and planning literature has strongly acknowledged that cities compete in terms of product markets, inward investments, the establishment of firms, population, tourists, hallmark events and government funding (Harvey, 1989; Lever and Turok, 1999). In this sense, cities have to work on their 'competitiveness,' in attracting firms and workers, in order to maintain or strengthen their position within the urban hierarchy and hence increase their standard of living (Porter, 1990; Storper, 1997). As a result, city marketing and city branding have become a 'booming business'. This increased interest in 'urban competitiveness' has led to a substantial number of urban ranking lists, in which cities are compared on the basis of their economic performance. However, despite the rich theoretical discourse concerning these 'place wars,' little attention has been paid to empirically measuring the intensity of competition between cities. Therefore, by analyzing corporate networks between cities, this chapter has made a contribution to theory on urban competition by showing how a relational understanding of competition can be determined based on corporate network interdependencies.

By using insights from evolutionary and organizational ecology, a particular technique has been introduced to estimate the degree of competition existing between cities, based on concrete patterns of interaction (networks) between the cities. Furthermore, this approach relaxes the stringent theoretical assumption that all cities compete with each other, where instead the competitive strength of individual cities is estimated and the clusters of competitive cities identified. Using insights from niche overlap theory (e.g. Hannan and Freeman, 1977), this study has developed a new indicator to measure the intensity

of corporate competition between cities, based on the functional linkages that these cities have with each other. Therefore it is important to note that this measure is not the same as connectivity between cities (outdegree and indegree), used in chapters three and four. Competition is a measure of how much cities compete for the same market, while connectivity is simply a measure of how integrated cities are. The data used in this study concerns global financial centers and the network of advanced producer services that connects them. Using the new technique, the degree of competition that a city holds relative to other cities in the network was calculated. The dataset concerns urban competition between the twenty strongest producer service cities. The analysis examined to what degree the connections of these twenty cities to all other cities in the network, are similar (market overlap). Applying the new measure, a matrix of the intensity of competition between twenty financial centres in the world city network was found.

Looking at the overall pattern of competitive relations, a number of empirical observations have been made. First of all, competition between cities for advanced producer services has a strong geographical dimension. Hence, the intensity of competition between cities that are geographically proximate is shown to be stronger than the competition between cities that are geographically distant. This confirms that distance and proximity do in fact matter to urban competition. This means that urban competition is generally strongest between cities within the same supra-region, for instance Pacific Asia. The results show that in general the intensity of competition between cities situated on different continents is poor to average. Moreover, strong intensity of competition between cities situated on different continents is shown to always involve at least one primary world city (e.g. London or New York). This is not surprising, as these primary cities serve a diverse geographical market with larger geographical scope than do other cities in the world city network (Derudder and Witlox, 2008). Furthermore, by applying a hierarchical cluster analysis to the resulting competition coefficients, two major clusters of contending cities have been identified, namely the Northern Transatlantic Seaboard (London, Frankfurt, Zurich, Paris, Amsterdam, Brussels, New York) and Pacific Asia (Tokyo, Osaka, Hong Kong, Singapore). From this it is also inferred that the intensity of competition that Tokyo receives from the other global cities e.g. London, New York, and Paris, is particularly limited. Whereas Tokyo's commanding intercity relations are primarily directed toward other Asian cities (over 70%), the commanding intercity relations of New York and Paris are predominantly directed towards European and North American cities. London holds the strongest competition of all cities, linking various cities in Europe and North America, but also to Pacific Asian cities e.g. Hong Kong and Singapore. These findings stress that not all world cities serve the same 'hinterworld' (cf. Taylor, 2001; Taylor and Walker, 2004).

Moreover, the results show that competition is fiercer between cities at the top of the urban hierarchy. Smaller world cities such as Atlanta, Berlin, Toronto, Dallas and Madrid face relatively little economic competition from the other world cities. This is possibly because the commanding relations (outdegree) of these cities, tends to be limited to their immediate regions. In other words, these cities have a relatively 'regionally oriented' hinterworld. For example, over two thirds of the commanding relations of Madrid remain within Southern Europe, connecting to cities like Barcelona and Milan. Likewise, over 90% of the commanding linkages of Toronto do not leave Canada. This verifies research conducted by Derudder and Witlox (2008), who found, based on airline data, that the intercity relations of the most important world cities, in terms of network connectivity, are predominantly

global in scope, while the intercity relations of the less well-connected cities in the network have a more regional scope.

7.7 Conclusions on performance

In the 6th chapter, it is argued that the integration of nations is strongly related to multinational networks. Although the process of globalization is not entirely new, it is clear that in recent decades significant shifts have occurred, as the capacity to produce and export manufactured goods has dispersed throughout an ever-expanding network of peripheral and core nations (Dicken, 2003). Today, the production of commodities spans more nations than ever before, with each nation performing specific tasks in which it has a comparative advantage (Gereffi, 1994). Facilitated by reduced transportation costs and advanced communication technologies, this interorganizational system connects firms and states to form the today's global economy, resulting in a greater functional interdependence than ever before (Hirst and Thompson, 1996). However, although it is often proclaimed that we live in a 'globalized world' (Friedman, 2006), in which economies are said to be converging, this study shows that even though the corporate 'reach' of multinational corporations is clearly global, the 'scope' of their transnational interaction remains particularly limited. Hence, contrary to popular literature, transnational corporate networks are shown to be mostly restricted to interactions between developed nations, revealing a disproportionate system. By focusing on the transnational corporate network of sharehold relationships between the global Fortune® 100 multinational headquarters and their many subsidiaries, it is shown in the 6th chapter that the developmental levels of nations, in terms of competitiveness, mirrors the disproportionality found in the global corporate network.

The corporate network data used in this study has helped to transcend the usually atomistic descriptions of cities, hereby enabling empirical knowledge of the interdependence between places (Alderson and Beckfield, 2004). These corporate networks represent approximately one third of all OECD revenue (2005), and are almost entirely based in developed nations in North America, Europe and Pacific Asia, particularly in the transatlantic zone between Europe and North America. Furthermore, besides revealing the structural composition of the contemporary global corporate system, its skewness has been clarified by means of explanatory variables, namely the competitiveness and market-size indices of the world's nations. This has been done while controlling for other national (openness, remoteness) and bilateral (geographical, cultural, and economic distance) variables. The research has explored two research questions that have focused on describing the structure of the corporate network, firstly in terms of national headquarter centrality (total headquarter outdegree and total subsidiary indegree) and secondly in terms of the corporate connectivity 'between' nations.

Regarding headquarter connectivity, the results confirm that both the level of competitiveness and the market size of nations show strong coherence with the total number of 'outdegree' headquarter linkages that a nation has. Hence, the competiveness indicator has served to capture both the 'qualitative' aspects of national economies and the 'quantitative' aspects of market size. In this study, Porter's (1990) observation that the endowment of a multinational headquarter's home base plays a vital role to its success, has been

demonstrated. These clustered factors include infrastructure, resources, effective business systems and labor processes, but also the reassurance of a more predictable and sizeable market (Cantwell, 1995). These variables have been captured in the independent variables that were used. In this light, the most important theoretical contribution of this chapter is that it has united Porter's work on the competitive advantage of nations to Friedmann's world city hypothesis.

Furthermore, the results show that the total subsidiary 'indegree' connectivity of nations reveals outcomes similar to that of headquarters, except that the effect proves to be smaller in all cases. Although competitiveness and market size do matter to the strength of both headquarter and subsidiary connectivity alike, the impact of a nation's competitiveness and market size is apparently far more associated with headquarters than with subsidiaries. This arguably is because multinational headquarters are located in a handful of developed nations, while subsidiaries, as shown in chapter 3, are abundant in, developed and developing nations alike. This means that their variance is greater than that of headquarters, as they are likely to be located in nations with differing levels of competitiveness and market size.

Concerning the second question, in which the linkage strengths 'between' nations have been calculated on the basis of national performance indicators, similar results are found. Market size and national competitiveness of both headquarter and subsidiary nations prove to be strongly associated with the contemporary global corporate structure. Nonetheless, the overall characteristics of headquarter nations prove to contribute more strongly to the probability of corporate connectivity between two nations and the volume of their linkages, than is the case for subsidiary nations. In other words, the competitiveness and market size of a headquarter nation is arguably more important to the structure of the global corporate network than the competitiveness and market size of a subsidiary nation. As discussed in the theory, this unevenness derives from the fact that only particular nations are developed enough to ensure the competitive advantage needed to attract multinational headquarters. The results of this study confirm that the world has not changed much since Hymer's (1972) postulation of the corporate unevenness of nations. The headquarter nations of Hymer's era still tend to dominate the global arena, serving as the primary command and control centers of today's world economy. Furthermore, as shown in the second chapter, this structure has incrementally developed over past centuries. It is likely that this structure is manifested through the fixedness and persistence of largely immobile social and physical infrastructures (Harvey, 1982). Hence, these results show that the structure of global corporate power does not subvert the dominance of the developed capitalist core, but instead reinforces it (Carroll, 2007).

7.8 Contribution to societal development

Because this dissertation empirically disclosed the invisible, yet very real network of corporate relationships between cities, it equally shows the structure of the capitalist class, as an organized network across global cities (Carroll, 2007 pp. 2300). In this light, the 'network bourgeoisie' (Taylor, 2004 pp. 214) at the start of the 21st century is exposed as a worldwide system of corporate governance, tying cities, nations and supra-regions together.

Furthermore, this study has shown that our contemporary 'network society' (van Dijk 1991, Castells 1996) is not an entirely new occurrence, but instead has incrementally developed over time. Furthermore, it shows that the vast majority of corporate connections take place 'between' cities and not 'within' them, and that this especially concerns cities beyond the confines of the state. Because it has been shown in this study that key cities tend to be far more connected to international cities than to their local counterparts, it may be interesting for policymakers to reconsider the boundaries of future urban development policies. Because the fate of cities are no longer only related to local central place characteristics (Christaller, 1933), but also worldwide intercity networks (Taylor et al, 2008), developmental policy should start to better understand the confluence of global and local forces. This means, in other words, the confluence between network economies and agglomeration economies. Hence, the common approach of policymakers to focus on only the development of spatial and functional cohesiveness within the boundaries of the state, may need be revised. This arguably means that national and municipal policy should strategically aim at backing local city development with empirical knowledge concerning the economic and social ties of their cities. The operationalization of this falls beyond the confines of this book, where instead this dissertation has focused on revealing the temporal, structural, scalar, competition and performance properties, of worldwide corporate networks.

More importantly a new methodology has been demonstrated, to better understand the ties that bind us. In a recent report by the Dutch government called 'Quality and Future', the incentive to get to grips with these issues is clearly expressed. The report explains that the future of urban development depends on new conceptions of what defines the quality of life, the distribution of this across the globe, and how humanity functions within this system (MNP, 2004). Within this context, the study contributes to the theory of uneven geographical development, by for instance showing the relationship between today's corporate system and the global competitiveness of nations (Porter, 1990). In this context, the research has clearly shown that the world is still far from flat (Friedman, 2005), but instead an extremely spiky corporate system has been exposed. Only a few nations and global cities hold almost all multinational ties, forming a dominant hegemony. The majority of cities and nations are poorly connected, or do not participate at all. Furthermore, it has been shown that the statistical structure found in the three worldwide networks used in this study, follows a power-law distribution, in which it has become clear that New York, Paris, London and Tokyo hold 25% of all 2557 global corporate connections. Because it has been argued that the fate of cities has become increasingly related to their worldwide corporate connectivity (Alderson and Beckfield, 2004) and that the results in this study show that only a handful of cities claim the majority of corporate shares, it raises questions on the structure of this disproportionality. For instance, if it is true that the world economy is converging (O'Brien, 1992; Cairncross, 1997; Friedman, 2005), then it can be expected that the statistical distribution of corporate connectivity will become less uneven. However, because it is said that the stability of the power-law distribution of firms over time is highly robust (Axtell, 2001) and because this disproportionality is found to exist in many natural and social networks (Barabási, 2003), it raises questions on whether this distribution is changeable at all.

Furthermore, this dissertation is specifically interesting to Dutch society, because it shows the extreme interdependency of cities in The Netherlands with other parts of the world. The results have shown that The Netherlands is one of the most economically connected countries in the world. More importantly, it has shown, in three different

scales of corporate data, exactly which cities and nations The Netherlands is connected to (e.g. Paris, London and Brussels), but also the direction of corporate power (command or subservience) that this represents. Because this study has demonstrated that the majority of Dutch corporate connectivity is to cities and nations beyond its boundaries; it raises questions concerning the future of Dutch urban development policies. For instance, how can knowledge on the global relations of Dutch cities be accommodated into future urban development strategies? Or, what can be learnt of the business networks of competing international cities? In this context, the methodology and techniques used, may represent useful devices to get more specific about inter-relational issues. At a time when The Netherlands is in recession, a new approach to mapping its past, present and future networks might give it an indispensable advantage in understanding its relative position within an increasingly uncertain world. In this way it is imaginable that this type of research can expose the global relations which contribute to the development of The Netherlands, revealing networks of competition and collaboration, and the specific industries that form these networks. Furthermore, it is arguable that longitudinal (time-series) datasets can be used to show causal relationships between cities, (e.g. gross city product and employment levels), and their global ties (e.g. corporate shares, trade flows and FDI). In this sense, it is proposed that the urban development levels of a city can someday be measured in terms of its relative local and global interdependency.

In thisthesis it has been shown that strong corporate connectivity is highly associated to the competitive advantage of cities and nations. Although the analysis in this study has not demonstrated causality between competitivity and network strengths, it has shown strong coherence between these variables. Therefore it is arguable that for a city to improve its performance it must also improve its global connectivity, which would mean further liberalization of trade and investment. Thus, as provocative as it may sound in todays perilous economic climate, freer and more flexible markets are likely to do more for the world economy than protectionism (The Economist, 2008). Hence, a city's prosperity is strongly related to its degree of corporate interdependence with other cities. Inversely, this might also mean that a city's level of development ensures its competitive ability to attract international corporate ties. However, this only addresses the fate of individual cities and does not consider higher uniformity of the global urban system. Recalling the unevenness of the world economic network represented in the GIS maps, it becomes interesting to ponder on what a more evenly globalized world might be (Wall, 2008). Is a more evenly spread corporate network conceivable, in which the diversity and intensity of economic relations to unconnected and weakly connected cities is improved? In this context, there is much controversy in economic theory about whether world development is diverging or converging. Several economists stress that economic inequality has not significantly changed over the last forty years and that the developed world still overwhelmingly dominates world trade (UNCTAD, 2008), while some developmental economists argue that because poorer economies tend to grow faster than richer ones, that eventually all economies should eventually converge in terms of per capita income and productivity (Matthews, 2006). Nonetheless, we should be cautious about such assertions, judging by the corporate disproportionality shown in this dissertation, and the fact that emerging economies are equally suffering from the plummet of the developed world's stock markets (The Economist, 2008).

The liberty will now be taken to speculate on what a more even global corporate system might be, although it cannot be verified at this point. Firstly, because it is shown in chapter 6 that the corporate network is predominated by a handful of nations that almost exclusively connect to each other; it is arguable that a more even global system would hold a higher diversity of intercity corporate linkages. Recollecting that the corporate data used in this study represent company shares, and that this has been shown to correlate highly with FDI and global trade; a higher diversity of connection could mean that nations and cities improve their attractiveness and openness towards firms, hereby encouraging higher levels of trade and investment. It is plausible that a denser network of collaborating and competing cities would benefit a larger share of the world population. To achieve this, cities, nations and supra-regions would need to adjust their trade and investment policies to diversify portfolio of cities with which they connect. Furthermore, reflecting on today's recession, it is imaginable that as more cities become more diversely connected, the global corporate system will become less vulnerable, because opportunities and risks will be more dispersed. Nonetheless, to achieve this, the corporate connections between cities should represent different economic activities (specialization).

7.9 Contribution to architecture and urban planning

In this last paragraph a brief reflection on the significance of this study to urban planning is made. Firstly this dissertation has for instance supported the theoretical arguments of Tafuri in *Progetto e Utopia* (1973) that the architect's hope of creating a better society would eventually be swamped by capitalism; or Sassen's (2003) assertion that urban planning and architecture still need to confront the 'massiveness of the urban experience.' (Sassen, 2003, pp. 402-403). Firstly, it has been shown in chapter 6 that competitivity and development levels of nations and cities are highly associated with their corporate networks. Furthermore, in chapter 3 it is shown that the global corporate network used in this study represents roughly 30% of the GDP of all OECD countries (2005), and that of this network, 84% concerns ties between cities. This supports the view that important cities derive their status from what flows between them rather than what remains fixed within them (Amin and Graham 1999, Allen 1999, Castells 2001). In light of this, it is argued that future urban development will depend on an integrated approach that connects urban development issues within particular cities, to knowledge of how cities interact with each other. In this way it is presumable that the 'invisible hand' of global economics can relate better to the more tangible world of urban planning. The development of such an approach may someday serve as a useful tool to all levels of governance and planning.

Because architecture and planning are said to be 'constantly losing ground' and where new forms of collaboration and modes of expression need to be found (Koolhaas et al, 2005), the results of this dissertation may serves as an interesting context for the development of a new approach to these disciplines. For example, as shown in chapter 5 and 6, having identified the most important competitors of a particular city, it may someday become possible for urban planners to recognize which aspects of urban competitiveness a city should concentrate on in future, in order to surpass its competitors. A city's true contenders can be identified through this type of analysis and at a more detailed level the industrial sectors in which this competition takes place. This kind of knowledge could eventually

clear the way for more goal-directed and effective strategic urban planning and policy-making, with regard to urban competitiveness (Ho, 2000, Van Dijk, 2006). In this sense, planning and policy could become manifest in an interactive understanding between cities and not only within cities. However, as chapter 5 shows, it is important for policymakers and urban developers to realize that not all cities are in competition. For this reason it is no longer necessary to put all cities on the same ranking lists or develop them in an equal way. Hence, future research should not only measure the intensity of competition between cities, but also start to examine the factors of urban competition. For instance, an interesting question for future research will be whether cities of similar size and geographic proximity will be more likely to be in competition? Furthermore, in future, besides only giving an indication of the intensity of competition between cities, competition coefficients can also be utilized in a regression framework to link competition to urban performance. Or, it can be questioned whether cities that receive less competition from other cities are more likely to grow and strengthen their position within the urban system? – and can urban competition explain the growth and shrinkage of cities?

This thesis has managed to take a step forward to map the contemporary worldwide city system. Contributions have been made to theory, empirics and methodology. However, as discussed in the introductory chapter, there are also several limitations. Firstly the network research is based on cross-sectional data. Although this provides a perspective on contemporary global economic networks, little can be empirically said about the past and future of corporate networks, or issues concerning causality. Although the data has revealed detailed knowledge of today's networks, empirically based recommendations on the future of worldwide city networks cannot be given. This is an interesting step for future research, in which the causality between performance and networks can be investigated, or models which could estimate changes in the network. Another limitation of this study is that the networks analyzed concern corporate ties, hereby providing only a partial view of the world. Although these are certainly important networks, other types of economic, social, cultural and political networks will need to be investigated, so as to give a more consistent understanding of the world system. Furthermore, although this research focuses on intercity linkages, the last chapter on performance had to be executed at the national level. As previously explained, this was unavoidable, seeing that no reliable attribute data exist on the many worldwide cities used in this study. In this light, future research can importantly show the impact of intercity networks upon urban performance and vice versa. It is hoped that this study will inspire new questions and that research into the netscape of our world will be continued.

Nederlandse samenvatting (Summary in Dutch)

Tegenwoordig hoort men meer dan ooit geluiden van het bestaan van een 'netwerkmaatschappij', alsmede beweringen dat multinationals de wezenlijke maatstaf voor globale productie en integratie zijn. Maar hoewel economische, sociale, politieke en technologische netwerken blijkbaar de moderne wereld bijeenhouden, begrijpt men empirisch gezien niet goed wat economische netwerken nu eigenlijk zijn, vooral niet als het gaat om wereldwijde bedrijfsnetwerken tussen steden. In dit kader levert het proefschrift een belangrijke bijdrage, aangezien het is gebaseerd op recente, unieke, 'relationele' datasets die nauwkeurig het huidige 'netwerklandschap' van bedrijfsbetrekkingen blootleggen dat steden over de hele wereld verbindt. Desalniettemin is, zoals in Hoofdstuk 1 wordt besproken, het huidige concept van de 'netwerkmaatschappij' niet slechts een recent verschijnsel, maar een momentopname in een lang historisch proces. Daarom verkent dit hoofdstuk verschillende ontwikkelingen van de opvattingen in de economische geografie, zoals Reynaud (1841), Christaller (1933), Friedmann (1986) en Taylor (2004), die hebben geleid tot de meer geavanceerde netwerkmodellen van tegenwoordig. Op basis van deze theorieën zijn er vijf belangrijke netwerkkenmerken vastgesteld, die in de rest van dit boek worden uitgediept, t.w. *tijdelijkheid*, *structuur*, *schaal*, *concurrentie* en *performance*. De onderzoeksvragen ten aanzien van deze vijf kenmerken worden duidelijk vermeld in de 'synopsis' van het eerste hoofdstuk. Daarnaast beschrijft het eerste hoofdstuk tevens de gebruikte gegevens, methoden en technieken.

Tijdelijkheid van een netwerk

In Hoofdstuk 2 wordt de temporele ontwikkeling van de mondiale stedelijke netwerken binnen het globalisatieproces bestudeerd, en wel vanaf de Industriële Revolutie. Daarbij wordt de vraag gesteld hoe de economische netwerken tussen de steden zich sinds de opkomst van de Industriële Revolutie tot aan vandaag hebben ontwikkeld, en hoe dit van invloed is geweest op de ontwikkeling van de netwerkeigenschappen structuur, schaal, concurrentie en performance. Er wordt onderzocht hoe deze ontwikkeling verliep tijdens vijf stadia van technologische vernieuwing: het tijdperk van waterkracht, ijzer en textiel; van stoomkracht, mechanisatie en spoorwegen; van elektriciteit, staal en zware industrie; van olie, motorisering en massaproductie; en tot slot het tijdperk van de informatie en communicatietechnologie. Op deze wijze wordt aangetoond dat het huidige globale netwerksysteem het resultaat vormt van een evolutionair opklimmend proces. Elke periode wordt geïllustreerd met een GIS-kaart die de desbetreffende fase van netwerkvorming aangeeft. Hierdoor worden de volgende vier hoofdstukken in een duidelijke historische context geplaatst. Op deze manier wordt niet alleen belicht dat de tussenstedelijke banden in de loop der tijd varieerden en hechter werden, maar ook dat efficiëntere technologieën leidden tot een snellere en in omvang grotere uitwisseling tussen steden, en vervolgens tot een exponentiële stijging van stedelijke bevolkingen in de afgelopen eeuwen. Daarnaast hebben de verhoudingen in en tussen de kern, de semiperiferie en de periferie zich in de loop der tijd ontwikkeld tot een steeds complexere structuur. In de kernen hebben zich toonaangevende technologieën en centrale markten gevestigd, die de diversiteit en intensiteit blootleggen van de betrekkingen die ze hebben met perifere en semiperifere

steden. De groeiende transnationale interactie hieruit heeft tegelijkertijd geleid tot de verbreiding van regionale en lokale subcentra, bestaande uit netwerken van bedrijven met in het algemeen een kleinere omvang. Op deze manier zijn gebieden die vroeger afgelegen lagen langzaam geïntegreerd in het globale systeem, waarin een groeiend aantal steden binnen het netwerk samenwerkt en concurreert.

Netwerkstructuur

In Hoofdstuk 3 wordt beargumenteerd dat het belang van steden in een globaliserende wereld dient te worden vastgesteld aan de hand van hun hiërarchische positie ten opzichte van andere steden, en aan de hand van hun onderlinge afhankelijkheid. Daarbij wordt eerst de vraag gesteld wat de hiërarchische positie van steden is binnen het contemporaine wereldomspannende bedrijfsnetwerk, als we kijken naar de netwerken van alle industriële sectoren, en speciaal als we kijken naar de belangrijkste sector, namelijk de geavanceerde producentendiensten. De tweede vraag is wat de netwerkstructuur is van dit systeem, in termen van geografische spreiding en spreiding van betrekkingen. Dit is proefondervindelijk onderzocht, op basis van een dataset van de multinationals uit de Fortune® top-100 en hun wereldwijde dochterbedrijven. Wat de eerste vraag betreft: er werd aangetoond dat de economische bindingen die werden aangetroffen binnen de gemeentegrenzen van steden een opmerkelijk klein deel uitmaken van de totale bedrijfsconnectiviteit in de dataset. Dit bevestigt dat vandaag de dag belangrijke steden meer relevant belang ontlenen aan de interstedelijke stromen in het economische verkeer dan aan wat ze binnen hun muren hebben en dit onderstreept dat de grenzen van de wereldsteden niet alleen worden bepaald door hun gebiedsgrenzen maar ook door verbanden van internationale interactie. Dit onderzoek toont eveneens aan dat het centrale bestuur van bedrijven voornamelijk plaatsvindt in slechts een handvol steden in ontwikkelde landen, wat wijst op systeem met zeer scheve verhoudingen. Aan de andere kant zijn dochterbedrijven juist sterk verspreid over veel steden. Het is zelfs zo dat in alle 2259 steden die in de dataset werden aangetroffen er in enige mate sprake was van activiteiten door dochterbedrijven. Ook worden de hoogst geklassificeerde dochterbedrijven opgeëist door steden in ontwikkelingslanden. Verder toont analyse van zowel de netwerken die voortkomen uit volledig industriële sectoren als van de netwerken die voortkomen uit uitsluitend geavanceerde producentendiensten hoe de resultaten van dit onderzoek zich tot andere onderzoeken verhouden. Door deze benaderingen op basis van één dataset te vergelijken, is er een bijdrage geleverd aan het verbeteren van conceptuele en empirische consistentie binnen deze onderzoeken. Het beantwoorden van de tweede vraag, die naar de netwerkstructuur, toont proefondervindelijk aan dat er een duidelijke wanverhouding is in de ruimtelijke spreiding van het netwerk van huidige multinationals, die in drie kernregio's zijn geconcentreerd, t.w. Noord-Amerika, Europa en de regio Azië/ Pacific. Bovendien wordt aangetoond dat de meest intensieve bedrijfsactiviteit plaatsvindt in de trans-Atlantische zone tussen Europa en Noord-Amerika. We zien dat er nog steeds sprake is van een scheidslijn tussen Noord en Zuid, waarbij vooral Afrika een marginale rol blijkt te spelen en slechts 1% van alle bedrijfsbanden heeft. Op zijn beurt blijkt dit bedrijfsnetwerk een statistische power-lawdistributie te volgen, met als kenmerk het feit dat de meerderheid van alle verbindingen draait om slechts enkele steden. Hoewel er veel steden deel uitmaken van het globale bedrijfsnetwerk, is daarom het grootste deel van hun bindingen zwak en blijft de kern van het wereldomvattende bedrijfsnetwerk beperkt tot slechts een paar bevoorrechte steden. In dit hoofdstuk wordt uiteengezet hoe het netwerk

van deze steden is verspreid, alsmede hoe dit netwerk tussen landen is verspreid. Zo wordt bijvoorbeeld aangetoond dat het overgrote deel van de betrekkingen bestaat tussen de drie kernregio's Europa, Noord-Amerika en Azië/Pacific, wat op een hoger aggregatieniveau opnieuw aantoont dat het grootste deel van de wereld slechts een marginale rol speelt in het globale bedrijfssysteem.

Netwerkschaal

Tegenwoordig wordt het belang van de Randstad-agglomeratie vaak besproken in termen van economische samenhang tussen de vier grootste steden. Dat is opmerkelijk als verschillende toonaangevende auteurs aangeven dat het economisch belang van steden sterk samenhangt met de economische netwerken tussen steden over de hele wereld. Deze discrepantie komt voort uit het feit dat er over bedrijfsnetwerken maar weinig empirisch onderzoek voorhanden is. Daarnaast is het relatieve belang van steden binnen verschillende onderzoeken gebaseerd op gegevens die qua functionaliteit en ruimtelijke schaal van elkaar verschillen, waardoor de resultaten niet met elkaar te vergelijken zijn. Daarom wordt in dit hoofdstuk de vraag gesteld wat het relatieve belang is van globale steden in het algemeen en van de vier grootste steden in de Randstad in het bijzonder, en wel binnen drie onafhankelijke, vergelijkbare netwerken (de top-100 van mondiaal opererende bedrijven, de top-100 van Europese bedrijven en de top-100 van Nederlandse bedrijven). Met behulp van technieken voor netwerkanalyses beoordeelt dit onderzoek het lokale, supraregionale en globale belang van steden binnen de drie onafhankelijke netwerken. De resultaten wijzen uit dat het relatieve belang en de netwerkstructuren van steden sterk afhankelijk zijn van de economische grootte en de plaats van de oorspronkelijke hoofdkantoren. In de mondiale dataset werd duidelijk dat New York op nr. 1 staat als het gaat om zowel de betrekkingen van hoofdkantoren als dochterbedrijven, en dat het die dominantie ontleent aan gezagsfuncties. Het grootste gedeelte van deze verbindingen bevindt zich echter binnen de grenzen van de VS. Düsseldorf blijkt op de 2de plaats te komen, München op de 3de en Zürich op de 4de, en zij vormen zo met New York de top van de steden met mondiale hoofdkantoren. Bovendien blijken Londen op de 6de, Parijs op de 7de en Tokyo op de 22ste plaats zwakker te zijn dan vaak wordt beweerd. Wat de steden in de Randstad betreft, blijkt dat, in termen van uitgraad (outdegree), Amsterdam de 9de en Den Haag de 11de plaats bezet in het globale bedrijfsnetwerk. Bovendien blijkt dat Rotterdam en Utrecht binnen het mondiale systeem geen belangrijke rol spelen op het gebied van hoofdkantoren. Maar als het gaat om de ingraad (indegree) van dochterondernemingen claimen Rotterdam en Utrecht wel een bescheiden belang. Ook blijkt dat bij optelling van de banden van deze vier Nederlandse steden, hun gecombineerde kracht slechts goed is voor de 5de plaats. Vandaar dat de positie van de Randstad binnen de mondiale dataset wordt overheerst door de bedrijfsactiviteiten van Amsterdam! Als het gaat om de sterkte van banden binnen de mondiale dataset blijkt Amsterdam krachtig gezag uit te oefenen over dochterbedrijven in Parijs, Brussel en Hongkong, terwijl Amsterdam aan de andere kant krachtige dochteronderneming-relaties heeft met hoofdkantoren in Brussel, Parijs, Düsseldorf en Londen. Wat de structuur van de banden tussen steden betreft, bleek dat bijvoorbeeld Parijs in de eerste plaats gezag over andere steden heeft. Evenzo oefent Londen krachtig gezag uit over New York, dat weer niet wordt beantwoord en aangeeft dat New York nationaal sterk, maar internationaal bescheiden voor het voetlicht treedt. Daarnaast blijkt Londen een krachtige gezagspositie te hebben ten opzichte van Hongkong en Singapore. Tokyo blijkt goede betrekkingen met

Londen te hebben, maar is verder helemaal verbonden met Aziatische steden als Taipei, Bangkok en Hongkong. Ook is het duidelijk dat Tokyo de sterkste bindingen onderhoudt met Kawasaki en Osaka, en dat geeft aan dat Tokyo vooral belangrijk is voor Japan. Als het om de Randstad gaat, blijkt duidelijk dat zowel Amsterdam als Den Haag een secundaire rol spelen in het mondiale systeem en dat elk specifiek banden heeft met Parijs en Londen.

Het blijkt dat in het Europese bedrijfsnetwerk het belang van Parijs en Londen groeit naar de 1ste en 2de positie, wat samenhangt met hun plaats in het mondiale netwerk. Dat geldt zowel voor hoofdkantoorfuncties als voor dochterondernemingen. Evenzo staan de steden in de Randstad hiërarchisch gezien binnen het Europese netwerk hoger dan in de mondiale dataset. In die dataset bekleedt Amsterdam, zo blijkt, de 4de positie als stad met hoofdkantoren, en toont daarmee aan dat ze binnen het Europese netwerk sterker is dan binnen het globale netwerk. Bovendien blijkt dat Utrecht en Rotterdam een bescheiden hoofdkantoorstatus hebben bereikt binnen het Europese netwerk, terwijl de hoofdkantoorstatus van Den Haag relatief minder belangrijk is geworden. Dat komt waarschijnlijk omdat zijn aardolieactiviteiten (Shell) belangrijker zijn binnen het globale netwerk dan die van de Europese bedrijven. In deze dataset blijkt bijvoorbeeld dat Amsterdam dominante banden heeft met Londen (outdegree), Zürich en Tokyo, maar tegelijkertijd onder het gezag valt van hoofdkantoren in Parijs, Vevey, München, Brussel en Londen (indegree). Als het gaat om de structuur van banden in het Europees bedrijfssysteem, zien we dat Parijs niet alleen sterker is dan Londen als het gaat om het geheel van connectiviteit, maar dat het ook veel diversere bindingen met andere steden heeft. Parijs is dus goed geïntegreerd met verschillende globale steden en het heeft de sterkste banden met Londen en Brussel. Maar Parijs blijkt, in tegenspraak met de resultaten van het mondiale netwerk, geen binding te hebben met Montreal, al is het goed verbonden met Hongkong en Tokyo. Evenzo is Londen binnen het Europese netwerk niet verbonden met Hongkong en Singapore, hoewel dat binnen het globale netwerk wel het geval is. Net als in het globale netwerk spelen Amsterdam en Den Haag een secundaire rol binnen het Europese bedrijfsnetwerk.

Binnen de derde dataset, het Nederlands wereldwijde netwerk, bleek dat Amsterdam, waar het om hoofdkantoorrelaties gaat, de 1ste plaats bezet, Utrecht de 2de, Rotterdam de 3de en Den Haag de 4de. Bovendien blijken Nederlandse dochterbedrijven, in termen van indegree, in dit netwerk veel belangrijker te zijn voor internationale steden als Londen en Parijs dan voor hun naburige Nederlandse steden. Dit geeft aan dat de Randstad de belangrijkste bedrijfsrelaties onderhoudt met steden buiten Nederland. Binnen dit netwerk onderhoudt Amsterdam zijn sterkste outdegree-relaties met Parijs, terwijl Rotterdam vooral met Londen verbonden blijkt. De resultaten wijzen uit dat Utrecht vooral met Amsterdam is verbonden, maar ook sterke bindingen heeft met steden als Luxemburg, Brussel en Willemstad. Den Haag, zo zien we, is op zijn beurt (vooral dankzij Shell) op de eerste plaats verbonden met Wilmington, vanwege Wilmington's belang in de wereld van de olieverzekering. Kijken we naar de interne relaties tussen Nederlandse steden, dan is duidelijk dat Amsterdam en Utrecht sterk met elkaar zijn verbonden; ze vormen een krachtige noordelijke regio, terwijl Rotterdam en Den Haag zeer bescheiden banden met elkaar onderhouden. Wat belangrijker is, de eerste twee steden zijn zwak verbonden met de laatste twee steden, en bevestigen dat de contingentie tussen de steden in de Randstad betrekkelijk zwak is.

Als we de totale resultaten van de steden in de Randstad binnen de drie datasets bekijken, is het belang van Amsterdam op alle schalen duidelijk. Den Haag blijkt hoog te scoren op mondiale en Nederlandse netwerkschalen, terwijl Utrecht en Rotterdam alleen op de Europese, maar vooral op de Nederlandse bedrijfsschaal belang hebben. Daarnaast zien we dat andere Nederlandse steden er weinig toe doen in mondiale, Europese en Nederlandse netwerken, hoewel er op de Nederlandse bedrijfsschaal van toename sprake is. Bovendien hebben de vier steden in de Randstad de neiging meer met internationale steden te werken dan met andere Nederlandse steden. Vervolgens werd, door onderzoek te doen naar stedelijke hiërarchieën op verschillende schalen van bedrijfsnetwerken, duidelijk dat geen enkel afzonderlijk netwerk een compleet inzicht in de aard van de steden kan geven. Het feit dat elk van de drie datasets geheel verschillende kennis oplevert over de rol die steden in de Randstad in bedrijfsnetwerken spelen, kan op verschillende niveaus van regeringsbeleid interessant zijn. Voor plaatselijk Nederlands beleid kan het bijvoorbeeld van belang zijn de banden tussen steden in de Randstad aan te halen, alsmede de banden met andere internationale steden als Londen en Parijs. Op de mondiale schaal kan de krachtige rol van Amsterdam en Den Haag binnen de wereldeconomie interessant zijn voor het Nederlands internationaal beleid. Maar met nadruk wordt erop gewezen dat de kracht van Den Haag vooral te danken is aan de aanwezigheid van Shell in deze stad. Daarnaast is een belangrijke uitkomst dat de drie onafhankelijke netwerken bijna identieke power-lawdistributies kennen. Dat laat zien dat bedrijfsnetwerken, ongeacht hun schaal, zeer disproportionele, 'zelfgeorganiseerde' systemen zijn. Het lijkt erop dat de disproportionaliteit onder bedrijven, die voor het eerst werd ontdekt door de economist Gibrat (1931), nog steeds bestaat. Omdat steden in de Randstad veel afhankelijker blijken te zijn van internationale steden dan van lokale steden, is het tenslotte interessant om in dit licht het beleid aangaande de toekomst van de Randstad nog eens te bekijken. Als gevolg daarvan zou het gangbare beeld dat plaatselijke cohesie en geografische nabijheid essentieel zijn voor het versterken van de economische performance van de Randstad mogelijk moeten worden bijgesteld.

Netwerkconcurrentie

In Hoofdstuk 5 wordt besproken dat steden in de moderne economie over het algemeen geacht worden een krachtige concurrentiestrijd met elkaar te voeren. Literatuur over stedelijk onderzoek en planning heeft de laatste decennia krachtig bevestigd dat steden concurreren op het gebied van productmarkten, interne investeringen, de vestiging van bedrijven, bevolking, toeristen, markante evenementen en overheidssubsidies. In dat opzicht moeten steden bij het aantrekken van bedrijven en arbeidskrachten, aan hun 'concurrentievermogen' werken, teneinde hun positie binnen de hiërarchie van steden te houden of te versterken en zo hun levensstandaard verbeteren. Daardoor zijn city marketing en city branding een 'booming business' geworden. Deze groeiende interesse in 'stedelijk concurrentievermogen' heeft geleid tot een groot aantal ranglijsten van steden, waarbij deze worden vergeleken op basis van hun economische performance. Maar ondanks de eloquente theoretische verhandelingen over deze 'strijd om een hoge plaats' is er maar weinig aandacht geschonken aan het proefondervindelijk meten van de intensiteit van de concurrentie tussen steden. Daarom wordt in dit hoofdstuk de vraag aan de orde gesteld welke concurrentie er bestaat tussen steden en hoe deze proefondervindelijk kan worden gemeten. Op die manier wordt er een bijdrage geleverd aan de theorie over stedelijke concurrentie. Door inzichten vanuit evolutionaire en organisatorische

ecologie te gebruiken, is een bijzondere techniek geïntroduceerd om te meten hoe groot de concurrentie tussen steden is, en wel op basis van concrete verbanden van interactie (netwerken) tussen de steden. Daarnaast maakt deze benadering de theoretische aanname dat alle steden met elkaar concurreren wat minder dogmatisch, en wordt in plaats daarvan de concurrentiekracht van de afzonderlijke steden geschat en worden de clusters van steden die met elkaar concurreren vastgesteld. Met behulp van inzichten uit de niche-overlaptheorie heeft dit onderzoek een nieuwe indicator ontwikkeld voor het meten van de intensiteit van zakelijke concurrentie tussen steden, gebaseerd op de functionele banden die deze steden met elkaar hebben. De data die in dit onderzoek worden gebruikt zijn data die betrekking hebben op mondiale financiële centra en op het netwerk van geavanceerde producentendiensten dat deze centra met elkaar verbindt. Met behulp van de nieuwe techniek werd berekend over hoeveel concurrentie een stad beschikt in vergelijking tot andere steden in het netwerk. De dataset heeft betrekking op stedelijke concurrentie tussen de twintig sterkste steden met producentendiensten. In de analyse werd onderzocht in welke mate de verbindingen van deze twintig steden met alle andere steden in het netwerk hetzelfde zijn (marktoverlap). Door de nieuwe meting toe te passen, werd een matrix van de intensiteit van concurrentie tussen twintig financiële centra in het netwerk van wereldsteden gevonden.

Door naar het totale verband van concurrerende relaties te kijken, is een aantal empirische observaties gedaan. Op de eerste plaats heeft concurrentie tussen steden voor geavanceerde producentendiensten een sterke geografische dimensie. De concurrentie-intensiteit tussen steden die geografisch gezien bij elkaar liggen blijkt daarom sterker te zijn dan de concurrentie tussen steden die in geografisch oogpunt ver van elkaar verwijderd zijn. Dat bevestigt dat afstand en nabijheid feitelijk van invloed zijn op stedelijke concurrentie. Dat betekent dat stedelijke concurrentie in het algemeen het sterkst is tussen steden binnen dezelfde supraregio, bijvoorbeeld Azië/Pacific. De resultaten laten zien dat in het algemeen de concurrentie-intensiteit tussen steden op verschillende continenten slecht tot gemiddeld is. Bovendien blijkt er bij een krachtige concurrentie-intensiteit tussen steden op verschillende continenten altijd ten minste één van de belangrijkste wereldsteden betrokken te zijn (bijv. Londen of New York). Dat wekt geen verbazing omdat deze primaire steden een gevarieerde geografische markt bedienen met een grotere geografische reikwijdte dan andere steden in het netwerk van wereldsteden. Door een hiërarchische clusteranalyse los te laten op de resulterende concurrentiecoëfficiënten werden er twee belangrijke clusters van concurrerende steden vastgesteld, namelijk de noordkant van de trans-Atlantische kust (Londen, Frankfurt, Zürich, Parijs, Amsterdam, Brussel, New York) en Azië/Pacific (Tokyo, Osaka, Hongkong, Singapore). Hieruit werd geconcludeerd dat de intensiteit van de concurrentie die Tokyo ondervindt van de andere globale steden, zoals Londen, New York en Parijs, nogal beperkt is. Terwijl de interstedelijke gezagsrelaties (outdegree) van Tokyo voornamelijk zijn gericht op andere Aziatische steden (meer dan 70%), zijn de interstedelijke gezagsrelaties van New York en Parijs hoofdzakelijk gericht op Europese en Noord-Amerikaanse steden. Londen kent de sterkste concurrentie van alle steden, door bindingen met verschillende steden in Europa en Noord-Amerika, maar ook met Aziatisch/Pacifische steden als Hongkong en Singapore. Deze bevindingen benadrukken dat niet alle wereldsteden dezelfde 'achterland' bedienen. Bovendien laten de resultaten zien dat de concurrentie tussen steden aan de top van de stedelijke hiërarchie sterker is. Kleinere wereldsteden als Atlanta, Berlijn, Toronto, Dallas en Madrid hebben relatief weinig economische concurrentie van de andere wereldsteden.

Dat komt waarschijnlijk doordat de gezaghebbende relaties (outdegree) van deze steden meestal beperkt blijven tot hun directe regio's. Met andere woorden, deze steden hebben een relatief 'regionaal georiënteerd' achterland. Zo speelt meer dan tweederde van de gezagsrelaties van Madrid zich af binnen Zuid-Europa, met steden als Barcelona en Milaan. Eveneens speelt meer dan 90% van de gezagsrelaties van Toronto zich niet buiten Canada af. Dit wordt bevestigd in onderzoek van Derudder en Witlox (2008), die, op basis van data van luchtvaartmaatschappijen, ontdekten dat de tussenstedelijke relaties van de belangrijkste wereldsteden, als het gaat om netwerkconnectiviteit, hoofdzakelijk globaal zijn qua reikwijdte, terwijl de relaties tussen minder goed verbonden steden in het netwerk een meer regionale reikwijdte hebben.

Netwerkperformance

In Hoofdstuk 6 wordt beargumenteerd dat de integratie van landen sterk gerelateerd is aan multinationale netwerken. Hoewel het globaliseringsproces niet geheel nieuw is, is het duidelijk dat er de afgelopen decennia aanzienlijke verschuivingen zijn opgetreden, omdat het vermogen om fabrieksgoederen te maken en te exporteren zich heeft verspreid over een zich steeds maar uitbreidend netwerk van perifere landen en van kernlanden. Vandaag de dag vindt de productie van goederen plaats in meer landen dan ooit tevoren, waarbij elk land die specifieke taken uitvoert die het een betrekkelijk voordeel opleveren. Geholpen door verminderde transportkosten en geavanceerde communicatietechnologieën verbindt dit inter-organisatorische systeem bedrijven en landen om zo de huidige mondiale economie te vormen, met als resultaat een grotere functionele interdependentie dan ooit tevoren. Hoewel er al vaak is verklaard dat we in een 'geglobaliseerde wereld' leven, waarin economieën naar men zegt convergeren, vraagt dit onderzoek zich echter op de eerste plaats af of het zakelijk 'bereik' van multinationale bedrijven wel echt mondiaal is. Zo blijkt dat transnationale bedrijfsnetwerken, in tegenstelling tot wat in de gangbare literatuur wordt beweerd, in het algemeen zijn beperkt tot interacties tussen ontwikkelde landen, een teken dat we te maken hebben met een disproportioneel systeem. Door te focussen op het transnationale bedrijfsnetwerk van aandeelhoudersrelaties tussen de multinationale hoofdkantoren uit de mondiale Fortune® 100 en hun vele dochterbedrijven, wordt vervolgens de vraag gesteld waarom bepaalde landen betere connecties hebben dan andere als het gaat om relaties van hoofdkantoren en dochterbedrijven. Deze vraag wordt beantwoord door de globale performance van landen (GCI-index) te koppelen aan de sterke punten van hun bedrijfsconnectiviteit. Mede dankzij de data van bedrijfsnetwerken die in dit onderzoek werden gebruikt, was het mogelijk uit te stijgen boven de gewoonlijk atomistische beschrijvingen van steden en zo empirische kennis van de interdependentie tussen plaatsen te realiseren. Deze bedrijfsnetwerken vertegenwoordigen ongeveer eenderde van alle OECD-inkomsten (2005) en omvatten bijna uitsluitend ontwikkelde landen. Deze scheve verhoudingen worden uitgelegd aan de hand van verklarende variabelen, namelijk de indices voor het concurrentievermogen en de marktomvang van de wereldlanden. Hierbij werden andere nationale (openheid, afstand) en bilaterale (geografische, culturele en economische afstand) variabelen onder controle gehouden. Wat betreft de connectiviteit van hoofdkantoren bevestigen de resultaten dat zowel het niveau van het concurrentievermogen als van de marktomvang van landen een sterke samenhang vertoont met het totale aantal 'outdegree' verbindingen van hoofdkantoren dat een land heeft. De indicator van concurrentievermogen heeft er dus toe gediend zowel de 'kwalitatieve' aspecten van nationale economieën als de 'kwantitatieve' aspecten

van de marktomvang te vangen. In dit onderzoek is Porter's observatie bevestigd dat het hebben van een thuisbasis voor een multinationaal hoofdkantoor een belangrijke rol speelt bij zijn succes. Tot dit cluster van voorzieningen behoren infrastructuur, fondsen, effectieve bedrijfssystemen en arbeidsprocessen, maar ook de geruststelling van een voorspelbare en omvangrijke markt. Bovendien wijzen de resultaten uit dat de totale 'indegree' connectiviteit van dochterbedrijven van landen ongeveer dezelfde uitkomsten laat zien als die van hoofdkantoren, behalve dan dat het effect in alle gevallen minder blijkt te zijn. Hoewel concurrentievermogen en marktomvang van belang zijn voor zowel de connectiviteit van het hoofdkantoor als van het dochterbedrijf, wordt de invloed van het concurrentievermogen en van de marktomvang van een land blijkbaar veel meer geassocieerd met hoofdkantoren dan met dochterbedrijven. Dat is misschien wel zo omdat multinationale hoofdkantoren zich in een handvol ontwikkelde landen bevinden, terwijl dochterbedrijven, zoals in Hoofdstuk 3 werd aangetoond, overvloedig aanwezig zijn in goed ontwikkelde en sommige ontwikkelde landen alsmede in ontwikkelingslanden. Dat betekent dat hun verscheidenheid groter is dan die van hoofdkantoren, omdat ze waarschijnlijk in landen zijn gelegen met uiteenlopende niveaus van concurrentievermogen en marktomvang. Door de sterkte van banden 'tussen' landen te analyseren werden gelijksoortige resultaten berekend. De marktomvang en het nationale concurrentievermogen van zowel landen met hoofdkantoren als dochterbedrijven blijken sterk in verband te staan met de vigerende mondiale bedrijfscultuur. Desalniettemin blijken de totaalkenmerken van landen met een hoofdkantoor sterker dan bij landen met dochterbedrijven bij te dragen aan de waarschijnlijkheid van bedrijfsconnectiviteit tussen twee landen en de omvang van deze banden. Met andere woorden: het concurrentievermogen en de marktomvang van een land met hoofdkantoren is misschien wel belangrijker voor de structuur van het globale bedrijfsnetwerk dan het concurrentievermogen en de marktomvang van een staat met dochterbedrijven. Theoretisch gesproken komt deze ongelijkheid voort uit het feit dat alleen bepaalde landen ontwikkeld genoeg zijn om het concurrentievoordeel te garanderen dat nodig is om hoofdkantoren van multinationals aan te trekken. De resultaten van dit onderzoek bevestigen dat de wereld niet veel is veranderd sinds Hymer's postulaat (1972) omtrent de bedrijfsongelijkheid van landen. De landen met hoofdkantoren uit de tijd van Hymer hebben nog steeds de neiging de mondiale arena te domineren, waarbij ze fungeren als de belangrijkste gezagscentra van de hedendaagse wereldeconomie. Zoals werd aangetoond in Hoofdstuk 2, heeft deze structuur zich bovendien de afgelopen decennia steeds verder ontwikkeld. Deze mogelijke 'padafhankelijkheid', zoals besproken in Hoofdstuk 6, wordt zichtbaar door de bestendigheid en de hardnekkigheid van grote sociale en fysieke infrastructuren. Deze resultaten bevestigen dus dat de structuur van globale bedrijfsmacht de overheersing van de ontwikkelde kapitalistische kern niet ondermijnt, maar deze juist versterkt.

Bijdrage aan maatschappelijke ontwikkeling

Omdat dit proefschrift proefondervindelijk het onzichtbare, maar zeer reële netwerk van bedrijfsrelaties tussen steden blootlegt, laat het tegelijkertijd de structuur van de kapitalistische klasse zien, als een georganiseerd netwerk dat zich over globale steden uitstrekt. In dit kader wordt de 'netwerkbourgeoisie' in het begin van de 21ste eeuw ontmaskerd als een wereldwijd systeem van 'corporate governance', dat steden, landen en supraregio's samenbindt. Dit onderzoek heeft uitgewezen dat onze huidige 'netwerkmaatschappij' geen geheel nieuw verschijnsel is, maar dat zij zich in de loop

der tijd steeds verder heeft ontwikkeld. Bovendien toont dit onderzoek aan dat er bij het leeuwendeel van de bedrijfsverbanden sprake is van verbanden 'tussen' steden en niet binnen steden, en dat het daarbij vooral gaat om steden buiten de grenzen van het land. Omdat dit onderzoek heeft uitgewezen dat belangrijke steden de neiging hebben veel sterkere banden met internationale steden te onderhouden dan met hun plaatselijke tegenhangers, is het voor beleidsmakers misschien interessant om de grenzen van toekomstige beleid ten aanzien van de stedelijke ontwikkeling te heroverwegen. Omdat het lot van steden niet langer uitsluitend gerelateerd is aan de kenmerken van een lokale centrale positie, maar ook aan wereldwijde interstedelijke netwerken, zou een ontwikkelingsbeleid eerst de samenvloeiing van globale en lokale krachten moeten begrijpen. Derhalve moet de gangbare benadering van beleidsmakers om alleen op de ontwikkeling van ruimtelijke en functionele cohesie binnen de grenzen van de staat te focussen, misschien worden herzien. Dit betekent misschien wel dat nationaal en gemeentelijk beleid zich strategisch zou moeten richten op het steunen van plaatselijke ontwikkeling met empirische kennis omtrent de economische en sociale banden die steden met afgelegen plaatsen hebben. De operationalisering hiervan valt buiten het bestek van dit boek, omdat dit proefschrift zich immers wil richten op het blootleggen van tijdelijke, structurele en scalaire eigenschappen, alsmede de concurrentie- en performance-eigenschappen van wereldwijde bedrijfsnetwerken, en – wat belangrijker is – door aan de hand van een nieuwe methodologie duidelijker te maken welke banden ons binden. In een recent rapport van de Nederlandse regering, getiteld 'Kwaliteit en toekomst' wordt een duidelijke aanzet gegeven om grip op deze kwesties te krijgen. In het rapport wordt uitgelegd dat de toekomst van stedelijke ontwikkeling afhangt van nieuwe opvattingen over de vraag wat de kwaliteit van leven uitmaakt, over de vraag hoe deze over de wereld moet worden verdeeld, en over de manier waarop de mensheid binnen dit systeem functioneert. Binnen deze context draagt het onderzoek bij aan de theorie van ongelijke geografische ontwikkeling door bijvoorbeeld de relatie tussen het hedendaagse bedrijfssysteem en het globale concurrentievermogen van landen aan te geven. In deze context heeft het onderzoek duidelijk uitgewezen dat in tegenstelling tot populaire theorieën bijvoorbeeld van Thomas Friedman (2005) dat de wereld nog altijd verre van plat is en heeft het in plaats daarvan een uiterst stekelig bedrijfssysteem blootgelegd werd. Slechts een paar landen en steden op de wereld trekken aan bijna alle multinationale touwtjes en vormen zo een dominante hegemonie. De meerderheid van steden en landen hebben slechte banden of nemen helemaal geen deel. Daarnaast werd aangetoond dat de statistische structuur die werd aangetroffen in de drie wereldwijde netwerken die in dit onderzoek werden gebruikt, verloopt volgens een power-lawdistributie, waarin duidelijk is geworden dat New York, Parijs, Londen en Tokyo 25% van alle 2557 globale bedrijfsverbanden bezitten. Omdat uiteen werd gezet dat het lot van steden steeds vaker verband houdt met hun wereldwijde bedrijfsconnectiviteit en dat de resultaten in dit onderzoek laten zien dat slechts een handjevol steden aanspraak maken op de meerderheid van de bedrijfsaandelen, doet het twijfels rijzen aan de structuur van deze disproportionaliteit. Als het bijvoorbeeld waar is dat de wereldeconomie convergeert, dan mag men verwachten dat de statistische distributie van bedrijfsconnectiviteit minder ongelijk wordt. Maar, omdat er wordt gezegd dat de stabiliteit van de power-lawdistributie van bedrijven in de loop der tijd zeer groot is en omdat deze disproportionaliteit blijkt te bestaan in veel natuurlijke en sociale netwerken, rijst de vraag of deze distributie te veranderen is of dat ze onvermijdelijk is.

Daarnaast is dit proefschrift vooral interessant voor de Nederlandse samenleving, omdat het de extreme onderlinge afhankelijkheid van steden in Nederland met andere delen van de wereld aantoont. Uit de resultaten is gebleken dat Nederland één van de meest economisch verbonden landen in de wereld is. En wat nog belangrijker is, het proefschrift heeft precies aangetoond, in drie verschillende schalen van bedrijfsgegevens, met welke steden en landen Nederland is verbonden (bijv. Parijs, Londen en Brussel), maar het heeft ook aangegeven in welke richting de macht van de bedrijven, waar deze verbindingen voor staan, verloopt (gezag, van boven naar beneden, of ondergeschiktheid, van beneden naar boven). Omdat dit onderzoek heeft aangetoond dat de meerderheid van de Nederlandse bedrijfsconnectiviteit betrekking heeft op steden en landen buiten de grenzen, rijzen er vragen naar de toekomst van Nederlands beleid ten aanzien van stedelijke ontwikkeling. Hoe kan bijvoorbeeld kennis over de globale relaties van Nederlandse steden worden meegenomen in toekomstige strategieën ten aanzien van stedelijke ontwikkeling? Of wat kan er worden geleerd van de zakelijke netwerken van concurrerende internationale steden? In dit verband vormen de methodologie en de technieken in dit onderzoek misschien wel nuttige middelen om specifieker op inter-relationele kwesties in te gaan. Op een moment dat Nederland aan het begin van een diepe recessie staat, kan een nieuwe benadering om zijn vroegere, huidige en toekomstige netwerken in kaart te brengen misschien een onmisbare voorsprong geven bij het begrijpen van zijn relatieve positie binnen een steeds onzekerder wordende wereld. Zo is het voorstelbaar dat dit soort onderzoek de globale relaties ontdekt die bijdragen aan de ontwikkeling van Nederland, en daarbij concurrentie- en samenwerkingsnetwerken blootlegt, alsmede de specifieke industrieën die deze netwerken vormen. Daarnaast is het misschien wel zo dat longitudinale (tijdreeksen) datasets kunnen worden gebruikt om causale verbanden aan te tonen tussen de performance van steden (bijv. bruto stadsproduct- en werkgelegenheidscijfers), en hun globale banden (bijv. bedrijfsaandelen, handelsstromen en buitenlandse directe investeringen (FDI's)). In die zin kan men zich voorstellen dat de niveaus van stedelijke ontwikkeling van een stad te zijner tijd kunnen worden gemeten in termen van zijn relatieve lokale en globale interdependentie.

In dit onderzoek werd aangetoond dat een sterke bedrijfsconnectiviteit in hoge mate wordt geassocieerd met het concurrentievoordeel van steden en landen. Hoewel de analyse in dit onderzoek geen causaliteit heeft aangetoond tussen concurrentievermogen en de sterke punten van een netwerk, heeft het een krachtige cohesie tussen deze variabelen laten zien. Daarom is het misschien wel zo dat een stad die zijn performance wil verbeteren ook zijn globale connectiviteit moet verbeteren, wat zou betekenen dat handel en investeringen verder dienen te worden geliberaliseerd. Dus hoe provocerend het ook moge klinken in het huidige gevaarlijke economische klimaat, vrijere en flexibelere markten doen waarschijnlijk meer voor de wereldeconomie dan protectionisme. Vandaar dat de voorspoed van een stad sterk samenhangt met de mate van interdependentie met andere steden. Omgekeerd betekent dit misschien ook dat het niveau van ontwikkeling van een stad borg staat voor zijn concurrentievermogen wat betreft het aantrekken van internationale bedrijfsrelaties. Maar dit richt zich alleen op het lot van afzonderlijke steden en gaat niet in op hogere gelijkheid van het mondiale stedelijke systeem. Als we even terugdenken aan de ongelijkheid van het netwerk van de wereldeconomie dat de GIS-kaarten vertonen, wordt het interessant om te bedenken hoe een meer gelijk geglobaliseerde wereld eruit zou zien. Is er een bedrijfsnetwerk denkbaar dat gelijker verspreid is en waarin er sprake is van een betere diversiteit en intensiteit van economische relaties met niet-

verbonden en zwak verbonden steden? In dit verband bestaat er veel onenigheid in de economische theorie over de vraag of de wereldontwikkeling divergeert of convergeert. Verscheidene economisten wijzen er met klem op dat economische ongelijkheid de laatste veertig jaar niet significant is veranderd en dat de ontwikkelde wereld nog steeds op een overweldigende manier de wereldhandel domineert, terwijl sommige ontwikkelingseconomisten redeneren dat vanwege het feit dat armere economieën de neiging hebben sneller te groeien dan rijke, alle economieën uiteindelijk dienen te convergeren als het gaat om inkomen en productiviteit per hoofd. Desalniettemin moeten we, afgaande op de bedrijfsdisproportionaliteit die in dit proefschrift werd aangetoond, en het feit dat opkomende economieën in gelijke mate te lijden hebben onder het kelderen van de aandelenbeurzen in de ontwikkelde wereld, voorzichtig zijn met zulke aannames.

Tot slot speculeert het proefschrift over hoe een evenwichtiger mondiaal bedrijfssysteem eruit zou zien, hoewel dit niet in dit werk wordt geverifieerd. Omdat werd aangetoond in Hoofdstuk 6 dat het bedrijfsnetwerk overheerst wordt door een handvol landen die bijna uitsluitend met elkaar banden onderhouden, is het ten eerste misschien wel zo dat een evenwichtiger globaal systeem een hogere diversiteit van tussenstedelijke bedrijfsverbanden zou betekenen. Als we ons eraan herinneren dat de bedrijfsdata die in dit onderzoek worden gebruikt aandelen van bedrijven vertegenwoordigen, maar dat dit in hoge mate blijkt te correleren met FDI's en globale handel, zou een hogere mate van verbindingsdiversiteit kunnen betekenen dat landen en steden hun aantrekkelijkheid en openheid ten opzichte van bedrijven verbeteren, en zo een aanzet geven tot hogere handels- en investeringsniveaus. Op die manier is het aannemelijk dat een dichter netwerk van samenwerkende en concurrerende steden een groter deel van de wereldbevolking ten goede zou komen. Om dit te bereiken zouden steden, landen en supraregio's hun handels- en investeringsbeleid moeten aanpassen om het portfolio van steden waarmee ze in verband staan te diversifiëren. Als we denken aan de huidige recessie is het bovendien voorstelbaar dat, naarmate meer steden met elkaar banden gaan onderhouden, het mondiale bedrijfssysteem minder kwetsbaar wordt, omdat kansen en risico's meer gespreid raken. Om dit te bereiken zouden desalniettemin de bedrijfsbanden tussen steden verschillende economische activiteiten moeten vertegenwoordigen.

Dit onderzoek heeft een stap voorwaarts weten te zetten bij het in kaart brengen van het huidige wereldwijde systeem van steden. Er zijn bijdragen geleverd aan de theorie, aan empirische bevindingen en aan de methodologie. Maar dit onderzoek kent, zoals al werd aangegeven in het inleidende hoofdstuk, ook verschillende beperkingen. Op de eerste plaats is het netwerkonderzoek gebaseerd op een dwarsdoorsnede van gegevens. Hoewel dit een recent gezichtspunt oplevert ten aanzien van de huidige globale economische netwerken, kan er proefondervindelijk weinig worden gezegd over het verleden en de toekomst van bedrijfsnetwerken of over kwesties ten aanzien van de causaliteit. Hoewel de data zeer gedetailleerde kennis over hedendaagse netwerken hebben opgeleverd, kunnen er geen empirisch adequate aanbevelingen ten aanzien van wereldwijde stedelijke netwerken worden gegeven. Dat zal een interessante stap voor toekomstig onderzoek zijn, waarbij onderzoek kan worden gedaan naar de causaliteit tussen performance en netwerken of naar modellen die veranderingen in het netwerk kunnen beoordelen. Nog een beperking van dit onderzoek is dat de geanalyseerde netwerken speciaal betrekking hebben op bedrijfsbanden, en zo slechts een gedeeltelijke kijk op de wereld bieden. Hoewel dit zeker belangrijke netwerken zijn om te onderzoeken,

dienen ook andere soorten economische, sociale, culturele en politieke netwerken te worden onderzocht, al was het maar om een meer consistent begrip van het wereldsysteem te geven. Hoewel dit onderzoek zich richt op de banden tussen steden, moest het laatste hoofdstuk over performance bovendien op nationaal niveau worden uitgevoerd. Zoals gezegd was dat onvermijdelijk omdat we zagen dat er geen betrouwbare toerekenbare gegevens bestaan over de vele wereldsteden die in dit onderzoek worden gebruikt. In dit kader kan toekomstig onderzoek op een belangrijke wijze de impact aantonen die interstedelijke netwerken hebben op de stedelijke performance en vice versa. Deze aanbevelingen zijn tenslotte uitdagend genoeg, al kunnen er nog vele andere worden bedacht. Laten we hopen dat deze studie een aanzet zal geven tot nieuwe vragen en dat het onderzoek naar het netwerklandschap van onze wereld zal doorgaan.

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Curriculum Vitae

Ronald Wall was born in Harare, Zimbabwe on the 27th of November 1966. He grew up in South Africa between 1971 and 1987. From 1987 onwards he has resided in The Netherlands. In 1991 he obtained his Bachelors degree at the Willem de Kooning Academy of Arts in architectural design, and commenced his education at the Rotterdam Academy of Architecture and Urban Planning, where he received his Masters degree in architecture and urban planning in 1998. During the period of 1991 to 2001 he has worked for urban planning offices like OMA (Rem Koolhaas) and has been project leader for West 8 (Adriaan Geuze) and MVRDV (Winy Maas). In 1997 he received a commendation from Nelson Mandela for his project Housing Generator, concerning township development in South Africa. He has also received several design awards such as the Rotterdam Design Prize and the International Design Award in 1996. In 2000 he was commissioned by the Rijksplanbureau (RPB/VROM) to execute a one year research on Healthy Cities. Between 2003 and 2008 has been scientific coordinator of a Dutch national research project called 'Network of Networks' for the Dutch Organization of Scientific Research (NWO). Ronald Wall has between 2001 and 2009 been professor in urban planning at the Berlage Institute and the Rotterdam and Amsterdam Academies of Architecture and Urban Planning. In 2006 and 2007 he carried out a four year contracted research for The Netherlands Environmental Assessment Agency (RIVM/MNP) concerning urban development in relation to world city networks. Similarly in 2007 he carried out research for the municipality of Almere concerning the position of this city within national and global corporate networks, in which the results were used to define a future urban vision of Almere 2020. The central interests of his work are statistics, network analysis, geographic information system (GIS) analysis and urban planning and design techniques. He has been published in some 30 journals, research reports, books and conference proceedings in the fields of architecture, urban planning and economic geography – for instance the Journal of Economic and Social Geography; Volume Planning Journal of University of Columbia/ AMO/Archis; the book Foreign Metropolitan Region Development of Jiao Tong University Shanghai; and the urban development journal 306090 of Princeton University.

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NETSCAPE
CITIES AND GLOBAL CORPORATE NETWORKS

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