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Spatial Characteristics of Internationally Competitive Cities:

A study of spatial characteristics of north-western European cities as location determinants of Multinational Corporation clusters.

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Summary

Due to globalization, traditional factors of competitive advantage (e.g. markets, natural resources, and labour) have become highly mobile, thereby permanently transforming the way in which cities and businesses compete for economic development. In this context, innovation became the leading driver of economic development in advanced economies. Because innovation requires continuous and efficient interfacing, businesses in knowledge-intensive industries tend to seek physical proximity to external factors (e.g. complimentary and supporting businesses, markets demands, and highly-skilled workers). Businesses also cluster together to take advantage of factors that are available only in economies of scale (e.g. well-developed infrastructure). As epicentres of agglomeration, cities are uniquely positioned to provide the set of urban amenities necessary for innovation and business growth in a global economy. However, cities are very diverse, as are the amenities that they provide. Consequently, some cities outperform others in attracting innovation-driven, knowledge-intensive industries. This heightens competitiveness between cities as they strive to increase their social and economic development.

While many studies have investigated the impact of urban socio-economic characteristics on competitiveness, there is a knowledge gap in the specific study of urban spatial characteristics and their impact on the attraction of Foreign Direct Investment. To help fill the gap, this study was conducted to identify the most relevant urban spatial characteristics to the clustering of Multinational Corporations in mid-sized north-western European cities. The aim was to provide an understanding of which urban spatial characteristics should be prioritized for economic growth in order to guide local and regional policies as well as urban design.

A unique methodology was developed to generate proximity data from geographically mapped spatial characteristics in 11 cities, which were then analysed through multiple negative binominal regressions. Findings confirmed that proximity to architectural aesthetics, train stations, well-connected streets, and local service firms all increase FDI clustering. In contrast, proximity to road interchanges, parks, and local hi-tech firms were found to decrease FDI clustering. In the interest of investigating the effect of proximity at the regional level, additional analysis was conducted using proximity data from twin cities. Results confirmed nearness affinity between FDI clusters in a city and architectural landmarks, local firms, and road interchanges in a neighbouring city. This study culminates on a set of recommendation to the city of Rotterdam aimed at improving international attractiveness and competitiveness through urban spatial design.

Keywords

Globalization, Competitiveness, Innovation, Knowledge-Intensive, FDI, MNC Clusters, Urban Spatial Amenities, Architecture, Infrastructure, Local Firms, Street Connectivity, Borrowed Proximity, Economic Development, Economic Geography, Urban Design.

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Abbreviations

IHS	Institute for Housing and Urban Development
FDI	Foreign Direct Investment
MNC	Multinational Corporations
NL	Netherlands
BE	Belgium
UK	United Kingdom
DE	Germany
R&D	Research and Development
SME	Small and Medium Enterprises
EU	European Union
NBR	Negative Binominal Regression

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Chapter 1: Introduction

1.1 Background

The world economy today is characterized by highly mobile resources; be it capital, people, services, or goods, made possible by rapid technological advances in transport and communication. The fact that firms and their resources can move so freely from one place to another has significantly increased the level of competition between cities across the globe seeking to improve or retain their economic performance (Begg, 1999).

Throughout history, cities were incrementally born from the interest of people and businesses in settling near one another, near natural resources and near collective built amenities. As a result, cities became the unrivalled centres of economic, social and political activities (Scott and Storper, 2015). The arrival of globalization, however, seemed to threaten the relevance of cities as they suffered through the loss of their manufacturing businesses to lower-cost economies. Many scholars predicted the demise of the city.

Indeed, Porter (2000) explains that because it shortened distances and barriers to global resources, markets and information, globalization replaced the traditional influence of local forces for more global ones. However, cities have continued to grow in the presence of globalization, becoming the very heart of advanced, knowledge economies (Clark et al., 2002). Storper and Manville (2006) clarify that the end of concentrated manufacturing did not mean the end of concentration. They contend that manufacturing in cities was in fact an anomaly, and globalization has duly restored them to their natural function as centres for innovation and service, instead of mass production of goods. In a similar thought, Simmie (2005) highlights that capital and innovation is more concentrated than ever in a few cities. Likewise, Scott and Storper (2015) confirm that "the rise of a globalizing world system has been associated - thus far at least - not with the demise of the city, but rather with intensifying agglomeration/urbanization processes across all five continents" (p.7).

Porter (2000) offers a clarification to this phenomenon arguing that "proximity in geographic, cultural, and institutional terms allows special access, special relationships, better information, powerful incentives, and other advantages in productivity and productivity growth that are difficult to tap from a distance" (p.32). It is extensively supported in the literature that innovation occurs most effectively in urban centres, where there is a larger pool of highly-skilled workers, greater access to capital, and better connectivity with the global market (Porter, 1990, Rogerson, 1999, Hanna and Walton-Roberts, 2004). As noted by Turok (2004), "urban assets are important sources of competitive advantage for firms in an era of more integrated markets and higher quality products and services" (p.1075). Furthermore, the choice of the right city to locate in can increase company opportunities and reduce risks (Porter, 2000; Huggins et al., 2017).

Despite the continued growth and relevance of urban centres, as a result of globalization the reasons that once caused businesses to cluster in cities are no longer the same. As explained by Begg (1999), "an implication of these changes is that urban hierarchies are shifting radically, with the result that cities which might have been comfortable with an allotted role (whether based on central places or some other tidy structure) now have to confront a more precarious and uncertain development path" (p.796).

Thus, 'improved competitiveness' has become a leading purpose for many local governments, also heavily encouraged by national and regional bodies, seeking to cultivate their city's economic profile (Begg, 1999). Cities with advanced economies, more specifically, have shifted their focus to knowledge-intensive industries, hoping to capitalize on their well-

developed infrastructure and large pool of highly-skilled workers (Gugler and Brunner, 2007). Indeed, the Global Competitiveness Index concluded that specifically for developed countries Foreign Direct Investment (FDI) is strongly related to technology advancement and innovation. In addition, some authors highlight the importance of anchoring the concept of economic competitiveness of a city to the sustainable wellbeing of its residents, as the former should not be an end in and of itself, but a means to achieve the latter (Storper, 1997, Rogerson, 1999, Hanna and Walton-Roberts, 2004).

It is undeniable that cities today compete in the international arena, and that some cities are more successful than others (Clark et al., 2002). Competitiveness, in fact, can be described as the optimization between the local and global spheres. To that end, cities of all sizes and shapes have experimented with a variety of social, economic, political, and environmental strategies. Their aim is to provide the best combination of 'urban assets' to enhance their attractiveness to international investments and improve their economic performance in the global market (Hanna and Walton-Roberts, 2004). Much of that effort is directed at creating a quality urban environment anchored by efficient infrastructure, cultural amenities, and attractive life-style. Clark et al (2002) reflects on this current trend as a welcome change from local governmental practices of patronage, such as subsidies to individual companies. They contend that by focusing on the quality of place, city governments are focusing on public goods that are beneficial to all.

Nowhere is this idea more truthful than in the advanced economies of north and western European cities. They were the birthplace of urban industrialization, and heavily relied on manufacturing and its technological innovations for most of the 19th and 20th centuries. Many of them saw the worst negative externalities of agglomeration, as well as the slow triumph of the working class as they fought for better quality of life in urban spaces. Today, the region is the largest hub in the world for high-tech and innovation industries, as well as a model for socio-economic development and quality of urban environment.

Figure 1 - Rotterdam

Source: Megatech Dev

Figure 2 - Witte de Withstraat in Rotterdam

Source: Alamy

Rotterdam, in the Netherlands, is an interesting example of this industry-innovation-urban dynamic. As the largest port in Europe, its economy continues to be based largely on the shipping and petro(chemical) industries, but its high-tech infrastructure and innovative operations are what has secured Rotterdam's leading position. At the same time, as the city transitions from an industrial past to an innovative future, the urban area of Rotterdam has begun attracting multinationals in the consumer goods and service sectors with little direct relation to the port, such as asset management, financial, legal, architecture, cosmetics, etc.,

which could be strongly related to the new-found quality of its urban environment. Striking modern architecture and innovative urban initiatives are just some of the elements that have helped Rotterdam rank 11th in Europe's best destinations for 2017. In fact, Rotterdam has recently been named 'Europe's Next Capital of Cool'. Like many other cities, Rotterdam is currently transitioning from an industrial past to an innovative future, and a comparative study of Rotterdam and similar competitive metropolitan regions in northwest Europe will provide a robust methodology for the general theory of the influence of spatial characteristics of cities in the attraction and concentration of knowledge-intensive international businesses.

1.2 Problem Statement

Cities compete in the international arena with a unique set of urban assets or characteristics. Whereas many studies have researched the impact of location characteristics to competitiveness between cities, most have focused on social and economic characteristics (Rogerson, 1999, Klaesson et al, 2011), rather than spatial characteristic. Nevertheless, spatial and physical characteristics are often mentioned in studies of economic competitiveness as relevant elements of local attractiveness for international investments. For instance, Turok (2004) has highlighted the importance of spatial characteristics of a city, such as cultural amenities, urban attractiveness, and quality of lifestyle in competing for high-skilled labour and knowledge-based industries. Similarly, Florida (2002) argues that advanced industries will follow highly-skilled workers, or the 'creative class', who in turn favours cities that offer physical amenities such as outdoor space, bike paths, cultural and social scenes. Likewise, Budd and Hirmis (2004) maintain that: "The importance of the spatial structure to regional competitiveness cannot be under-estimated. The spatial structure can, therefore, be considered part of the regional production function, in addition to the conventional inputs of labour, capital, and land" (p.1026). Moreover, Rogerson (1999) affirms that quality of life in cities is closely linked to spatial assets, and can be an important factor in successfully attracting wealth and urban development. In a recent study of the impact of spatial characteristics of business clusters to the attraction of FDI, van t'Hoff and Wall (2017) found that while FDI is driven primarily by "proximity to local innovators, producers and suppliers", local spatial characteristics do have an influence, even if reduced, in the location choices of international businesses (p.17).

Urban amenities have increasingly gained attention from cities that aim to attract global businesses. Whereas many researchers suggest a correlation between spatial amenities and economic development, only few studies have investigated their relationship (van t'Hoff and Wall, 2017). Therefore, there exists a knowledge gap in understanding the depth and extent of the relationship to which this study can contribute. A study aiming to identify the most relevant spatial amenities and their impact on the presence of clusters of Multinational Corporations in mid-sized north-western European cities will assist in the prioritization of policies and programs for urban development.

1.3 Research Objective

Through the application of concepts and tools from economic geography and urban planning and design, this research sought to expand on the relevancy of spatial characteristics to the competitiveness of urban centres established above by assessing their influence on the attraction of Multinational Corporation clusters in Rotterdam and its competitor cities in Europe. Stemming from these results, policy recommendations may then be provided to cities,

and more specifically Rotterdam, aimed at enhancing their attractiveness to Multinational Corporations through the implementation of specific spatial elements.

1.4 Research Question

The main research question was**: Which spatial characteristics of cities and firms are determinants of Multinational Corporation clusters in north-western European cities?** Other related questions answered by this research are:

1. What is the spatial distribution of Multinational Corporation clusters in selected midsize north-western European cities?
2. How does the spatial distribution of Multinational Corporation clusters relate to the average spatial distribution of urban physical amenities?
3. Which spatial characteristics of midsize north-western European cities impact their attraction of Multinational Corporation clusters?
4. Is the FDI attractiveness of north-western European cities impacted by their borrowed proximity[1] to spatial characteristics of neighbouring cities?

1.5 Significance of Study

Cities are gaining ever more prominence in the international arena, and their policy-makers are confronted with selecting strategies that will advance their city's economic competitiveness. Despite cities' growing focus on developing urban amenities that will attract knowledge-intensive industries, there is little academic understanding of the level and extent to which physical/spatial amenities impact a city's ability to attract investment. While the characteristics that can shape the competitiveness of cities are seemingly unlimited, the resources available to them are not. Therefore, local governments require empirical knowledge that can guide their policies and programs toward the optimal combination of 'urban assets' afforded by the resources available to them. To that end, this study aimed to address the topical knowledge gap on this subject by providing policy-makers with a framework to guide the development of urban spatial amenities.

1.6 Scope and Limitations

Cities (not countries) are the driving force of the global economy (Scott, 2001). Therefore, this study focused on 11 north-western European cities that are evaluated as competitors to Rotterdam based on proximity, size, population and economic profile. Those cities are: Rotterdam (NL), The Hague (NL), Amsterdam (NL), Utrecht (NL), Antwerp (BE), Ghent (BE), Birmingham (UK), Coventry (UK), Manchester (UK), Dusseldorf (DE), Essen (DE).

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[1] Borrowed Proximity is a concept created by the author to describe the idea that through spatial proximity of neighbouring cities, urban amenities of one city has an impact in the economic development of another city. More about the concept can be found in Chapter 3.

Clusters of Multinational Corporations (MNCs) through inward flow of Foreign Direct Investment (FDI) is an accepted measure of local economic development in the global world. FDI was analysed in this study by count rather than value and by neighbourhood location within the selected cities. It should be noted that, as a cross-sectional study, only one year of FDI flow was considered and this study focused primarily on the urban spatial characteristics presently considered attractive to MNC clusters by leading urban and business theory.

Limitations to this study included high multicollinearity between independent variables, forcing the exclusion of some variables that were initially included based on the theory review. Multicollinearity was also an issue in the borrowed proximity analysis, forcing a model with only one independent variable at a time. Moreover, because the data was generated using proximity measurements, only neighbourhoods with FDI could be included as observations, which limited their number and precluded analyses at the city level. Only a model with all cities combined was possible. In addition, because of the use of proximity data, no social-economic variables could be used as control. Lastly, secondary data was acquired from an open source database, which has the advantage of being up-to-date, but could present issues with reliability.

Chapter 2: Literature Review / Theory

This chapter provides an overview of the relevant theories surrounding the concepts that were inputs to this study. A conceptual framework is presented at the end of the chapter.

- Economic Globalization
  - Global Perspective
  - Regional Perspective
  - Local Perspective
  - Clusters
  - Innovation
- Competitiveness
  - Place Competitiveness
  - FDI & Multinational Corporations
- Location Factors
  - Location Factors in Business Theory
  - Location Factors in Urban Theory
  - Urban Assets and Urban Spatial Assets in Advanced Economies
  - Urban Asset and Regional Integration
- Conceptual Framework

2.1 Economic Globalization

2.1.1 Global Perspective

The global integration of markets has profoundly changed the economic geography of production and has severely impacted national and local economies. Advances in transport and communication technologies and opening of markets have substantially increased the location options of firms looking for the best global advantage (Rogerson, 1999). Consequent offshoring and segmentation led to unparalleled growth in developing economies, particularly in Asia and Latin America, at the same time that it crippled many US and European economies that relied heavily on manufacturing and mining industries (Begg, 1999).

Economic globalization can be described as the increasing long-distance flow of capital, services, goods, and information (Keohane and Nye, 2000). Within the economic dimension of globalization, much has been debated regarding its positive and negative consequences to nations and their cities. For instance, it has long been debated whether or not globalization promotes growth, and there is a wide body of empiric research to support either side (Dreher, 2006).

In parallel, the issue of wealth distribution is placed at the forefront of discussions about globalization. In the 1970s, the main concern was that globalization would produce uneven development and deepen inequality by favouring wealthier nations at the expense of poorer countries. In the 1990s, however, the core of the debate shifted to concerns over the capacity of post-industrial economies to remain relevant and guard their advanced societal benefits in face of large-scale economies, such as that of the United States and Japan, or of the increased yet low-cost capacity of developing countries (e.g. China) (Krugman and Venables, 1995). More recently, many studies have sought to understand the impact of globalization in the internal distribution of wealth at national and local scales, as there is growing fear that rising internal inequality could cause not only a recoil of globalization but also political instability in both developed and developing nations. To this point, Dreher (2006) defends that while

globalization does produce economic growth in both developed and developing nations, its contribution to equality is a long and uneven process.

2.1.2 Regional Perspective

The European economy was severely impacted by global integration, as its relatively small separate national markets could no longer compete with large-scale economies such as the Unites States and Japan. This was perhaps one of the most significant reasons why the European Union came to be. In an interview for the Harvard Business Review in 1989, Wisse Dekker (then chairman of the Roundtable of European Industrialists, a group of business leaders with the purpose to help strengthen and develop Europe's competitive capacities) advocated for a single European market that would be the biggest in the world at the time with 320 million people and would allow European companies to compete at a larger scale production. Dekker also mentioned Europe's generous social benefits as another important difference between Europe and its global competitors, and that Europe would have to focus on innovation (particularly organizational and political) to retain its social gains and yet remain competitive in a globalized world (Stone and Dekker, 1989).

Nevertheless, as explained by Burger et al (2013), European integration also increases competition within the continent "as the free movement of capital, goods and workers and the removal of economic, social and cultural barriers have made national boundaries disappear" (p.22). They argue that the union system enhances competition between cities in different countries but with similar characteristics, rather than cities within one country.

2.1.3 Local Perspective

Local governments are perhaps the most affected by globalization. There are many examples to support this view. For instance, cities that were once the engines of their regional economies lost entire industries (and jobs) when firms opted to displace whole segments of their production to suburbs and low-cost nations (Begg, 1999). On the other hand, the demands of international firms strongly accelerated rural to urban migration in the developing world, where urban services and infrastructure were insufficient and institutions unprepared, leading to many social ailments. Consequently, globalization is often viewed as being driven exclusively by the will of global businesses and at the expense of local economies.

Nevertheless, while cities are perhaps more vulnerable to global changes than regions or nations, they are also the most flexible and innovative. The ability to absorb and respond to shifting global demands places cities at the centre of globalization and economic development (Castells, 1993; Scott, 2001; Porter, 2000). This rationale explains, at least in part, why cities have continued to grow through the last few decades, becoming the powerhouses of advanced economies (Clark et al, 2002). Audretsch (1998) contends that "the global demand for innovative products in knowledge-based industries is high and growing rapidly" (p.19), and externalities available in urban areas are the most relevant resources for innovation. In fact, Storper and Manville (2006) advocate that cities' inherent purpose is to be centres of services and innovation, and globalization has shifted the urban path towards its right, natural direction. Indeed, most of global capital and innovation remain concentrated in cities, and in just a few, for that matter (Simmie, 2005).

To that end, Florida (2008) famously describes the globalized world as both flat and spiky. Flat because globalization has allowed for the spreading of economic activity, removing barriers

and making it possible for businesses and people to operate from virtually anywhere in the world. However, the world is also increasingly spiky because population, economic activity and innovation continue to concentrate in just a few urban areas. Globalization did not end concentration, but rather shifted and intensified it in well-networked nodes across the globe.

2.1.4 Clusters

Economists have long tried to understand the geography of economic development; particularly with respect to why certain places outperform others. Location characteristics and competitiveness have always been a central focus of this discussion. Ricardo (1816) first used the term 'comparative advantage' to describe how a place's specific set of physical, human, capital and infrastructure factors impacts its productivity and economic growth. Globalization brought updates to Ricardo's theory, such as the Hecksher-Ohlin model attempting to explain the offshoring of certain industries to countries offering low-cost resources. Here, nations were considered the main drivers of economic development, while cities were simply parts of the whole.

Marshall (1890) placed urban areas at the centre of discussions with his theory on agglomeration, where the main idea was that proximity to other firms brought advantages of scale that reduced costs and increased gains. In addition, Schumpeter (1939, 1942) introduced the focus on innovation as the main reason for agglomeration in the modern economy, giving way to new theories on urban concentration (Simmie, 2005).

Porter (2000) explains clusters as "a system of interconnected firms and institutions whose whole is more than the sum of its parts" (p.21). His theory suggests that much of the competitive advantage of firms is related to the concentration of information, employees, supporting industries, and public goods that certain locations provide. Porter's cluster theory opens the concept of clusters to include not only firms, but also institutions and local amenities that together enhance production growth and innovation while also reducing risks.

Global cities theory (e.g. Jacobs, 1970; Sassen, 1991; Beaverstock et al., 1999) introduced the idea that the complementarity of industries is an advantage of urbanization, contending that diversification of knowledge and activities within a cluster maximizes spillover and innovation (Nielsen et al., 2017).

Duranton and Puga (2004) describe the logic of agglomeration through the mechanisms of sharing, matching and learning. Sharing corresponds to advantage of scale, in which urban services and amenities can be provided at lower cost and higher value. Matching is more commonly associated to the labour market as a greater pool of jobs and job-seekers will result in more quality pairing of demands and skills. Lastly, learning refers to knowledge generation, diffusion and accumulation, often through face-to-face interaction. Those mechanisms combined give rise to powerful dynamics of innovation and economic growth. Many other theories focus on specific aspects of agglomeration and clustering. For example, Florida (2008) focuses specifically on the mobility and concentration of creative and knowledge workers in cities that offer diversity, specialization, and quality of life. More recently, van t'Hoff and Wall (2017) proved that FDI not only concentrates in just a few cities, but also in a few business districts within those cities providing proximity to innovation, production and market advantages, as well as sector-specific urban amenities.

Agglomeration and clustering mechanisms offer compounded advantages to those involved, such as shared infrastructure, exchange of knowledge and information, larger pools of high-skilled human resources, etc. This explains why foreign direct investments tend to concentrate

in just a few locations, as cluster advantages are ever more important in this highly competitive economy where firms must constantly innovate to compete at a global scale.

2.1.5 Innovation

The focus on innovation in the global economy has changed the way in which cities now compete to attract businesses (Begg, 1999). For the larger portion of the history of the world, the economic success of companies was tied to the cost-effective, combined proximity to labour, natural resources, and markets. However, as a result of globalization, advancements in communication and transport technology, proximity to those combined resources were no longer the determinants of prosperity. As effectively summarized said by Porter (2000), "anything that can be efficiently sourced from a distance has essentially been nullified as a competitive advantage in advanced economies". If traditional advantages no longer hold, then firms must continually innovate to succeed and stay relevant in an ever more complex and dynamic world.

The European Commission defines innovation as the "commercially successful exploitation of new technologies, ideas or methods through the introduction of new products or processes, or through the improvement of existing ones" (quoted by Simmie, 2005, p.790). Schumpeter (1939) highlights innovation as the principal driver of capitalism and economic growth, and Porter (2000) argues that "productivity and innovation—not low wages, low taxes, or a devalued currency—are the definition of competitiveness" (p.30).

Simmie (2005) notes that company innovation requires constant interaction between internal and external players. Cities have a distinct advantage in this process as greater agglomeration of key players is found in urban areas. Audretsch (1998) contends that "since knowledge is generated and transmitted more efficiently via local proximity, economic activity based on new knowledge has a high propensity to cluster within a geographic region" (p.18). Already in the 1970's Jacobs (1970) defended that knowledge spillover is highly dependent on factors that are external to the firms, and that cities are at the centre of this dynamic. Similarly, Porter (2000) supports that proximity to consumers, suppliers and other influencing actors is crucial for productivity and innovation, and refers to this dynamic as the 'location paradox': in a globalized economy, the most valuable resources appear to be more local than ever.

Figure 3 - Innovation in a Spiky World.

Source: Who is Your City? Florida, 2008

Proximity has remained an important concept, even as it has changed in purpose. In this context, firms continuously choose to concentrate in just a few locations around the globe where they can harness the updated advantages of proximity (Figure 3). This high propensity for concentration with the purpose of innovation is ultimately what benefits cities over non-urbanized or suburbanized locations. However, it also places great pressure on cities to compete for a place among the global players.

2.2 Competitiveness

2.2.1 Place Competitiveness

The term *competitiveness* has been extensively used in academic literature, often under conflicting definitions. For instance, some contend that competitiveness is a feature exclusively of firms, and caution against the use of the concept to increase the economic role of governments (Krugman, 1994). Others suggest that the prosperity of cities, regions and nations rest heavily on the success of their firms, and governments should play an essential role in providing for the unique set of assets that will contribute to economic productivity (Naponen et al., 1993; Porter, 2000). In yet another description, Begg (1999) maintains that as a "collection of assets", nations, regions and cities should certainly fit into the same definition of competitiveness that is applicable to firms.

Begg (1999), Turok (2004), Hanna and Walton-Roberts (2004) draw attention to the fact that some approaches to competitiveness can be unproductive and exacerbate social weaknesses, but also suggest that competitiveness is a positive driving force for continuous and innovative urban development. Correspondingly, Begg (1999) contends that competitiveness should not be confused with competition. The first is based on a sustainable rise in productivity encompassing human, infrastructure, and institutional development, while the latter is simply a zero-sum rivalry for market-shares. Similarly, many scholars highlight the importance of anchoring the concept of competitiveness of a place to the sustainable wellbeing of its residents (Storper, 1997, Rogerson, 1999, Hanna and Walton-Roberts, 2004). Storper (1997) defines competitiveness as "the ability of an economy to hold stable or increase market shares in an activity, while sustaining or increasing standards of living for those who participate in it" (p.264). Similarly, from the perspective of place resources, the European Commission defines competitiveness as "the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work".

The continuous ability to remain relevant in a global economy may determine the success or demise of a place. Therefore, cities compete to attract people, capital and businesses to their boundaries with the purpose of sustainable economic and social development. As well described by Burger et al. (2013): "With respect to foreign investments, the aim is not only to attract high value-added investments, but also to avoid the relocation of firms and attract re-investments by MNCs already present in the region" (p.7).

2.2.2 FDI & Multinational Corporations

Cities with advanced economies have shifted their focus to attract Multinational Corporations (MNCs) in knowledge-intensive sectors which are strongly linked to innovation and economic development (Gugler and Brunner, 2007). Multinational Corporations are a direct product of globalization as large firms expanded their activities to other nations through subsidiary branches, also known as foreign direct investment (FDI). Different from other

internationalization mechanisms such as selling knowledge-based assets to foreign companies (e.g. license), FDI guarantees control and ownership retention of the firm's activities. FDI is generally consists of three (3) types: greenfield investments (ground-up development of a new site); brownfield investment (rebuilt or redevelopment of an existing site); and merger & acquisitions (transfer of ownership of an existing site) (Meyer and Estrin, 2001).

Gugler and Brunner (2001) explain that in the 1970s inward FDI was perceived as harmful to national and local development. Today, despite conflicting studies, the presence of MNCs through inward FDI is considered a key driver of enhanced competitiveness and economic development. Porter (2000) defends that FDI not only increases the benefits attributed to clustering, but also improves the local job and capital markets. Blomström and Kokko (1998) support that FDI is associated with transfer of technology and knowledge spillover. Similarly, Dunning (1998) affirms that global subsidiaries bring extensive knowledge and innovation of products, services, and processes, and benefit the local industry through collaboration and fruitful competition. Yet, Narula and Marin (2003) caution that while collaboration and competition brought on by inward FDI can be very beneficial to host places, it will heavily depend on the capacity of the local industry to absorb and respond to new challenges.

From the point of view of firms, location theories suggest that local characteristics of a place (e.g. social, economic, physical) can influence the success or demise of a business, including its survival over time (Huggins et al, 2017). In a highly competitive and globalized world, firms branch out to foreign locations not only in search of natural resources and markets, but also to take advantage of the knowledge, skills and network opportunities present in those locations (Dunning, 1998). For all those reasons, FDI is considered an important measure of local economic development in the context of global integration (Wall and Stavropoulos, 2016).

2.3 Location Factors

2.3.1 Location Factors in Business Theory

There is a wide body of research within International Business studies dedicated to understanding location preferences of firms, particularly of MNCs through FDI.

In a thorough review of the literature, Kim and Aguilera (2015) groups location factors influencing FDI strategies into six (6) categories: economic geography, emerging markets, strategic-asset seeking, regions, networks, and institutions. Economic geography refers particularly to agglomeration and clustering externalities, which corresponds, for example, to why MNCs choose specific locations (e.g. urban areas) within a country. This category of thinking defends the notion that spillover and cooperation with other existing firms in a given location are valuable assets that can only be harnessed through proximity.

Access to emerging markets is another significant factor that brings MNCs to set subsidiaries in foreign countries. In this case, it is worth noting that MNCs will favour FDI instead of licensing agreements when they intend to retain marketing and brand control. Strategic-asset seeking refers to MNCs interest in knowledge assets that are not available anywhere, such as high-skilled labour, R&D, and advanced technology. More recent studies also focus on regional integration and MNCs' strategic position within a network.

Both formal (e.g. advantageous property rights and corporate tax laws) and informal (e.g. shared culture and social values) institutions are considered of significant importance to MNCs when choosing a foreign location as institutional affinity can "minimize transaction costs, facilitate more complex exchanges among social actors and, consequently, achieve sustained

economic growth" (Kim and Aguilera, 2015, p.143). For example, Keller and Schanz (2013) found that the host nation's tax environment has a significantly positive effect to the location decisions of German MNCs. Galan et al (2007) found that Spanish MNCs are more likely to invest in Latin American countries based on cultural proximity and shared social values, which tends to improve acceptability of the local market to the foreign firm.

Performing a statistical analysis of location studies, Nielsen et al (2017) also identified a number of determinants that influence MNCs' decision when settling in a foreign location; among them are market demands, cost of wages, corporate tax rate, quality of institutions, infrastructure, human capital, concentration of firms from similar and diverse industries, and international brand. In their findings, they reported that despite some contrary studies, market demands, quality of institutions, infrastructure, human capital, and concentration of firms have more often than not presented a significant impact on location decisions.

In another comprehensive review, Galan et al (2007) outlined 20 location factors found in empirical studies (Figure 4).

	Location factors	*Empirical studies*
Cost factors		
F1	Low labour costs (workforce)	Dunning (1988, 1998); Wheeler and Mody (1992); Hennart and Park (1994); Summary and Summary (1995); Buckley and Casson (1998); Tatoglu and Glaister (1998); Globerman and Shapiro (1999); Cheng and Kwan (2000); Tahir and Larimo (2004)
F2	Low transportation/logistics costs (supply and distribution)	Goodnow and Hansz (1972); Davidson and McFetridge (1985); Dunning (1988, 1998); Hennart and Park (1994); Buckley and Casson (1998); Tatoglu and Glaister (1998)
F3	Low cost of raw materials, energy and water	Dunning (1988, 1998); Hennart and Park (1994); Buckley and Casson (1998); Tatoglu and Glaister (1998)
F4	Availability and low costs of land	Dunning (1988, 1998); Gomes-Casseres (1990); Hennart and Park (1994); Buckley and Casson (1998); Tatoglu and Glaister (1998)
Market factors		
F5	Large size of host market	Kobrin (1976); Root and Ahmed (1978); Davidson (1980); Dunning (1980); Lunn (1980); Scaperlanda and Balough (1983); Culem (1988); Dunning (1988, 1998); Sabi (1988); Agarwal and Ramaswami (1992); Li and Guisinger (1992); Hennart and Park (1994); Grosse and Trevino (1996); Jun and Singh (1996); Buckley and Casson (1998); Tatoglu and Glaister (1998); Zhou *et al.* (2002); Tahir and Larimo (2004)
F6	Growing demand in host markets (potential growth)	Kobrin (1976); Davidson (1980); Dunning (1980); Lunn (1980); Scaperlanda and Balough (1983); Dunning (1988, 1998); Sabi (1988); Grosse and Trevino (1996); Buckley and Casson (1998); Tatoglu and Glaister (1998); Cheng and Kwan (2000); Zhou *et al.* (2002)
F7	Low level of competition in host markets	Goodnow (1985); Dunning (1988, 1998); Hennart and Park (1994); Buckley and Casson (1998); Tatoglu and Glaister (1998)
Infrastructure and technological factors		
F8	Very well-developed infrastructures	Dunning (1988, 1998); Porter (1990); Gomes-Casseres (1990); Krugman (1991); Dunning and Kundu (1995); Loree and Guisinger (1995); Ulgado (1996); Buckley and Casson (1998); Tatoglu and Glaister (1998); Cheng and Kwan (2000); Zhou *et al.* (2002)
F9	High industrial concentration (industrial parks, technology networks, etc.)	Dunning (1988, 1998); Porter (1990); Gomes-Casseres (1990); Krugman (1991); Buckley and Casson (1998); Cheng and Kwan (2000); Zhou *et al.* (2002)
F10	Availability and expertise of workforce	Agodo (1978); Root and Ahmed (1979); Dunning (1988, 1998); Gomes-Casseres (1990); Buckley and Casson (1998); Tatoglu and Glaister (1998); Cheng and Kwan (2000); Zhou *et al.* (2002)
F11	Access to reliable and cooperative suppliers	Mattsson (1985); Dunning (1988, 1998); Buckley and Casson (1998)
F12	Technologically advanced country (learning opportunities)	Johanson and Wiedersheim-Paul (1975); Johanson and Vahlne (1977, 1990); Dunning (1988); Kogut and Singh (1988); Kogut and Zander (1993); Barkema *et al.* (1996); Barkema and Vermeulen (1998); Delios and Beamish (1999)

Political and legal factors		
F13	Political stability	Kobrin (1976); Agodo (1978); Root and Ahmed (1979); Nigh (1985); Dunning (1988, 1998); Fatehi-Sedeh and Safizadeh (1989); Agarwal and Ramaswami (1992); Agarwal (1994); Grosse and Trevino (1996); Buckley and Casson (1998); Butler and Joaquin (1998); Tatoglu and Glaister (1998)
F14	International trade agreements	Dunning (1988, 1997, 1998); Grosse and Trevino (1996); Buckley and Casson (1998); Globerman and Shapiro (1999)
F15	Tax reduction incentives in host markets	Alworth (1971); Nigh (1985); Gersovitz (1987); Dunning (1988, 1998); Fatehi-Sedeh and Safizadeh (1989); Jun (1989); Gomes-Casseres (1990); Loree and Guisinger (1995); Yamada and Yamada (1996); Tatoglu and Glaister (1998); Cheng and Kwan (2000)
F16	Grants and tax reductions in the home country	Alworth (1971); Gersovitz (1987); Dunning (1988); Jun (1989); Buckley and Casson (1998)
F17	More benign environmental legislation	Dunning (1988, 1998); Gomes-Casseres (1990)
Social and cultural factors		
F18	Standard of living and public services	Dunning (1988, 1998); Gomes-Casseres (1990)
F19	Attitude of the community towards the firm	Dunning (1988, 1998); Buckley and Casson (1998); Globerman and Shapiro (1999)
F20	Cultural affinity	Dunning (1988, 1998); Mikalak (1992); Shane (1994); Kogut and Singh (1988); Barkema *et al.* (1996); Grosse and Trevino (1996); Tahir and Larimo (2004)

Figure 4 - Main empirical studies on FDI location factors.

Source: Galan et al, 2007

Jain et al (2016) highlight the importance of also considering firms' internal characteristics when studying location patterns. To that end, they suggest splitting FDI location determinants into firm determinants and host-place determinants. Firm determinants include factors that relate to resources and structure of firms: experiential learning, customer relationship, top-management or firm's background and networks, and industry characteristics. Host country or city determinants include inter-regional ties, macroeconomic environment, various types of institutional relationships between a home and host-country, availability of natural resources, and agglomeration.

2.3.2 Location Factors in Urban Theory

Also in Urban Studies there is much debate on how a location can achieve or increase its competitiveness in the international economy. Porter (2000) argues that productivity through innovation and specialization is essentially what defines competitiveness. Kresl (1995) understands competitiveness as a result of economic factors (such as production capacity and infrastructure) and institutional factors (for example, governance efficiency and responsiveness) which model and determine the ability of a place to attract international attention. Similarly, Turok (2004) notes that competitiveness is primarily "an indication of the drivers and dynamics of economic success" (p.1070).

Other scholars (e.g. Stoker, 1990; Peck, 1985; Peck and Tickell, 1992; Cox and Mair, 1988) emphasize more specifically the character and quality of institutions and their ability to communicate and collaborate (Rogerson, 1999). Also, important to note is that different economies compete at different levels and with different strategies. Some economies focus on currency devaluation, tax incentives, and other lowering-cost strategies while others, particularly of more advanced economies, invest in education, technology, and infrastructure aimed at attracting knowledge-based industries (Begg, 1999; Turok, 2004).

Porter (1990) outlined the theory of 'competitive advantage' and within it described four different stages of competitiveness: factor-driven, investment-driven, innovation-driven, and wealth-driven. Locations that compete at the factor-driven stage source their advantages solely from basic factors of production (e.g. natural resources, inexpensive semi-skilled labour pool). Investment-driven stage is found in places with firms that invest heavily on more advanced factors, such as efficient infrastructure and modern technologies. In the innovation-driven stage, technology is not only appropriated and improved upon, but also created. This stage comprises all determinants of economic development described in Porter's Diamond: factor conditions, firm strategy, structure, and rivalry, demand conditions and related and supporting industries (Figure 5). Lastly, wealth-driven economies represent a stage of decline in which continuous advancement is no longer in motion and the economy will eventually fall behind. Porter (1990) defends that nations must progressively expand their and their firms 'competitive advantages' or risk losing their economic relevance.

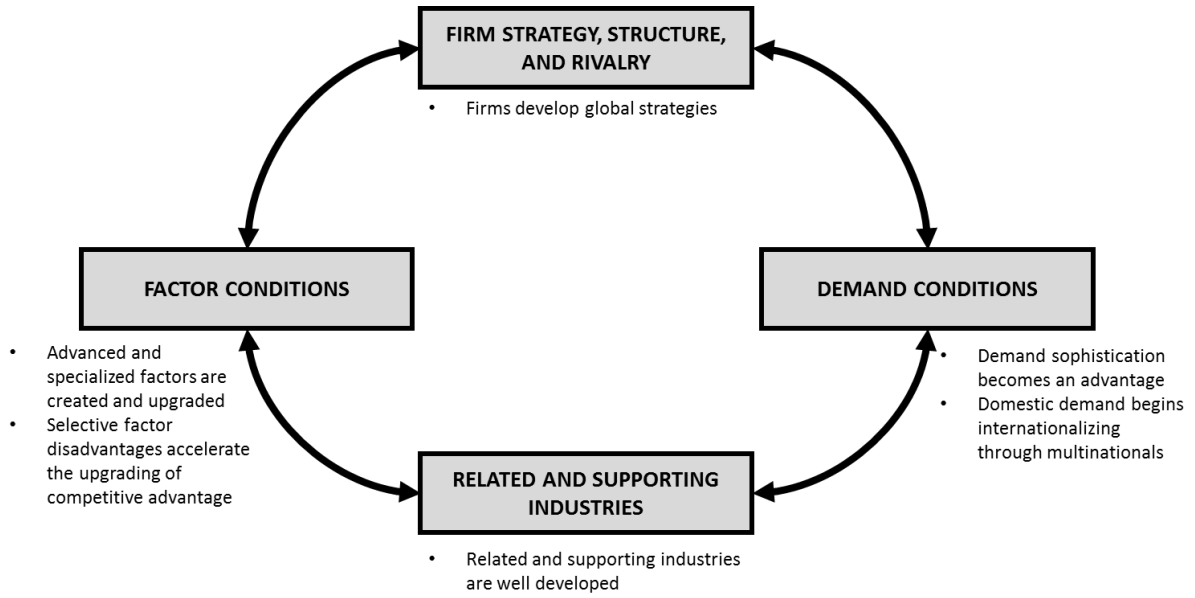


Figure 5 - Porter's Diamond of the Innovation-Driven Economy – Sources of Competitive Advantage

Source: Porter, 1990

The 2016-2017 Global Competitiveness Report applies Porter's model to their framework and groups several different determinants of competitiveness into three (3) categories: basic requirements, efficiency enhancers, and innovation and sophistication factors (Schwab, 2016). Under these determinants, it reported several European countries among the most competitive economies in the world, for example Sweden, Finland, Denmark, Germany, and the Netherlands. It can, thus, be argued that the advanced economies in north and western Europe strongly satisfy the determinants of Porter's competitiveness diamond for innovation-driven economies. Nevertheless, Ranci (2011) cautiously adds that competitiveness shows great variation even between advanced European economies. For example, Brussels, Paris, and Oslo have high levels of productivity, but London, Milan and Frankfurt have stronger outward connectivity. Additionally, in a study of competitiveness of European regions Burger et al (2013) found that small and mid-sized regions with similar location endowments compete

severely with one another, while larger regions face a lower level of competition not only for their size but also for their distinctiveness.

The European Commission believes that competitiveness is "a key determinant for growth and jobs in Europe and very important for small and medium-sized companies (SMEs)". It refers to economic competitiveness through two distinct lenses: firms and places. First, the EU is concerned with the internal ability of its firms to compete nationally, regionally and internationally by leading research and innovation, focusing on sustainable production, and continuously investing in the industry and society. Second, it emphasizes the role of its nations and regions in providing the right environment for businesses to grow, for example, through access to regional and global networks, quality infrastructure, financing, and appropriate skilled labour.

In its 2016 findings the European Commission observed continuous growth of polycentric regions, with larger metropolitan areas driving economic performance. Looking specifically at the performance of the Netherlands, the country has shown some decline in the last five years. However, it continues to strongly outperform the European region as a whole (Figure 6). The competitive performance of South-Holland, where the city of Rotterdam is the largest urban centre, is remarkably well-aligned with the rest of the Netherlands. It is worth noting that there is variation in the variables used by the European Commission from those used by the Global Competitiveness Report. It is also worth noting that both institutions focus mostly on socio-economic factors, leaving a gap in understanding with respect to how and which spatial characteristics beyond basic infrastructure are relevant to competitiveness.

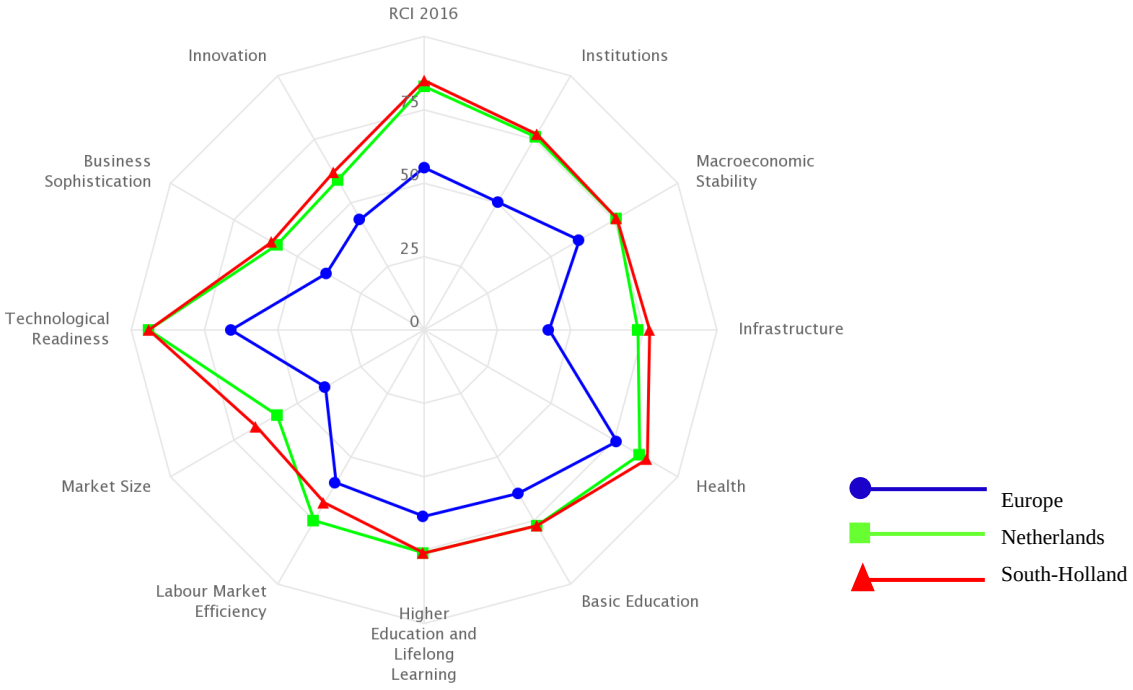


Figure 6 - Comparative graph of the Regional Competitiveness Indexes of Europe/Netherlands/Sou

Source: European Commission, 2016

2.3.3 Urban Assets and Urban Spatial Assets in Advanced Economies

Determinants are weighted differently in the location decision depending on which advantages the MNC is seeking. Innovation-driven MNCs tend to value, for example, "market size and growth, availability and cost of technically-qualified labour, educational infrastructure and technological development of a country, taxes and country openness" (Jain et al, 2016, p.313). Galan et al (2007) identifies three (3) categories of the most relevant location factors related specifically to advanced economies: very well-developed infrastructure, availability of high-quality created assets, and availability of clusters of related activities. Many of the assets that compose those desired location factors are intrinsically urban, which puts cities in a unique position to appeal to innovation-driven FDI. The many attractive urban assets cited by the literature can be largely divided in socio-economic and spatial factors.

In advanced economies, the most consistently cited socio-economic factors are related to availability and cost of high-skilled labour and advanced market demands. Advanced market demand refers to a customer base that demands innovation and technology-advanced products and services.

On the topic of availability of high-skilled labour, Landry (2012) highlights that cities are the spatial background where "a critical mass of entrepreneurs, intellectuals, social activists, artists, administrators, power brokers or students can operate in an open-minded, cosmopolitan context and where face to face interaction creates new ideas, artefacts, products, services, and institutions" (p.133). Florida (2000) defends that due to globalization, people have become increasingly mobile and the most skilled workers have the opportunity to select where they want to live and work from any place in the world. Florida argues that while job placement factors are important in those decisions, social and environmental factors are becoming increasingly significant. Those factors are usually related to quality of life, and are more often than not, though not exclusively, present in advanced economies. Rogerson (1999) cites a number of studies (e.g. Fothergill and Gudgin, 1982; Hart et al., 1989; Healey and Baker, 1993; Senn, 1995) where companies reported quality of life as an important factor considered in their location decision. Quality of life includes variables such as cost of living, public transport, security from crime, schools, environmental quality, housing and climate (Rogerson, 1999). Some of the attributes of quality of life actually fall into the spatial factors category.

Urban spatial factors correspond to natural or built physical elements of the urban environment. For spatial factors, the literature systematically highlights collaborative and supplementary concentration of firms, and well-developed transport and communication infrastructure with access to regional and global networks. Other scholars theorize on place aesthetics, environmental amenities, and local connectivity.

Well-developed infrastructure is an important advantage that advanced economies have over developing economies, but it can also vary greatly between cities and regions of the developed world. It relates to the reach, quality and cost of infrastructure, transport and communications being one example (Cheshire and Gordon, 1998; Begg, 1999; Simmie, 2005), and has heightened importance due to the increase in regional and global network activities.

In addition, Glaeser et al (2001) mention place aesthetics, quality of public amenities and dynamic milieu as components of an attractive urban environment for creative and knowledge workers. Martin-Brelot et al (2010) found in a study of the mobility of the creative class in Europe that foreigners moving to Amsterdam place high value on the city's local amenities. Similarly, Kahsai et al (2011) found that historical and cultural amenities have a significant impact on population growth in the U.S. northeast region, and that areas with higher levels of water based recreational facilities are associated with high levels of per capita income. Wu and

Mishra (2008) explain that, "because amenities attract human capital, which in turn attracts firms, locations with superior amenities tend to have a higher demand for labour and thus higher wage rates" (p.98). Glaeser and Mare (2001) also add that urban environments make workers more productive.

In sum, local governments' decisions are increasingly related to the quality of their cities, particularly on how to build or enhance the features that are simultaneously desired by both businesses and people in a globally integrated economy. Urban theory looks at the sustainable development of cities, which includes providing for the wellbeing of citizens and success of businesses. The list of urban spatial assets is incredibly diverse and has gained more importance as local governments seek to improve life-style amenities and branding of their cities. Public amenities (for example, related to mobility, recreation, and natural environment), and a dynamic milieu are the focus of much attention. Aesthetics in the form of architectural assets and attractive waterfronts are also thought to be important in creating a city that can both attract and retain the most innovative businesses and workforce. Moreover, urban spatial assets within a region, and between neighbouring cities, may also play an important role in an increasingly connected economic system.

2.3.2 Urban Assets and Regional Integration

Urban areas must be understood not within the physical boundaries of cities, but from the complex network of integrated functions of neighbouring locations.

As explained by Burger et al (2015): "due to the presence of spatial interdependencies, smaller places can "borrow size" and host functions that they could not have hosted in isolation" (p.1092). Particularly in European countries, such as Germany, the Netherlands, and Belgium, where cities tend to be of small and medium sizes, they can achieve competitive advantage by strengthening their network of nearby cities and borrowing size from each other (Alonso, 1973). Small and medium cities highly interconnected and dependent on one another and on larger cities for their amenities, resources, and labour.

The New Metropolis theory by Lang and Knox (2009) contends that "metropolitan expansion and regional integration […] invites a reconsideration of the traditional separation of urban and regional scales in the analysis and theorizing of spatial organization" (p. 799). In effect, the number of people who commute, shop, or visit areas officially outside of their metropolitan area is continuously growing. Specially in European cities, where distances are short and transport technology is advanced, there exists an increasingly complex pattern of interdependency in the movement of people and goods, business relations, cultural cohesion, and spatial environment. This is seen not only in the relationship between larger cities, but also with the smaller urban nodes that exist between them – the called 'micropolitan areas' (Lang and Knox, 2009).

2.5 Conceptual Framework

Globalization has created a new economic system of production in which resources are highly mobile. In this context, many developed nations struggled to stop their economy from collapsing as jobs were being lost to low-wage economies, while cities seemed to be permanently losing their relevance to sub-urban and industrial areas. However, companies have also had to re-evaluate their competitive advantages to succeed and survive in the new global

environment. Innovation became the motor of capitalism and economic growth for international companies, and, as a result, also for cities aiming to compete within more advanced economies (Schumpeter, 1939, 1942).

Because innovation requires constant and efficient interaction of knowledge, and knowledge is better transmitted through proximity (Audretsch, 1998), companies in the knowledge-intensive industries tend to cluster together (Porter, 2000). Complementarity of businesses through proximity enhances spillover effects and leads to greater innovation (Jacobs, 1970; Simmie, 2005). Furthermore, proximity allows companies to share amenities through advantages of scale (Marshall, 1890), and match workers and jobs more effectively. Where they choose to cluster, however, depends on the availability of external factors that best facilitate the sharing, matching, and learning mechanisms of innovation (Duranton and Puga, 2004). Cities, which exist under the very premise of proximity, are the natural grounds for innovation (Jacobs, 1970), which explain why cities have recovered and continued to grow even through shifting global demands.

Nevertheless, not all cities in advanced economies are growing equally. An effect of clustering is that MNCs attract MNCs, thus creating an exponential concentration of international firms in just a few cities across the globe (Florida, 2008). Consequently, cities are increasingly focused on enhancing their international competitiveness not only to attract but also retain MNCs bringing inward FDI (Burger et al., 2013). As defined by the European Commission, competitiveness is "the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work". FDI firms are strongly linked to innovation and economic development (Gugler and Brunner, 2007). They can increase the benefits of clustering, improve the local job and capital markets, provide transfer of technology and enhance knowledge spillover (Blomström and Kokko, 1998; Dunning, 1998; Porter, 2000). For those reasons, increased competitiveness aimed at the attraction and retention of FDI is vital for the sustainable economic and social development of places.

Urban Theory and Business Theory have produced many studies on the impact of a place's economic geography on the attraction of FDI. Each discipline has evaluated a variety of social, economic, political, cultural, environmental and spatial factors thought to attract or deter global businesses to specific cities, as well as certain locations within those cities. While Business Theory mostly focuses on those advantages of place that can improve business growth and profitability, Urban Theory goes beyond that to also focus on the wellbeing and social development of cities and their citizens. Interested particularly in the factors related to economic geography and urban design, and moderated by theories on proximity, this research focused only on spatial assets in order to highlight their influence on MNC clusters in cities.

According to the theory review described above, some of the spatial assets listed are the concentration of complementary and supporting industries, the reach of infrastructure (e.g. international airports, efficient railway and road systems) (Galan et al, 2007; Keller and Schanz, 2013; Kim and Aguilera, 2015; Jain et al, 2016; Nielsen et al, 2017), place aesthetics (e.g. architecture), environmental amenities (e.g. water areas, parks), and local infrastructure (e.g. street connectivity) (Kresl, 1995; Cheshire and Gordon, 1998; Rogerson, 1999; Begg, 1999; Porter, 2000; Florida, 2000; Glaeser et al, 2001; Turok, 2004; Simmie, 2005; Wu and Mishra, 2008; Kahsai et al, 2011; Landry, 2012).

Cities that provide the 'right' set of local characteristics can, in theory, attract more FDI and build a higher concentration of MNCs, thus increasing the flow of capital, jobs, knowledge and innovation that characterize economic development. This dynamic, in fact, characterizes a self-reinforcing cycle as more clusters, capital, jobs, knowledge, and innovation enhance a city's competitiveness in the globalized economy, which in turn attracts more clusters, capital, jobs,

knowledge, innovation, and so on. Ultimately, the terms local and global are blurred by the shared need for constant innovation, and improved competitiveness is realized by the continuous optimization of factors at both levels.

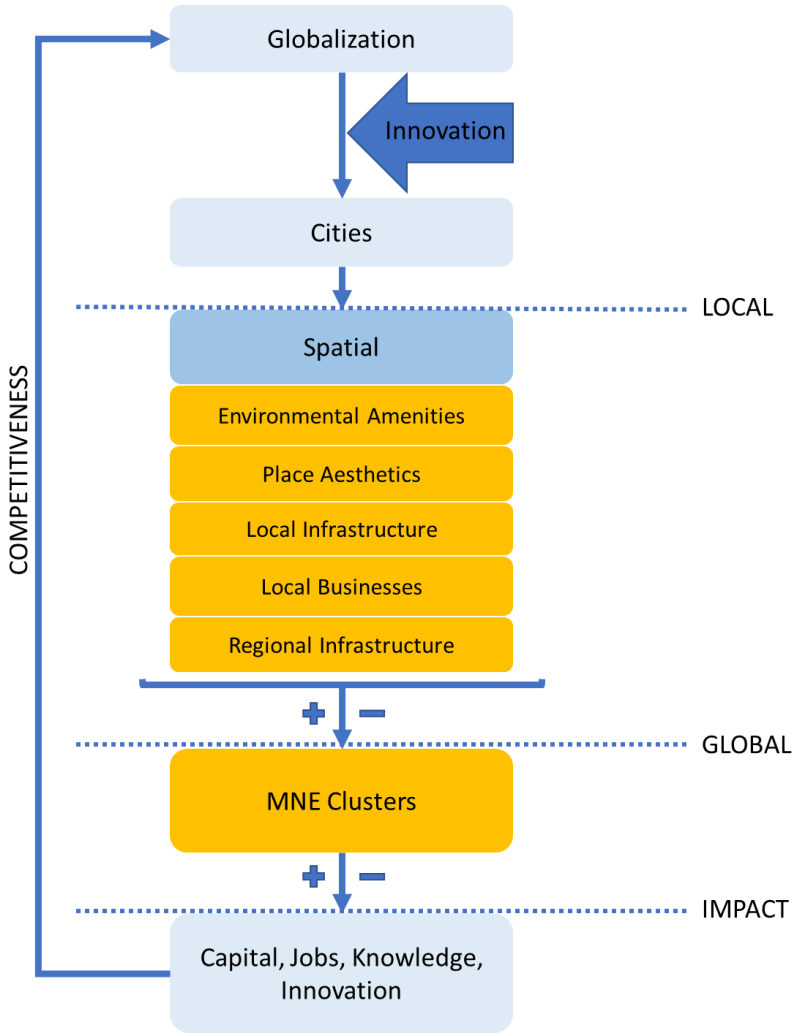


Figure 7 - Conceptual Framework by author

Chapter 3: Research Design and Methods

The present research combined statistical and geographic approaches by analysing the spatial quantitative data of 11 north-western European cities from four different countries. The research design and method sought to explain which of the selected spatial characteristics are most relevant in attracting knowledge-based FDI clusters in mid-sized advanced economies. This chapter describes the methodology used in the design, data collection, and analysis in this research.

- Revised Research Question
- Research Strategy
- Operationalization: variables, indicators
- Selection of Cities
- Data Collection Methods
    - Street Connectivity
    - Borrowed Proximity
- Data Analysis Methods
- Validity and Reliability

3.1 Revised Research Question

The revised research question for this study is as follows:

Which spatial characteristics of cities and firms are determinants of Multinational Corporation clusters in north-western European cities?

Related questions that will be answered by this research are:

5. What is the spatial distribution of Multinational Corporation clusters in selected midsize north-western European cities?
6. How does the spatial distribution of Multinational Corporation clusters relate to the average spatial distribution of urban physical amenities?
7. Which spatial characteristics of midsize north-western European cities impact their attraction of Multinational Corporation clusters?
8. Is the FDI attractiveness of north-western European cities impacted by their borrowed proximity to spatial characteristics of neighbouring cities?

3.2 Research Strategy

Based on the deductive and explanatory nature of the research question, the present study performed quantitative analysis of secondary and primary data. This strategy is well-suited for statistically investigating a large number of known independent variables, while also covering a wide geographic scope. Urban theory and business theory have output several spatial and socio-economic urban characteristics that can explain why certain cities outperform others in attracting international businesses. Through a deductive approach and thorough theory review, a set of spatial characteristics was selected covering different aspects of economic geography and urban design. Reliable secondary data was available for the dependent variable (FDI count). Data for the independent variables (spatial characteristics) was primarily created using

secondary data, mapping and distance measuring tools between the dependent variable and each spatial indicator to determine average distances for each FDI cluster (defined by neighbourhood boundaries).

To answer sub-question 1, the study examined FDI cluster spatial distributions in 11 cities by use of GIS weighted mapping. Cities were chosen based on their size, population, and competitive similarities to Rotterdam. Based on the theory reviewed, FDI tends to concentrate in just a few areas in the city, particularly central areas where urban amenities are more abundant. This leads to sub-question 2, for which a correlation analysis was performed (positive or negative) between the dependent variable and each independent variable. Sub-question 3 required negative binominal regressions to determine which characteristics or group of characteristics were most relevant in attracting greenfield FDI in cities with similar macroeconomic features. Sub-question 4 was also addressed by running negative binominal regressions defining one city as the base.

This study aims to perform a broad analysis of the topic. It does not offer an in-depth investigation of the reasoning behind MNC preferences, to which interviews with MNC decision-making staff would be better suited.

3.3 Operationalization: Variables, Indicators

The tables below describe the main concepts treated in this research as well as the variables and indicators analysed. Concepts are defined in accordance with urban and business literature. An operational definition is offered for the purpose of this research. The dependent variable (Y) is FDI clusters, measured through inward flow of FDI as an acceptable measure of competitiveness. The independent variables (X) are comprised of spatial characteristics from 11 cities observed at the neighbourhood level and within city boundaries.

Concept	Competitiveness
Definition	Storper (1997) defines competitiveness as "the ability of an economy to hold stable or increase market shares in an activity, while sustaining stable or increasing standards of living for those who participate in it" (p.264).
	The presence of MNC clusters through inward FDI is considered a key driver of enhanced competitiveness and economic development (Gugler and Brunner, 2001). "The higher a city's relative position in FDI attraction, the more stable its economy, and the more likely investors will continue to invest there in future" (Wall and Stavropoulos, 2016).
Operational Definition	Competitiveness is defined as the optimization between the local and global spheres through the presence of FDI clusters.

Concept	Location Factors in Business Theory
Definition	Local characteristics of a place (e.g. social, economic, physical) can influence the success or demise of a business, including its survival over time (Huggins et al, 2017).

	In a highly competitive and globalized world, firms branch out to foreign locations not only in search of natural resources and markets, but also to take advantage of the knowledge, skills and network opportunities present in those locations (Dunning 1998).
Operational Definition	Location Factors in Business Theory are defined as local characteristics that can influence the success or demise of a business, in this case MNC subsidiaries.

Concept	Location Factors in Urban Theory
Definition	"Proximity in geographic, cultural, and institutional terms allows special access, special relationships, better information, powerful incentives, and other advantages in productivity and productivity growth that are difficult to tap from a distance". Because competitive advantages are increasingly urban, cities take a central role in economic development (Porter, 2000, p.32).
	Nations and regions have the important role of providing the right environment for businesses to grow (European Commission).
	Local governments aim to provide the best combination of 'urban assets' to enhance their attractiveness to international investments and improve their economic performance in the global market. Much of that effort is directed at creating a quality urban environment anchored by efficient infrastructure, cultural amenities, and attractive life-style. (Hanna and Walton-Roberts, 2004).
Operational Definition	Location Factors in Urban Theory are defined as local characteristics that can influence a city's economic development through the attraction of international businesses, capital, and people.

Y-variable: MNC clusters

Concept	Variable	Indicators	Data Type	Source	Values
Competitiveness	FDI Clusters	Greenfield FDI count by neighbourhood level from 2003 to 2015	Count	FDI Markets	Higher concentration of FDI = increased innovation, competitiveness and economic development

X-variable: Spatial characteristics of cities

Concept	Variable	Indicator	Data Type	Source	Values
Spatial Location Factors in Business Theory	Local Business Concentration	Average distance between neighbourhood FDI points and local businesses across the city by sector	Ratio	Open Street Map and Primary	Lower distance to local firms = higher FDI concentration
	Regional Infrastructure	Average distance between neighbourhood FDI points and train stations across the city	Ratio	Open Street Map and Primary	Lower distance to train stations = higher FDI concentration
		Average distance between neighbourhood FDI points and the main international airport in the region	Ratio	Open Street Map and Primary	Lower distance to airport = higher FDI concentration
		Average distance between neighbourhood FDI points and highway interchanges across the city	Ratio	Open Street Map and Primary	Higher distance to highway interchanges = higher FDI concentration

Spatial Location Factors in Urban Theory	Environmental Amenities	Average distance between neighbourhood FDI points and their nearest water area	Ratio	Open Street Map and Primary	Lower distance to water = higher FDI concentration
		Average distance between neighbourhood FDI points and their nearest park area	Ratio	Open Street Map and Primary	Lower distance to park = higher FDI concentration
	Place Aesthetics	Average distance between neighbourhood FDI points and architectural landmarks across the city built until 2015	Ratio	Stijn Vossen and Primary	Lower distance to architectural landmarks = higher FDI concentration
	Local Infrastructure	Average of all street connectivity values by neighbourhood	Ratio	Open Street Map and Primary	Higher connectivity values = higher FDI concentration

3.4 Geographic Scope: Cities

3.4.1 Selection of Cities

A total of 11 cities in 4 different countries were selected for this study based on proximity, size, and socio-economic profile. All cities are in north-western European countries, are midsize, have a high level of socio-economic development, have similar weather conditions, and share many cultural affinities.

- Rotterdam
- The Hague
- Amsterdam
- Utrecht
- Antwerp
- Ghent
- Birmingham
- Coventry
- Manchester
- Liverpool
- Dusseldorf
- Essen

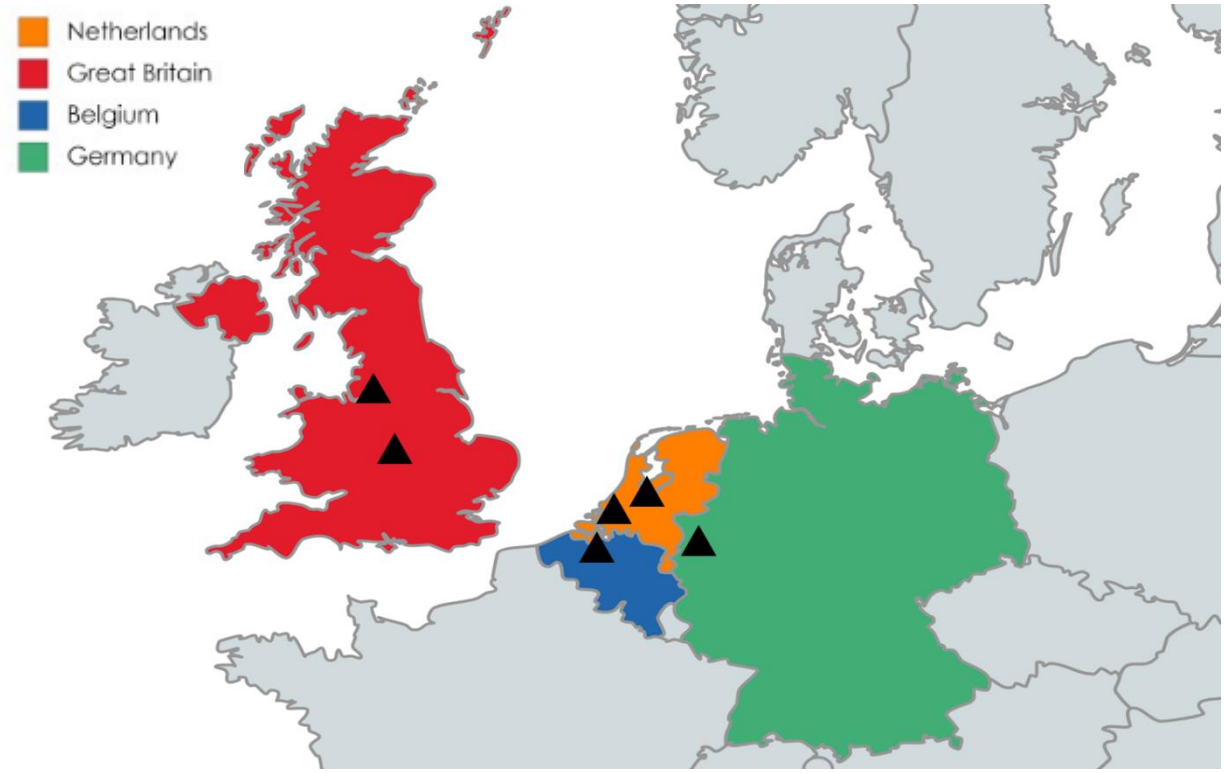


Figure 8 - Northwest European metropolitan areas under study (Rotterdam-The Hague and Amsterdam-Utrecht, Netherlands; Antwerp-Ghent, Belgium; Dusseldorf-Essen, Germany; Manchester-Liverpool and Birmingham-Coventry, Great Britain).

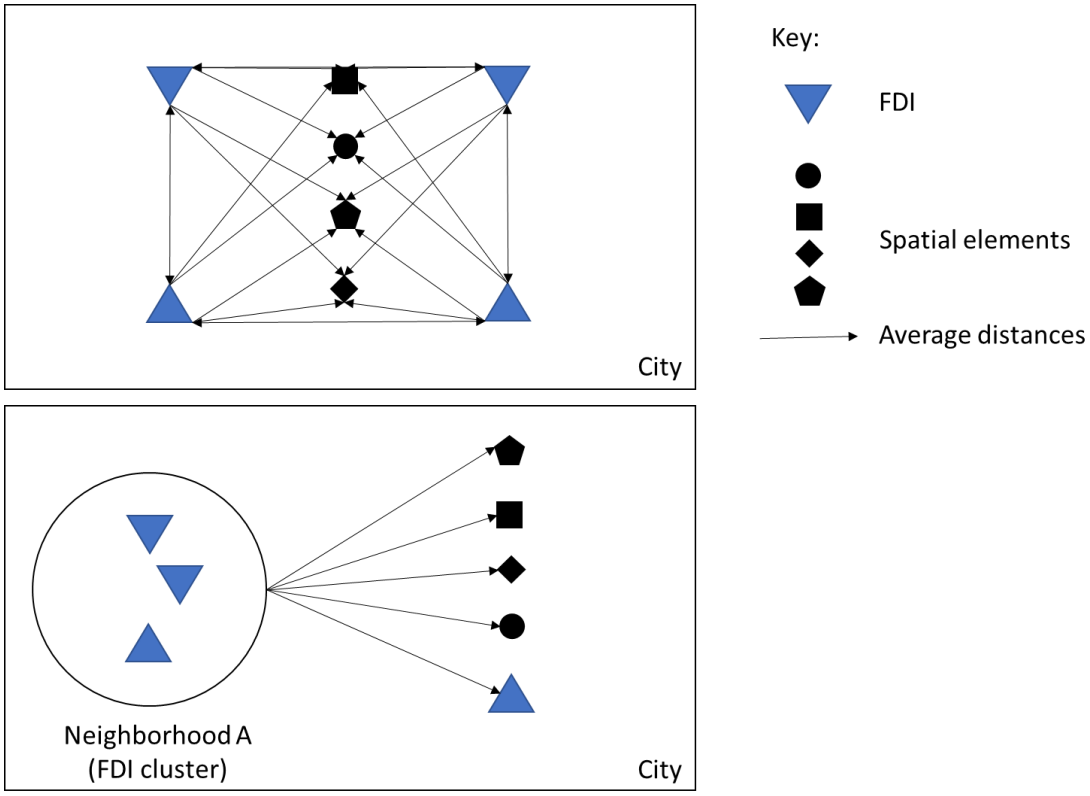
Source: www.mapchart.net

3.5 Data Collection Methods

Data for this research was entirely quantitative and collected from primary and secondary sources. For the dependent variable, reliable and comprehensive data was available from FDI Markets. The independent variables were generated by applying a few different methodologies.

For the variables Architecture, Train Stations, Road Interchanges, and Local Firms, secondary data was collected from the open source organization OpenStreetMap and work performed by Stijn Vossen. FDI firms and spatial elements were laid out on city maps using postal codes and

geographic coordinates. Using ArcGIS *near distance* tool, the distance between each FDI point and each spatial element point was calculated. The use of proximity data instead of count data eliminated the arbitrary constraints of neighbourhood boundaries in the definition of the independent variables. Next, the average distances from each FDI point to all spatial elements in the city were calculated in Excel. Lastly, the data was spatially joined into neighbourhoods to correspond to the dependent variable FDI Clusters. The data was finally organized into a cross-sectional attributes table fitted for the inferential analysis in STATA. It is important to note that while the final data is observed at the neighbourhood level, the primary data was generated using proximity measures not restricted by arbitrary neighbourhood boundaries.



Graph 1 - Graphic representation of the process of generation of independent variables in ArcGIS. The first image represents calculation of distances between every FDI point and every spatial element point for each city, performed for Architecture, Train Station, Road Interchanges, and Local Firms. The second image represents the spatial join of FDI within neighbourhood boundaries to create FDI cluster data and average distances between clusters and spatial elements.

Source: Author

For the independent variables Airports, Water Areas, and Parks, the *near distance* tool calculated only one distance per FDI point, that being the distance to the nearest water area, the nearest park, and the single most relevant international airport in the region. These values were then spatially joined into neighbourhoods and included along with the variables described above.

3.5.1 Street Connectivity

Concerning street connectivity, the measure was calculated using Space Syntax software, ArcGIS and Excel. First, the road network map was obtained from OpenStreetMap's online

data source for all 11 cities. This was done to ensure standardized comparative data. Next, the road networks were adjusted in ArcGIS to ensure that roads were not bisected at road crossings but were instead represented by continuous vectors. This data was then loaded into Space Syntax software and the technique of "global integration", otherwise known in statistics as the "betweenness" measure, was carried out on the data to measure the movement efficiency of each street within the network of streets. The heatmap below (Map 1) represents the calculated measures, where red, orange, and blue road network clusters represent highly, moderately, and poorly connected streets, respectively. Lastly, by means of a spatial join in ArcGIS, the average scores (or average connectivity) of all the roads in a neighbourhood were calculated. These average betweenness scores were exported to Excel and joined into a table along with all other variables.

Map 1 – Rotterdam heatmap of street connectivity scores calculated in Space Syntax and imported into ArcGIS.

Source: Prepared by author in ArcGIS, based on data from OpenStreetMap (2016).

According to UCL Space Syntax, "betweenness centrality is a metric for quantifying the probability that a street segment falls on a randomly selected shortest path linking any pair of segments". For instance, street A in the star network (Figure 9) is at an advantage because it stands between all other pairs of streets. To get from street B to street E, for example, one must pass through street A. Street A, thus, is strategically positioned to moderate or be included in all interactions. This is a good indicator to investigate the hypothesis that FDI firms chose to locate in areas that provide greater interaction with the urban market, suppliers, knowledge institutions and resources. For a thorough explanation of betweenness centrality, refer to Alderson and Beckfield (2004), and Wall and Van der Knaap (2011).

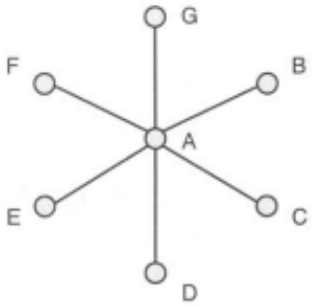


Figure 9 - ***Star network illustrating betweenness centrality***

Source: Alderson and Beckfield, 2004

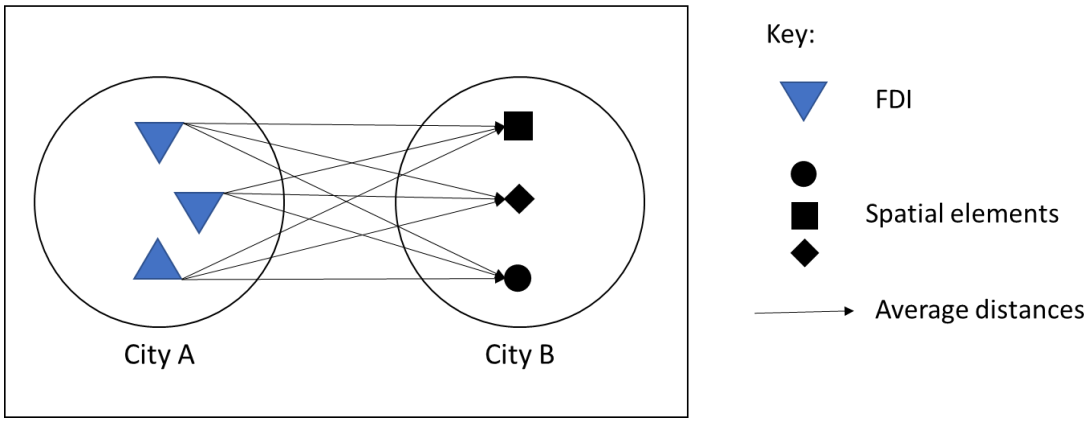
Based on the theory review of proximity theories, and inspired particularly by the concepts of clusters, complementarity, and innovation in urban areas (e.g. Audretsch, 1998; Porter, 2000), as well as the concepts of borrowed size (Alonso, 1973) and new metropolis (Lang and Knox,

2009), this research included an analysis on the impact of spatial amenities on FDI clusters between neighbouring cities. For the purpose of this research, this new conceptualization using proximity data has been named *Borrowed Proximity*.

3.5.2 Borrowed Proximity

For the Borrowed Proximity analysis, the same methodology described above was applied, except that the distances measured in step 1 were between FDI firms in city A and spatial elements of city B, and vice-versa. In more detail, the data for the Borrowed Proximity analysis was generated by calculating the average distances between FDI in city A and spatial elements in city B, which were then averaged within the neighbourhoods of city A as units of observation. The process was repeated from city B to city A (Graph 2).

For this purpose, 10 cities were paired together as follow: Rotterdam and The Hague, Amsterdam and Utrecht, Antwerp and Ghent, Birmingham and Coventry, Dusseldorf and Essen. This is a pioneering analysis as it is rooted on mapped distances of physical factors. It provides an innovative approach to understanding borrowed proximity and aims to bridge economic geography and urban design at a regional level.



Graph 2 - Graphic representation of borrowed proximity in which proximity data is calculated between FDI of City A and Spatial Elements of City B.

Source: Author

3.6 Data Analysis Methods

Descriptive and inferential analysis of primary and secondary quantitative data were performed using ArcGIS and STATA. ArcGIS is a suitable tool for the geographic and spatial analysis of maps. It allows for layered analysis of location-specific data overlapped with the geographic layout of cities and neighbourhoods. In the context of this research, ArcGIS was used to map the location of different indicators and produce accessible colour graduated maps.

STATA is a tool used for multiple regression analysis and investigation of correlations and causal relationships between dependent and independent variables. For the present study, NBR (negative binominal regressions) were employed, which is the most suitable model for over-dispersed count data as is the case for the dependent variable in question (FDI clusters by count). The described method aimed to find positive and negative significant relationships between spatial characteristics of cities and clustering of Multinational Corporations. In

addition, dummy variables for each of the 11 cities were included in the models to determine whether certain cities are performing better than others within the model.

3.7 Validity and Reliability

To achieve internal validity, variables were derived from a thorough review of Urban and Business Theories. Moreover, independent variables were generated by using proximity measurements, which allowed for a more fluid, dynamic, and realistic representation of spatial relationships than the alternative count data confined to artificial boundaries. Multicollinearity tests were performed to prevent over-inflated results and separate models were completed to ensure result robustness. For control, cities with similar size, population, and socio-economic profile were selected.

To attain external validity, this study included 11 cities and four different countries. Additionally, the analysis was performed at the neighbourhood level which led to a greater number of observations.

Reliability was addressed through the use of up-to-date secondary data from FDI Markets and OpenStreetMap. Advanced software programs were used to create primary data from the aforementioned secondary data.

Chapter 4: Research Findings

The purpose of this study was to provide statistical support to the theoretical discussion on the impact of urban spatial characteristics and the attraction of Multinational Corporation clusters as a measure of competitiveness. Furthermore, it sought to provide an understanding of how cities could improve their competitiveness by making changes to the spatial distribution of certain amenities. This study aims to contribute primarily by bridging the gap between urban design and economic geography.

Cities compete in the international arena with a unique set of urban assets or characteristics that are sought after by international businesses. There is consistent theoretical support for the importance of spatial characteristics of cities in determining competitiveness and economic development. Nevertheless, despite the growing interest of local governments in understanding this phenomenon, only a few studies have investigated their objective relationship. The application of economic geography tools to urban design considerations can deliver unprecedented perspective on this relationship.

This chapter reports and examines the results of the descriptive and inferential analysis designed to answer the principal research question and its sub-questions. The chapter is organized as follows:

- Sample Size and Characteristics
- Spatial Distribution of Independent Variables
- Negative Binominal Models
- Architectural Properties

4.1 Sample Size and Characteristics

The present analysis included 11 cities, 277 observations, 1 dependent variable and 10 independent variables. Observations are neighbourhoods where FDI is present. Neighbourhoods with no FDI were excluded from the analysis. The dependent variable *FDI Clusters* is composed of discrete data (count), and spans from a minimum of 1 and maximum of 35 firms per cluster. A histogram of the dependent variable *FDI Clusters* showed an uneven distribution of data (Graph 3). Most neighbourhoods under analysis are home to 1 to 5 FDI firms.

Variable	Obs	Mean	Std. Dev.	Min	Max
FDI_Clusters	277	4.519856	6.274269	1	35
Airports	277	23856.23	22201.95	551.9635	131409.1
Interchanges	277	6349.271	2520.901	1409.038	24709.55
Architecture	277	4753.148	3149.581	1247.078	31083.44
Parks	277	1011.366	880.5899	0	4929.766
Trains	277	6384.515	2848.986	2086.598	26800.66
Water	277	1301.858	1320.47	0	5897.554
SpaceSyntax	277	2.18e+10	1.81e+10	6.86e+08	1.63e+11
L_Hitech	277	5419.261	2992.046	1355.836	31588.99
L_Transport	277	5254.616	2871.183	800.5841	29379.89
L_Service	277	5320.437	3073.849	1305.873	31665.31

Dependent variable FDI Clusters spans between 1 and 35 firms.

Table 1 - Summary description of dependent and independent variables.

Source: STATA output, based on data by FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016)

Amsterdam and Dusseldorf receive the most FDI (250+) (Graph 4). Rotterdam only hosts 90 FDIs, which is less than, but closer in number to Antwerp, Birmingham, and Manchester. The Hague, Utrecht, Coventry and Essen all host less than 50 FDIs. When looking at pairs of cities, it is worth noting that Utrecht and Essen receive the least FDI, and are the closest cities in proximity to the top FDI recipients, Amsterdam and Dusseldorf. Together, Rotterdam and The Hague attract less FDI than the other city pairs. Most FDI in the studied cities are knowledge-intensive FDI.

Using the data preparation methodologies explained in Chapter 3, 10 independent variables were generated: *Airports, Architecture, Road Interchanges, Train Stations, Parks, Water Areas, Street Connectivity, Local Hi-tech Firms, Local Service Firms, Local Transport Firms.*

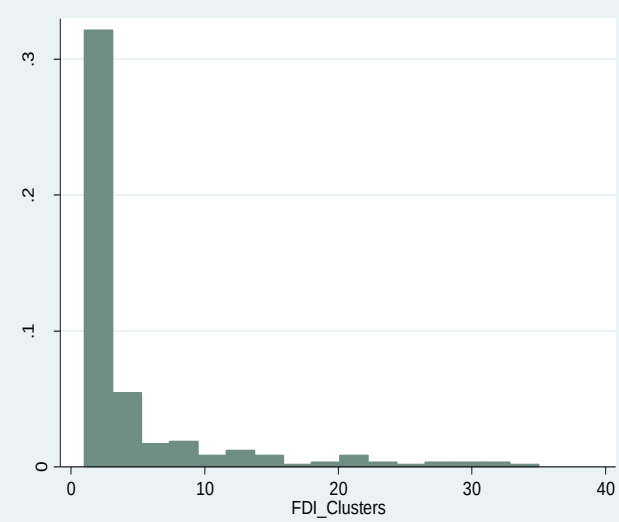
The variable *Architecture* took into consideration the most important architectural landmarks in each city from a variety of styles and functions, and corresponds to the average distances between those and FDI clusters.

Road Interchanges corresponds to road interchanges, meaning the highway junctions, and their average distances to FDI clusters. *Train Stations* represents the average distances between FDI clusters and each tram station or train station within city boundaries.

Local Hi-tech Firms, Local Service Firms, and *Local Transport Firms* refer to the average distance measured between FDI and local businesses divided by sectors.

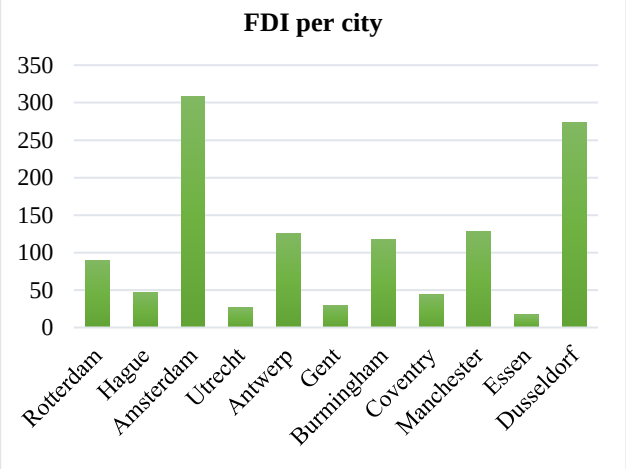
The variables *Parks, Water Areas, Airports* were created with slight variations to the method mentioned above in accordance with the theory review. The variable *Parks* was generated from the average distances between FDI clusters and their single closest park, instead of all parks in the city. The same methodology was used for the variable *Water Areas*, measuring the average distances between FDI clusters to their closest body of water. Similarly, *Airport* refers to the average distances from FDI clusters to the most relevant airport in the area.

The variable *Street Connectivity* was created by calculating the average of all street connectivity scores within each observed neighbourhood. The scores were obtained by use of Space Syntax software, which measured the betweenness or movement efficiency of each street within the network of streets.



Graph 3 – Histogram of dependent variable FDI Clusters.

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).

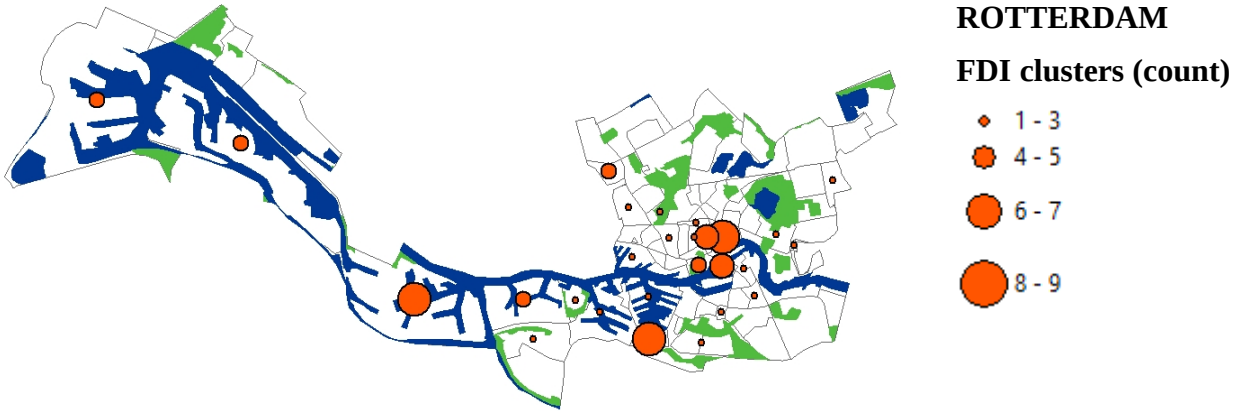


Graph 4 – *Number of FDI firms per city.*

Source: Prepared by author, based on data from FDI Markets (2016) and OpenStreetMap (2016).

4.2 Spatial Distribution of FDI Clusters

To answer sub-question 1: *What is the spatial distribution of Multinational Corporation clusters in selected midsize north-western European cities?* GIS mapping software was used to conduct a visual analysis of FDI cluster size and distribution in the 11 cities studied. In the cities with a medium to large number of FDI (e.g. Rotterdam, Hague, Amsterdam, Antwerp, Dusseldorf, Birmingham, and Manchester), FDI is heavily clustered in the central commercial area. Cities that receive a low number of FDI tend to exhibit a wider spatial distribution (e.g. Utrecht, Essen, Ghent). This leads to the initial observation that the more FDI exists in a city, the more heavily clustered they seem to become. Indeed, this is one of the main phenomena described by cluster theories. Furthermore, port cities (Rotterdam, Antwerp, and Ghent) display some FDI presence along the harbour. Those companies most likely seek very specific resources and are outliers in the data. As an example, a map of the distribution of FDI clusters in Rotterdam is shown below (Map 2). Water areas (blue) and parks (green) were included for reference. The higher concentration of FDI is presently found in the centre of town. However, some large clusters are also present in the harbour areas due to Rotterdam's port activities. Maps for all cities are made available in Appendix 5.



Map 2 - Rotterdam FDI Clusters.

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Parks were generally observed to be well distributed across the cities, mostly towards the edges, and often with no FDI nearby. As for water areas, in many of the cities studied FDI is heavily clustered near a major river. Historically, many cities were formed on river basins, and even now their commercial and cultural centres remain located in those areas. Furthermore, those rivers are integrated into the fabric of the urban environment, constituting part of the identity of those cities.

Nevertheless, the spatial distribution of FDI clusters in relation to water areas also depends on the industry they operate in. For instance, Utrecht shows higher FDI concentration away from its main river because the city's economy is heavily focused on science and research produced in the Utrecht Science Park, which is part of the city's more recent history on the far west side of the city. As already mentioned, port cities such as Rotterdam and Antwerp attract FDI along their important harbours as well as near the city centre portions of the rivers.

Some cities, on the other hand, may not have a major river crossing through town. This is the case for the British cities, as well as The Hague. Interestingly, The Hague does not display FDI concentration near the sea and the beach, which perhaps serve more as a cultural amenity than

an economic one. Most FDI in The Hague is concentrated in the centre of town, where there is easier access to transportation and other urban services.

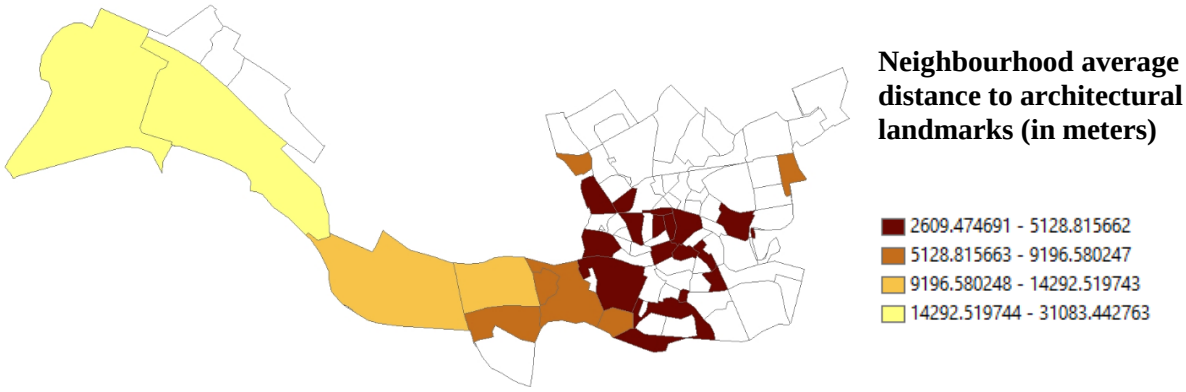
All those mapped observations provide a preliminary geographical understanding as to where FDI is located in the cities under study. Furthermore, it already indicates a preference towards urban centres.

4.3 Spatial Distribution of Independent Variables

To answer sub-question 2: *How does the spatial distribution of Multinational Corporation clusters relate to the average spatial distribution of urban physical amenities?* the generated independent variables were plotted on graduated coloured maps.

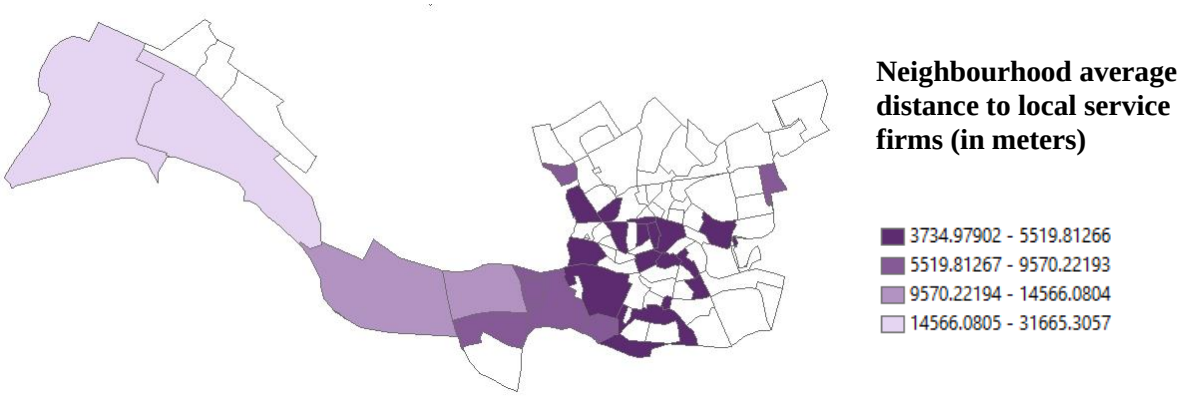
It is important to note that this is a descriptive analysis of the independent variables, which represent the average distance from FDI clusters to physical amenities around the city. It does not take into consideration the size of the clusters, which will be explored in section 4.4 with the regression analysis. Therefore, this analysis is used to indicate the areas in the city where urban amenities are closest in proximity to FDI. For example, the map below (Map 3) shows darker colours in the central neighbourhoods of Rotterdam, indicating that lower average distances between architectural landmarks and FDI are found in those areas. The same is seen in the map displaying average distances to local service firms (Map 4). Both of those physical amenities are highly urban and are found in greater concentration in the centre of the city. Similar patterns are found in all other cities, for which graduated maps are shown in Appendix 5.

As for train stations, because they are located more dispersedly, the central neighbourhoods are not necessarily the closest in average distance. This can be seen, for example, in Coventry, where the neighbourhoods with shortest average distances to train stations are found towards the outskirts of the city. In Manchester, neighbourhoods with smaller average distances to train stations are found both in the centre of town as well as in other areas. In Rotterdam (Map 5), the pattern follows a chain of neighbourhoods from the centre to the northwest peripheral areas of the city. Again, this analysis provides a visual understanding of the location of train stations in the cities in relation to their distances to FDI firms.



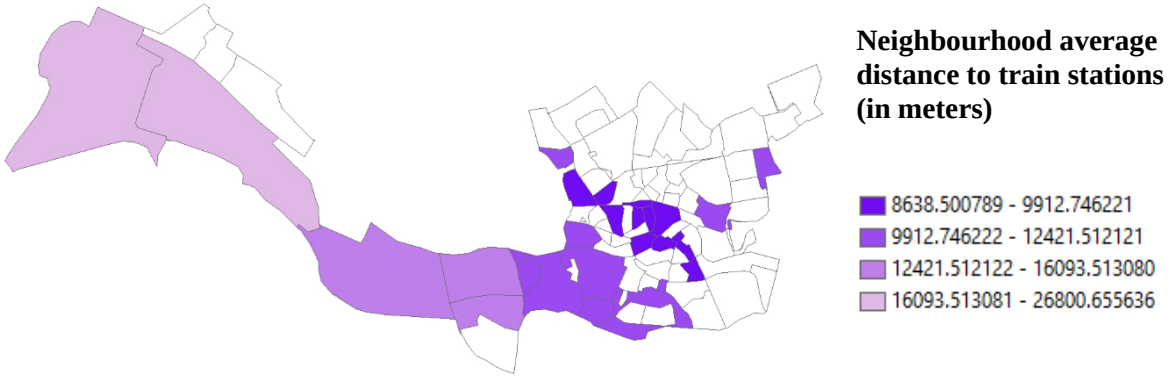
Map 3 – Rotterdam Neighbourhood average distance to architectural landmarks.

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpernStreetMap (2016), and Stijn Vossen (2016).



Map 4 – Rotterdam Neighbourhood average distance to local service firms.

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).



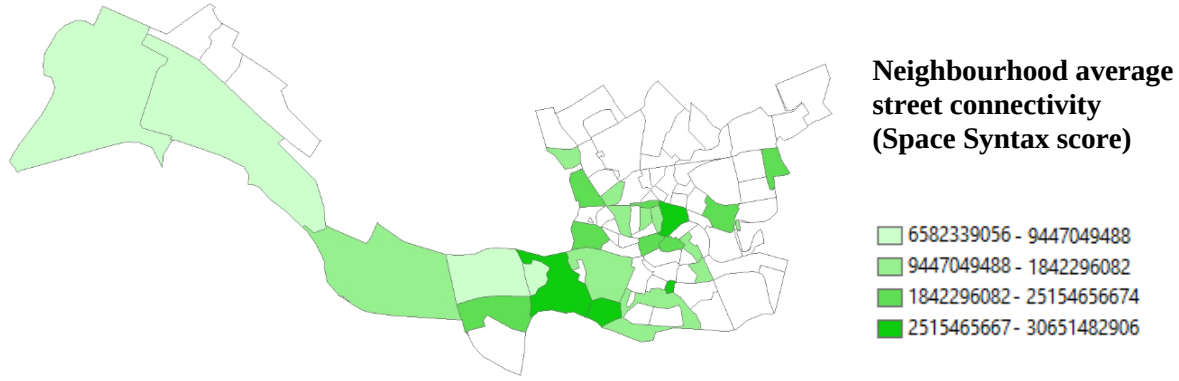
Map 5 – Rotterdam's neighbourhood average distance to train stations.

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Street Connectivity showed a disperse distribution in most cities, and neighbourhoods with higher street connectivity were found across all areas of the cities. Values represent how connected neighbourhoods are to every other neighbourhood in the city. Higher values mean better overall network connection. Lower values are found in local streets, mostly isolated from main roads and avenues. These patterns can be explained by the abundance of small streets in central neighbourhoods, particularly in historical centres, in contrast with the many major avenues, tunnels and bridges that cross through multiple neighbourhoods with the intended purpose of providing better connectivity to neighbourhoods that are further away from the centre. Interestingly, many of the neighbourhoods that are not central but are nevertheless home to larger FDI clusters show good street connectivity, and thus higher strategic position within the city.

The distribution patterns for road interchanges vary greatly from city to city. In Rotterdam (Map 7), and most other cities here studied, proximity from FDI to road interchanges is found in both central and peripherical neighbourhoods. This is probably because the road interchanges are found in opposite sides of the city. Therefore, FDI in central neighbourhoods have an average distance to all interchanges that is lower than those FDIs that are located very

near one interchange, but far away from interchanges. In other cities, such as Manchester and Ghent, only the peripheral areas show high proximity to road interchanges.



Map 6 – Rotterdam's neighbourhood average street connectivity (space syntax).

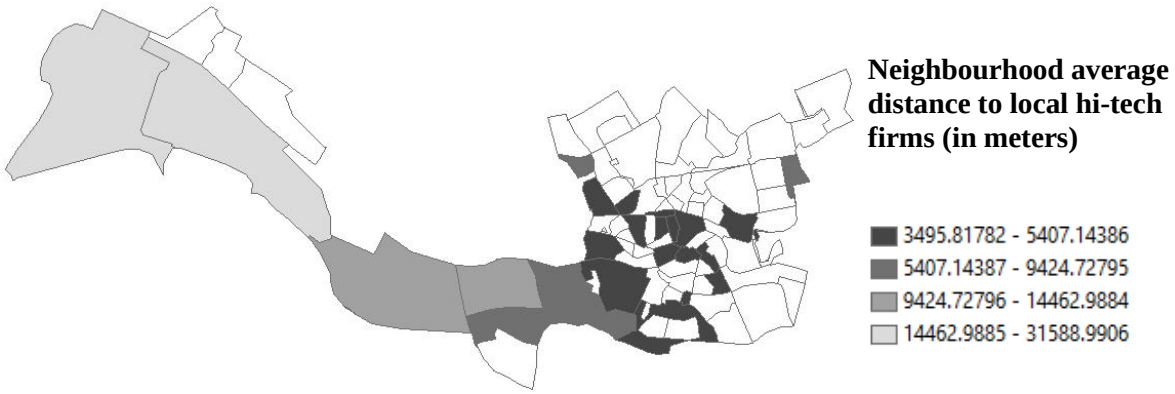
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Map 7 – Rotterdam's neighbourhood average distance to road interchanges.

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).

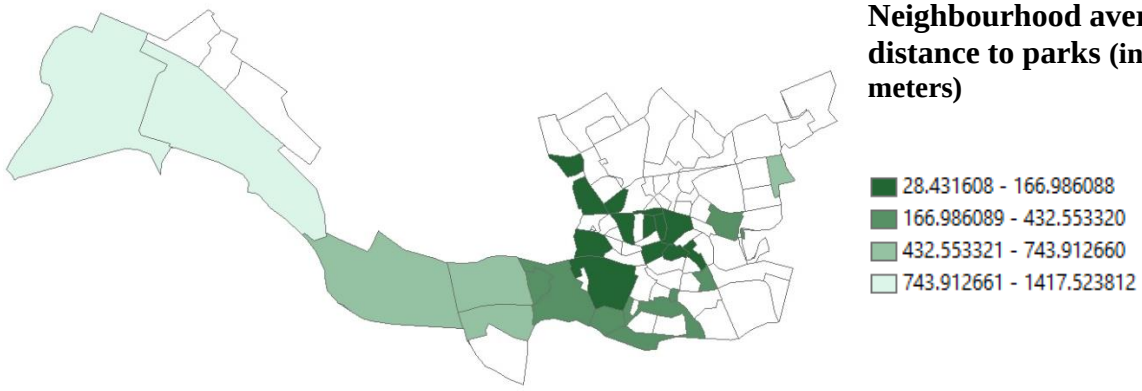
A similar situation is found when analysing the average distance from FDI firms to local hi-tech firms. Hi-tech firms are often located in areas further away from the centre, in designated science and industrial parks. However, they are also abundant in central areas, particularly in the form of tech start-ups.

When analysing the independent variable for parks, most cities show higher proximity in the outskirt areas, as expected because most parks are found in those areas as well. Only in Rotterdam, Antwerp, and Manchester did central neighbourhoods display the closest proximity to parks. It is important to note that this variable takes into consideration only the distance to the closest available park to each FDI, instead of an average of all parks in the city. This method was chosen to investigate whether FDI is interested in being close to a park as an urban amenity, as opposed to average proximity to park areas in general which would be a less urban characteristic. Therefore, this analysis showed that in Rotterdam (Map 9), Antwerp, and Manchester, FDI firms located in the central neighbourhoods are also the closest to parks. These three cities indeed have many small parks in the central areas as can be seen in the FDI cluster maps.



Map 8 – Rotterdam's neighbourhood average distance to local hi-tech firms.

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).



Map 9 – Rotterdam's neighbourhood average distance to parks.

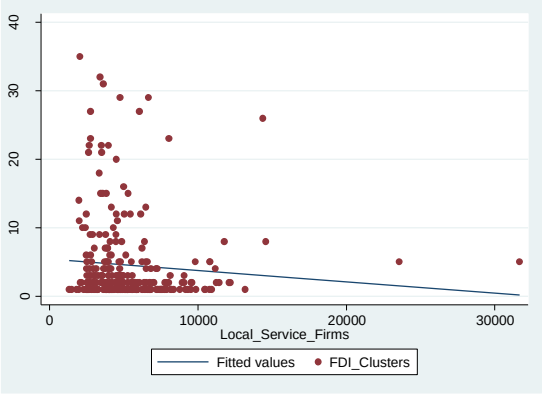
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Subsequently, scatter plots provided yet another visual understanding of the relationship between FDI concentration (FDI Cluster) and their distribution in terms of average distance to urban spatial elements. In the examples shown in Graph 5, 6 and 7, *Architecture*, *Local Service Firms*, and *Train Stations* all show a negative linear relationship, as expressed by the blue line. It is also easy to see the strong concentration of *FDI Clusters* on the left side of the graphs, representing lower average distances.

Graph 8 shows a positive relationship between *FDI Clusters and Road Interchanges* (see Appendix 1 for all scatter plot graphs). This analysis supports existing theory by showing that FDI cluster in higher density when in relative close proximity to urban spatial element. Exceptions are road interchanges, parks, and local businesses in the transportation sector. FDI clusters are usually concentrated in the centre of cities, which explains their proximity to urban amenities. Road interchanges, parks and the local transport sector are found more commonly on the outskirts, thus further away from the centre and its amenities.

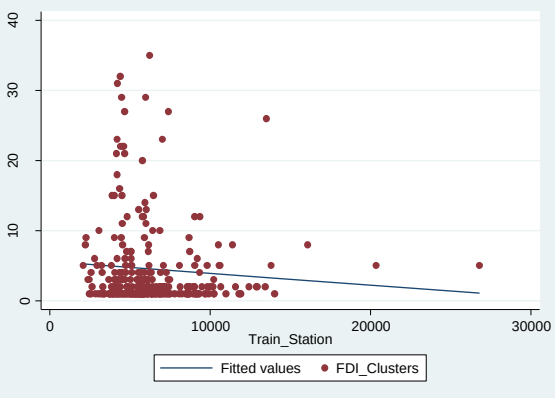
Graph 5 – Scatter plot looking at the relationship of proximity between FDI Clusters and Architecture.

Source: STATA output, based on data from FDI Markets (2016) and Stijn Vossen (2016).



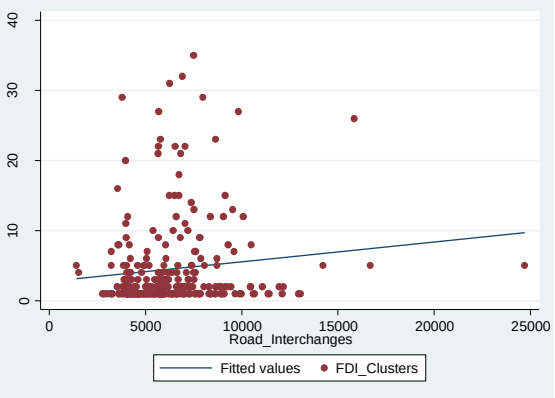
Graph 6 - Scatter plot looking at the relationship of proximity between FDI Clusters and Local Service Firms.

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Graph 7 - Scatter plot looking at the relationship of proximity between FDI Clusters and Train Stations.

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Graph 8 - Scatter plot looking at the relationship of proximity between FDI Clusters and Road Interchanges.

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016)

4.4 Negative Binominal Regression

The previous two sub-questions were descriptive in nature. Sub-questions 3 and 4, however, required the use of regression analysis.

3. *Which spatial characteristics of midsize north-western European cities impact their attraction of Multinational Corporation clusters?*
4. *Is the FDI attractiveness of north-western European cities impacted by their borrowed proximity to spatial characteristics of neighbouring cities?*

Because the dependent variable *FDI Clusters* is expressed as count or discrete data, the most appropriate regression model to be used is the Negative Binominal Regression (NBR). The UCLA Institute for Digital Research and Education defines the NBR model as the regression that "can be used for over-dispersed count data, that is when the conditional variance exceeds the conditional mean. It can be considered as a generalization of Poisson regression since it has

the same mean structure as Poisson regression and it has an extra parameter to model the over-dispersion". in the binominal regression equation below, note that the model incorporates a new parameter: α (alpha). Alpha represents the extension of the over-dispersion.

$$\mu = e^{\sum_{j=1}^{K} \beta_j X_{ji} (+\varepsilon_i)}$$

$$P(y \mid X) = \frac{\Gamma\left(y + \alpha^{-1}\right)}{y!\Gamma\left(\alpha^{-1}\right)} \left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu}\right)^{\alpha^{-1}} \left(\frac{\mu}{\alpha^{-1} + \mu}\right)^{y}$$

To determine the suitability of this model over the Poisson model, mean and variance were calculated (Table 2) for the dependent variable. Results showed that the mean of *FDI Clusters* is much lower than its variance, therefore suggesting that the data is over-dispersed and a NBR would be the more appropriate model.

```
. tabstat FDI_Clusters, stats(mean v n)
```

variable	mean	variance	N
FDI_Clusters	4.519856	39.36645	277

Table 2 – Results for mean and variance of dependent variable FDI Clusters.

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Furthermore, a goodness-of-fit test (Table 3) confirmed the extreme significance of chi-squared, thereby indicating that the Poisson regression model was inappropriate. A comparison of the log-likelihoods of the Poisson model and the NBR showed higher values for the NBR, further confirming the suitability of this model. A model including all 11 cities was preferred to increase the number of observations (277).

```
estat gof

      Deviance goodness-of-fit =  1266.362
      Prob > chi2(267)         =    0.0000

      Pearson goodness-of-fit  =  1745.198
      Prob > chi2(267)         =    0.0000
```

Table 3 – Goodness-of-fit test of a model including FDI Clusters, Airports, Architecture, Train Stations, Road Interchanges, Local Transport Firms, Local Service Firms, Local Hi-tech Firms, Parks, Water Areas, and Street Connectivity.

Source: STATA output, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

Initially, there were two more independent variables being analysed: proximity to other FDI clusters and proximity to arts and culture elements. However, following a test for multicollinearity, those two variables were dropped. The choice was made based on the quality

of the data and interest in the results. Proximity to other FDI clusters is a thoroughly studied topic (Marshall, 1890; Schumpeter,1939; Jacobs, 1970; Porter, 2000; Duranton and Puga, 2004; Galan et al. 2007; van t'Hoff and Wall, 2017). Therefore, other variables were prioritized in this study.

The most viable regression model (Table 4) tested for proximity to architectural buildings, major airports, road interchanges, parks, water areas, train stations, street connectivity (space syntax), and local firms in the services, hi-tech and transportation sectors.

VARIABLES	FDI Clusters
Airports	4.60e-06
	(3.81e-06)
Road Interchanges	0.000163***
	(3.93e-05)
Architecture	-0.000161**
	(6.74e-05)
Parks	0.000257***
	(8.72e-05)
Train Stations	-0.000134**
	(5.42e-05)
Water Areas	-8.00e-05
	(5.86e-05)
Street Connectivity	6.98e-12**
	(3.34e-12)
Local Service Firms	-0.000309**
	(0.000122)
Local Transport Firms	0.000124*
	(6.41e-05)
Local Hitech Firms	0.000335**
	(0.000136)
Constant	0.735***
	(0.278)
Observations	277

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 – Results of Negative Binominal Regression of FDI Clusters and Urban Spatial Elements in all cities combined.

Source: STATA output, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

High significance was found for *Architecture*, indicating that an increase in the average distance to architectural landmarks will decrease FDI. This verifies that architectural attractiveness and design is important for economic growth, and that the more architectural highlights a city creates the higher the expected number of multinationals (FDI). This finding matches theory on knowledge-intensive FDI, the kind most common in north-western European cities, which tends to seek high quality urbanity. In fact, the aforementioned high collinearity between the proximity to other FDI clusters and *Architecture* could indicate that multinational firms often tend to locate their offices not only near, but inside noteworthy architectural buildings. Both business and urban theories support these findings arguing that architecturally important office buildings represent a level of brand and status that is sought after by international firms. A question can be raised here about the direction of the causality. An overview of the architecture data used in the analysis showed that 75% of all architectural landmarks were built before 2003, which is the start year of the FDI data collected. Therefore, because 75% of the architecture in the analysis predates the period of the FDI data, it is quite safe to reason that architecture is causal to FDI and not the other way around.

Road Interchanges showed positive significance, while *Train Stations* indicated negative significance. Therefore, an increase in the distance to major highway junctions will increase FDI, while a decrease in the distance to train stations will increase FDI. These results explain that FDI tends to cluster far from major highway junctions but near train stations. Interchanges are usually found closer to the edges of the cities and industrial zones, where motorized vehicles are given priority in navigating the highway system. On the other hand, train stations are typically found closer to the centre of town where there is high pedestrian traffic, and where most urban elements can be found. These results, again, indicate that FDI seeks more inner-city, urban, central locations, where there is a larger pool of highly-skilled workers, greater access to capital, and better connectivity with the global market (Porter, 1990, Rogerson, 1999, Hanna and Walton-Roberts, 2004). Both urban and business theories suggest that regional

transport infrastructure (i.e. intercity trains) are very attractive to FDI as they allow access to consumers, workers, firms, and other resources within a greater network of cities (Cheshire and Gordon, 1998; Begg, 1999; Simmie, 2005). For instance, it is known that CEOs of MNCs in north-western Europe, which mostly consist of headquarters of knowledge-intensive activities, make ample use of the comfort and efficiency of trains to do business in the greater region and access international airports.

Similarly, the variable *Street Connectivity* (strategic network position of neighbourhoods with regards to movement efficiency and interactions) was found to be positive and significant, indicating that higher street network connectivity will increase the presence of FDI. Higher values represent higher connectivity to the network in general, or rather higher probability that a specific street segment is needed for interactions between other street segments.

It is not surprising that the present study showed that FDI clusters seek areas with higher street connectivity, as they provide the highest level of interaction with the urban market, suppliers, knowledge institutions and resources. Connectivity is an increasingly important aspect of business and innovation, and while it is often referred to as global communication or regional and international transport infrastructure (i.e. trains, airports), the connectivity within a city can be just as important. By locating themselves in neighbourhoods with high street connectivity, FDI clusters enhance their chances of interaction with urban resources, not only by enjoying the shortest path to them, but also by positioning themselves on their direct path. Physical proximity, which is the case of this variable is understood a position that maximizes interactions with urban resources, is one of the main reasons behind urbanization and the raising importance of cities.

Parks also showed significant results, in that an increase of the distance to parks will increase FDI. Parks are more frequently found in the suburban and peripheral zones of cities than in urban areas. Again, this proves that FDI is attracted by urban areas and, hence, tends not to locate close to parks. However, parks could be an important feature if analysed at a regional level, or as a weekend recreational site valued specifically by residents (in this case highly-skilled workers).

It was also found that an increase of the distance to *Local Hi-tech Firms* will increase FDI clusters. This suggests that MNCs prefer to be at a distance to local hi-tech clusters. A possible explanation is that most FDIs comprise of headquarters and are more attracted by urban settings than hi-tech industrial parks. Though not as significant, an increase in the distance to local businesses in the transportation sector will also increase FDI. This could be due to the fact that this type of local firm is mostly found further from the center of town and closer to industrial areas where boats, trains, and buses can be maintained.

On the other hand, a decrease in the distance to *Local Service Firms* will increase FDI. This leads to the interpretation that FDI firms cluster more intensively near local businesses providing services (e.g. law, finance, and accounting firms). This is in line with theory proposing that convenient access to services plays a role in MNC's decisions to seek urban settings. However, an issue can be raised relating to cause and effect, since the relevance could be due to a tendency for services to locate close to the areas in which they are most needed, which in this case would be near FDI clusters.

No significance was found for *Water Areas* confirming previous research on the topic. Nevertheless, it is worth noting that the cities under analysis are very diverse in the layout of their water areas, which could have affected the results. Rotterdam, Antwerp, and Ghent are port cities, with their economies relying heavily on harbour activities. Moreover, major rivers

pass by the centre of these three towns, as well as by Dusseldorf and Amsterdam, rendering them important elements to the urban landscape of these cities. By contrast, in the British cities water areas are sparse and do not represent an essential characteristic of these urban environments. To better understand this variable, a more robust analysis could be conducted with cities that exhibit similar water characteristics, such as port cities. Furthermore, the quality and accessibility to water areas could be investigated, particularly in connection to recreational use and waterfront parks.

Proximity to major regional *Airports* also showed no significance. This could be due to the fact that major international airports, where high passenger traffic is found, are located along the outskirts of cities, or even in altogether different cities. Accessibility and efficiency of trains become a major component of the relative proximity to international airports, which is in keeping with the findings reported for proximity to train stations (i.e. Rotterdam's main international airport is Schiphol Airport, near Amsterdam, but it can be reached in just 25 minutes by express train).

An additional model was run with dummy variables for each of the 11 cities, in which Rotterdam was used as the baseline city (see Appendix 2). The results of this analysis showed that given the group of independent variables included (airports, architecture, road interchanges, parks, water areas, train stations, street connectivity, and local hi-tech, transport, and service sectors), Antwerp appears to perform better than Rotterdam in attracting FDI.

Lastly, it was of interest to investigate whether the FDI attractiveness of a city is impacted in any degree by spatial factors of a nearby city (Table 5). Three independent variables were selected for the analysis: *Road Interchanges, Local Businesses* (all sectors), *and Architecture*. Road interchange was selected because it is considered an important element of the regional transport infrastructure as it facilitates the exiting and entering of cities. Unlike the previous analysis which considered local businesses by sector, the analysis on borrowed proximity included local businesses from all sectors calculated together as one variable. This approach was considered more sensible for an analysis at the regional level where distances are inherently greater than at city level. Architecture was included as an exploratory variable, and the dependent variable was again FDI clusters.

Interestingly, results indicate that an increase in the distance to architectural landmarks in city B would decrease FDI clusters in city A, thus proving the relationship of borrowed proximity between cities in a region. In other words, cities benefit from closer proximity to architectural elements from neighbouring cities. Dummy variables for the cities of the dependent variable (FDI Clusters) were also added to the models. Using Rotterdam as the baseline (Rotterdam FDI and The Hague architecture), the model showed that regarding FDI attraction, Amsterdam, Antwerp, and Dusseldorf may benefit more from borrowed proximity to architectural elements from their paired cities than Rotterdam does to architectural elements from The Hague.

The same kind of relationship was found for road interchanges and local businesses. An increase in the distance to road interchange in city B would decrease FDI clusters in city A. This is not surprising, as road interchanges are a key feature of the regional transport infrastructure and provides fast access from vehicles from one city to another city. Amsterdam, Antwerp, Ghent, and Dusseldorf seem to perform better than Rotterdam regarding their borrowed proximity to road interchanges of neighbouring cities and the attraction of FDI.

For local businesses, an increase in the distance to local businesses from city B would decrease FDI in city A. The result is coherent, as theory suggests that MNCs seek proximity to local businesses for access to services, resources, and collaboration. Particularly in north-western European cities, where well-developed regional infrastructure provides easy accessibility between neighbouring cities, the pool of local services for MNCs extends beyond the boundaries of one city. Like the other two variables presented previously, Amsterdam, Antwerp, and Dusseldorf seem to perform better than Rotterdam regarding their borrower proximity to local businesses in neighbouring cities and attraction of FDI.

VARIABLES	(1) FDI Clusters	(2) FDI Clusters	(3) FDI Clusters
Architecture	-4.96e-05**		
	(2.47e-05)		
Local Firms		-5.67e-05**	
		(2.45e-05)	
Road Interchanges			-4.07e-05*
			(2.41e-05)
2.The Hague	0.170	0.136	0.155
	(0.339)	(0.339)	(0.340)
3.Amsterdam	1.271***	1.243***	1.248***
	(0.387)	(0.347)	(0.422)
4.Utrecht	0.194	0.213	0.208
	(0.465)	(0.447)	(0.507)
5.Antwerp	2.043***	1.853***	1.905**
	(0.775)	(0.612)	(0.828)
6.Ghent	1.363*	1.539**	1.282
	(0.774)	(0.763)	(0.849)
7.Birmingham	0.0125	0.0328	0.0766
	(0.281)	(0.276)	(0.317)
8.Coventry	0.0299	0.0596	0.109
	(0.346)	(0.344)	(0.382)
9.Dusseldorf	1.336***	1.351***	1.380***
	(0.317)	(0.305)	(0.359)
10.Essen	-0.293	-0.297	-0.254
	(0.448)	(0.438)	(0.476)
Constant	2.286***	2.469***	1.983***
	(0.572)	(0.581)	(0.500)
Observations	243	243	243

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 – Results of Negative Binominal Regression of borrowed proximity analysis between FDI Clusters in City A and Urban Spatial Elements in City B, including city dummies.

Source: STATA output, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

4.5 Architectural Properties

Proximity to architectural landmarks proved attractive for FDI clusters at both the city level analysis and the borrowed proximity analysis. Therefore, it is relevant to seek a more qualitative understanding of the different architectural styles and building functions of the data in use.

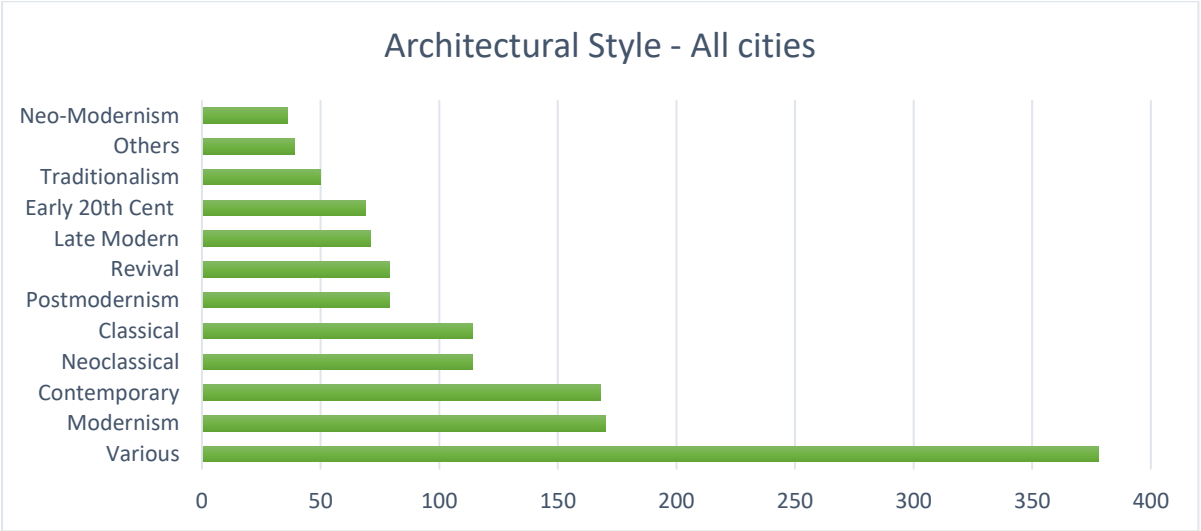
When looking at all the cities combined, the most common architectural style is *various*, which can be understood as eclectic, or heterogeneous (Graph 9). Those are buildings that have undergone changes throughout time (e.g. RDM Droogdok 17 in Rotterdam - Figure 11) or that were designed taking inspiration from two or more styles (e.g. Maastheatre in Rotterdam – Figure 12). The two more common styles after *various* are *modernism* and *contemporary*. Looking at the building function, most of them are used for commercial and cultural activities (Graph 10). Using this information in connection with the results of the regression analysis, it can be inferred that FDI clusters value proximity to eclectic, modern, and contemporary architectural styles, particularly in commercial and cultural buildings. In fact, many of the commercial buildings may serve as home to FDI firms.

Figure 10 - RDM Droogdok 17 was originally built in 1913 in a business expressionist style. It has been recently renovated and redesigned in a more contemporary style to house innovative research & design institutions.

Source: Google Street View

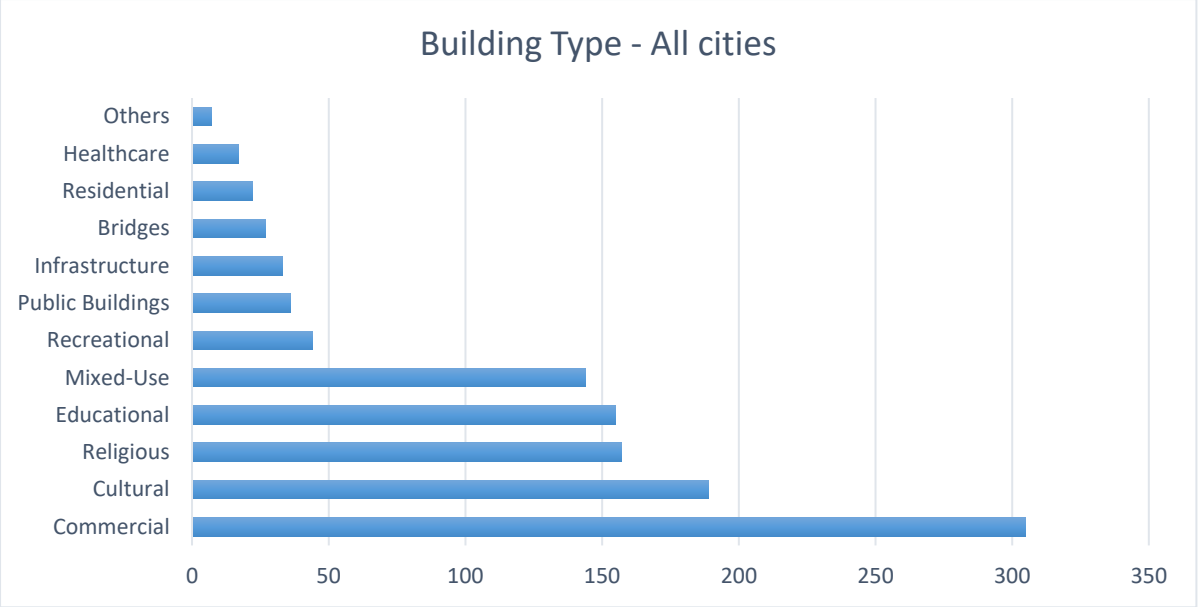
Figure 11 - Maastheatre, in Rotterdam, was opened in 1996 in a style that bridges between modernism and post-modernism.

Source: www.maastd.nl



Graph 9 - Number of landmark buildings by architectural style in all cities combined.

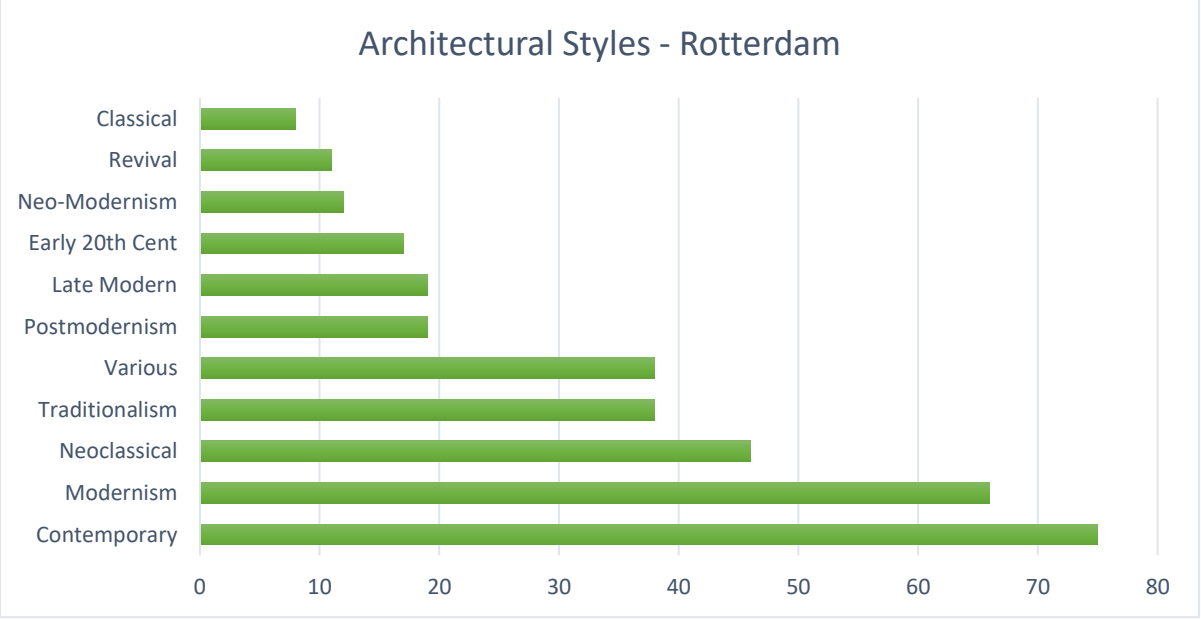
Source: Prepared by author, based on data by Stijn Vossen (2016).



Graph 10 - Number of landmark buildings by function/type in all cities combined.

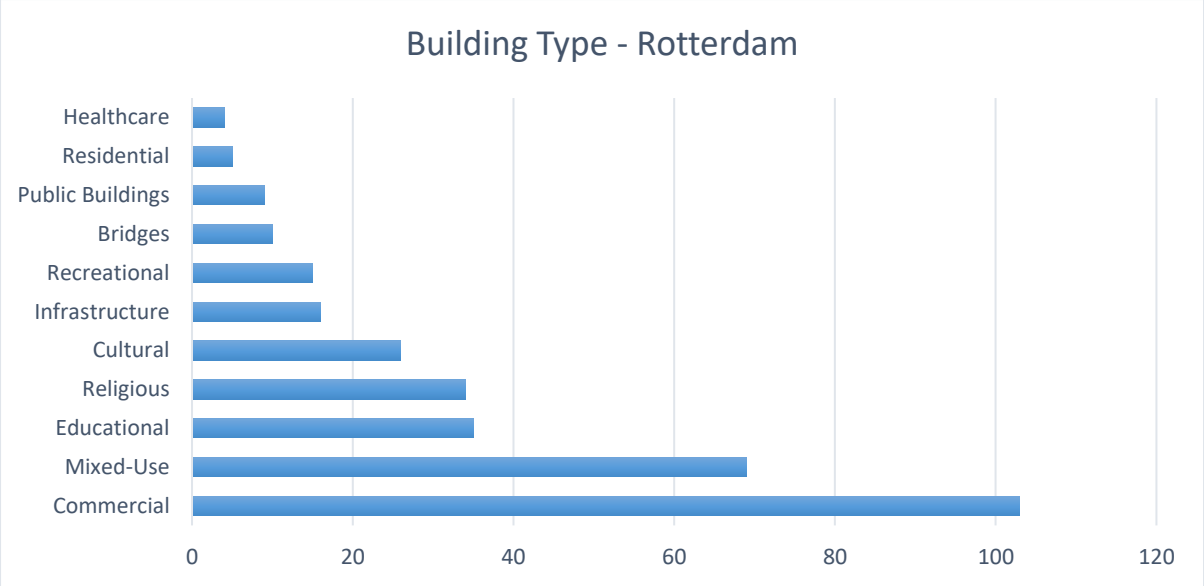
Source: Prepared by author, based on data by Stijn Vossen (2016).

Charts displaying the proportions of buildings by architectural style and building function for each of the 11 cities can be seen in Appendix 3 and Appendix 4, respectively. Rotterdam's architectural styles are mostly modern and contemporary. This is not surprising given that the city had to be almost entirely reconstructed after World War II. Unlike Amsterdam, Rotterdam had very little to work with in terms of historical buildings, but had ample space and freedom of form to develop a new architectural identity.



Graph 11 - Number of landmark buildings by architectural style in Rotterdam.

Source: Prepared by author, based on data by Stijn Vossen (2016).



Graph 12 - Number of landmark buildings by function/type in Rotterdam.

Source: Prepared by author, based on data by Stijn Vossen (2016).

Slowly, Rotterdam has become a testing ground for new and innovative architecture. In Rotterdam, most architectural landmarks are of commercial or mixed-use nature. Since the 1990s, mixed-use buildings have become an important concept of modern urban planning, and many of the buildings in Rotterdam have been constructed under those guidelines. For example, the iconic Markthal Rotterdam (Figure 13) which opened in 2014, includes 228 apartments, several stores, and restaurants, and encloses a large indoor market.

Figure 12 - Markthal, in Rotterdam, is a contemporary mixed-used building opened in 2014.

Source: Tom Van Vark

As the city continues to modernize and update its architectural identity, it has recently begun to attract a lot of international attention. The results presented here confirm that proximity to architectural landmarks is valued by international firms, and that modern and contemporary could be among the most relevant styles.

This chapter reported and analysed the results for both descriptive and inferential statistics performed by use of GIS maps and negative binominal regression models aimed at providing answers to the research question and sub-questions. It was proved that FDI firms are largely located in central areas. In addition, it was also shown that FDI firms located in central areas are in closest proximity to architectural landmarks and local service firms. Proximity to train stations and street connectivity was found in all areas. Proximity to parks are found mostly along the outskirts of cities, except for Rotterdam, Antwerp, and Manchester. Proximity to road interchanges and local hi-tech firms was found in both central and peripheral neighbourhoods; the first due to the equidistant nature of road interchanges to the centre of town, and the second

due to the strong presence of tech firms in central neighbourhoods as well as in peripheral science parks.

Regression models proved that FDI tends to cluster in higher count when in closer proximity to architecture, train stations, local service firms, while also in greater distance to parks, road interchanges, and local hi-tech firms. It also verified that FDI clusters are attracted to areas with better street connectivity. The borrowed proximity model indicated that FDI clustering is positively affected by proximity to architecture, local businesses, and road interchanges in a neighbouring city.

Chapter 5: Conclusion

Businesses have always sought proximity to resources, such as workers, customers, natural assets, and collective built infrastructure. This need for proximity to resources has been and continues to be the force behind the formation and continued growth of cities (Scott and Storper, 2015). Even as globalization at first seemed to flattened distances and challenge the importance of cities, it in fact created an international competitive environment in which both businesses and cities must innovate to succeed and remain relevant (Clark et al., 2002).

Innovation as the main component of modern economic growth, is best produced in urban settings, where highly-skilled workers, knowledge-spillover, well-developed infrastructure, services, and capital come together in a dynamic union (Porter, 1990; Rogerson, 1999; Hanna and Walton-Roberts, 2004; Turok, 2004). Greater access and connectivity to those highly-sought urban resources can increase opportunities and reduce risks for international businesses (Porter, 2000; Huggins et al., 2017). Urban environments that manage to optimize the local and global spheres are more successful in attracting Foreign Direct Investment, technology advancement and innovation, thereby increasing their competitiveness and economic growth.

Cities strive to find the "right mix" of urban characteristics that can attract international investments and improve their economic performance, while also creating quality living environments for their residents (Hanna and Walton-Roberts, 2004). In that setting, spatial (physical) amenities have gathered increased interest from local governments, particularly in cities with advanced economies seeking to differentiate themselves and attract knowledge-intensive industries.

While many studies have investigated the impact of urban socio-economic characteristics on competitiveness, there is a knowledge gap in the specific study of spatial characteristics and their impact on FDI. To help fill the gap, this study was conducted to identify the most relevant spatial characteristics to the clustering of Multinational Corporations in mid-sized north-western European cities. The aim was to provide an understanding of which spatial characteristics should be prioritized for economic growth in order to guide local and regional policies as well as urban design.

Internal validity was attained by using variables derived from a thorough review of Urban and Business Theories. Moreover, cities with similar size, population, and socio-economic profile were selected for the analysis. For external validity, the study included 11 cities and four different countries analysed at the neighbourhood level for an increased number of observations. Though the independent variables were generated by the author, calculations were performed by using advanced software, and source data was gathered from up-to-date secondary databases from OpenStreetMap.

Some limitations encountered in this study included high multicollinearity between independent variables, particularly in the borrowed proximity analysis, forcing a model with only one independent variable at a time. Moreover, because the data was generated using proximity measurements, only neighbourhoods with FDI could be included as observations, which limited their number and precluded analyses at the level of individual cities. In addition, due to the use of proximity data, no socio-economic variables were available as control, except to some extent *Local Firms*. Lastly, secondary data was acquired from an open source database, which has the advantage of being comprehensive and up-to-date, but potentially presented issues with reliability.

5.1 Spatial characteristics of cities and firms are determinants of Multinational Corporation clusters in north-western European cities?

The main research questions sought to be answered by this study is *Which spatial characteristics of cities and firms are determinants of Multinational Corporation clusters in north-western European cities?* To thoroughly answer this question, an analysis of *the current spatial distribution of Multinational Corporation clusters* in those cities was first conducted. It was verified that FDI concentrates in central commercial neighbourhoods, creating nodes or clusters of international firms.

These findings strongly support Marshall's theory on agglomeration, which explains that firms seek proximity to one another to take advantage of shared resources, thus reducing costs and increasing gains (Marshall, 1890). Because most FDI in advanced economies are of the knowledge-intensive and innovation-driven kind, Schumpeter's theory also applies under the argument that innovation drives agglomeration (Schumpeter, 1939, 1942). As explained by Audretsch (1998): "since knowledge is generated and transmitted more efficiently via local proximity, economic activity based on new knowledge has a high propensity to cluster within a geographic region" (p.18).

The mapped descriptive analysis confirmed that cities with higher FDI concentration also possess a higher number of FDIs, thus proving that a self-reinforced cycle is at play in which cities attract more FDI by having a higher concentration of FDI. This is supported by Florida's graphical representations of a globalized world, which show that global capital and innovation are increasingly concentrated in just a few cities (Florida, 2000).

Furthermore, these findings are in line with the research of van t'Hoff and Wall (2017) which proved that FDI is not only focused in a few cities, but are particularly concentrated in businesses districts that offer the combination of urban resources that FDIs need.

5.2 How does the spatial distribution of Multinational Corporation clusters relate to the average spatial distribution of urban spatial amenities?

Having proved that FDI concentrates in clusters, and mostly in central locations, the research progressed to identify *how the spatial distribution of Multinational Corporation clusters relates to the average spatial distribution of urban spatial amenities*.

It was observed that in most cities, central neighbourhoods provide higher average proximity between architectural landmarks and FDI, as well as between local service firms and FDI. This is a pattern that can be found more commonly in cities with high density and a strong commercial centre. Proximity to train stations and high street connectivity were found in all areas of the cities, showing that while those urban amenities are rather dispersed, there is always FDI with relative proximity. The areas where proximity to parks was highest were along the outskirts of the cities, which matches the physical location of the majority of green areas in the cities. Proximity to road interchanges showed an eclectic pattern, but generally included neighbourhoods moving from the centre to the outskirts of the cities. Proximity to local hi-tech firms was found in both central and peripheral neighbourhoods, which suggests a varied distribution of this type of industry among small start-ups in central neighbourhoods and more established research facilities in science industrial parks.

In summary, central neighbourhoods showed higher proximity between FDI and intrinsically urban amenities (architecture and local service firms), while peripheral neighbourhoods showed higher proximity between FDI and more "sub-urban" amenities (parks and road interchanges). Expectedly, a diverse pattern was displayed for train stations and street connectivity, verifying that those amenities are related to connectivity, serving as a network to bring the city together.

5.3 Which spatial characteristics of midsize north-western European cities impact their attraction of Multinational Corporation clusters?

Based on the observations developed in response to sub-question 1 and 2 described in the sections above, inferential analyses were conducted to determine *which spatial characteristics of midsize north-western European cities impact their attraction of Multinational Corporation clusters*. It was found that proximity to architectural aesthetics, train stations, well-connected streets, and local service firms all increase FDI clustering. Contrastingly, it was found that proximity to road interchanges, parks, and local hi-tech firms all decrease FDI clustering.

The study proved that architectural aesthetics are a feature of the urban brand and status that is sought after by international firms. The image they project with their location choice can impact their attractiveness to creative and knowledge-workers as well as to local and international markets (Glaeser et al, 2001; Turok, 2004). In fact, more often than not MNCs' headquarters and offices are located inside architectural landmarks. Indeed, a qualitative analysis indicated that most architectural landmarks in the 11 cities studied are occupied by commercial activities. In addition, it was also observed that the most common architectural styles are eclectic, modern, and contemporary. Rotterdam, in particular, has a majority of modern and contemporary architecture, and its buildings are mostly occupied by commercial and mixed-used activities.

The study also proved that train stations are an important component of the well-developed infrastructure sought by FDI clusters, as they connect and broaden the reach of MNCs to a network of regional services, customers, related industries, and labour (Porter, 2000; Turok, 2004; Simmie, 2005). Furthermore, railway infrastructure is only available in agglomeration economies, where demand is at a large enough scale to justify the high investment costs (Marshall, 1890). Similarly, but at a more local level, proximity to well-connected streets was proved to be a valuable asset to FDI. A strategic location within a network of streets not only increases access to local resources (Dunning, 1998; Porter, 2000), but also increases the chances of interaction with resources transiting through a necessary path (Alderson and Beckfield, 2004). Increased opportunities arising from increased interactions lead to more innovation and economic success for businesses and cities (Schumpeter; 1939; Simmie, 2005). It is important to note that both train stations and high street connectivity are present in neighbourhoods all over the city and appear to be important attractors of FDI to less central neighbourhoods. This offers further proof that efficient local and regional connectivity are valued amenities for FDI, regardless of whether they choose to be centrally located or not.

Proximity to local service firms was also proved to be attractive to FDI clusters. This result ties into theories of agglomeration and clustering, more specifically to the idea of collaboration imparted by Porter (1990) and Dunning (1998). Particularly in advanced economies, where most FDI is represented by headquarters, local firms in the service industry, such as accounting, banking, law, and marketing, are in higher demand than other industries.

It is not surprising that all the spatial factors that were found to increase FDI clustering through proximity are highly urban amenities. It proves that even within the boundaries of a city, FDI is strongly attracted to the more urbanized areas of the city.

In contrast, road interchanges are typically located in the outskirts of cities to provide efficiency to road traffic. It is used mostly for inter-city connections, or for urban-suburban and urban-rural connections. While it can also be considered a feature of infrastructure, it is less urban in nature. That FDI clusters value distance to road interchanges proves again that FDI, particularly of the knowledge-intensive kind, is attracted to highly urban characteristics.

The fact that FDI is attracted to locations that are at a distance to parks may speak more to the urban character of knowledge-based FDI than to its lack of affinity for green areas. As already seen, most

FDI is found concentrated in central commercial areas where there is access to a higher concentration of urban amenities. However, most cities studied do not offer many green areas in central locations. The conclusion that can be drawn from this result is that while parks are likely valued by highly-skilled workers (Florida, 2000; Glaeser et al, 2001), perhaps it may suffice to have access to them on weekends, in which case it does not the location choices of FDI within a city, particularly if one must choose between proximity to parks and proximity to other more urban amenities (Rotterdam and Manchester were the only two cities where central neighbourhoods have a high average proximity between parks and FDI).

Proximity to local hi-tech services proved to decrease FDI clusters, perhaps because most FDI in advanced economies is focused on central operations rather than R&D. Firms could be placing higher value on proximity to urban amenities found in more central locations than to hi-tech industrial parks that are typically located in more sparse areas of the city. Nevertheless, descriptive analysis showed that local hi-tech firms are present in both central and peripheral areas. Additionally, theory suggests that R&D is a knowledge asset sought by MNCs in advanced economies (Kim and Aguilera, 2015). These considerations show that an in-depth research on the topic is needed to yield more conclusive results.

When comparing cities, Antwerp appeared to perform better than Rotterdam in attracting FDI. This suggests that Antwerp could serve as a good case study in looking for ways to improve the FDI attractiveness of Rotterdam based on spatial attributes. The comparison is also relevant in that both Antwerp and Rotterdam are port cities and strong competitors to each other in attracting international businesses.

5.4 Is the FDI attractiveness of north-western European cities impacted by their borrowed proximity to spatial characteristics of neighbouring cities?

Lastly, in response to *whether FDI attractiveness of north-western European cities is impacted by their borrowed proximity to spatial characteristics of neighbouring cities*, exploratory analyses revealed that FDI clusters value the proximity to architectural landmarks, local firms, and road interchanges present in a neighbouring city. These findings prove that cities can improve their competitive advantage by strengthening their network with nearby cities and borrowing amenities from each other (Burger et al, 2015; Alonso, 1973). They also corroborate the observation that twin cities tend to develop towards each other, which would lend support to the New Metropolis theory and its call for the focused development of “micropolitans” (smaller urban nodes between two metropolitan areas) (Lang and Knox, 2009). These results serve as starting basis for further research on the topic including reginal data points instead of city only.

Looking more closely into architecture, it was found that Amsterdam, Antwerp, and Dusseldorf benefit more from borrowed proximity to architectural elements in their paired cities than Rotterdam does from the architectural elements in The Hague. This could be an indication that those three cities have a more well-developed linkage with their twin cities (e.g. movement of people, goods, business relations, cultural affinity and physical environment) than Rotterdam does.

5.5 Recommendations

This research added to the existing body of knowledge by proving that, in addition to the socio-economic factors discussed in the literature review, urban spatial factors do have a significant impact on the location of Multinational Corporations in midsized north-western European cities.

Furthermore, it demonstrated that proximity to decidedly urban elements (architecture, trains stations, street connectivity and local service firms) is desired by knowledge-intensive FDI clusters, while proximity to peripheral urban elements (road interchanges, parks, and local hi-tech firms) is avoided or not prioritized. This research also offered further proof that FDI tends to concentrate, in clusters, and prefers central urban locations where urban amenities are also denser.

Perhaps the most innovative and contributing aspects of this research are: 1 - the exciting substantiation that proximity to architectural landmarks increases the FDI clustering effect; 2 - the proof that FDI is attracted by high street connectivity as it relates to increased chances of interaction; and 3 - the validation of the concept of borrowed proximity, in which FDI in a city can be influenced by spatial elements of a neighbouring city.

With respect to the contributions above, this research not only filled a gap in the academic knowledge, but also established a foundation from which policy makers and urban planners can draw from when prioritizing interventions for successful economic development and enhanced international competitiveness. Based on this added knowledge, a few recommendations can be developed to help Rotterdam plan for its urban design in the interest of attracting FDI and increasing its international competitiveness:

1. Cultivate cultural and policy environments that enable innovative architecture to flourish in the city, particularly of commercial, cultural, and mixed-used nature.
2. Invest in new and existing areas, especially around train stations, by: a) developing innovative architectural projects; b) providing appropriate physical and policy infrastructure aimed at attracting local service businesses; c) providing efficient path connections within the network of streets. Avoid areas near major highways, peripheral parks and local transport firms.
3. Consider strategic street connectivity a tool to both increase the chances of interactions between FDI clusters and urban resources in a city, and to promote new areas for FDI development. For example, consider developing areas that are in the necessary path between two large FDI clusters, or reorganize street patterns to create such circumstance in areas that are currently being developed to attract FDI.
4. Seek joint development and policy projects to enhance regional connectivity (e.g. infrastructure, architectural partnerships, national and international marketing of architectural amenities and local services of the Rotterdam-The Hague region.

To continue developing this area of research, additional studies could be conducted on twin cities and their interconnected corridors by using total count data (larger number of cities required), or by investigating proximity relationships within entire regional areas. Further research on the quality and quantity of spatial elements could offer different perspectives on the topic. Qualitative research using surveys and interviews with MNC management staff could provide more insights into the reasons why proximity to certain spatial elements are more important than others.

In conclusion, while they may not be the biggest factors, spatial characteristics of cities do have an important role in defining where innovation-driven international investments choose to settle. Cities that are more architecturally attractive, that have better infrastructure, that provide efficient local and regional connectivity, will progressively attract more knowledge-intensive FDI clusters, improve their socio-economic status, and continuously increase their international competitiveness in a highly globalized world.

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Appendix 1: Scatter Plot Analysis of FDI Clusters and each Spatial Asset Independent Variable

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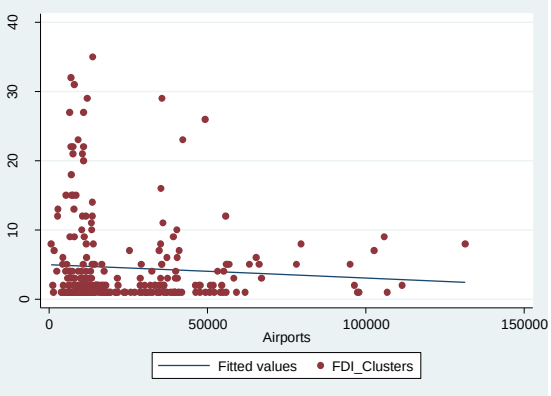
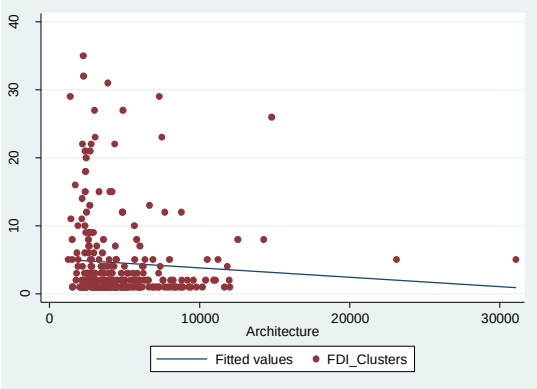


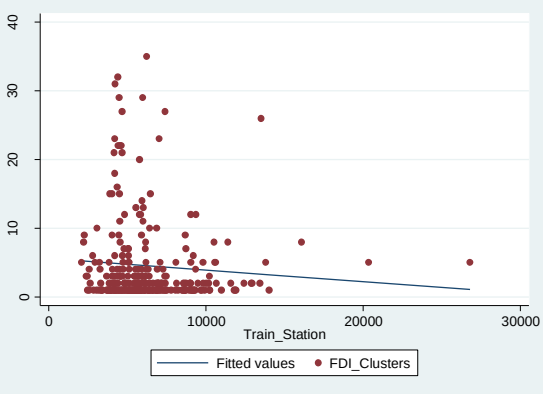
FDI Clusters (y) and Airports (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



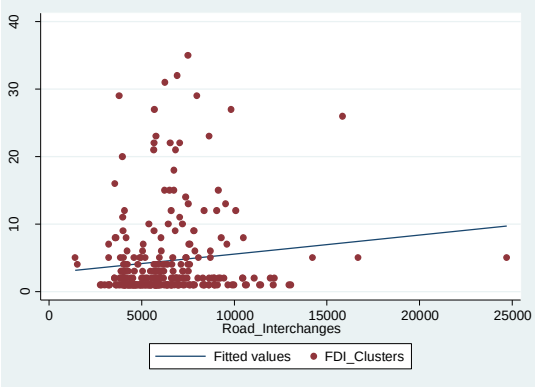
FDI Clusters (y) and Architecture (x)

Source: STATA output, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



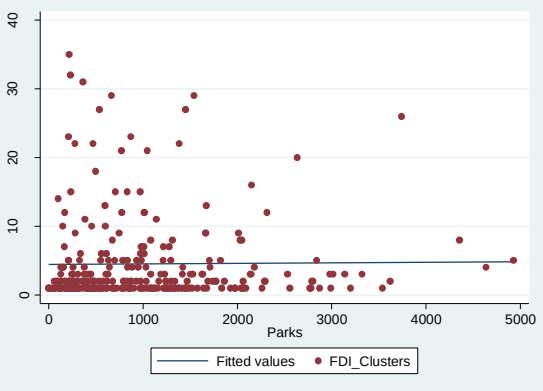
FDI Clusters (y) and Train Stations (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



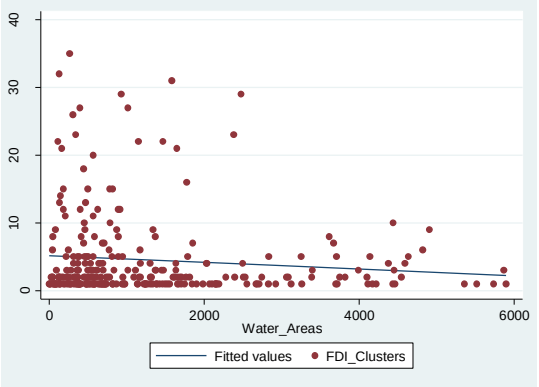
FDI Clusters (y) and Road Interchanges (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



FDI Clusters (y) and Parks (x)

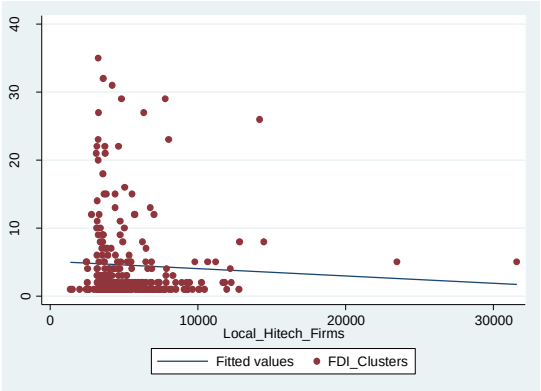
Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



FDI Clusters (y) and Water Areas (x)

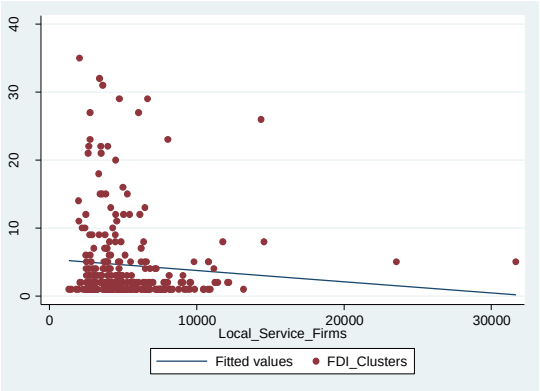
Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Appendix 1: Correlation Analysis (continued)



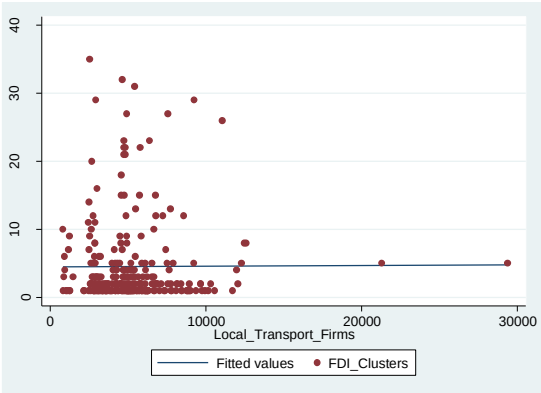
FDI Clusters (y) and Local Hi-tech Firms (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



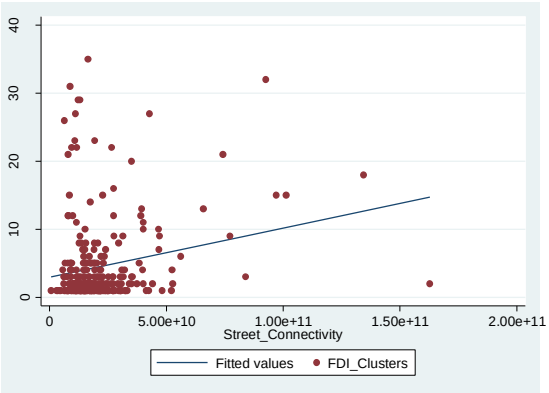
FDI Clusters (y) and Local Service Firms (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



FDI Clusters (y) and Local Transport Firms (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).



FDI Clusters (y) and Street Connectivity (x)

Source: STATA output, based on data from FDI Markets (2016) and OpenStreetMap (2016).

Appendix 2: NBR with Dummy Variables for Cities

VARIABLES	FDI Clusters
Airports	1.25e-05*
	(7.36e-06)
Road Interchanges	0.000150***
	(4.78e-05)
Architecture	-7.67e-05
	(8.65e-05)
Parks	0.000191**
	(9.09e-05)
Train Stations	-6.15e-05
	(7.92e-05)
Water Areas	-6.02e-05
	(6.97e-05)
Street Connectivity	8.41e-12*
	(4.60e-12)
Local Hi-tech Firms	-0.000457
	(0.000450)
Local Transport Firms	0.000391*
	(0.000219)
Local Service Firms	9.89e-05
	(0.000413)
The Hague	1.281
	(0.819)
Amsterdam	0.613
	(0.944)
Utrecht	-0.195
	(0.668)
Antwerp	1.464***
	(0.537)
Ghent	-0.463
	(0.692)
Manchester	0.895
	(0.841)
Birmingham	0.356
	(0.597)
Coventry	-0.119
	(0.769)
Dusseldorf	0.419
	(0.849)
Essen	-0.363
	(0.732)
Constant	-0.0148
	(0.813)
Observations	277
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Source: STATA output, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

Appendix 3: Chart of number of buildings by architectural style

	All	Rotterdam	The Hague	Amsterdam	Utrecht	Antwerp	Ghent	Manchester	Birmingham	Coventry	Dusseldorf	Essen
Art Deco	4	0	2	0	0	0	2	0	0	0	0	0
Baroque	5	0	0	0	0	0	5	0	0	0	0	0
Classical	114	9	13	24	3	13	0	12	10	15	7	8
Contemporary	168	75	2	10	10	7	14	15	14	7	8	6
Deconstructivism	1	0	0	1	0	0	0	0	0	0	0	0
Early 20th Cent (Art Nouveau / Expressionism)	69	17	9	16	4	1	2	5	2	0	6	7
Eclecticism	3	0	0	0	0	0	3	0	0	0	0	0
Gothic	8	0	0	0	0	1	7	0	0	0	0	0
Gothic Revival	2	0	0	0	0	0	2	0	0	0	0	0
Gothic, Baroque, Gothic Revival	2	0	0	0	0	1	1	0	0	0	0	0
Late Modern	71	17	8	15	3	1	1	9	8	2	5	0
Minimalism	1	0	0	0	1	0	0	0	0	0	0	0
Modernism	170	61	17	30	7	8	7	8	6	3	8	8
Modernism, Art Deco	1	0	0	0	0	0	1	0	0	0	0	0
Modernism, International Style	1	0	0	0	0	1	0	0	0	0	0	0
Neoclassical	114	49	5	13	1	8	4	17	8	1	5	3
Neoclassical, Art Deco	1	0	0	0	0	0	1	0	0	0	0	0
Neoclassical, Baroque	1	0	0	0	0	0	1	0	0	0	0	0
Neoclassical, Beaux-Arts	2	0	0	0	0	1	1	0	0	0	0	0
Neo-Modernism	36	14	1	14	1	1	0	0	0	3	2	0
Postmodernism	79	23	17	15	7	1	1	1	5	4	1	2
Renaissance	4	0	0	0	0	3	1	0	0	0	0	0
Revival	79	11	4	6	0	3	5	22	11	0	5	12
Romanesque	1	0	0	0	0	0	1	0	0	0	0	0
Romanesque, Gothic	1	0	0	0	0	1	0	0	0	0	0	0
Romanesque, Gothic, Baroque	1	0	0	0	0	1	0	0	0	0	0	0
Traditionalism	50	37	2	2	0	1	0	0	0	0	3	4
Various	378	38	36	111	20	10	0	37	37	6	46	36

**** Highest values are highlighted in yellow.***

Source: Prepared by author, based on data by Stijn Vossen (2016).

Appendix 4: Chart of number of buildings by function

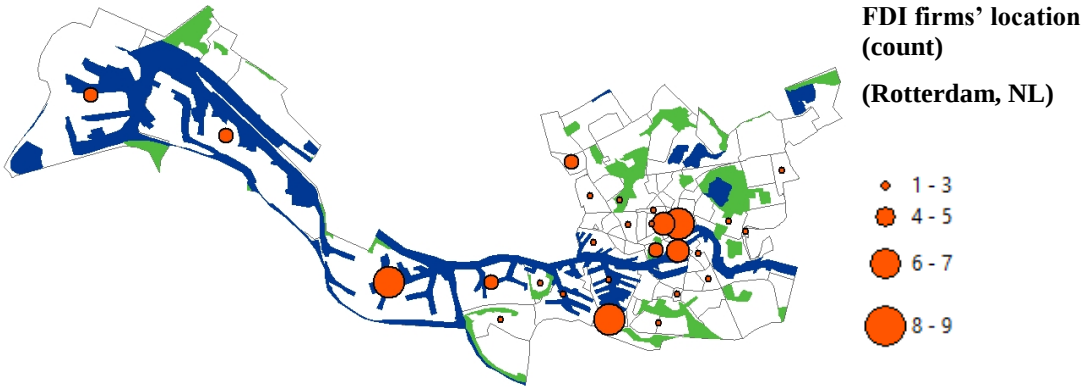
	All	Rotterdam	The Hague	Amsterdam	Utrecht	Antwerp	Ghent	Manchester	Birmingham	Coventry	Dusseldorf	Essen
Bridges	27	10	0	9	1	0	1	3	2	0	1	0
City Planning	1	0	0	0	0	0	0	0	1	0	0	0
Commercial	305	102	26	53	10	15	12	23	12	4	33	14
Cultural	189	28	18	32	5	17	13	19	12	10	20	15
Educational	155	35	15	26	18	3	9	17	17	7	5	3
Governmental	3	0	0	0	0	0	2	1	0	0	0	0
Healthcare	17	4	1	1	3	1	1	0	1	1	1	3
Infrastructure	33	16	3	3	1	0	1	2	4	1	1	1
Mixed-Use	144	70	9	21	2	4	3	15	7	1	9	3
Monument	1	0	0	1	0	0	0	0	0	0	0	0
Municipal	1	0	0	0	0	0	0	1	0	0	0	0
Prefab	1	0	0	0	0	0	0	0	1	0	0	0
Public Buildings	36	10	7	1	3	3	3	3	1	2	2	1
Recreational	44	14	4	9	1	2	2	9	0	0	1	1
Religious	157	37	10	17	4	11	10	8	18	3	14	25
Residential	22	2	4	7	2	1	0	0	0	0	1	0

**** Highest values are highlighted in yellow.***

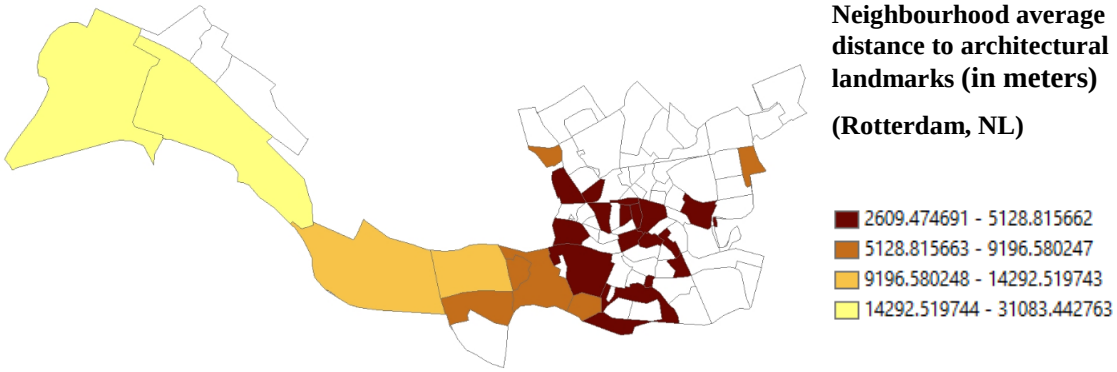
Source: Prepared by author, based on data by Stijn Vossen (2016).

Appendix 5: Graduated maps of independent variables

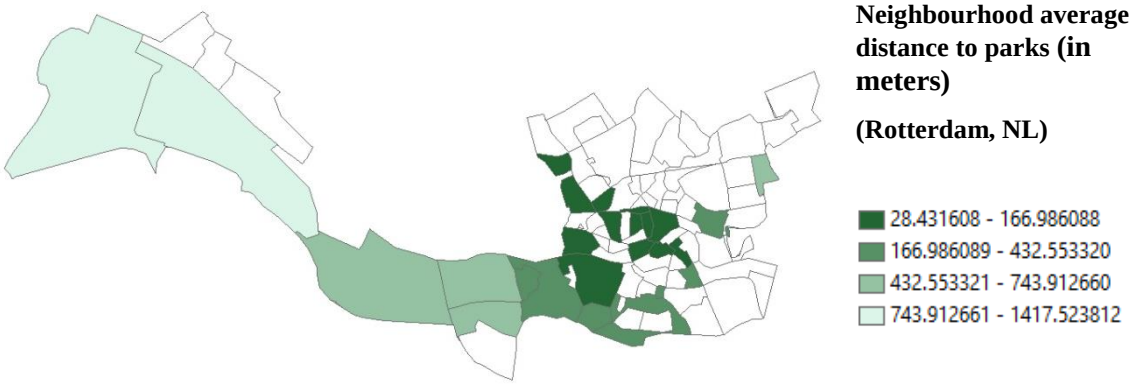
Rotterdam, NL



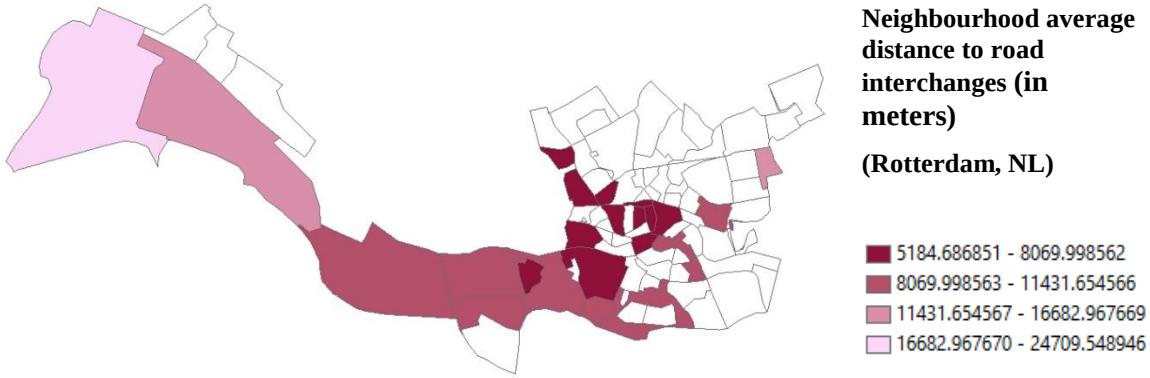
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



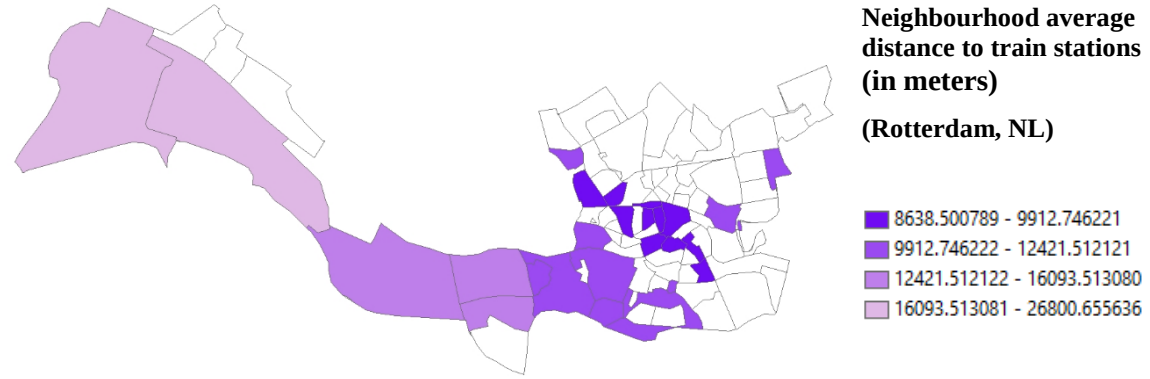
Source: All Rotterdam maps were prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



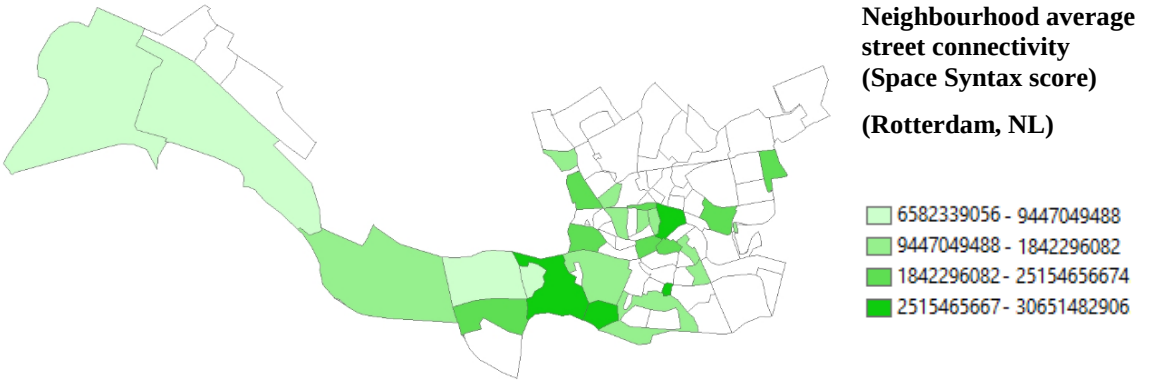
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



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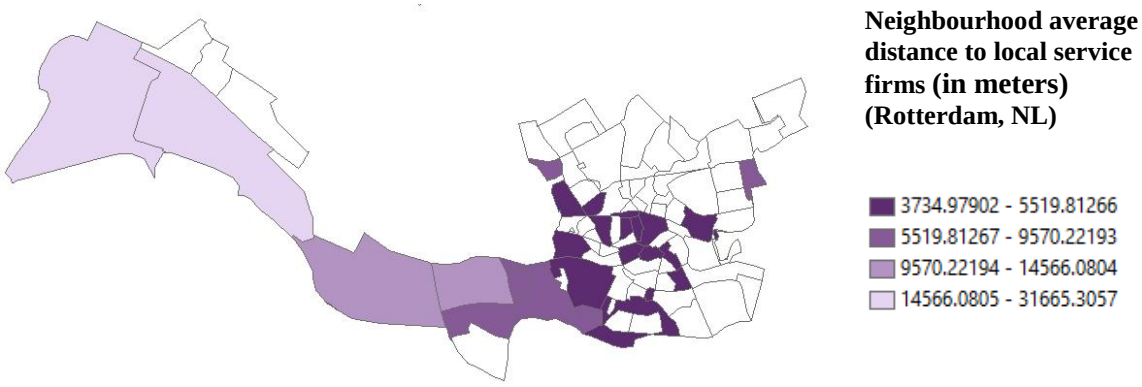
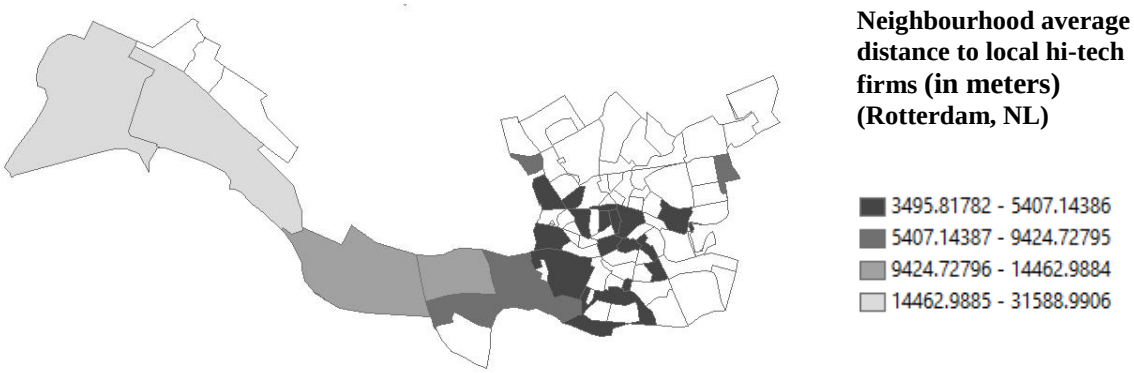


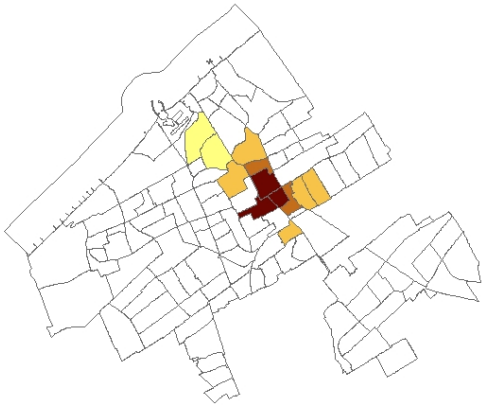
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



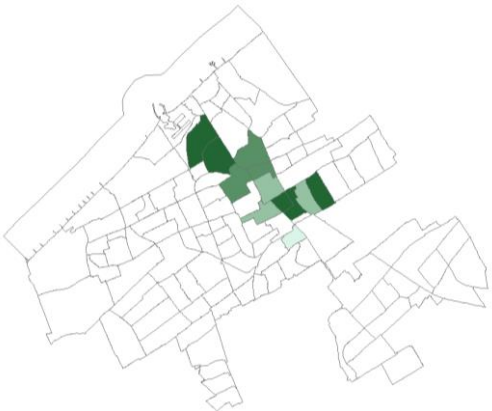
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

The Hague, NL

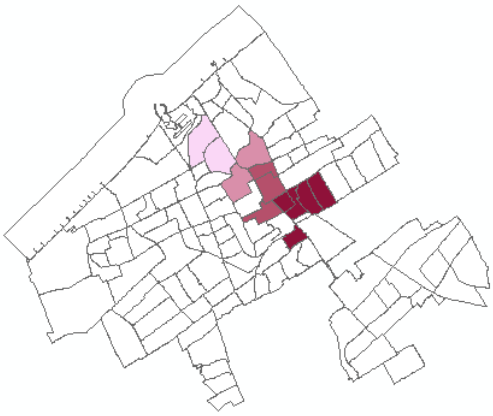
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

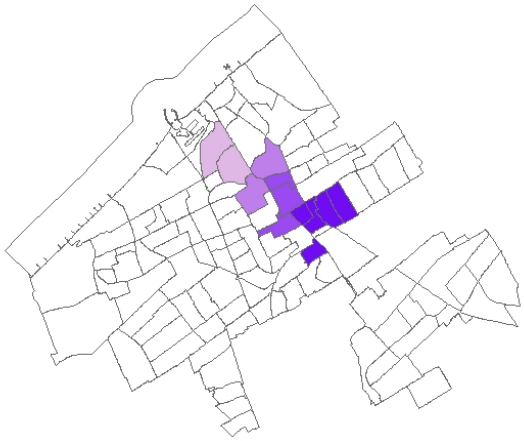


Neighbourhood average distance to road interchanges (in meters)

(The Hague, NL)

3994.05662 - 4787.56492
4787.56493 - 5512.34509
5512.34510 - 6374.45482
6374.45483 - 7855.13080

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

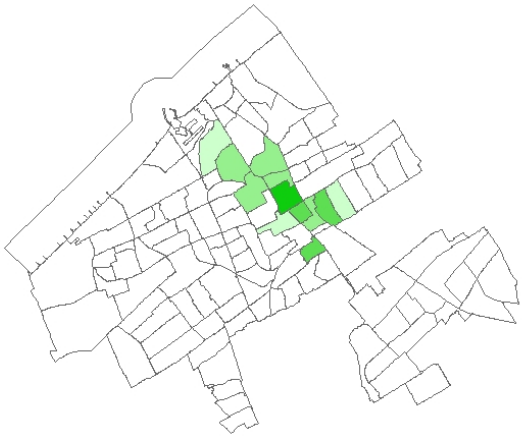


Neighbourhood average distance to train stations (in meters)

(The Hague, NL)

2248.730254 - 2570.198684
2570.198685 - 3193.824217
3193.824218 - 3965.774513
3965.774514 - 5372.476749

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Neighbourhood average street connectivity (Space Syntax score)

(The Hague, NL)

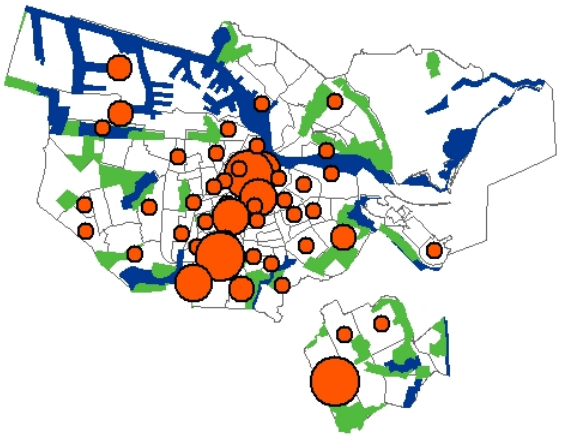
9527660128 - 1462346561
1462346561 - 2544279947
2544279947 - 3136921362
3136921362 - 4665518371

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

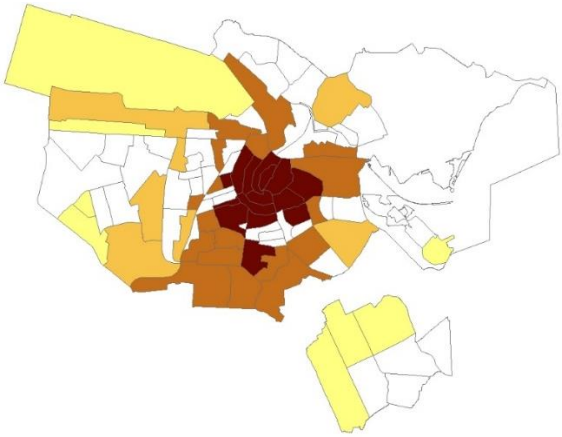
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Amsterdam, NL

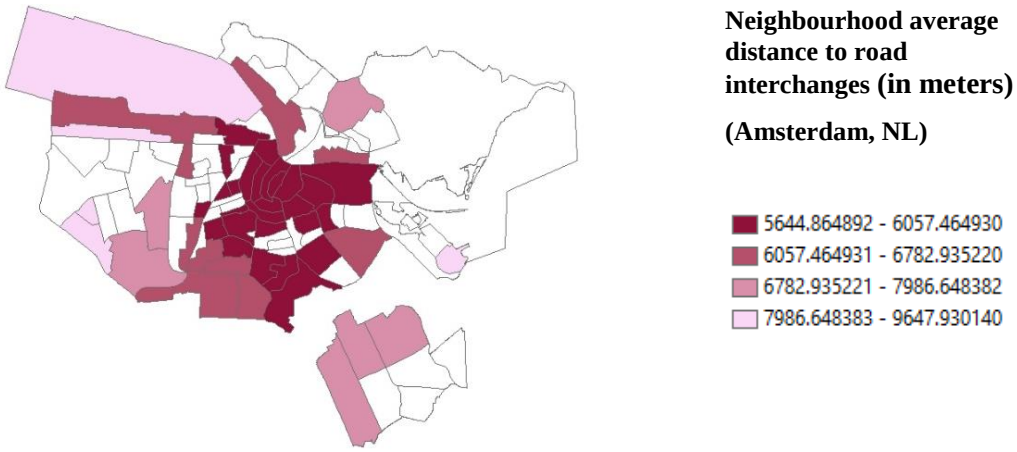


Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

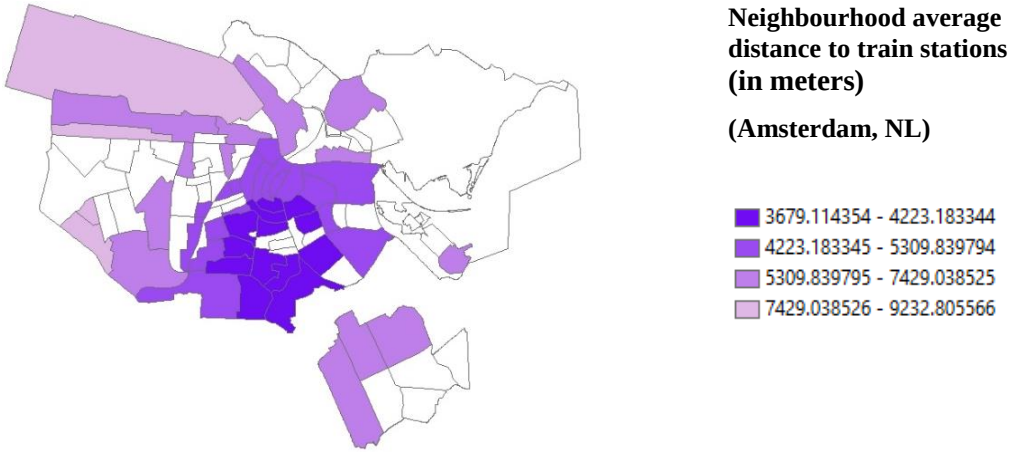


Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

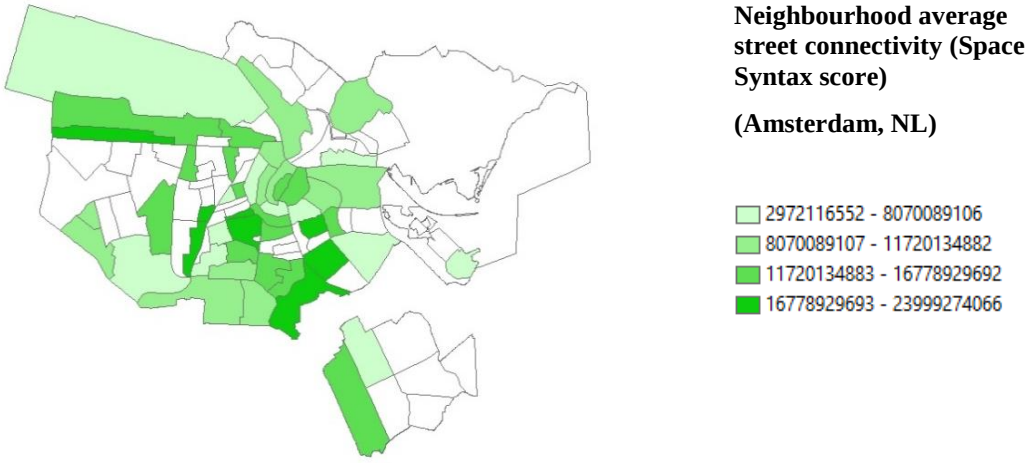
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



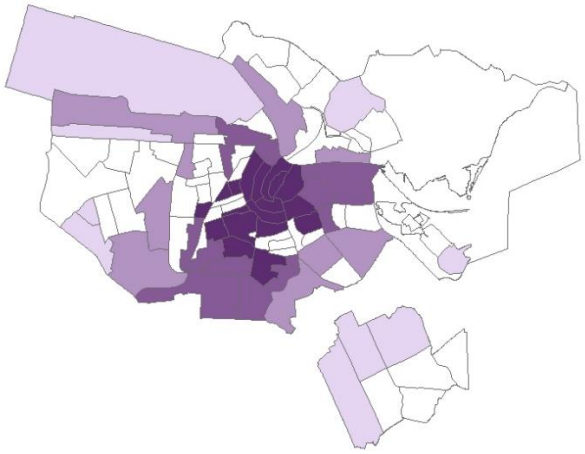
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Neighbourhood average distance to local service firms (in meters)

(Amsterdam, NL)

4726.00552 - 5277.41183
5277.41184 - 5894.79326
5894.79327 - 7226.77801
7226.77802 - 9944.71318

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

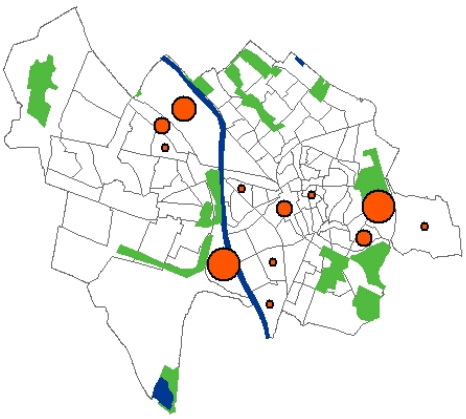
Neighbourhood average distance to local hi-tech firms (in meters)

(Amsterdam, NL)

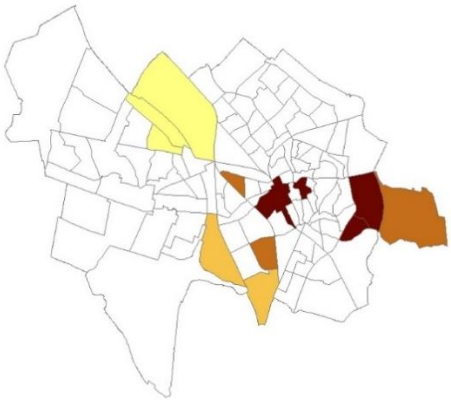
3118.30065 - 3569.93697
3569.93698 - 4256.71377
4256.71378 - 5690.44858
5690.44859 - 8520.76526

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

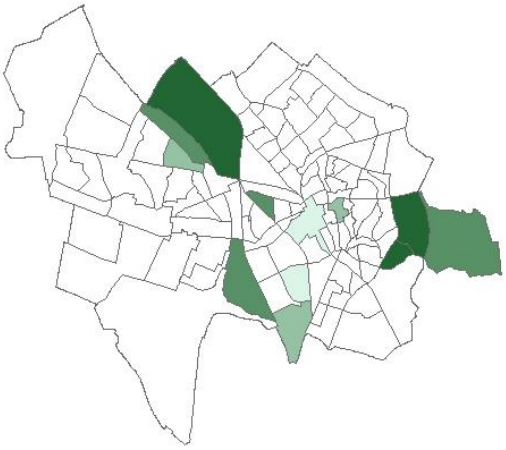
Utrecht, NL



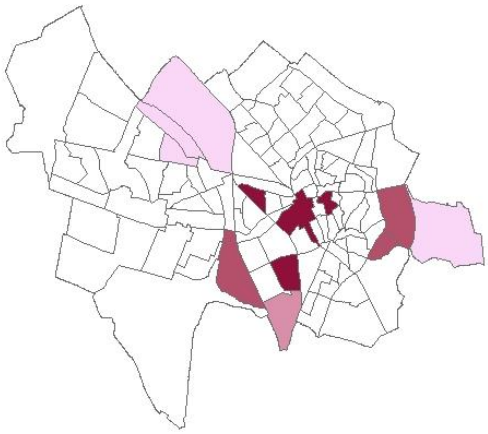
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

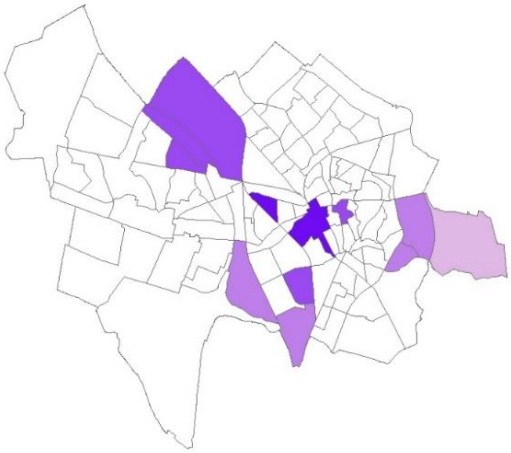


Neighbourhood average distance to road interchanges (in meters)

(Utrecht, NL)

4510.801006 - 4637.488715
4637.488716 - 5089.017672
5089.017673 - 5340.870101
5340.870102 - 6031.174056

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

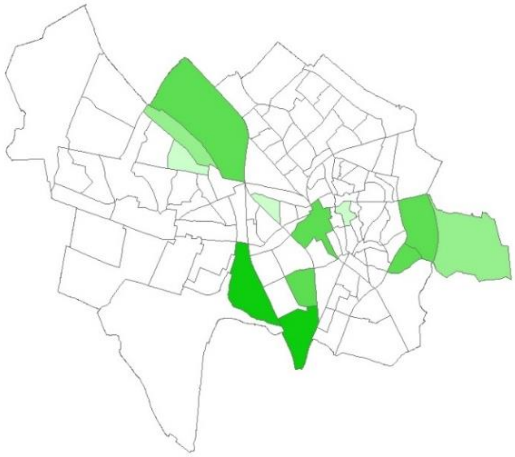


Neighbourhood average distance to train stations (in meters)

(Utrecht, NL)

3056.586961 - 3289.038260
3289.038261 - 4179.672159
4179.672160 - 5332.904544
5332.904545 - 6594.033427

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

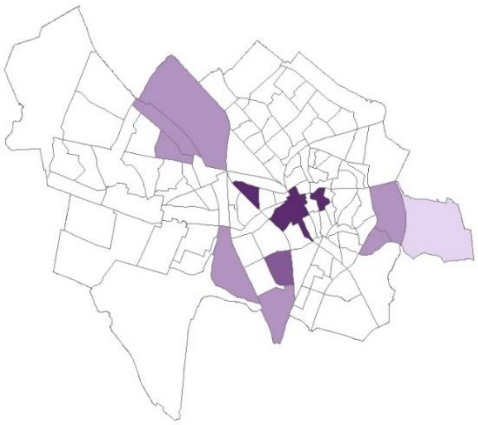


Neighbourhood average street connectivity (Space Syntax score)

(Utrecht, NL)

685921572 - 4812635795
4812635796 - 8288963829
8288963830 - 18110432700
18110432701 - 30295043904

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Neighbourhood average distance to local service firms (in meters)

(Utrecht, NL)

2738.07584 - 2836.34909
2836.34910 - 3377.79473
3377.79474 - 4615.12126
4615.12127 - 5581.75196

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

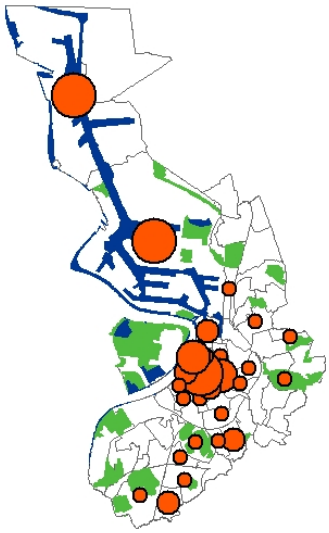
Neighbourhood average distance to local hi-tech firms (in meters)

(Utrecht, NL)

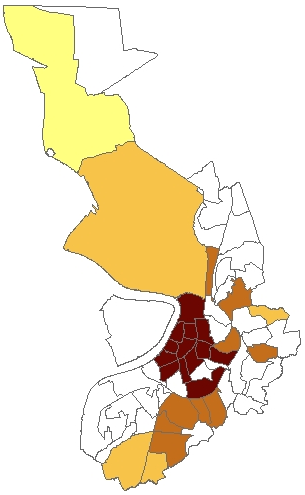
2501.46144 - 2967.43713
2967.43714 - 3864.81758
3864.81759 - 4082.81806
4082.81807 - 5082.71513

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

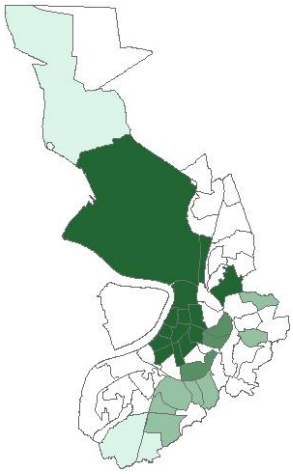
Antwerp, BE



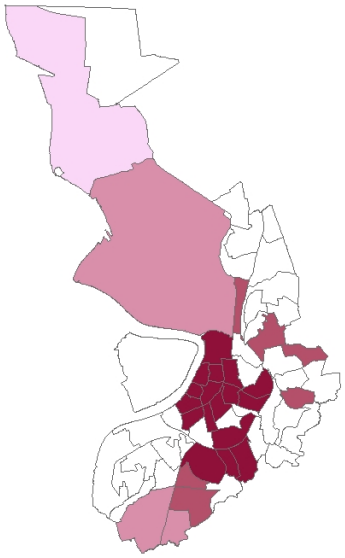
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

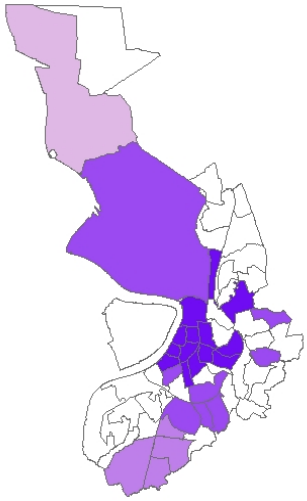


Neighbourhood average distance to road interchanges (in meters)

(Antwerp, BE)

3531.11036 - 4218.61962
4218.61963 - 5476.99330
5476.99331 - 8644.10305
8644.10306 - 15850.9157

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

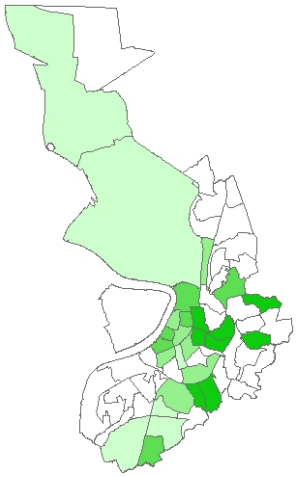


Neighbourhood average distance to train stations (in meters)

(Antwerp, BE)

4144.837703 - 5030.578252
5030.578253 - 7030.332481
7030.332482 - 9803.309091
9803.309092 - 13515.573904

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

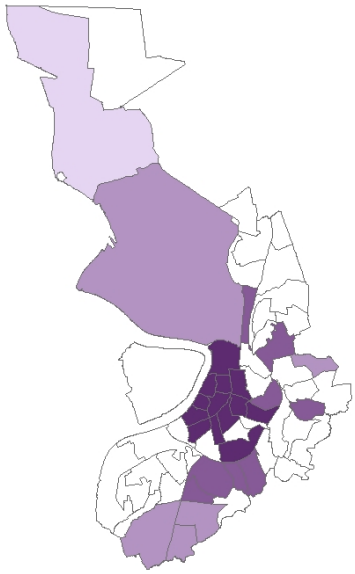


Neighbourhood average street connectivity (space syntax score)

(Antwerp, BE)

6378538423 - 10879382156
10879382157 - 15259737619
15259737620 - 22048374051
22048374052 - 37339176612

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

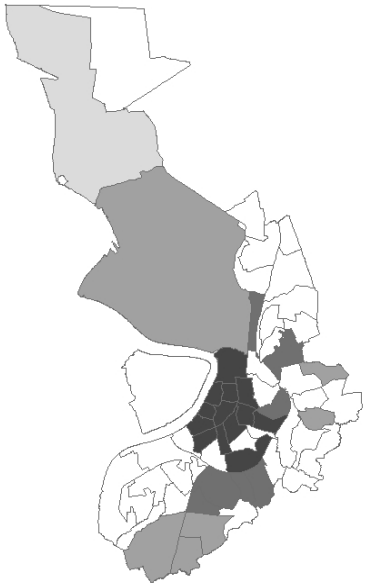


Neighbourhood average distance to local service firms (in meters)

(Antwerp, BE)

4574.46028 - 5684.46300
5684.46301 - 7526.04930
7526.04931 - 9819.53433
9819.53434 - 14373.7387

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



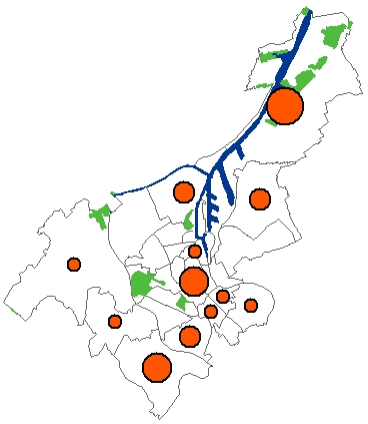
Neighbourhood average distance to local hi-tech firms (in meters)

(Antwerp, BE)

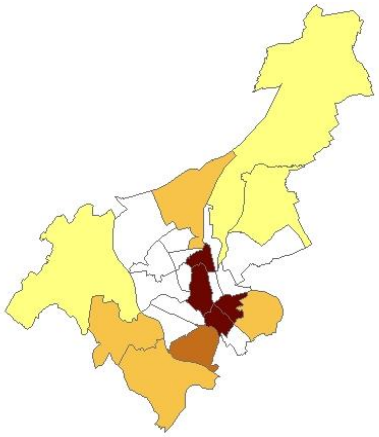
4724.82107 - 5771.12359
5771.12360 - 7397.57705
7397.57706 - 9797.05989
9797.05990 - 14194.1945

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

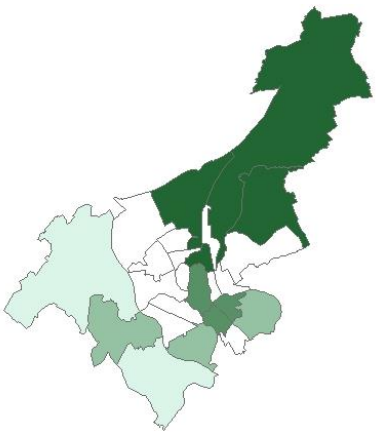
Ghent, BE



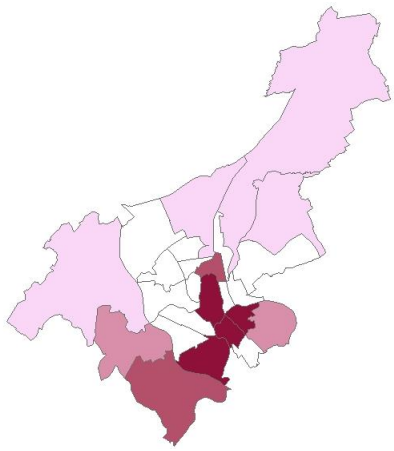
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

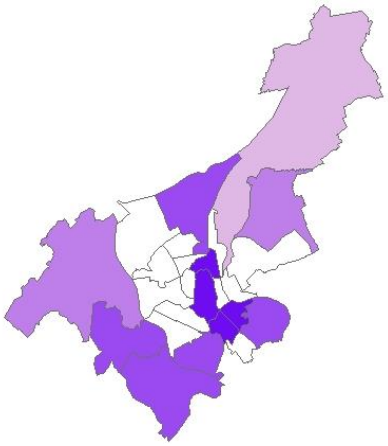


Neighbourhood average distance to road interchanges (in meters)

(Ghent, BE)

3614.33564 - 4146.47786
4146.47787 - 4588.82368
4588.82369 - 5510.88915
5510.88916 - 10070.8922

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

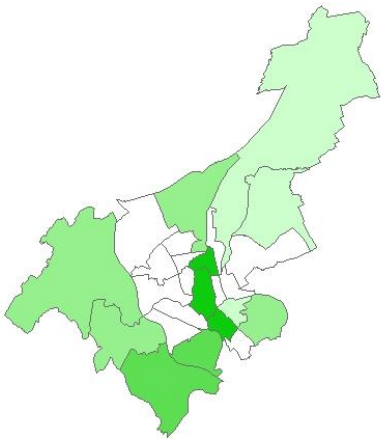


Neighbourhood average distance to train stations (in meters)

(Ghent, BE)

3214.215301 - 3392.957659
3392.957660 - 5955.910522
5955.910523 - 7258.301952
7258.301953 - 9373.905660

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

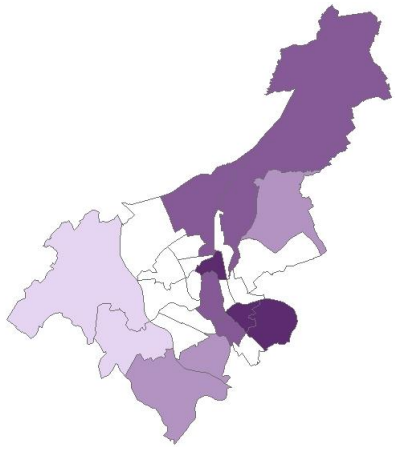


Neighbourhood average street connectivity (Space Syntax score)

(Ghent, BE)

9220833408 - 9892137702
9892137703 - 11817822355
11817822356 - 15391558391
15391558392 - 20732210718

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

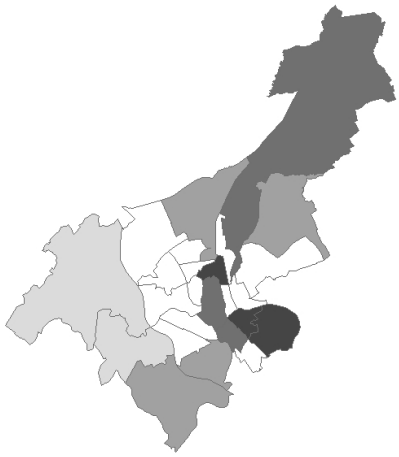


Neighbourhood average distance to local service firms (in meters)

(Ghent, BE)

1305.87312 - 1822.22598
1822.22599 - 3508.43047
3508.43048 - 5503.84760
5503.84761 - 8174.79759

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



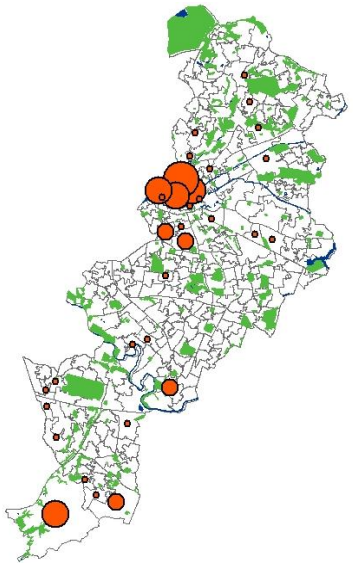
Neighbourhood average distance to local hi-tech firms (in meters)

(Ghent, BE)

1355.83628 - 1987.40474
1987.40475 - 2785.38939
2785.38940 - 5456.26271
5456.26272 - 8202.97399

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Manchester, UK

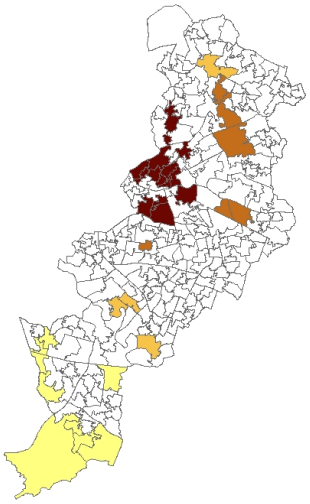


FDI firms' location (count)

(Manchester, UK)

1 - 2
3 - 6
7 - 14
15 - 35

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

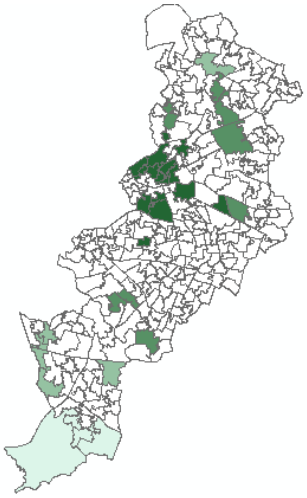


Neighbourhood average distance to architectural landmarks (in meters)

(Manchester, UK)

1506.839737 - 2585.887448
2585.887449 - 4889.841078
4889.841079 - 7938.673799
7938.673800 - 12979.962142

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

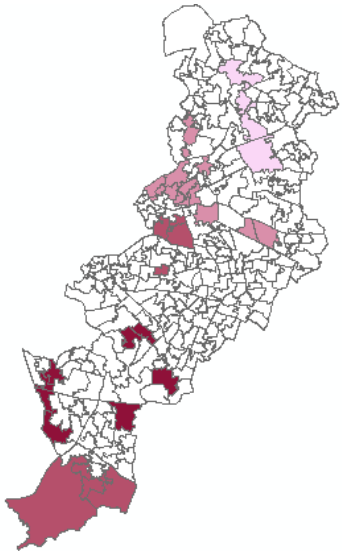


Neighbourhood average distance to parks (in meters)

(Manchester, UK)

5194.86022 - 5936.91712
5936.91713 - 7288.68873
7288.68874 - 9494.65159
9494.65160 - 11237.1896

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

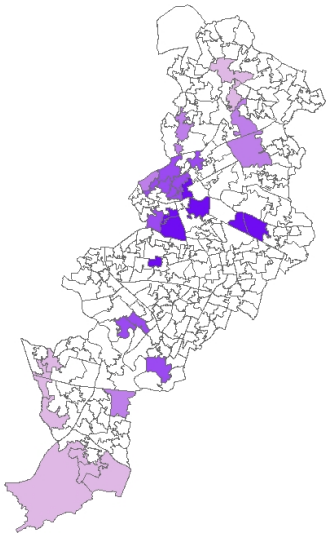


Neighbourhood average distance to road interchanges (in meters)

(Manchester, UK)

3271.97444 - 4352.64017
4352.64018 - 6353.34233
6353.34234 - 8926.88294
8926.88295 - 12098.3679

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

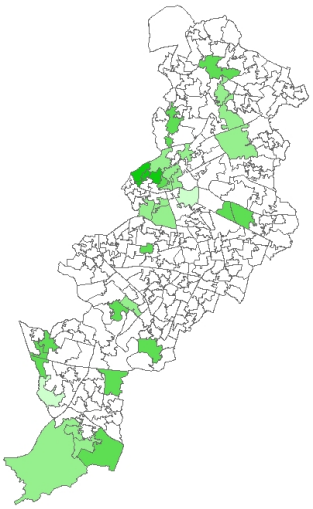


Neighbourhood average distance to train stations (in meters)

(Manchester, UK)

4251.708060 - 5243.705765
5243.705766 - 6234.276655
6234.276656 - 7166.611754
7166.611755 - 10520.096559

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

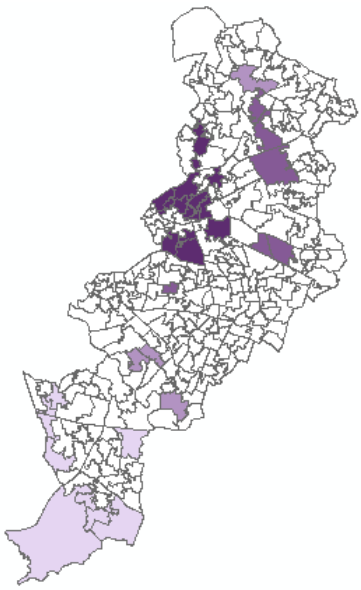


Neighbourhood average street connectivity (Space Syntax score)

(Manchester, UK)

7640210603 - 13139711699
13139711700 - 19117013344
19117013345 - 27949878962
27949878963 - 40130182646

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

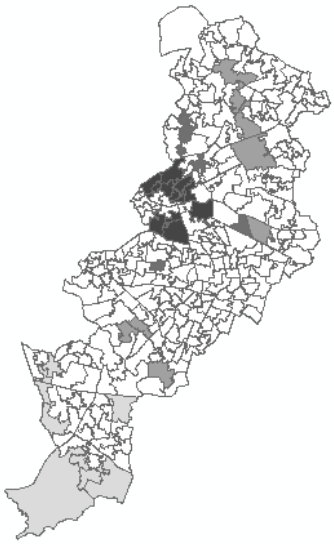


Neighbourhood average distance to local service firms (in meters)

(Manchester, UK)

1979.81596 - 3014.78730
3014.78731 - 5246.24699
5246.24700 - 7235.13013
7235.13014 - 11764.9011

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



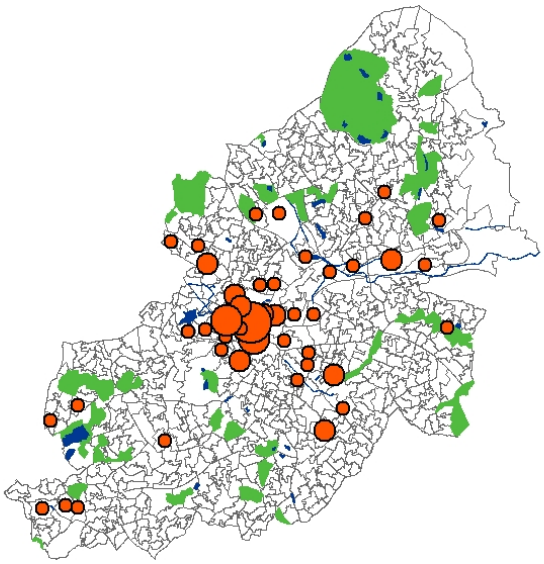
Neighbourhood average distance to local hi-tech firms (in meters)

(Manchester, UK)

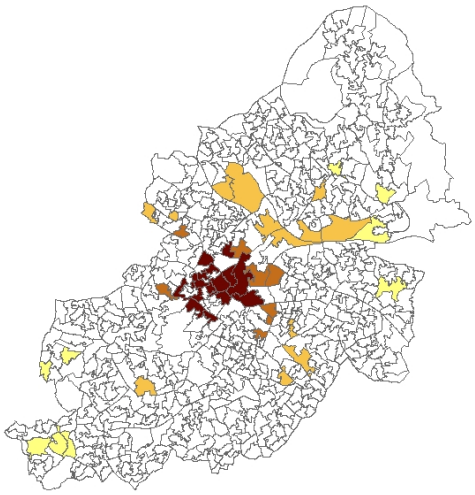
3144.38027 - 3663.46780
3663.46781 - 4785.64142
4785.64143 - 7876.49990
7876.49991 - 12826.9121

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

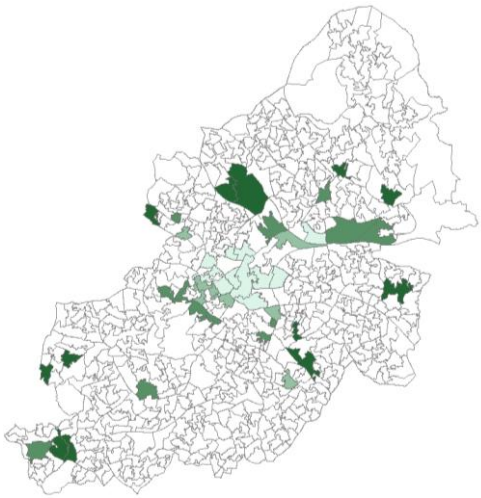
Birmingham, UK



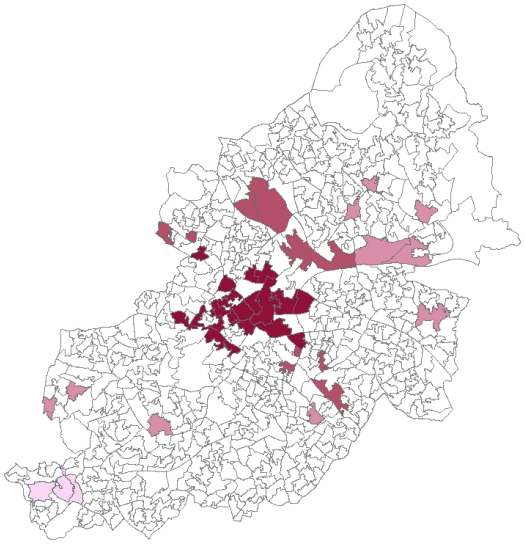
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



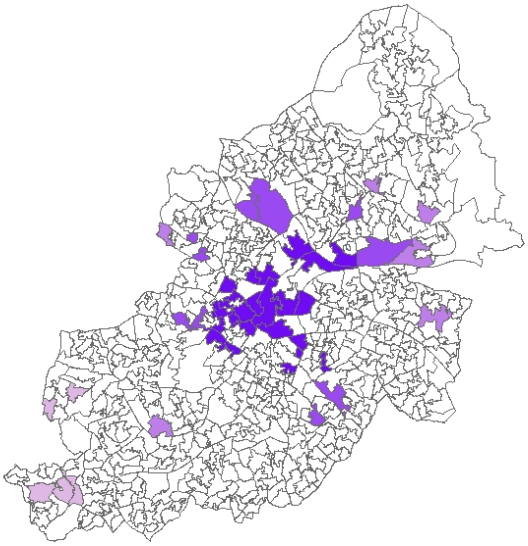
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).



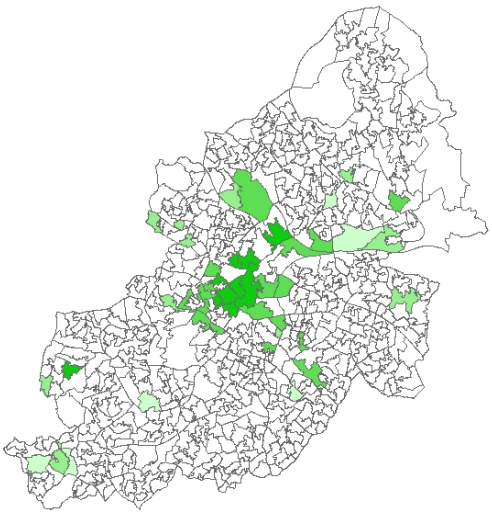
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



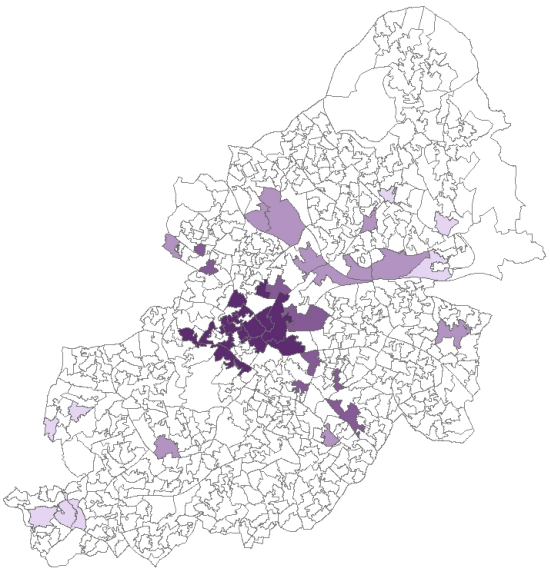
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

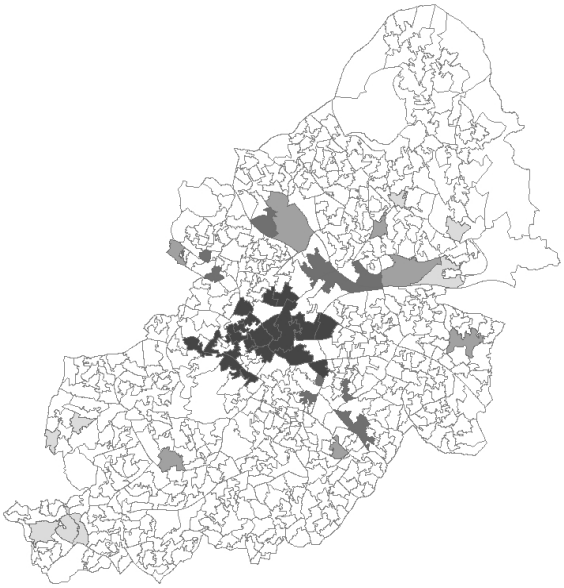


Neighbourhood average distance to local service firms (in meters)

(Birmingham, UK)

4423.08638 - 5278.26237
5278.26238 - 6749.06429
6749.06430 - 9532.02319
9532.02320 - 13172.5352

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



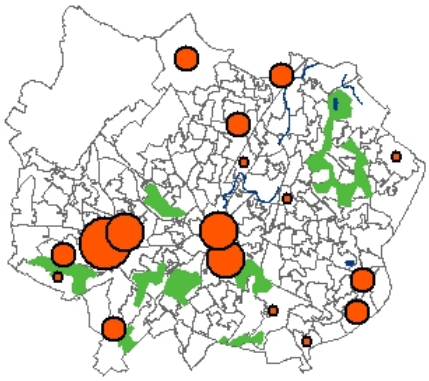
Neighbourhood average distance to local hi-tech firms (in meters)

(Birmingham, UK)

3219.96944 - 4562.98707
4562.98708 - 6266.26873
6266.26874 - 8504.08992
8504.08993 - 12780.2717

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Coventry, UK

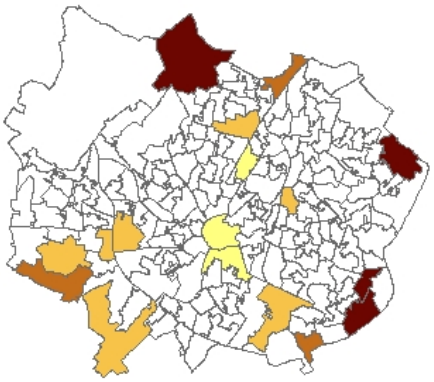


FDI firms' location (count)

(Coventry, UK)

1
2 - 3
4 - 5
6 - 8

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

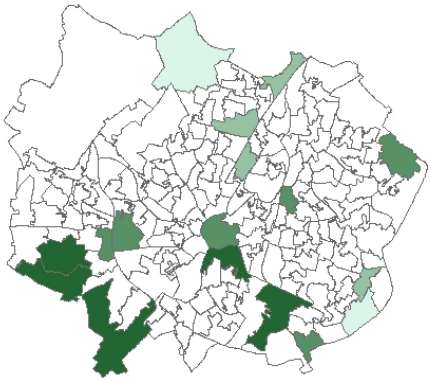


Neighbourhood average distance to architectural landmarks (in meters)

(Coventry, UK)

1931.168211 - 2892.317591
2892.317592 - 4207.224909
4207.224910 - 5217.339812
5217.339813 - 6636.800540

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

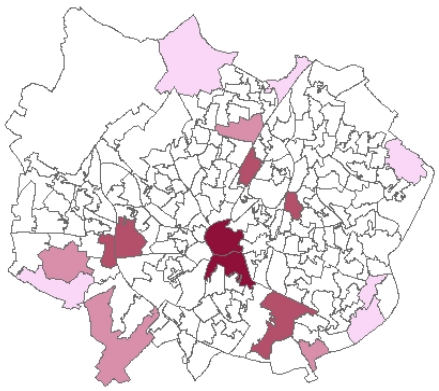


Neighbourhood average distance to parks (in meters)

(Coventry, UK)

228.049719 - 604.383359
604.383360 - 1411.56127
1411.56128 - 2296.37288
2296.37289 - 3621.22774

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

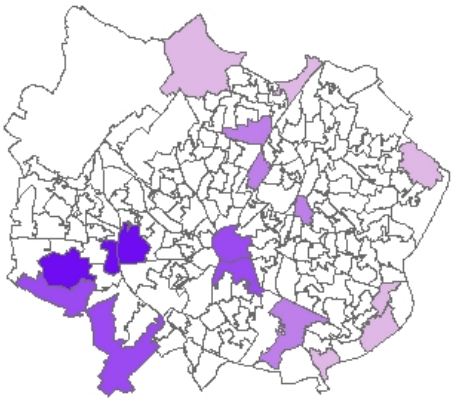


Neighbourhood average distance to road interchanges (in meters)

(Coventry, UK)

1409.03792 - 1523.76981
1523.76982 - 3561.72255
3561.72256 - 4442.53400
4442.53401 - 6610.69342

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Neighbourhood average distance to train stations (in meters)

(Coventry, UK)

2086.597921 - 2441.483364
2441.483365 - 3256.476999
3256.477000 - 5578.348050
5578.348051 - 9054.708262

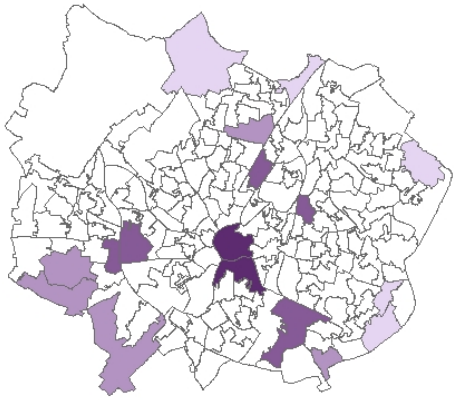
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Neighbourhood average street connectivity (Space Syntax score)

(Coventry, UK)

6087670587 - 7542161689
7542161690 - 10890567324
10890567325 - 16014599462
16014599463 - 21728913332

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

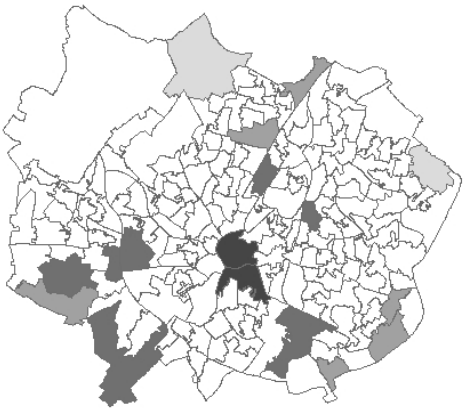


Neighbourhood average distance to local service firms (in meters)

(Coventry, UK)

2843.07484 - 2951.39156
2951.39157 - 4077.72700
4077.72701 - 5334.88361
5334.88362 - 6766.95121

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



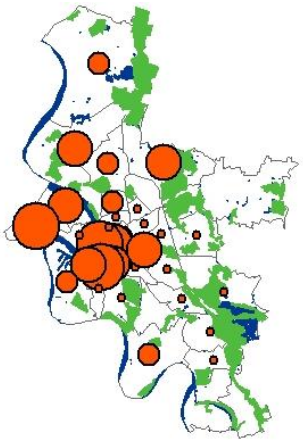
Neighbourhood average distance to local hi-tech firms (in meters)

(Coventry, UK)

2443.15576 - 2530.73747
2530.73748 - 4015.83289
4015.83290 - 5530.03677
5530.03678 - 6361.84539

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Dusseldorf, DE

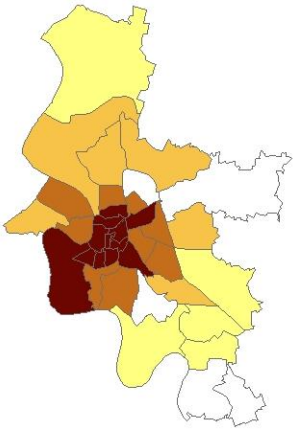


FDI firms' location (count)

(Dusseldorf, DE)

1 - 4
5 - 9
10 - 18
19 - 32

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

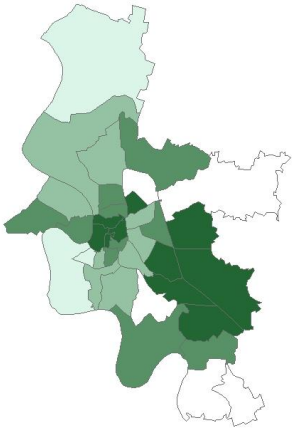


Neighbourhood average distance to architectural landmarks (in meters)

(Dusseldorf, DE)

2201.247886 - 3105.907756
3105.907757 - 4462.591754
4462.591755 - 6667.446141
6667.446142 - 11218.104611

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

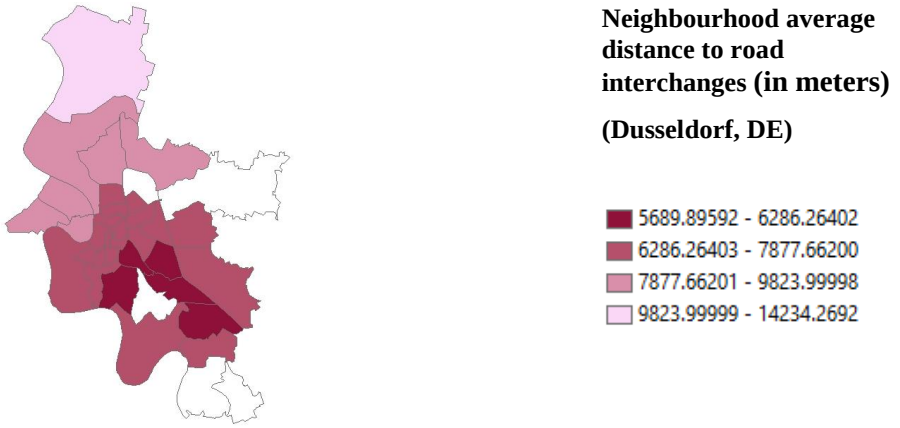


Neighbourhood average distance to parks (in meters)

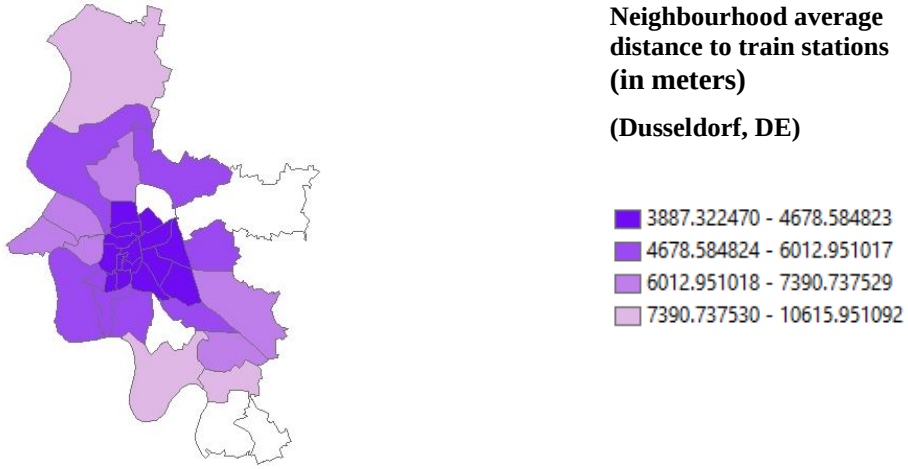
(Dusseldorf, DE)

224.419569 - 364.304110
364.304111 - 706.699236
706.699237 - 1215.66349
1215.66350 - 1705.94106

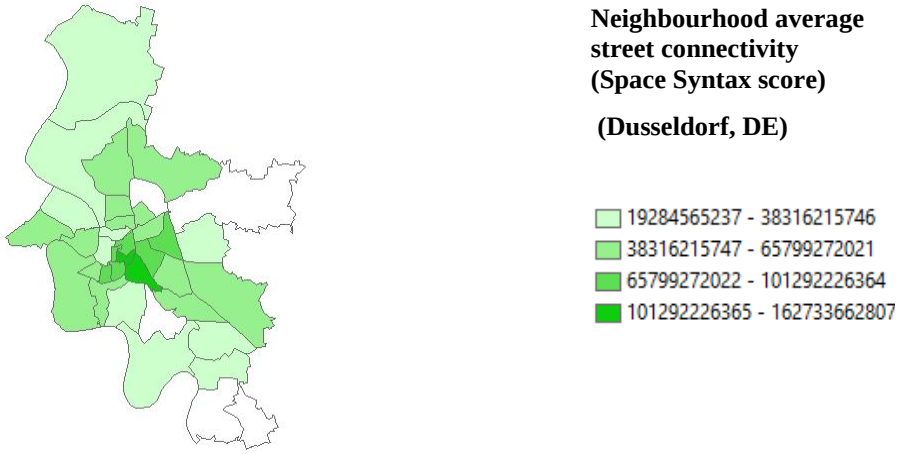
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



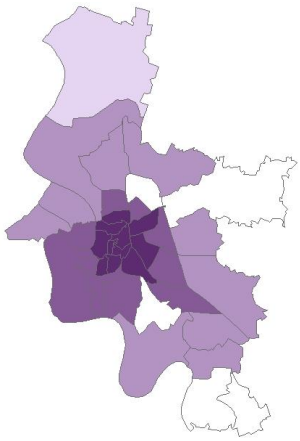
Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

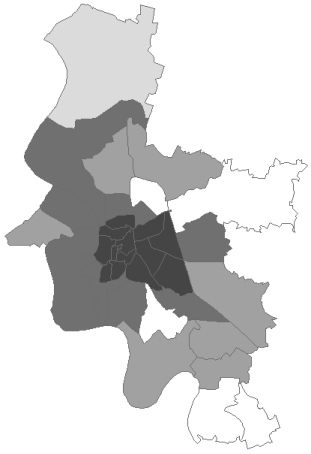


Neighbourhood average distance to local service firms (in meters)

(Dusseldorf, DE)

3349.52684 - 3732.30356
3732.30357 - 4804.22078
4804.22079 - 6976.19878
6976.19879 - 10786.6987

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



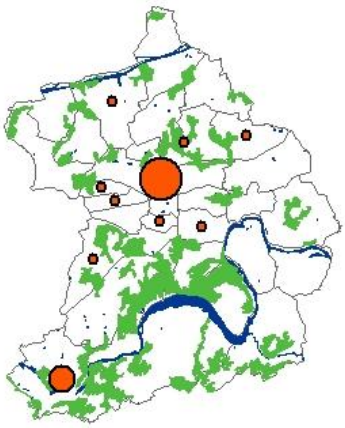
Neighbourhood average distance to local hi-tech firms (in meters)

(Dusseldorf, DE)

3549.98905 - 4249.87664
4249.87665 - 5722.60089
5722.60090 - 7401.06785
7401.06786 - 11204.6958

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

Essen, DE

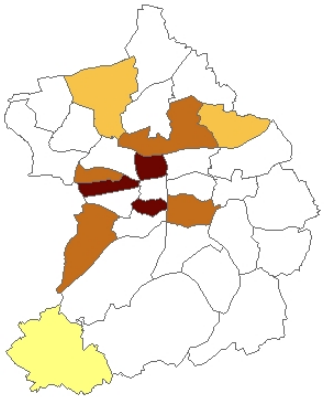


FDI firms' location (count)

(Essen, DE)

1
2
3 - 7

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

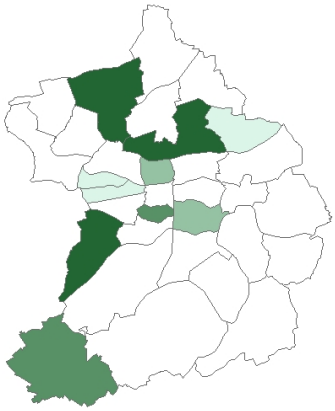


Neighbourhood average distance to architectural landmarks (in meters)

(Essen, DE)

2626.273555 - 3217.794417
3217.794418 - 4558.536626
4558.536627 - 7258.349723
7258.349724 - 10402.036973

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016), OpenStreetMap (2016), and Stijn Vossen (2016).

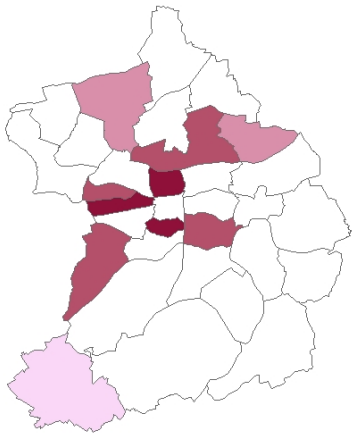


Neighbourhood average distance to parks (in meters)

(Essen, DE)

134.774417 - 317.849612
317.849613 - 692.093454
692.093455 - 977.835715
977.835716 - 1518.30472

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

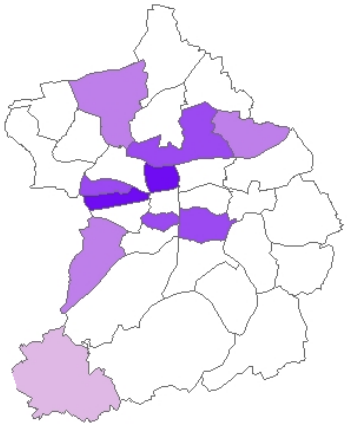


Neighbourhood average distance to road interchanges (in meters)

(Essen, DE)

3176.43718 - 3248.44477
3248.44478 - 4923.52761
4923.52762 - 6580.39866
6580.39867 - 10481.3715

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

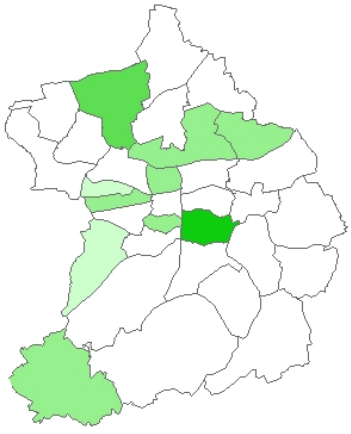


Neighbourhood average distance to train stations (in meters)

(Essen, DE)

5057.244603 - 5296.311182
5296.311183 - 5829.604439
5829.604440 - 7068.876445
7068.876446 - 11589.427077

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

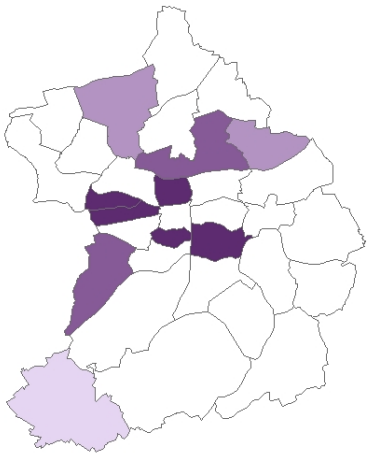


Neighbourhood average street connectivity (Space Syntax score)

(Essen, DE)

10328486689 - 12045060073
12045060074 - 17060044865
17060044866 - 21090344057
21090344058 - 32548199013

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)

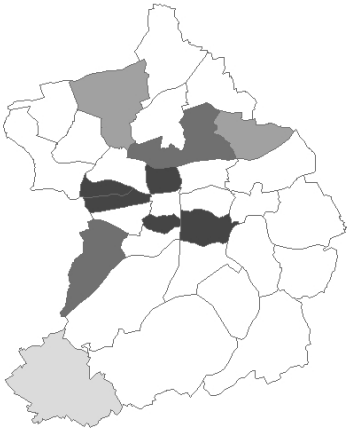


Neighbourhood average distance to local service firms (in meters)

(Essen, DE)

3834.81832 - 4316.35266
4316.35267 - 4928.00583
4928.00584 - 6677.87835
6677.87836 - 9075.12394

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)



Neighbourhood average distance to local hi-tech firms (in meters)

(Essen, DE)

4008.53918 - 4550.16297
4550.16298 - 5199.65709
5199.65710 - 6999.97284
6999.97285 - 9226.90518

Source: Prepared by author in ArcGIS, based on data from FDI Markets (2016) and OpenStreetMap (2016)