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# Business districts: the spatial characteristics of FDI within cities

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**ABSTRACT**

Many studies focus on the competitive characteristics of cities – such as accessibility, infrastructure, knowledge, creativity, institutions, face-to-face-contacts, tacit knowledge, and business interaction – and how these attract FDI, firms, and people. However, few studies focus on the spatial characteristics of urban clusters. In this study, knowledge-intensive FDI into 15 Northwestern European cities was explored. The FDI was geo-mapped at a district level, and the characteristics of these districts regarding proximity, functionality, urbanity and spatial quality were classified. The results revealed the spatial indicators that attract FDI in knowledge-intensive industrial activities.

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## 1. Introduction

The economy has globalized rapidly due to new technologies and industries (Castells, 1996). Multinational Enterprises (MNEs) compete for market shares within the global economy and serve as one of the main driving forces (Porter, 2000). In this context, city-regions compete to attract firms, foreign direct investment (FDI), people and knowledge. Urban competitiveness is regarded as a success factor in which cities succeed in attracting market share, capital, and workers (Kitson, Martin, & Tyler, 2004). Although some researchers question the utility of competitiveness for regional and urban development (e.g. Bristow, 2005), many researchers believe that it plays an important role in urban development, with the emphasis on creating high-quality urban locations to attract international firms and investors (Florida, 2002; Glaeser, Kolko, & Saiz, 2001; Rosenthal & Strange, 2004).

Firms look for the most convenient location for production and markets but also for business environments that enhance their global connectivity, company image, and interaction with other firms (e.g. De Hoog, 2013; McCann, 2008). Studies (e.g. Florida, 2005; Hall, 2002; Sassen, 1991; Taylor, 2001) show that some cities worldwide are better in attracting high-level service industries. These studies focus on the factors that attract companies, although they tend to be at a higher aggregation level and particularly non-spatial. However, the notion that spatial structure is essential to economic competitiveness has

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been put forth by Budd and Hirmis (2004, p. 1026): 'The spatial structure can, therefore, be considered as part of the regional production function, in addition to the conventional inputs of labour, capital, and land.'

In this study, by combining concepts of economic geography and urban planning, it is argued that economic competitiveness is also related to different firm activities and their location preferences. Hence, to know what spatial aspects contribute to attracting firms, we must know in what type of locations their activities are established. Considering the increasing global competition in attracting firms, the focus is on the attraction of foreign direct investment (FDI), in which we argue that in addition to non-spatial characteristics, urban elements and the quality of city districts influence the locational choice of multinational firm activities. Therefore, the central research question of this study is as follows: 'Which spatial characteristics of different types of business districts attract particular types of FDI?'

The aim of the study was to derive recommendations for the spatial and urban development of the city of Rotterdam, a port city in the Netherlands that is transforming into a more service- and innovation-oriented city. Therefore, our focus has been on knowledge-intensive FDI and its location needs. The study includes 15 Northwestern European cities comparable to Rotterdam and the urban districts where their FDI is located. The spatial characteristics of these locations (proximity, typology, functionality, and spatial quality) were classified and analysed using statistical techniques. The descriptive and inferential results show that each type of firm activity has its own distinct locational needs.

## 2. Theory

### *2.1. Urban competitiveness and FDI*

Due to new technologies and lower transport costs (Castells, 1996), forces of urbanization and globalization have increased and contributed to the competition of multinational enterprises for labour, markets and knowledge. In his World City Hypothesis, Friedmann (1986) argued that certain cities serve as basing points in the global organization of capital and markets, while their linkages are arranged into a complex global hierarchy. Recent studies on world city networks also observed firm relations as a worldwide interlocking network that ties cities together. For instance, Wall and Van der Knaap (2011) look at the networks of multinational enterprises and show that 84% of the network occurs amongst cities and that urban regions strongly compete to attract these investments (Burger, van der Knaap, & Wall, 2012).

According to Kitson et al. (2004), urban competitiveness for economic gain is determined by a variety of factors, such as the skills and education of the population (labour capital), accessibility and connectivity (infrastructural capital), existing firms and capacity (productive capital), institutions and networks (social-institutional capital), available knowledge and technology (knowledge and creative capital), and the attractiveness and amenities of a place (cultural capital). These factors are consistent with the earlier theories of Marshall (1920) and Jacobs (1969) on agglomeration and urbanization effects. Additionally, Rosenthal and Strange (2004) show that natural advantage, home market effects, consumption opportunities and rent-seeking contribute to urban agglomeration and thereby attractiveness of cities to firms. Similarly, Cassidy and Andreosso-O'Callaghan (2006) reveal the importance of spatial factors such as inland waterways and coastal location to FDI attraction in cities. Hence, although cities do not compete in themselves, urban competitiveness can be seen as the non-spatial and spatial ability of cities to attract firms and their activities.

Due to globalization and the rise of new communication technologies, factors have changed that influence the location of FDI. Dunning (1998) distinguishes four types of motives for FDI: resource seeking, market seeking, efficiency seeking and strategic asset seeking – the latter gaining more importance over recent decades. These motives have led to a concentration of investment activities (e.g. manufacturing, research, logistics) in different regions of the world, which in turn benefit recipient cities in terms of increased capital, labour, knowledge and technology. In this light, FDI is said to be 'an effective way to update technology and skills (and) may improve institutions, open up the economy, and motivate other firms to catch up to the world technology frontier' (Poelhekke & Van der Ploeg, 2009, p. 751). Thus, flows of FDI are an important measure of urban development within the globalizing world (Wall & Stavropoulos, 2016). This is also an indicator of the economic attractiveness of a city, as the data show where companies decide to locate their subsidiaries (Shi, Wall, & Pain, 2018; UN-Habitat, 2018).

### 2.2. Local clusters and functional specialization

As enterprises globalize, their corporate activities are spatially dispersed worldwide. Each activity has its own locational needs and requirements. 'Different business functions have different locational needs and, because these needs can be satisfied in various types of geographical location, each part tends to develop rather distinctive spatial patterns' (Dicken, 2011, p. 134). These activities are distributed across different types of cities but also concentrate within particular urban districts of these cities. Some corporate activities need to co-locate, while others need proximity to spatial nodes or hubs, and require knowledge interactions or proximity to other firms.

Marshall (1920) explained that by agglomerating, firms have the advantage of shared input economies, information and knowledge spillovers, and labour market pooling. Jacobs (1969) stated that big cities and agglomerations are more innovative in producing work and that this is essentially due to the proximity of different types of firms and related activities within the same city. Porter (2000) discussed specialized urban clusters of interconnected companies in a particular sector with specialized suppliers, service providers, and associated institutions.

A study by Duranton and Puga (2005) showed that over recent decades a transformation has occurred from the sectoral to functional specialization of cities. Instead of sector based (with different firm activities in one sector), they found a functional specialization (activities across sectors) with, e.g. various headquarters and business services clustered together in larger cities, and production activities clustered in smaller cities. In this context, technological changes in transport and communication technologies have made it less costly for firms to separate their activities: As a result, 'some cities specialize in headquarters and business services and others in final and intermediate production' (Duranton & Puga, 2005, p. 362). This enables diversification of activities in different sectors and thereby strengthens related variety, which in turn enables a resilient economic base for future urban development (Neffke, Henning, & Boschma, 2011).

### *2.3. Firm interaction and business districts*

Global networks and local clusters have the common characteristic that they exist due to their opportunities for interaction. Manuell Castells (1996) stated that the world exists of a space of places (the physical places of interaction and face-to-face encounters) and a space of flows (the virtual places of interaction of data-streams and information, forming global networks). According to Bathelt, Malmberg, and Maskell (2004), networks are global pipelines of information and codified (or tangible) knowledge that are maintained for control, interaction and cooperation. International access, both for ICT and people, is an important spatial aspect of these networks. In contrast, interaction in local clusters is mainly based on tacit knowledge and information spillovers, for which face-to-face-contacts are critical (Marshall, 1920; Storper & Venables, 2004). This 'local buzz' is stimulated by meetings, accidental encounters, and the interaction of different agents involved in related activities (Bathelt et al., 2004).

Castells and Hall (1994) studied the spatial structure of the information age and described the various types of information and knowledge districts, where the multiplicity of face-to-face-contact are critical. Distinct types of districts were identified, such as high-tech industrial complexes, science cities, and technology parks. Later, Hall (2002), defined six types of business districts in which he described the spatial structure of the polycentric global city region, by means of traditional and new locations of face-to-face contact (Table 1).

The new district types of contemporary European metropolises are also described by Gospodini (2006), which are designated to services, commerce, residence, leisure and culture. The post-modern urban landscape is formed by the 'eclectic clustering of particular flourishing urban economic activities' (Gospodini, 2006, p. 313). In her study, Gospodini signifies factors such as mixed-use, density, cultural heritage, public space, architecture and spatial proximity to be important for these districts. Interaction within urban districts has also been studied by De Hoog (2013). His study shows that concentrations of similar functions attract particular people and thus serve as interaction districts: 'a spatial environment with facilities for meeting and exchange of people, goods, capital, and information'. He finds specific spatial typologies for different functional clusters; however, these do not include corporate environments (business districts).

In the case of new business districts, attention is paid to the needs of the employees, and not only to the requirements of firms (Van Dinteren, 2007). For instance, there is a trend to create green business parks, for sustainability, inspiration and the recreational purposes of employees. These green office parks are regarded as a new type of business district,

**Table 1.** Taxonomy of district types, characteristics and business activities by Peter Hall (Source: Hall, 2002).

| District | Characteristics | Business activities |
|---|---|---|
| 1. Traditional downtown centre | Walking distances, radial public transport centre | Older informational and business / financial services |
| 2. New business centre | Old prestige quarter | New corporate headquarters and business services |
| 3. Internal edge cities | Development of industrial areas and transport land | |
| 4. External edge cities | Often located on the axis of the main airport | |
| 5. Outermost edge cities | Typically at major train stations | Back offices and R&D |
| 6. Specialized sub-centres | | Education, entertainment, sporting, exhibition etc. |

where the non-built space comprises a combination of green, space for interaction, sports and recreation and amenities (Van Dinteren, 2007). Green areas and the need for human interaction are also observed in the development of campuses. Both De Hoog (2013) and Hoeger and Christiaanse (2007) wrote about the relationship between campus and city: the campus being a place for exchange and development of ideas and knowledge, and thus benefiting the innovation capacity of a city and the local economy.

Different location needs for knowledge-intensive industries were found by Spencer (2015), who examined the urban form of business districts in relation to the geography of such industries and found that science-based firms are more concentrated in low-density single-use districts outside the centre. In addition to this, Scott (2013) argue that peripheral airport territories have become central to city development. Proximity to airport areas is said to favour firm development because this links companies to the global network of international business. In addition, the international image of airports in itself functions as a location factor for firms.

### *2.4. Conceptual framework*

Based on the arguments above, the location of firms in specific business districts is seen to be partly determined by the spatial needs of their business activities: proximity, typology, functionality, and quality. Although a specific type of business district is not the only factor to attract FDI (e.g. institutional and business environment, knowledge and education level, and corporate tax rate also matter), we posit that a business district that also answers to the spatial needs of firm activities will attract more foreign investment. In turn, this will strengthen the city's economic performance and competitiveness. In this context, this study focuses specifically on the spatial-economic factors that determine FDI clusters and how cities can improve their attractiveness.

## 3. Materials and methods

This research used a quantitative spatial approach based on two types of data: FDI data, and locational data for cities and districts. fDi Markets (2012) provides information on global investments of MNEs across the world. Using this data, an analysis was conducted for investment clusters in several Northern and Western European cities. The dependent variable in this research concerns FDI in knowledge-intensive activities, such as headquarters (HQ), business services (BS), research and development (R&D), design, development and testing (DDT), sales and marketing services (SMS), education and training (E&T), and information services (ICT). Although the database provides various characteristics on firms and their investments, it does not contain locational data (e.g. addresses, postcodes). These data have been derived from the ORBIS database (2013) and supplementary Internet search engines.

### *3.1. Geographical scope and data*

This study focused on cities in Northwestern Europe, as they are comparable in urban and economic development history, i.e. they were founded in the Middle Ages along rivers or waterfronts, have seen economic industrialization since the nineteenth century, and since the second half of the twentieth century, have experienced growth in service industries and urban expansion. Due to restrictions in locational data on the postcode level, six countries were used: the United Kingdom (UK), the Netherlands (NL), Switzerland (CH), Germany (DE), Norway (NO), and Sweden (SE). Based on an FDI competition-analysis, 15 comparable cities were derived (see results section).

In the next step, the FDI-data in these cities were geo-mapped, revealing 93 distinct districts of FDI-locations. For each district, the location characteristics were calculated and classified using Google Maps and Google Streetview, based on four aspects:

(a) proximity (distance to the city centre/city hall, the airport, the railway station, the closest university /research institute, the main highway, and other firms)
(b) functional type of the district (i.e. industrial, mixed-use area of research complex)
(c) urban characteristics (degree of urbanization, number of floors, presence of amenities and waterfront location)
(d) spatial quality (presence of green or water, type of parking, public space quality).

In Appendix 1, an overview of all indicators is given and described. Distance data were derived from calculations using Batchgeo and Excel. Indicators for the functional type, urban characteristics and spatial quality were assessed in a virtual survey study using Google Earth and Streetview; indicators were qualified for at least three points in a district, then the average was used.

### 3.2. Methodology

For the analyses, UCINET network analysis software, ArcGIS geographic software and Stata statistical software were used. The used databases, indicators and methods have proven to be consistent and operational in earlier scientific research. The quantitative data were collected from official sources, guaranteeing the reliability of the data. For the check and control of validity and reliability, there was a triangulation of the results of the regression analysis with evidence of the empirical findings in the business districts, and with findings in theory and other studies. To run the regression models, the data were tested on outliers, multicollinearity, heteroscedasticity and endogeneity (explained in more detail further on).

Because district location factors were only available for one moment in time, cross-sectional models were conducted. As the fDi Markets data are count data, the Poisson category of models was used. The Poisson regression equation below has a distribution with a conditional mean that is a function of several independent variables. The observed FDI number of the spatial unit i is assumed to have a nonnegative integer value, in which the exponential of the independent variables is taken, which must be zero or positive. More formally:

$$P(Y_i = y_i|X_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!};\ \lambda_i = e^{\beta_{xi}},\ i = 1, 2, \ \ldots n$$

Parameter $\lambda_i$ depends on a series of explanatory variables $X_i$, which indicates the factors that possibly attract FDI. The $\beta$ is the regression coefficient of each $X_i$. An assumption of the Poisson regression model is that it assumes equi-dispersion, where the conditional variance should be equal to the conditional mean. Often this condition is not satisfied, and the dependent variable is over-dispersed. To correct for over-dispersion, the model is adapted to a negative binomial regression. This model allows the variance of the dependent variable to be greater than the mean value and captures the degree of over-dispersion. In this study, the variance of the dependent variable proves to be 14 times larger than the mean, thereby justifying the use of the negative binomial model above the Poisson model. Furthermore, at the end of each negative binomial model run, a likelihood-ratio test was run, revealing that the calculated alpha value is significantly different from zero, thereby underlining the use of negative binomial models.

In this study, the effect of urban characteristics on FDI clusters was explored. The procedure for this included testing four categories of spatial indicators, namely, 'Proximity', 'Typology', 'Functionality' and 'Quality' (see Descriptive Table, Appendix 2) and a final category of the combined indicators, i.e. 'Overall'. For each category, two models were utilized. The first was based purely on spatial indicators and provides knowledge on the effects of urban characteristics upon FDI clusters, while the second controlled for the effect of the number of other firms. This is because FDI is generally expected to be located in cities for essentially economic reasons (e.g. shared knowledge and local suppliers), rather than spatial ones.

In terms of assumption tests, all models were checked for the multicollinearity of independent variables (VIF test), as well as heteroskedasticity using the Huber-White sandwich estimator. To test for possible endogeneity in the five models, the independent variables of each model were reduced to a single vector using principal components analysis (PCA). Each vector was assumed to be endogenous. An instrumental variable (IV) was constructed called 'Urbanity Degree', which was used to test for the possible endogeneity of the vector. The IV was created using Google Maps and Streetview in which each FDI district was classified under four levels of urban density. It was assumed that the IV affects the independent vector but not the error term of the dependent variable. Next, using the IV, a generalized method of moments (GMM) estimator was used for each of the five models (see endogeneity model results, Appendix 3).

## 4. Results

Within the six selected NW-European countries, there are 1114 cities that received FDI in one or more knowledge-intensive activities, during the period 2003–2013. More than half (618 cities) received only one investment, while approximately 92% of the cities received less than ten investments. The remaining 8% (90 cities) received the largest number of FDI, i.e. 7351 investments (79% of all knowledge-intensive activities). This shows that knowledge-intensive FDI is limited to only a few cities. Looking at the top cities that received more than 30 investments, it is clear that even here different leagues exist (Figure 1). The top receiver is London with 2239 investments, holding 24% of all investments. London can therefore be regarded as Europe's global hub of knowledge-intensive FDI. Second is Munich, followed closely by Amsterdam and Frankfurt. In addition, Stockholm, Düsseldorf, Zürich, and Berlin are part of the top league, with between 200 and 300 investments. The secondary level of knowledge-intensive investments is held by 15 cities that received approximately 50–200 investments.

This secondary level of cities (orange in Figure 1) comprising Aberdeen, Belfast, Birmingham, Cambridge, Edinburgh, Geneva, Glasgow, Gothenburg, Hamburg, Köln, Manchester, Oslo, Reading, Rotterdam, and Stuttgart is the focus of the following part of the study. These cities differ in the share of knowledge-intensive FDI. The larger the share of knowledge-intensive FDI, the more a city depends on knowledge, information and highly educated people. Cities with a greater share of knowledge-intensive FDI are Reading, Geneva (both specialization in advanced business and international services), Cambridge and Stuttgart (both university cities). The cities with the lowest share of FDI are Rotterdam and Glasgow, both with a strong history in industrial and harbour-related activities. For these cities, it is interesting to see whether they can change their spatial-economic performance.

### 4.1. Location characteristics of knowledge-intensive FDI

By geo-mapping the knowledge-intensive FDI within the 15 cities, a particular spatial-economic investment pattern emerges for each city. This is seen in the maps of the 15 cities (Figure 2(a,b)). Some FDI is located in single locations, but most FDI is concentrated in clusters within the city: these clusters can be small (2–5 investments), medium (6–10), or large (>10). For each city, the different clusters have been identified.

In the provided table, we see the average characteristics of all knowledge-intensive FDI clusters within all 15 cities (Figure 3). For total (all) FDI, it can be concluded that there is no specific proximity to the centre, the airport, the university, or the main road. The average number of firms within a location is approximately 17, translating to an average concentration ratio of 0.26 for all cities and activities. Most knowledge-intensive FDI is concentrated in mixed-use (56.0) and office locations (22.0%), with a moderate number of FDI also concentrated in industrial estates (10.9%). The average urban

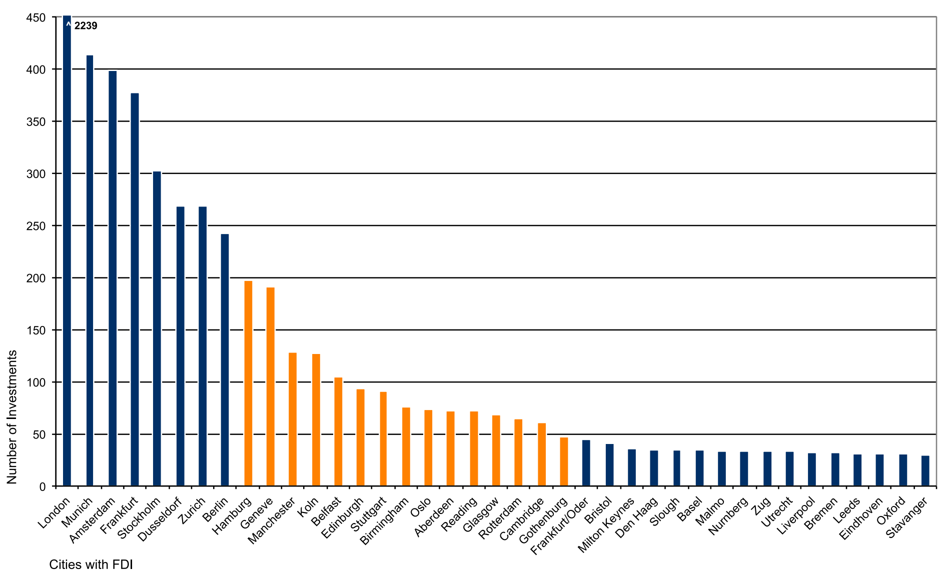


**Figure 1.** Hierarchy for Knowledge-intensive FDI into NW-European cities (2003–2012).

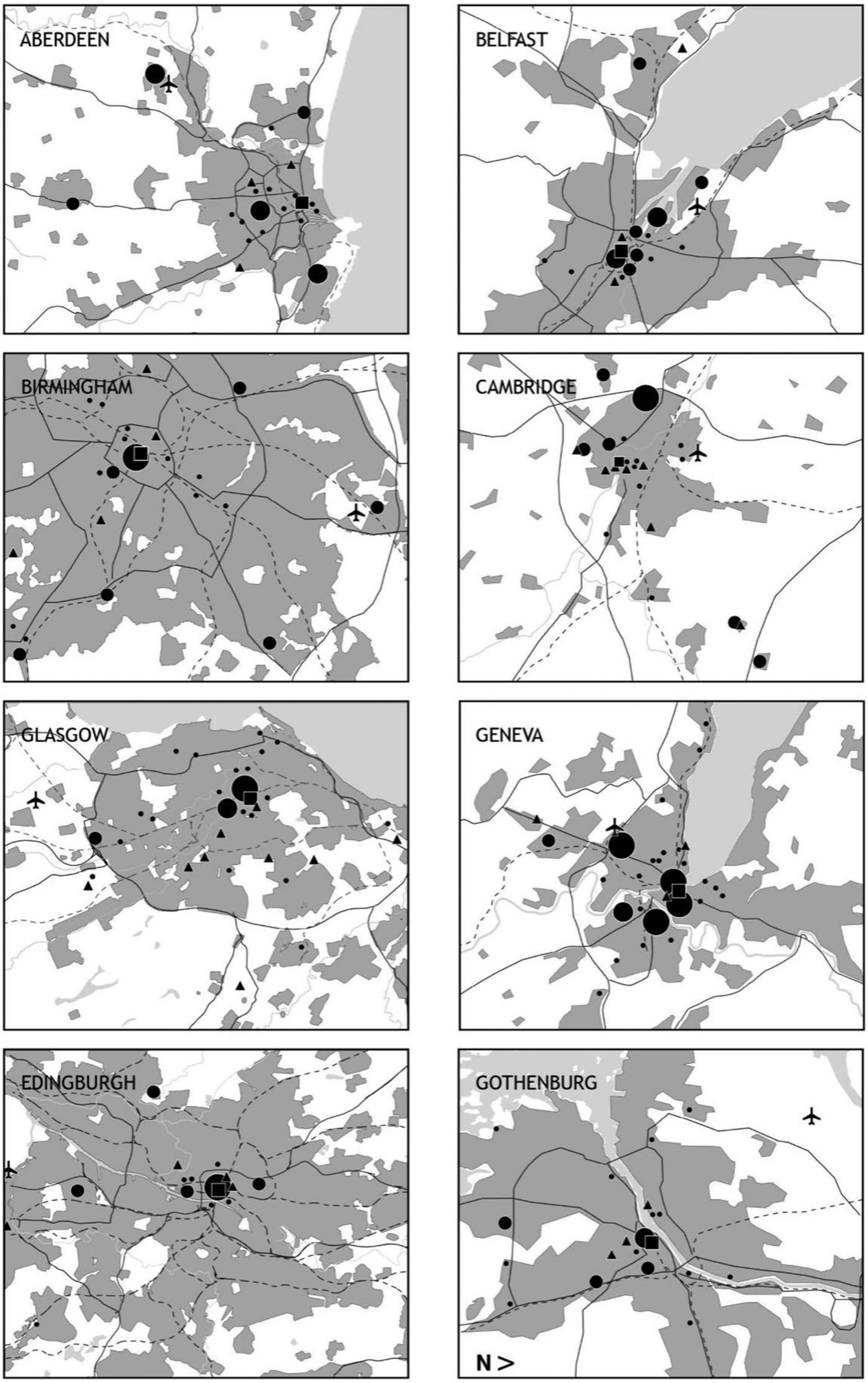


**Figure 2.** Geo-location of KI FDI in the selected cities.

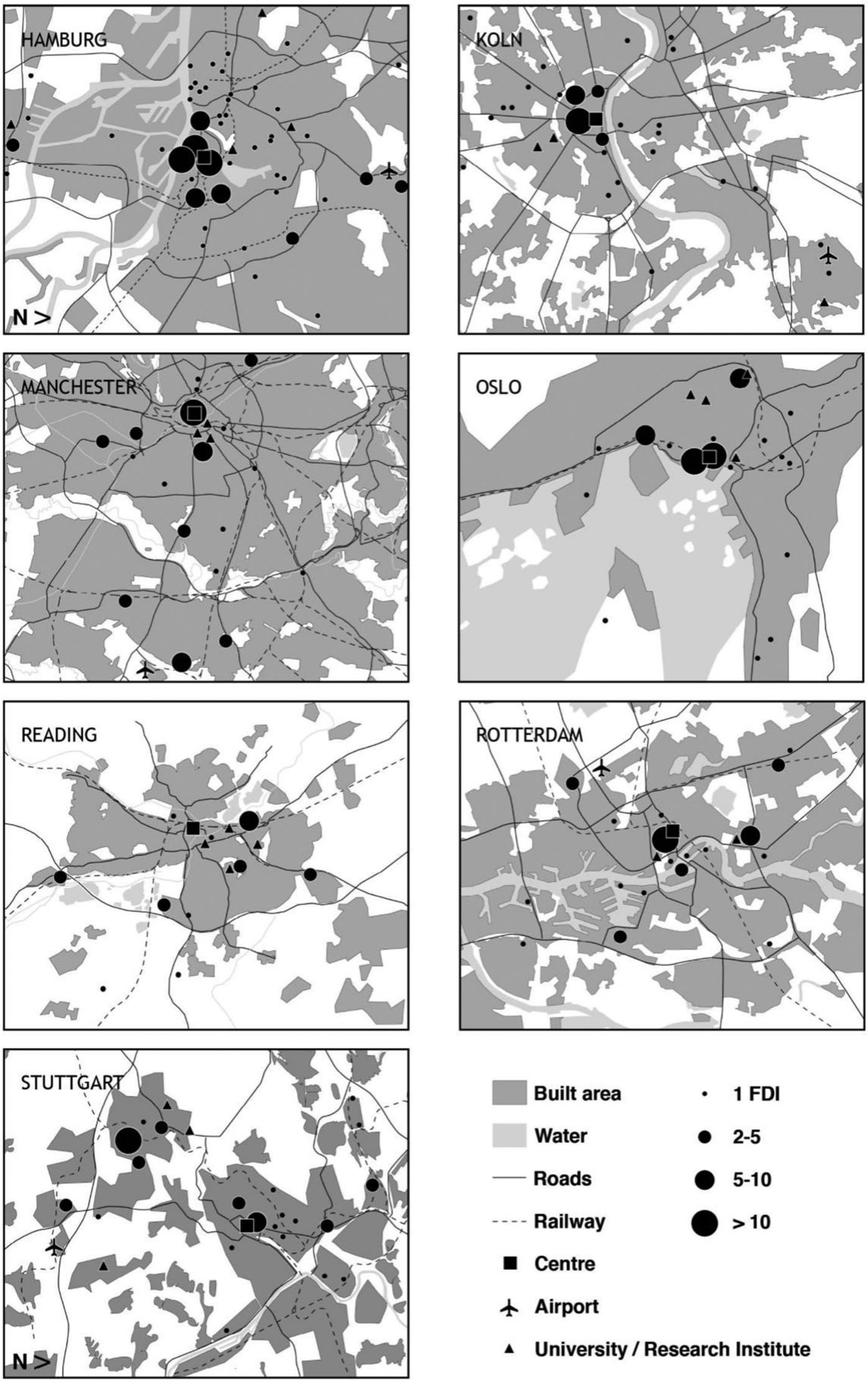


**Figure 2** *Continued*

| *firm activity* | All | SMS | BS | HQ | DDT | ICT | R&D | E&T |
|---|---|---|---|---|---|---|---|---|
| total FDI investments* | 1042 | 402 | 321 | 122 | 117 | 18 | 47 | 15 |
| ***proximity*** | | | | | | | | |
| rd airport | 1,01 | 1,04 | 0,98 | 0,97 | 1,03 | 0,75 | 1,07 | 1,01 |
| rd uni | 1,74 | 1,90 | 2,14 | 1,19 | 1,25 | 0,73 | 1,01 | 0,94 |
| rd center | 0,97 | 0,94 | 0,70 | 1,22 | 1,31 | 1,45 | 1,28 | 1,32 |
| cd main road | 2,32 | 2,33 | 2,50 | 2,33 | 2,12 | 1,78 | 1,81 | 2,27 |
| number of firms | 16,67 | 13,51 | 23,58 | 15,72 | 13,59 | 11,44 | 9,64 | 12,27 |
| concentration ratio | 0,26 | 0,21 | 0,32 | 0,19 | 0,24 | - | 0,29 | - |
| ***functional*** | | | | | | | | |
| commercial | 5,9% | 5,5% | 6,7% | 7,4% | 3,4% | 11,1% | 4,3% | 6,7% |
| green | 0,5% | 0,5% | 0,3% | 0,0% | 0,9% | 0,0% | 0,0% | 6,7% |
| industrial estate | 10,9% | 14,1% | 5,4% | 14,9% | 11,1% | 16,7% | 10,6% | 6,7% |
| mixed | 56,0% | 55,2% | 73,0% | 42,1% | 44,4% | 27,8% | 21,3% | 60,0% |
| office | 22,0% | 21,5% | 13,0% | 29,8% | 29,9% | 38,9% | 42,6% | 13,3% |
| technical estate | 2,2% | 2,1% | 1,6% | 3,3% | 1,7% | 5,6% | 4,3% | 0,0% |
| complex | 2,6% | 1,0% | 0,0% | 2,5% | 8,5% | 0,0% | 17,0% | 6,7% |
| ***characteristics*** | | | | | | | | |
| Urbanity (1-4 highest) | 3,03 | 2,97 | 3,41 | 2,79 | 2,79 | 2,78 | 2,34 | 2,67 |
| number of floors | 4,87 | 4,77 | 5,55 | 4,58 | 4,26 | 4,42 | 3,81 | 4,14 |
| amenities (yes) | 50,2% | 47,9% | 67,9% | 40,5% | 39,3% | 27,8% | 19,1% | 26,7% |
| waterfront (yes) | 8,9% | 10,3% | 7,9% | 7,4% | 10,3% | 16,7% | 4,3% | 0,0% |
| ***quality*** | | | | | | | | |
| public space (1-4 highest) | 2,75 | 2,75 | 2,89 | 2,66 | 2,52 | 2,75 | 2,53 | 2,77 |
| green area (1-4 highest) | 2,30 | 2,34 | 2,23 | 2,36 | 2,11 | 2,22 | 2,70 | 2,47 |
| water area (1-4 highest) | 1,81 | 1,91 | 1,80 | 1,81 | 1,47 | 2,06 | 1,74 | 1,60 |
| street parking | 26,3% | 30,5% | 29,8% | 17,4% | 17,9% | 22,2% | 6,4% | 46,7% |
| lots parking | 31,1% | 30,0% | 12,7% | 45,5% | 52,1% | 38,9% | 72,3% | 26,7% |
| built parking | 42,6% | 39,4% | 57,5% | 37,2% | 29,9% | 38,9% | 21,3% | 26,7% |

* *FDI investments in knowledge intensive firm activities (2003-2012) in the cities of Aberdeen, Belfast, Birmingham, Cambridge, Edinburgh, Geneve, Glasgow, Gothenburg, Hamburg, Koln, Manchester, Oslo, Reading, Rotterdam, and Stuttgart with a tracked address or postcode.*

legenda: highlights highest averages; stronger than average; weaker than average; excluded in analysis (low FDI)

**Figure 3.** Average location characteristics of knowledge-intensive FDI.

characteristics of all knowledge-intensive FDI clusters has an urbanity degree of 3 (medium urban), i.e. a building height of 5 floors, with half of them providing amenities (shops and restaurants) on the ground floors. Regarding the public space, the average quality is 2.75 (below medium). In addition, the amount of water and green areas is quite low for all FDI clusters, which can be explained by the overall medium urbanity that provides less space for water and green. This urban factor also explains the high presence of built parking in knowledge-intensive FDI areas (42.6%).

Looking at different activities, substantial differences in the average characteristics of all FDI clusters are found. The features of the locations of SMS resemble the average of all knowledge-intensive FDI, which can be explained by the SMS locations (as seen in the GIS maps) showing both concentrations in clusters as well as individual locations scattered around the city. For FDI in BS, the characteristics indicate a more urban and concentrated character: the relative distance to the city centre is below average, and the number of firms (23.6) and concentration ratio (0.32) are above average. In addition, the functional and urban characteristics show this: 73% of BS are located in mixed-use areas, with an urbanity degree of 3.41 and with a high presence of amenities (67.9%) and built parking (57.5%), which is characteristic of central urban areas.

The observed spatial patterns and characteristics for HQs show a more dispersed location: they have a low concentration ratio (0.19) and a higher relative distance to the city centre (1.22). They are also found in office locations (29.8%) and less in mixed-use areas (42.1%). These proximity and functional characteristics also influence the lower presence of amenities (50.2%) and higher presence of parking lots (45.5%).

For DDT, the observed average characteristics indicate a location outside the centre (rd = 1.31), closer to the university (rd = 1.25). Like HQ, the preferred functional area is mixed-use, followed by office locations. In addition, a relatively high percentage of DDT is located in complex areas: locations dedicated to a specific firm or university with access to other firms. The lower urbanity degree of DDT locations also reveals a lower percentage of amenities and a higher percentage of parking lots.

The characteristics of R&D sites indicate smaller locations outside the inner-city fringe: greater distance to the city centre (rd = 1.28), and closer to the university (rd = 1.01) and to main roads (rd = 1.81). In addition, the number of firms are considerably lower (9.64), with a concentration ratio above average. This distance characteristic is also visible, mostly in office locations (42.6%), less so in mixed-use areas (21.3%), and relatively more in complex districts (17.0%). This translates into characteristics of a lower urban degree (2.34), lower number of floors (3.81), a small presence of amenities (19.1%), and a high presence of parking lots (72.3%). Moreover, R&D locations have a greater presence of green areas (2.70) compared to the average (2.30). Since the total number for ICT and E&T is too small, no conclusions could be drawn for these activities.

### *4.2. Urban characteristics as determinants of knowledge-intensive FDI*

In this section, we discuss the econometric relationships of urban indicators upon FDI clusters. As discussed in the methodology, this is done first for the separate independent variables to see the individual relationships, and then second for the vector form of the independents to test for endogeneity. A descriptive summary is seen in Appendix 2.

#### *4.2.1. Proximity*

In this first model on 'Proximity' (Table 2), the independent variables are based on the relative distances between FDI clusters and urban functions, i.e. Airport, University, City Centre and Main Roads. This means that the distances between FDI clusters and urban utilities, for each city, have been made relative to those of all cities. First, we see

**Table 2.** Proximity model.

| Variables | M1 | M2 | M3 (R&D) |
|---|---|---|---|
| RD to Airport | −0.259*** | −0.109** | 0.0856 |
| | (0.0899) | (0.0494) | (0.2530) |
| RD to University | 0.330*** | 0.0549** | −0.769* |
| | (0.1280) | (0.0252) | (0.4620) |
| RD to City Center | −0.211*** | −0.032 | −0.0768 |
| | (0.0690) | (0.0286) | (0.1590) |
| Proximity to Main Roads | −0.065 | −0.113** | −0.477** |
| | (0.1030) | (0.0470) | (0.2170) |
| Number of Firms | . | 0.119*** | 0.123*** |
| | . | (0.0202) | (0.0406) |
| Constant | 1.378*** | 0.665*** | −0.924 |
| | (0.2600) | (0.1620) | (0.5660) |
| Observations | 323 | 323 | 323 |
| Pseudo $R^2$ | 0.0547 | 0.2586 | 0.0941 |

Notes: Robust standard errors in parentheses.
***$p < .01$.
**$p < .05$.
*$p < .1$.

that the Relative Distance to Airport has a significant effect on FDI clusters. This means that an increase in distance to the airport has a negative impact on the number of FDI, or alternatively that international firms tend to locate close to airports.

Concerning the Relative Distance to University, we see that being further from universities has a positive effect on FDI. This is arguably because the observed clusters concern the combined sectors of FDI and not particular R&D types. Hence, most firms do not benefit from being close to universities, but expectedly only R&D types. This was verified in a test on only R&D FDI (see Table 2, model 3), in which indeed the opposite significant relationship is seen. This means that an increase in the distance to the university will negatively affect R&D FDI cluster formation, or that these firms prefer to be in close proximity to universities.

Concerning the category of Proximity characteristics, the spatial variables on their own explain approximately 6% of the variance (R2), while by including the control variable Number of Firms, the explained variance increases to 26%. This shows us that the variance of FDI clusters is 20% explained by proximity to other firms, producers and suppliers. Despite this, spatial proximity characteristics do contribute a small part to the location decisions made by international firms to locate in certain areas (6%).

In Appendix 3, the table shows the results of the GMM endogeneity test on the different models. In the case of the Proximity model, we see that the vector made of variables with a negative sign, i.e. RD to Airport, RD to City Centre and Proximity to Main Roads indeed determines the presence of FDI clusters and maintains the initial negative sign. A separate test was done for the positive sign variable RD to University (see separate results at the bottom of the table), which similarly maintained the expected causality and sign of this variable.

### *4.2.2. Typology*

Next, we explore the impact of different urban economic typologies on FDI clusters (Table 3). These variables on their own explain 4% of the model (R2), and when the Number of Firms is added, it rises to 27%. In the first model, we see that FDI situated in a Mixed Zone is most significant and has the strongest beta values. It arguably means that FDI benefit from the strong diversity and amenities found in these areas. However, when controlling for the Number of Firms, this variable becomes insignificant. Possibly this is because Mixed Zones also hold on average more firms than other types of zones, which is now accounted for. Techno Zones have a large beta value and the positive significance on FDI clusters, arguably due to the availability of local technologies and innovations in these areas. In model 2, the Techno Zone becomes even more significant. Commercial and Office Zones also bear some significance on FDI clusters. The GMM models show that indeed the assumed sign of these variables are correct and that these typologies determine FDI clusters and not the other way around (Appendix 3).

### *4.2.3. Functionality*

This model explores spatial functionality's effect on FDI clusters (Table 4). First, it is evident that parking and amenity characteristics explain 8% of the model. The strongest predictor of FDI clusters is the Number of Amenities. International firms prefer to be in close proximity to a variety of urban amenities, probably for reasons of business and pleasure. Parking also appears to be correlated, although for model 1 it concerns built

**Table 3.** Typology model.

| Variables | M1 | M2 |
|---|---|---|
| Industrial Zone | 0.024 | 0.0355 |
| | (0.1840) | (0.1370) |
| Commercial Zone | 0.692** | 0.294* |
| | (0.3370) | (0.1750) |
| Mixed Zone | 1.284*** | 0.167 |
| | (0.2400) | (0.1500) |
| Office Zone | 0.574*** | 0.328** |
| | (0.1880) | (0.1360) |
| Techno Zone | 1.124** | 0.598*** |
| | (0.4390) | (0.2180) |
| Number of Firms | . | 0.125*** |
| | . | (0.0191) |
| Constant | 0.358** | 0.125*** |
| | (0.1410) | (0.0191) |
| Observations | 321 | 321 |
| Pseudo $R^2$ | 0.0415 | 0.2572 |

Note: Robust standard errors in parentheses.
***$p < .01$.
**$p < .05$.
*$p < .1$.

parking, such as garages, while in model 2 it refers to local parking on streets. This shows that accessibility is still a main characteristic to international firms, although it does not account for the number of parking spaces needed. Interestingly, the Number of Floors (spatial density) has no significant effect on FDI clusters. This shows that many clusters are located outside city centres where the average number of built floors is lower. The endogeneity test on the vector of these variables again verifies the assumed sign and causality between the variables (Appendix 3).

#### *4.2.4. Quality*

The last category investigates the effect of qualitative indicators upon the formation of knowledge-intensive FDI clusters (Table 5). It is clear from this analysis that aesthetic properties such as Green Area, Water Area, Public Space and Waterfront do not

**Table 4.** Functionality model.

| Variables | M1 | M2 |
|---|---|---|
| Number of Floors | 0.0448 | −0.00406 |
| | (0.0408) | (0.0208) |
| Built Parking | 0.462* | 0.128 |
| | (0.2520) | (0.1280) |
| Local Parking | 0.348* | 0.257*** |
| | (0.1810) | (0.0819) |
| Number of Amenities | 1.296*** | 0.281** |
| | (0.2240) | (0.1240) |
| Number of Firms | . | 0.122*** |
| | . | (0.0206) |
| Constant | 0.228 | 0.112 |
| | (0.1960) | (0.1010) |
| Observations | 320 | 320 |
| Pseudo R2 | 0.0807 | 0.2571 |

Note: Robust standard errors in parentheses.
***$p < .01$.
**$p < .05$.
*$p < 0.1$.

**Table 5.** Quality model.

| Variables | M1 | M2 |
|---|---|---|
| Green Area | −0.118 | −0.0184 |
| | (0.1060) | (0.0429) |
| Water Area | 0.147* | 0.0396 |
| | (0.0813) | (0.0391) |
| Public Space | 0.12 | 0.0796 |
| | (0.1320) | (0.0656) |
| Waterfront | −0.377 | 0.0557 |
| | (0.4210) | (0.1340) |
| Number of Firms | . | 0.124*** |
| | . | (0.0184) |
| Constant | −1.168*** | 0.0814* |
| | (0.3390) | (0.1310) |
| Observations | 321 | 321 |
| Pseudo R2 | 0.03 | 0.25 |

Note: Robust standard errors in parentheses.
***$p < .01$.
**$p < .05$.
*$p < 0.1$.

have significant effect on investment districts. International firms assumedly seek areas with a more urban presence, and not specifically environmental qualities. The GMM results reveal the same evidence, in which the vector is not significant (Appendix 3).

#### *4.2.5. Overall*

In the last analysis, we consider all indicators together (Table 6). In the spatial study, we see that 11% of the variance is explained. This model clearly reveals the best explanation of variance of all the spatial models. This means that urban characteristics contribute much to FDI location. By adding Number of Firms to the model, the results improve substantially to now explain approximately 27% of the variance. This means that 16% is explicated by the number of firms. The significant individual indicators are Relative Distance to the Airport, Relative Distance to University, Proximity to Main Roads, Office Zones, Techno Zones, Local Parking, Number of Amenities, and Number of Firms, which are significant predictors of FDI clusters in NW-European cities.

## 5. Discussion

### *5.1. Spatial-economic concentration*

An important finding of this study is that FDI locations are not scattered but concentrated into a variety of distinct districts within the observed cities. Although this study has not analysed the business relations between these proximate international firms, it is evident that they co-locate for a reason (Bathelt et al., 2004; Porter, 2000; Scott, 2001; Storper & Venables, 2004), e.g. face-to-face contact, knowledge exchange, and shared service centres. Instead, this study has focused on economic cluster specialization (e.g. Gospodini, 2006; Spencer, 2015), by uniquely exploring the effect of urban spatial characteristics on FDI clusters.

A major finding is that urban characteristics do explain a small part of the variance in models (relatively low R2) and that even when controlling for an economic factor such as Number of Firms, the urban characteristics still maintain their strength. In fact, in the

**Table 6.** Overall model.

| Variables | M1 | M2 |
|---|---|---|
| RD to Airport | −0.269*** | −0.137** |
| | (0.0864) | (0.0541) |
| RD to University | 0.124 | 0.0566** |
| | (0.0791) | (0.0244) |
| RD to City Center | −0.0159 | −0.045 |
| | (0.0499) | (0.0287) |
| Proximity to Main Roads | −0.115 | −0.0929* |
| | (0.0740) | (0.0506) |
| Commercial Zone | (0.1510) | 0.287 |
| | (0.3190) | (0.186) |
| Industrial Zone | 0.128 | 0.0742 |
| | (0.2380) | (0.171) |
| Mixed Zone | −0.107 | 0.0781 |
| | (0.2620) | (0.162) |
| Office Zone | 0.452** | 0.295** |
| | (0.2090) | (0.145) |
| Techno Zone | 0.767** | 0.633** |
| | (0.3450) | (0.253) |
| Number of Floors | −0.0588 | −0.0382 |
| | (0.0444) | (0.0247) |
| Local Parking | 0.456*** | 0.177* |
| | (0.1650) | (0.093) |
| Built Parking | 0.307 | 0.0561 |
| | (0.2320) | (0.15) |
| Number of Amenities | 0.694*** | 0.295** |
| | (0.2150) | (0.141) |
| Waterfront | −0.323 | 0.092 |
| | (0.3340) | (0.128) |
| Green Area | −0.0904 | −0.0245 |
| | (0.1030) | (0.0478) |
| Water Area | 0.122* | 0.0358 |
| | (0.0720) | (0.0382) |
| Public Space | 0.0765 | 0.0719 |
| | (0.1250) | (0.0709) |
| Number of Firms | . | 0.110*** |
| | . | (0.0208) |
| Constant | −1.059** | 0.347*** |
| | (0.4800) | (0.273) |
| Observations | 316 | 316 |
| Pseudo R2 | 0.11 | 0.27 |

Note: Robust standard errors in parentheses.
***$p < .01$.
**$p < .05$.
*$p < 0.1$.

overall model, it was shown that 11% of the variance of FDI clusters is explained by urban characteristics, and 16% is explained by the presence of other firms. Because urban characteristics do contribute a small part to improving urban competitiveness, they arguably can be informative to both urban and economic planning policy. These contributions will now be discussed.

In the descriptive results, it was found that BS and R&D activities are more concentrated into clusters than average. Arguably both activities co-locate due to the benefits of face-to-face-contacts and knowledge spillovers, as often explained in theory but also because of the presence of (shared) facilities and amenities. Additionally, it has been shown that HQs concentrate the least with other knowledge-intensive FDI activities. As corporate control centres, they form particularly stand-alone establishments. Alternatively, SMS clusters have been shown to occupy locations outside the cities, particularly connected to key infrastructural routes. Importantly, the descriptive study shows that particular FDI activities require different types of business areas, with variations in functional and urban characteristics.

The econometric results show that for proximity characteristics, on average, the closer FDI districts are to the airport, the more FDI are located in them, thereby supporting the work on airport cities by Appold and Kasarda (2013), who claim that vicinity to an airport strengthens a firm's international connectivity. It is arguable that FDI activities that are more internationally focused, such as headquarters and business services, have a preference for locating close to airports, which underlines similar results by Bel and Fageda (2008). Furthermore, our work corresponds with the findings of Strauss-Kahn and Vives (2009) that international firms tend to locate in metropolitan areas with excellent airport facilities.

In terms of proximity, the study shows that total FDI (all investment sectors combined) do not tend to be located close to universities. This is because many sectors do not require the research capacity of universities. Indeed, our results show that when looking specifically at R&D FDI, that these firms do significantly locate close to universities, in which they arguably utilize the research strength of local universities. These findings support the work of Spencer (2015), who found that science-based firms are more concentrated in low-density single-use districts outside the centre.

The study shows that there is a significant relationship between FDI clusters and the relative distance to the city centre (with the City Hall as proxy for the city centre), but that when the number of local firms are also considered, this no longer remains significant. This means that in general, FDI firms are more attracted by the presence of local corporate activity than the need to be close to the city centre.

Considering typology determinants, we see that Mixed Zones (such as those found in inner city areas) are a predictor of FDI clusters but likewise are mainly caused by the number of firms present there. When this aspect is considered, then there is no significant relationship. Furthermore, we see that FDI tends to significantly concentrate in Technological and Office zones, revealing a need to utilize local knowhow and services.

In relation to the functionality model, it is shown that the presence of urban amenities also significantly explains FDI cluster formation. This means proximity to services, retail, restaurants and other urban amenities are important location factors for FDI. In addition, the availability of local parking proves to be important for FDI, although this study has not examined the relationship with public transport (due to a lack of data).

Finally, we found no evidence of FDI clusters being significantly related to aesthetic qualities, i.e. green areas, water areas, public spaces and waterfront. In this case, we do not verify the arguments for green space discussed by Van Dinteren (2007). This might be due to heterogeneity of the data and that if specific sectors of FDI such as R&D were explored, some of these urban characteristics might bare significance.

The above results are important because they show that spatial characteristics of cities do contribute modestly to the spatial clustering of FDI in cities, which in turn contribute to the economic development of cities. These results pave the way to evidence-based urban planning and urban design.

### *5.2. Types of business districts*

Based on the descriptive characteristics and the econometric results of the business clusters in the cities studied, combined with the information and theories from the background literature (Garreau 1991; Gospodini, 2006; Hall, 2002; Lang & Knox, 2009), we determine four types of business districts that are important for different firm activities and FDI.

First, inner-city districts are the largest clusters of FDI. They are located in and around the city-centre and are characterized by a high urbanity degree, a high number of firms, presence of urban amenities, and a functional mix. Although the econometric results show that firms are not specifically related to the distance indicator, the other significant variables are common to the inner-city districts. These districts provide business environments with high possibilities for contact and interaction. This shows that the inner-city is a great attractor for investments, due to the dense presence of amenities and other firms. This is in line with the theories of Storper and Venables (2004) on face-to-face contacts and buzz: companies concentrate where there is a high opportunity of meeting. The need for face-to-face interactions is high in FDI activities that require high levels of trust among partners, particularly for Business Services. Additionally, Dicken (2013) named the inner-city as an international interaction environment for culture, congress, and knowledge.

In addition, Science and Techno Complex districts are attractors for FDI. These districts close to universities or research firms are located at the fringe of the city and have their spatial development history. These districts have a lower urbanity degree and presence of amenities; however, theirs is still one with an urban look and feel. These findings are coherent with the study on Innovation Districts by Katz and Wagner (2014) and districts for science-based industries as shown by Spencer (2015).

The Office Park is a business district that is mostly located near main roads and transport, offering good accessibility and providing higher levels of green and water areas. The main firm activities found herein are Headquarters and Sales Marketing & Support. These districts are related to business locations along highways and (public) transport nodes, as defined as Edge Cities by Garreau (1991) and Hall (2002). The Research Park is a specific type of office location with a high concentration of research firms, and with a low distance to a university.

The fourth type is the international Airport district that focuses on international firms, providing quick air access and an international business environment. Particularly for international firms, the good international connections that are provided by larger airports are a main element for FDI. This is in line with the research by Appold and Kasarda (2013) on Airport cities.

### 5.3. Planning strategies

Regarding planning policies and strategies for cities in need of a transition to a knowledge-based economy, the following aspects should be considered in a policy on spatial-economic development to attract more FDI in knowledge-intensive activities:

(1) Focus on firm activities. Most cities tend to have an economic development policy that is focused on a particular economic sector. This study, as well as others (e.g. Duranton & Puga, 2005) show that currently firm activities rather than sectors tend to co-locate. For a sector, different location needs are to be fulfilled regarding the different activities within a sector. For the same type of activities in different sectors, the number of location needs is smaller, so it is easier to invest in these. Based on an analysis of the strongest firm activities now, and the type of business districts already available

within a city, a new economic policy can be directed to attract more of the same type of firm activities in various sectors or niches. At the same time, policies should consider the firm activities with the highest growth potential. For example, the empirical results of this study show that the activity of Design, Development & Testing (DDT) has seen considerable growth during recent years in the number of FDI, offering good prospects for future development.

(2) Strategies for business districts. Regarding the spatial and functional needs of firm activities, a policy should focus on district diversity (different types of districts) and district size (concentration in these districts). Having more than one district type allows for choice for firms. As this study shows, there is no one-size-fits-all-business district for each type of firm activity: diversity of districts is still needed to attract different types of FDI activities. In addition to this, concentration (and being near other firms and research institutes) is one of the advantages of business districts, so the number of locations should not be too large, but policies should concentrate on a small number of different types. In particular, districts with a high level of amenities are proven to be appreciated by certain types of FDI.

(3) International connectivity. This study shows that firms and FDI tend to cluster and have a significant relationship with the number of other firms, where the international business ties are additionally important. As the study shows, the proximity to airports and highways are relevant. Although this study did not look at public transport and international train connections, it is likely that physical connectivity is an important driver for attracting foreign investment and related economic activities.

### *5.4. Limitations and further research implications*

The first limitation is that only FDI data are explored, limiting the scope to foreign MNCs. Investments by national and local firms are not considered. The second limitation concerns the sample of cities that is restricted to NW- European cities, and therefore, the results may not be applicable to cities in other regions.

In future research, other spatial characteristics such as heritage and historical components, the presence of cultural amenities, public transport, and the potential for interaction within a district (length of roads, number of crossings, street design, and presence of squares or parks) can be included. In addition, a broader sample of cities can be researched: more expansive by geographical scope (outside the six countries of this research), broader by number of FDI investments, and broader by researching the city-regions and including the surrounding municipalities.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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# Appendices

## *Appendix 1. Table of variables and indicators*

| Name | Description | Source | Unit | Data Type |
|---|---|---|---|---|
| **Y-variable: FDI** | – | – | – | – |
| FDI dataset | contains: | fDi Markets | – | Nominal |
| | - number of FDI | fDi Markets | – | Ratio |
| | - year of Investment | fDi Markets | – | Interval |
| | - economic sector | fDi Markets | – | Category |
| | - firm Activity | fDi Markets | – | Category |
| | - address: (street), postcode, city | ORBIS, own research | – | Nominal |
| **X-variable: Location** | – | – | – | – |
| ***Proximity*** | *Proximity of the location to infrastructure, the city and other firms.* | | | |
| - rdist Airport | relative distance to the closest Airport (real distance divided by distance city centre – airport) | own research (batchgeo.com) | – | Ratio |
| - dist Station | distance to Central Railway Station | own research (batchgeo.com) | km | Ratio |
| - cdist Main Road | distance to Main Road (1: <1 km; 2: 1–2 km; 3: >2 km.) | own research (google earth) | – | Ordinal |
| - rdist UNI | relative distance to closest University or Scientific Institute (real distance divided by average distance to city centre) | own research (batchgeo.com) | – | Ratio |
| - rdist Center | relative distance to City Hall as proxy for the city centre (real distance corrected for average distance to city centre) | own research (batchgeo.com) | – | Ratio |
| - N Firms | number of FDI investments in same cluster (proxy for number of firms) | own research (fDi Markets) | – | Ratio |
| ***Functional type*** | *Functional typology of the location* | | | |
| - Functional zone | categorization of the district in functional type: Industrial, Office, Mixed-use, Green, Commercial, Technological /Research, Complex. | own research (using Google Earth) | – | Category |
| ***Urban characteristic*** | *Characterization of the urbanity level.* | | | |
| - Urban degree | density of the area: 1 = solitaire building; 2 = low density area (detached buildings); 3 = medium density area (attached buildings); 4 = high density area (closed blocks and towers). | own research (assessed from Google Earth and Streetview) | – | Ratio |
| - N floors | average number of floors in the area, (based on virtual fieldtrip research). | own research (assessed from Google Earth and Streetview) | – | Ratio |
| - Amenities | presence of amenities in the area: 1 = yes; 0 = no (based on virtual fieldtrip research) | own research (assessed from Google Earth and Streetview) | – | Dummy |
| - Waterfront | area is located on a waterfront or riverbank: 1 = yes; 0 = no (based on virtual fieldtrip research) | own research (assessed from Google Earth and Streetview) | | Dummy |
| ***Spatial quality*** | *Specific location qualities.* | | | |
| - Green | amount of green in area in comparison to the other locations: 1 = none; 2 = low; 3 = medium; 4 = high (based on virtual fieldtrip research) | own research (assessed from Google Earth and Streetview) | – | Ratio |
| - Water | amount of water in area in comparison to the other locations:: 1 = none; 2 = low; 3 = medium; 4 = high (based on virtual fieldtrip research) | own research (assessed from Google Earth and Streetview) | – | Ratio |
| - Parking | type of car parking: S = street parking; L = parking lots; B = built parking (based on virtual fieldtrip research) | own research (assessed from Google Earth and Streetview) | – | Category |
| - Public Space Design | quality of public space in comparison to the other locations:: 1 = none; 2 = low; 3 = medium; 4 = high (based on virtual fieldtrip research) | own research (assessed from Google Earth and Streetview) | – | Ratio |

## *Appendix 2. Descriptive table*

| | Descriptives table | | | | | |
|---|---|---|---|---|---|---|
| | Variable | Obs | Mean | Std. Dev. | Min | Max |
| DV | FDI (total) at postcode sites | 347 | 3.0173 | 6.5101 | 1 | 77 |
| PROXIMITY MODEL | RD to airport | 347 | 1.1254 | 0.6607 | 0.03 | 4.64 |
| | RD to university | 347 | 1.0904 | 1.1951 | 0.00 | 15.60 |
| | RD to city Center | 347 | 1.5039 | 1.3059 | 0.04 | 8.41 |
| | Proximity to Main Roads | 323 | 2.2411 | 0.8434 | 1.00 | 3.00 |
| TYPOLOGY MODEL | Industrial Zone | 321 | 0.2386 | 0.4215 | 0 | 1 |
| | Commercial Zone | 321 | 0.0654 | 0.2477 | 0 | 1 |
| | Mixed Zone | 321 | 0.3479 | 0.4763 | 0 | 1 |
| | Office Zone | 321 | 0.2759 | 0.4422 | 0 | 1 |
| | Techno Zone | 321 | 0.0156 | 0.1240 | 0 | 1 |
| FUNCTION MODEL | Number of Floors | 320 | 4.0234 | 1.9704 | 1 | 12 |
| | Built Parking | 322 | 0.2270 | 0.4153 | 0 | 1 |
| | Local Parking | 322 | 0.4580 | 0.4978 | 0 | 1 |
| | Number of Amenities | 323 | 0.2056 | 0.4036 | 0 | 1 |
| QUALITY MODEL | Green Area | 323 | 2.3329 | 0.9357 | 1 | 4 |
| | Water Area | 323 | 1.5702 | 1.0210 | 1 | 4 |
| | Public Space | 321 | 2.4663 | 0.8224 | 1 | 4 |
| | Waterfront | 326 | 0.0785 | 0.2600 | 0 | 1 |
| | Number of local Firms | 323 | 3.3787 | 6.3229 | 1 | 70 |
| IV | Urbanity Degree | 323 | 2.4568 | 0.7159 | 1 | 4 |

## *Appendix 3. GMM models to test endogeneity*

| GMM models based on vectors of independent variables for each model | | | | |
|---|---|---|---|---|
| | PROXIMITY | TYPOLOGY | FUNCTIONS | QUALITY |
| VARIABLES | | | | |
| Proximity vector | −0.797*** | . | . | . |
| | (−0.239) | . | . | . |
| Typology vector | . | 0.450*** | . | . |
| | . | (−0.113) | . | . |
| Functionality vector | . | . | 0.634*** | . |
| | . | . | −0.177 | . |
| Quality vector | . | . | . | 4.004 |
| | . | . | . | −4.806 |
| Number of local firms | 0.0531*** | 0.0531*** | 0.0462*** | 0.0877*** |
| | (−0.00633) | (−0.00661) | (−0.00699) | (−0.0712) |
| Constant | 0.473*** | 0.616*** | 0.505*** | −6.641* |
| | (−0.119) | (−0.0746) | (−0.133) | (−11.63) |
| Observations | 323 | 321 | 320 | 321 |
| | PROXIMITY | | | |
| VARIABLES | Model 1 | | | |
| RD to university | 0.234*** | | | |
| | (-0.057) | | | |
| Number of local firms | 0.0602*** | | | |
| | (-0.00482) | | | |
| Constant | 0.300*** | | | |
| | (-0.0993) | | | |
| Observations | 323 | | | |

Note: Robust standard errors in parentheses.
***$p < .01$; **$p < .05$; *$p < .1$.