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On how to analyse accessibility, agglomeration as location factors: a life cycle analysis of relocating firms in The Netherlands

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Abstract

The spatial choice behaviour of firms is an important component of spatial economic development. It is argued that this behaviour can be better understood if the preferences underlying relocations decision are analysed from both the life cycle of the firm and the attributes of the firm location. Advanced speifications for accessibility and agglomeration are applied to analyse their importance as location factors. First, infrastructure proximity is measured with the distance to transport infrastructure access points. Next, the quality of accessibility is measured through utility based logsums from a transport model. Finally, measures for specialisation and diversity of the firm population are included to test the importance of spatial externalities. The applied measures for specialisation and diversity explicitly account for the transport dimension, which is often neglected in empirical studies in urban economics. First, this avoids 'border'-effects that arise when agglomeration is measured for one isolated administrative area. Second, the measures can be used to analyse effects of transport developments on agglomeration economies when results from a transport model are combined into the analysis.

The paper discusses an analysis of the spatial choice behaviour of relocating firms in a Dutch case study. The objective is to increase the understanding of the influence of accessibility, agglomeration and the life cycle of firms on the location decision of firms. A spatial choice model is applied that accounts for the spatial interdependency between location alternatives (Fotheringham, 1983).

The results confirm a pattern that fits into an agglomeration and life cycle perspective of firms. The estimations show that relocation probabilities are higher among firms in diverse locations and firms with higher growth rates. This is interpreted as a pattern of successful and maturing firms that depart their breeding area. Next, the location choice models confirm a significant and positive utility for locations that have a higher level of specialisation in the respective industry sector. The location choice models further more show that infrastructure proximity are significant location factors, and distinctive preference are measured across industry sectors.

KEY WORDS: firm location, discrete choice, accessibility, urban economics

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1. Introduction

The spatial choice behaviour of firms is an important component to spatial economic development. Many theories exist into the driving factors behind this behaviour but many questions still exist. Since early spatial economic research, accessibility is a general accepted location factor determining the quality of firm location and many different definitions to accessibility exist (Geurs and Van Wee, 2004). Next, spatial externalities are identified as a crucial factor to firm location in recent urban economic literature (Duranton and Puga, 2004). Finally, the literature on industrial organisation indicate firm internal developments as influential factors in firm behaviour (Carroll and Hannan, 2000).

This article presents an integrated analysis of individual firm preferences, and the influence of accessibility and agglomeration attributes on relocations decision. It is argued that the preferences of relocating firms can be better understood if the preferences underlying relocations decision are analysed from both the life cycle of the firm and the attributes of the firm location. In recent literature this approach gains growing interest (Duranton and Puga, 2001). Theories on industrial organization (Carroll and Hannan, 2000) and urban economic theories (Duranton and Puga, 2004) are combined in a discrete choice analysis. Hypotheses are tested on the influence of firm or location factors on firm relocation events. Following Duranton and Puga (2001), firms are more likely to be formed in diversified locations, where processes and ideas can be burrowed from other activities. Once a firm becomes successful, it moves to specialised locations where production costs is lower and access to skilled labour is improved. This view is tested at the intra urban area by incorporating both firm characteristics as well as location attributes simultaneously into the analysis.

A firm level analysis is presented on a longitudinal set of firm data. All observed firm relocations are analysed with two subsequent models. First the relocation probability of firms is analysed with a binary regression model. Next, the observed location decisions and the underlying location preference of firms is analysed from the estimations of a number of Competing Destinations models (Fortheringham, 1983). The choice models include firm attributes on the one hand and accessibility and agglomeration attributes on the other. The location choice models include labour market and supplier accessibility through logsum accessibility measures for commuters and business strips. Proximity measures are included to measure the distance to highway onramps and train station. The level of specialisation and diversification of locations is measured as distinct agglomeration economies. These measures are computed from the composition of the firm population within a specific range bands that can be reached from a location over the road network. The choice models are estimated on a dataset with all relocating firms in the area 'South-Holland' in the Netherlands.

2. Background

Transport infrastructure is accepted as an important location factor for firm location. However, the way in which firm location decisions are influenced by transport infrastructure is far from trivial. It is complex, and interpreted under a broader 'accessibility' definition it not only covers a transport dimension but a land use dimension as well (Geurs and Van Wee, 2004). In case of firm location decisions, elaborate theories are available on the extend of agglomeration economies as location factors. Hence, this analysis strives to bring together accessibility and agglomeration location factors in a conclusive analysis.

The specification of accessibility and agglomeration is complex. Based on empirical literature, proximity measures and general gravity based accessibility measures are identified as commonly applied accessibility indicators. For empirical examples of studies that apply such indicators see Shukla and Waddell (1991), Leitham *et al.* (2000), Waddell and Ulfarsson (2003), Holl (2004a, 2004b) or De Bok and Sanders (2005). The literature on urban economics emphasizes the importance of agglomeration economies from different types of spatial externalities that are the result of the urban environment or the firm population in the surroundings of a firm (Duranton and Puga, 2004).

Firms can benefit form agglomeration economies by being located near other firms. Agglomeration economies exist where firms benefit from spatial externalities. These spatial externalities are production advantages that are beneficial to a firm, but where a firm does not have to pay any cost for it directly. In contrast to firm internal economies of scale (lower unit production costs with increasing production volume), agglomeration economies are benefits that are externally derived. These external economies of scale can come from input/output sharing (lower input costs as a result of production advantages for suppliers), labour market pooling or other sources. Internal economies of scale are a result of production advantage for larger firms. In those cases, larger production volumes lead to lower average unit production costs.

In urban economics, researchers have claimed many sources of spatial externalities. Perhaps the most appropriate sources were already identified in Marshall's original contributions (Marshall, 1890). Marshall distinguishes three sources of externalities:

1. labour market pooling;
2. input sharing;
3. knowledge spill overs.

Labour market pooling is claimed to be an important source of spatial externalities. The concentration of industrial activity implies the presence of a labour force as well. One of the advantages of firms to be located at such areas is the availability of such a labour force. This reduces search costs and offers more opportunities for letting off employees. The advantage is two-directional since for employees it is beneficial to have more alternative job opportunities nearby as well.

Input sharing leads to externalities that are the result of scale economies in input production for the suppliers. A supplier that has more customers nearby has larger production volumes and lower average unit production costs. In addition, the concentration of possible customers is likely to lead to a higher availability of suppliers as well.

Knowledge can spill over between firms and improve the firm's performance. This knowledge is viewed as an externality because it originates from outside of the firm and there is no fee or compensation for the development of this knowledge. The transfer of knowledge can be the result of job mobility or social activities between employees from different firms.

The exact nature of these spatial externalities is subject of much research and it seems impossible to give a generally accepted specification of these externalities. In literature, agglomeration economies are roughly subdivided in localisation and urbanisation economies. This subdivision is based upon a different industrial scope of the externalities. In other words, are the agglomeration externalities related to the concentration of a specific industry or to the size of the whole economy? Table 1 presents a framework of different sources of agglomeration economies, in relation to localisation and urbanisation economies. Localisation economies deal with externalities that are the result of the concentration of a specific industry sector. Urbanisation economies deal with externalities that are the result of the size of a local economy. In this context, the distinction between localisation economies and urbanisation economies is interpreted as a distinction between geographical scope.

Table 1: Types of agglomeration economies, specified to source and industrial scope. Source: elaboration of Weterings (2006) and Capello (2002).

Source:	Localisation economies:	Urbanisation economies:
Labour market pooling	Accessibility to specialised labour market	Cost benefits from accessibility to large labour market
Input/output sharing	Accessibility to specialised suppliers	Cost benefits from accessibility to customers
Knowledge spill overs	Industry specific knowledge spill-overs *(Marshall externalities)*	Knowledge spill-overs between different industries or from scientific environment *(Jacobs externalities)*

Urbanisation economies arise from urban size and density that is firms located in larger urban areas benefit from a well developed infrastructure, a larger labour pool, the abundance of potential customers and suppliers and are more likely to have universities and research institutes in its surroundings. First of all suppliers and customers are better accessible, resulting in lower transport costs. Next, large urban areas have more resources to develop or improve transport infrastructure. In general, urbanisation economies refer to benefits on transport or production costs from a good market accessibility. Common gravity based accessibility measures are often used as an indicator for such a market size, e.g. labour market or customers. Good accessibility can lead to cost efficiency and is regarded as a static benefit. Next to the positive externalities from urbanisation economies, negative externalities exist as well such as higher prices for land or space, congestion or pollution.

Localisation economies refer to a local concentration of firms from the same industry sector. If any of all of the distinguished sources of externalities are the result of the concentration in the particular industry, we speak of localisation economies or *Marshall externalities* or *specialisation externalities*. The specialisation of industries leads to an improved supply of skilled labour that is required in the respective industry. This specialisation is likely to coincide with a high availability of (specialised) suppliers as well. These are attracted by the concentration of possible customers. The high availability of suppliers presumably implies lower input costs. Finally, industry specific knowledge transfers can be a source of externalities. Knowledge can be transferred through job mobility or social activities between employees from competing firms. This hypothesis was originally developed by Marshall (1890) and later formalised by Arrow (1962) and Romer (1986), together usually labelled MAR. In the context of Marshall externalities, knowledge is assumed to be sector-specific.

In a broader urbanisation economies context, knowledge transfers are assumed to occur between firms from different industries. Jacobs (1969) suggested that knowledge is most likely to spill over between firms from different industry sectors. Advantages that enhance firm performance are referred to as *Jacobs* or *diversification externalities*.

It is argued that this behaviour can be better understood if the preferences underlying relocations decision are analysed from the life cycle of the firm. In some recent studies, it is argued that agglomeration economies have a shifting influence along an industries life cycle. So, to better understand the exact influence of agglomeration, it is important to incorporate the state of individual firms. Duranton and Puga (2001) speak of nursery cities where new products are developed in diversified cities, trying processes borrowed from other activities. After finding the ideal production process, firms switch to mass production and relocate to specialised cities where production costs are lower. Their study is supported by evidence on French establishments relocations in the period 1993 and 1996. Neffke, Van Oort and Boschma (2006) find similar evidence for a longitudinal dataset on employment in UK counties. They find Jacobs externalities to be more apparent in early high skill periods of an industry, but they disappear if an industry sector matures. In the mature stages the MAR externalities are more apparent.

From these theoretical elaborations a number of hypotheses are formalised on the expected location preferences of firms.

1. Firms in general show a preference for *limited migration distances*, in order to maintain existing spatial relations. Firms prefer locations close to their original location, as a result of keep-factors. The shorter the migration distance, the less effort it takes to maintain existing spatial relations, e.g. with commuters, suppliers or customers.

2. Firms from different industries have different preferences with respect to *proximity* to *highway onramps* or *train stations*.

3. Firm prefer locations that have good urbanisation economies. Therefore it is expected that firms have a preference for locations with a high values for logsums of commuting and business trips.

4. a) Relocating firms seek each other's presence in order to derive Marshall externalities. Therefore it is expected that firms have a preference for *specialised* locations.
   b) Specialisation is more important for growing firms.

5. a) Firms benefit from Jacobs externalities resulting from a rich variety of firms in the surroundings of a location. Therefore it is expected that firms have a preference for *diverse* locations.
   b) Diversity is more important for young firms.

The spatial dimension of a location decision, introduces complexities in how spatiel alternatives are valuated. Location alternatives that are in each other's proximity are more likely to be each other's substitute than more remote alternatives (Fortheringham, 1983). In the following of this article a location choice model is estimated that can test the following hypothesis:

6. Firms *evaluate alternatives* grouped in *spatial clusters*.

The estimation results of the location choice models will be discussed in the light of these hypothesis.

3. Method

3.1. The firm migration model

The analysis is based on a general behavioural model for the location decision of firms. This model describes the spatial location decision of an individual firm in a disaggregated physical environment. The firm has individual attributes and is located at an origin location. The choice alternatives are real estate objects, characterised by size of the location and location attributes, such as location type and accessibility. The firm migration behaviour of an individual firm within this physical environment is regarded as a choice process that consists of a sequence of considerations and decisions.

The first step in migration behaviour is the decision to relocate. This decision is analysed with a binary logistic regression model similar to the approach presented by Van Wissen (2000). The relocation probability of a firm is determined by attributes of the firm and attributes of the current firm location:

$$P_i^{MP}(t) = \frac{1}{1+\exp[-(\beta_0^{MP} + \sum_{n=1}^{N} \beta_n^{MP} Y_{in} + \sum_{m=1}^{M} \beta_m^{MP} X_{jm}]}, \forall i \in F_s(t), \qquad (1)$$

where β_0^{MP} is the constant that describes the base for the move probability, Y_{in} as attribute *n* of firm *i* and X_{jm} as attribute *m* of location *j*. The move probability parameters β_x^{MP} are estimated in the empirical part of this article.

For each observed firm relocation, first a representative choice situation is created by generating a choice set that is representative for the firm (sector, firm size). The formation of these choice sets is simulated by a hierarchical search process, similar to route choice modelling (Bovy, 2007). For each firm *i* a representative consideration set L_i is generated with feasible choice alternatives, based on individual choice constraints and the awareness space of firms. The observed utility of each location alternative, V_{ij}, is specified with an industry specific linear additive utility function. So, each sector has its specific parameters in the utility function:

$$V_{ij} = \beta_{0s}^{LC} d_{ij} + \sum_{m=1}^{M} \beta_{ms}^{LC} \cdot X_{jm} + \beta_{rs}^{LC} \cdot Y_{ir} \cdot X_{jr}, \forall i \in F_s. \qquad (2)$$

The utility of location alternative *j* is first of all includes d_{ij}, the distance between the current location of *i* and the alternative *j*. Next it includes a number of location attributes of alternative *j*, X_{jm}, such as accessibility or agglomeration. In addition, some utility specifications are tested that include interaction terms between location attribute X_{jr} and firm attributes Y_{ir}. These interaction terms are used to test if firms with a specific characteristic have a preferences for specific issues, e.g. the preference for specialised locations increases with firm size. The parameters of the location choice model, β_{xs}^{LC}, are to be estimated for each industry sector *s*.

The similarity between spatial alternatives is measured with a centrality measure that is a proxy for the spatial cluster membership. Following Fotheringham (1983), this centrality measure c_j is based on geographic space and recognises the more proximal alternatives are in space, the more likely they are to be substitutes for one another:

$$c_j = (1/(K-1)\sum_{k \neq j} w_k / d_{kj}), \quad (3)$$

with K as the number of available firm locations, d_{kj} as the distance between alternative *k* and *j* and w_k as the size of alternative *k*. The size of an alternative is specified as the available floor space or industrial area at a firm location. So, for each alternative that is selected in the consideration set, the centrality relative to all other available alternatives is computed. The distance d_{kj} is derived from the location of each alternative.

In this application, c_j measures the clustering of *available* locations. In previous studies centrality is often measured relative to current activities instead of available alternatives (Pelligrini and Fortheringham, 2002). In those cases centrality is similar to agglomeration. It is stressed that in the presented model measures centrality relative to available firm locations. The influence of agglomeration economies is measured with other measures, presented in the following section.

The competing destinations location choice model for firm *i* choosing location *j* out of consideration set L_i becomes:

$$P_{ij|L_i}^{LC} = \frac{\exp(V_{ij} + \theta_s^{LC} \ln c_j)}{\sum_{k \in L_i} \exp(V_{ik} + \theta_s^{LC} \ln c_k)}, \forall i \in F_s \quad (4)$$

with centrality parameter θ_s^{LC}. This parameter measures the extent to which location alternatives are evaluated in clusters. If $\theta_s^{LC} < 0$ then competition effects are present: in other words alternatives that are close to many other alternatives are less likely to be selected compared to more isolated alternatives.

Transport based accessibility

The quality of the transport based accessibility is measured both with distances to infrastructure access points and logsum accessibility measures. The distance to infrastructure access points express a specific transport infrastructure quality that is easily interpreted by the decision makers. Empirical findings in the literature suggest such measures can be significant location factors in the location preference of firms (De Bok and Sanders, 2005). Utility based measures on the other hand are less easily interpreted, but provide the most conclusive approach to measuring the valuation of all possibilities that can be reached from a location, taking into account individual preferences, the available modes of transport, the variation of travel times and travel costs over the day (De Jong et al. 2005). Both measures are defined subsequently.

The distances to the nearest highway onramp and nearest train station is used as spatial attribute. These attributes are calculated in GIS, using coordinate information. They appeared to be highly correlated, which might lead to biased estimation results. This was solved by recoding the distance measures into a categorical variable describing the position of a location in relation with the physical infrastructure. An α-location is a typical train stations location: within 800m. of a train station and not too close to a highway onramp. Locations nearby highway onramps (within 2000m.) are labelled as γ-locations. If a location is close to a train station as well as a highway onramp (within 800m and 2000m respectively) it is labelled as a β-location. If a location has a considerable distance to both the nearest train station and highway onramp, it is labelled as a ρ-location.

The second type of accessibility measure that will be tested for its influence on firm demographic change are logsums. These measures are well founded in micro economic theory. In this application the logsums for two trip purposes are assumed to be relevant: the logsum for (non-home based) business trips and the (reflected) logsum for commuting trips.

First of all, the logsum for business trips are assumed to be a representative measure for customer and supplier accessibility. This logsum is calculated as the sum of the trip utilities to all destination zones *d* for all person types *p* for all trips with purpose *m* = 'business trips':

$$A_{om} = \frac{1}{\beta_m} \log \sum_{d} \sum_{p} \exp(V_{odpm}) \tag{5}$$

with V_{odpm} as the expected utility for person type *p* to make a business trip from origin *o* to destination *d* and β_m as purpose specific travel time coefficient. The division by this coefficient, converts the logsum to time units.

Labour market accessibility is derived from the commuting trips computed in the transport model. Labour market accessibility is in this case measured from the perspective of the firm. Or in other words: how well is a firm location accessible for commuters. Therefore the reflected logsum is used for commuting trips. A reflected logsum measures the destination accessibility given measures of origin accessibility. For example, the attractiveness of locations for places of work or for shops will depend on the ease with which people can reach them from their homes. an (approximate) reflected logsum, specified as:

$$A_{dm} = \log \sum_{o} \sum_{p} \exp(V_{odpm}) \tag{6}$$

with trip purpose *m* 'commuting' and V_{odpm} as the expected utility for person type *p* to commute from origin *o* to destination *d*.

Measures for agglomeration

Agglomeration is an important issue that should be accounted for in spatial economic simulation models. Moreover, agglomeration is clearly related to accessibility. However, the transport dimension is often underrepresented in agglomeration measures. The structuring influence of transport infrastructure in urban networks is often ignored and the fact that transport infrastructure is a condition for interaction is neglected.

The following general requirements should apply to agglomeration measures:

- agglomeration measures specify the spatial composition or dispersion of the firm population;
- different types of agglomeration forces should be distinguished: 'specialisation' and 'diversification';

- transport infrastructure is conditional for spatial interaction within the urban structure.

The majority of empirical studies in urban economic literature neglect the transport dimension and compute agglomeration measures for aggregated administrative zones that are isolated in space (for a contemporary overview see Rosenthal and Strange, 2004). Spatial autocorrelation is a technique to account for geographical nearness of adjacent zones, however the transport dimension of this nearness is not represented.

The specification of agglomeration measures in this research strives to meet the requirements that apply to agglomeration measures, particularly the transport infrastructure dimension. The approach extends general specialisation and diversification measures from the urban economic literature with travel time matrices from a transport model. The urban area that is within range from a location is subdivided in 'range bands' and the firm population within this range band is specified with specialisation and diversity measures.

Following the example of Rosenthal and Strange (2003) and Van Der Panne (2004), the agglomeration measures are computed for specific range bands. In this way the spatial dimension is introduced explicitly. The level of agglomeration within each range band can be measured by analysing the level and composition of employment within the range band. A range band represents the area that can be reached within a specific range of travel times, for instance between 5 and 10 minutes. In this approach we take travel times to define our range bands instead of distance. In this way the effect of transportation developments on agglomeration is represented explicitly.

Specialisation

Specialisation is measured as the representation of one industry within a specific travel range of a location relative to that industries share in the region. The measure is based on the commonly applied production specialisation index (PS), and is enhanced with a spatial dimension with range bands. For each location j the level of agglomeration is measured in specific range bands, R_{jb}, for a set of ranges b=0-5, 5-10,…, 25-30. The level of agglomeration in each range band is derived from the level of employment in each industry sector in each range band. For location j the share of the employment in industry sector s in a range band R_{jb} from j is measured relative to the share of employment in that industry in the whole region. The production specialisation index for location j and range band R_{jb} becomes:

$$PS_{jsb} = \frac{E_{sR_{jb}} \Big/ \sum_s E_{sR_{jb}}}{\sum_j E_{sR_{jb}} \Big/ \sum_j \sum_s E_{sR_{jb}}} \qquad (7)$$

with $E_{sR_{jb}}$ as the employment in industry s, within range band R_{jb}.

Diversity

Diversity externalities are measured with the similar range band concept as well. The common productivity diversity index (PD) that is computed for each range band, is based on the specification of Paci and Usai (1999). If the number of industry sectors is defined by S, and all industries are sorted in increasing order, the production diversity index PD_{jb} for location j and range band R_{jb} is defined as:

$$PD_{jb} = \frac{1}{(S-1)E_{SR_{jb}}} \sum_{s=1}^{S-1} E_{sR_{jb}} \tag{8}$$

with $E_{SR_{jb}}$ as the employment in the largest industry within range band R_{jb} .

3.2. Data

The model has been estimated on a longitudinal dataset, covering all developments in the firm population. This dataset has been constructed by linking the annual LISA datasets (National Information System of Employment) from 1988 to 1997. The following firm attributes are available: industry sector, size (in full time employment units), the age of the firm, the location (6 digit zip code), the change in size compared to previous years, and dummy's for firm demographic events. The spatial detail of firm locations allows a detailed analysis of spatial attributes of each location. Firm growth is expressed as the change in firm size, relative to the absolute firm size. The age of the firm is included in the estimations by a 'youngness' attribute, defined as 'yougness' = 1/age. The firm population is segmented to 12 industry sectors.

The accessibility and agglomeration attributes are linked to the locations. The distance measures to highway onramps and trainstation are derived from the location of each firm (6 digit zip code) and a GIS analysis. The logsum accessibility attributes, and the travel time between zones in the study area, are provided by backcasting data from the National Modelling System (NMS), the national transport model for the Netherlands (Hague Consulting Group, 2000). The attributes for diversification or specialisation in the direct surroundings of a location or in specific range band from that location, are computed from the travel times from the NMS and the location of all firms in the LISA-dataset.

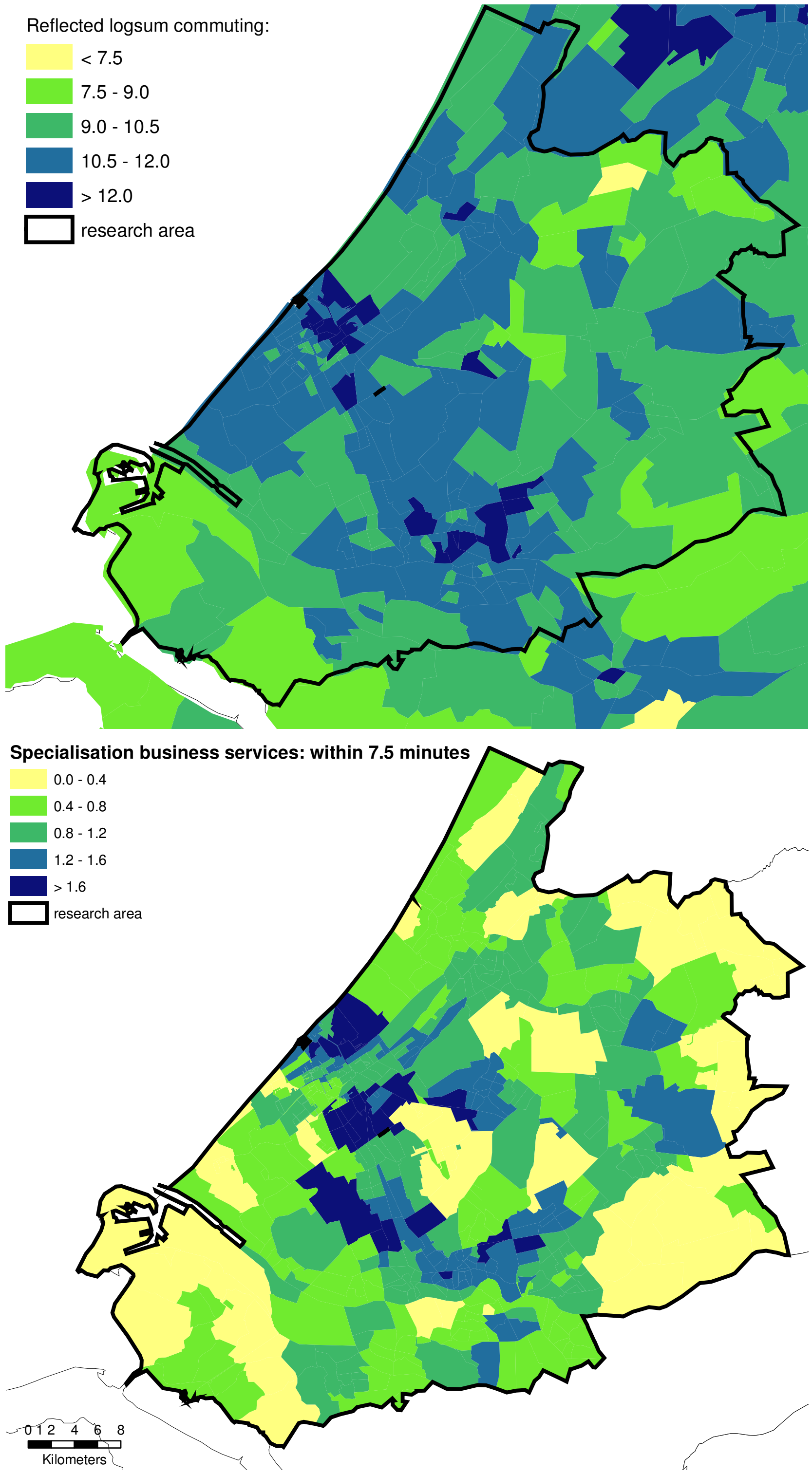

Figure 1: Examples of logsum accessibility (top) and specialisation index (bottom)

4. Results

For practical reasons this analysis focuses on all firms in the following industry sectors: business services, government, financial services, general services and health services.

4.1. Relocation probability

The binary regression models for relocation probabilities include firm attributes and accessibility and agglomeration attributes. The life cycle is captured in the attributes firm size, age and firm growth. The firm's industry sector is included with a dummy variable. On forehand, the influence of accessibility or agglomeration is expected to be minimal, however the accessibility and agglomeration attributes are tested in the estimations as well.

Table 2 presents the estimation results for three different model specifications. The estimated parameters are presented with their corresponding standard error. The significance level of the estimated parameters are indicated with ** or *. Model MP-1 includes a base set up. Next, model MP-2 includes the youngness attribute, defined as [1/age]. Model MP-3 finally includes the urbanisation attribute to see the effect of the inclusion of this attribute on the estimated parameters for the other estimated parameters.

Table 2: Estimated parameters relocation probability.

	MP-1			MP-2			MP-3		
	β	S.E.		β	S.E.		β	S.E.	
Constant	-3.939	0.054	**	-4.008	0.055	**	-5.215	0.145	**
Individual firm attributes									
Log of size	-0.035	0.009	**	-0.003	0.009		-0.012	0.009	
Growth rate	0.420	0.039	**	0.376	0.039	**	0.381	0.039	**
1 / age				0.738	0.040	**	0.710	0.041	**
Industry sector									
Finance	0.412	0.043	**	0.410	0.043	**	0.417	0.044	**
Business services	0.749	0.031	**	0.675	0.031	**	0.664	0.032	**
Government	0.504	0.073	**	0.444	0.073	**	0.417	0.076	**
Education	0.082	0.050		0.067	0.050		0.076	0.052	
Health service	0.181	0.039	**	0.163	0.039	**	0.164	0.040	**
General Services (ref.)	-			-			-		
Accessibility attributes									
α-location; near trainstation	0.041	0.031		0.047	0.031		0.053	0.031	
β-location; near trainstation & highway onramp	0.055	0.022	*	0.044	0.023		0.044	0.023	
γ-location; near highway onramp	-0.102	0.020	**	-0.103	0.020	**	-0.097	0.020	**
ρ-location; neither	0.007			0.012			0.000		
Urbanisation economies:									
Logsum business and commuting trips							0.075	0.008	**
Agglomeration attributes									
Diversity within < 7,5 min.	0.492	0.077	**	0.425	0.077	**	0.130	0.085	
Specialisation within < 7,5 min.	0.081	0.018	**	0.060	0.018	**	0.004	0.020	
Number of observations	226463			226463			226463		
Cox and Snell	0.005			0.006			0.007		
Nagelkerke	0.017			0.022			0.023		

** = significant at the 0,99 level ; * = significant at the 0,95 level

The estimated parameters show that the relocation probability are mainly influenced by firm attributes. The size and growth rate parameters are significant and in line with empirical literature. The negative parameter for the log of firm size indicates that bigger firms are less likely to relocate (Carroll and Hannan, 2000; Brouwer, 2002). The same holds for age: the positive parameter for the youngness attribute in model MP-2 and MP-3, indicates that young firms are more likely to relocate. The decrease of significance of the estimated parameter for firm size in model MP-2 compared to MP-1 is caused by correlation between age and size. The sign of the estimated parameter however, still remains negative, confirming the lower move probability for large firms. Furthermore, firms with large growth rates are more likely to relocate (Carroll and Hannan, 2000; Pellenbarg 1996; Louw, 1996). The positive parameter for absolute growth rate in model BL-1 (0.420) indicates a higher relocation probability for growing either shrinking firms. Apparently, firm growth (or decline) can cause a mismatch with the available space at the current location, leading to a relocation decision and initiating the firm migration process.

Next, large differences in relocation probability exist between industry sectors as well. Firms in business services appear to be the most mobile industry sectors with the largest estimated parameter (of 0.664 in MP-3). The firms in general services, the reference category, are the least 'mobile' industry sectors.

The positive parameters for diversity in the models, indicate that firms at diverse locations are more likely to relocate. This can be understood from an agglomeration and life cycle perspective on firms described in Duranton and Puga (2001). Diverse environments are regarded as breeding areas where firms start up. The higher relocation probability in diverse locations are interpreted as an indication of successful firms that leave their diverse breeding areas, to move to specialised locations. Similar evidence is found by Holl (2004b) for relocating manufacturing firms in Portugese data on relocating firms in manufacturing.

The estimated parameters for Model MP-3 reveal an influence of the inclusion of the urbanisation attribute on the estimated parameters for specialisation and diversity. The inclusion of urbanisation (the logsum for business and commuting trips) leads to a large shift in estimated parameter value for diversity. It shifts from 0.425 in MP-2 to 0.130 in MP-3. The same pattern can be seen for specialisation. The sign of the estimated parameters does not chance, however their significance decreases.

The estimated parameters for αβγ-locations reveal a modest influence of infrastructure proximity. Firms near motorway onramps (γ-locations) are less likely to relocate what might be interpreted as evidence for a higher satisfaction among firms at such locations. To test the sensitivity of the αβγ-location parameters to diversity, model MP-1 has been estimated without diversity and specialisation attributes as well but the estimated parameters for αβγ-locations were affected minimal, so those estimation results are omitted from Table 2.

4.2. Firm location choice

Table 3 presents the estimated parameters for the Business services sector and the Government. Table 4 presents the results for the Financial services and General services. Finally, Table 5 presents the results for the Health sector. To avoid biases from small non-active firms, the location choice models are estimated on all observed relocations of firms that have more than 2 employees. Some observations had to be excluded from the analysis because address information of the new location or the original location was incomplete. In total we had a dataset with 3788 observations of relocated firms.

In order to test the hypothesis that are formulated, a number of models are estimated with different combinations of accessibility and agglomeration attributes. For each sector, four different model specifications were tested that vary in the attributes that are included in the estimations. Model I is a base set up for the model, that includes the regular attributes for accessibility and agglomeration. Next model II until IV, each test the influence of adding a specific interaction term with an individual firm attribute into the analysis. With model II it can be analysed if an extra preference exist for growing firms for specialised locations. Model III tests the influence of age (youngness) on specialisation, model IV tests the influence of age on preferences for diverse locations. Based on the Estimated parameters for these models, the hypothesis are addressed successively.

Hypothesis 1:Preference for limited migration distance

Firms prefer alternatives that are close to their original location. This preference is found for all industry sectors. The estimated parameters for migration distance are negative and significant in all model specifications. In other words: locations in the proximity of the original location are preferred. This is interpreted as a confirmation of the existence of keep-factors: relocating firms strive to maintain their existing spatial relations with employees, customers and suppliers. These are expected to be more easily maintained close from their original locations, making firms inclined to stay near their original location.

Hypothesis 2: Industry specific preference for infrastructure proximity

The estimation results reveal an industry specific preference for locations with infrastructure access points in its proximity. The preference for locations in the proximity of highway onramps or train station is tested with four dummy attributes for the location type. The parameter for locations with a poor infrastructure proximity (ρ-locations) has been derived from the effect coding scheme that has been applied in the αβγ-location type attributes.

Almost all sectors prove to have the largest preference for locations close to highway onramps and train station (β-locations), although only for the Business services the parameter is actually significant. The financial sector has the largest preference for locations close to train stations (α-locations). For all sectors, the resulting parameter for ρ-locations (no train station or highway onramp in the proximity) has a negative value, which is as intuitively expected. To a large extend the parameters for infrastructure proximity are plausible. This gives good confidence in the explaining value of these distance based location attributes in the choice behaviour of firms. Previous model specifications with a distinctive industry segmentation confirmed the industry specific preferences for infrastructure proximity as well (De Bok and Sanders, 2005).

Hypothesis 3: Relocating firms have a preference for urbanisation economies

The estimated parameters reveal a preference for urbanisation economies. This hypothesis is tested with the estimated parameters for the logsum for commuting and business trips. These are positive and significant across all industry sectors, confirming an evident influence of urbanisation economies. In other words, firms show to have a preference for firm locations with good business accessibility and the labour force.

Hypothesis 4a: Relocating firms prefer specialised locations

The estimation results provide strong evidence that firms in Business services prefer locations that have a relatively high representation of firms from their own industry sector. This is interpreted as evidence for the existence of Marshall externalities for this sectors. For the other sectors, the parameters is negative but not significant. The evidence for a preference for specialised locations in the specific event of relocation can be viewed from a life cycle perspective. It is interpreted as evidence for a pattern of maturing firms that are successful and growing that relocate to more specialised locations (Duranton and Puga, 2000). This is consistent with the interpretation of the results found for the estimation of relocation probabilities. Those results were interpreted as evidence for successful maturing firms leaving their diverse breeding areas, for more specialised locations where they benefit from labour market pooling or knowledge transfers. Apparently, firms in Business services are more sensitive to these externalities compared to the other industry sectors.

Hypothesis 4b: Growing firms or older firms have a stronger preference for specialised locations

The estimation results for model II show that growing forms do not have an additional preference for specialised locations. None of the estimated parameters for the specialisation and growth rate interaction term are insignificant. The age of the firm however, does influence the preference for specialised locations for some sectors. The interaction term for specialisation and youngness, [1/age], in model III is positive and significant for Business services, government and the general services sector. This implies that young firms attribute a higher location utility to alternatives in specialised locations.

Hypothesis 5a: Relocating firms prefer diversified locations

Evidence for the existence of a location preference for diverse locations is not found for firm relocations. None of the estimated parameters are significant. This result can be interpreted from an agglomeration and life cycle perspective. Firms that relocate are mature and leave their (diversified) breeding areas and relocate to more specialised locations (Duranton and Puga, 2000). Thus, diverse locations are not preferred by firms that relocate.

Hypothesis 5b: Young firms have a preference for diverse locations

The estimation results for model IV show no significant increase in location preference for diverse locations for young firms from any sector. The interaction term, between youngness (1/age) and diversity in model IV, does not yield any significant parameters for diversity. Again, this result might be explained from an agglomeration and life cycle perspective. Firms that relocate are mature and leave their (diversified) breeding areas and relocate to more specialised locations (Duranton and Puga, 2000).

Hypothesis 6: Evaluation of location alternatives in clusters

The spatial cluster hypothesis is tested with the centrality parameter θ, that tests the influence of clustering of available location alternatives. If $\theta < 0$ then competition effects are present: in other words alternatives that are close to many other alternatives are less likely to be selected. If $\theta > 0$, then alternatives that are clustered are each more likely to be selected compared to more isolated alternatives. The spatial clustering of location alternatives proves to have a significant influence on the choice behaviour of firms in Business services, Finance and Health services. The negative parameters imply that alternatives that are clustered in space, individually have a smaller choice probability by these sectors. The estimated parameter for the centrality measure is significant in for most industry sectors. In` most cases the parameter is negative, which implies that alternatives in each other's proximity negatively influence each other's probability. This is in line with empirical findings of other competing destination models in literature (Fortheringham and Pelligrini, 2002). Please note that this result does not refer to the actual location preference of firms, but how the information on the available spatial alternatives is processed by the decision maker. Apparently, the clustering of spatial alternatives leads to a smaller choice probability for each individual alternative within this cluster.

Table 3: Estimated parameters Business services and Government sector.

	Business services							
	Model I		Model II		Model III		Model IV	
Variable	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Migration attribute								
Distance to original loc.[$km^{1/2}$]	-1.86	0.04 **	-1.86	0.04 **	-1.86	0.04 **	-1.86	0.04 **
Infrastructure proximity								
α-location; near trainstation [-]	-0.09	0.12	-0.09	0.12	-0.11	0.12	-0.09	0.12
β-location; near trainstation & highway onramp [-]	0.20	0.08 **	0.20	0.08 **	0.21	0.08 **	0.21	0.08 **
γ-location; near highway onramp [-]	0.02	0.06	0.02	0.06	0.06	0.06	0.02	0.06
ρ-location; neither [-]	-0.14		-0.14		-0.15		-0.14	
Urbanisation economies								
Logsum business and commuting trips [-]	0.018	0.004 **	0.018	0.004 **	0.021	0.004 **	0.018	0.004 **
Diversity attributes								
Diversity Rb < 7,5 min. [-]	-0.18	0.24	-0.18	0.24	-0.29	0.23		
Diversity x Age [-]							1.00	0.76
Diversity x Growth [-]								
Specialisation attributes								
Specialisation Rb < 7,5 min. [-]	0.44	0.07 **	0.43	0.07 **			0.46	0.07 **
Specialisation x Age [-]					0.78	0.20 **		
Specialisation x Growth [-]			0.030	0.157				
Centrality parameter								
Teta [-]	-1.21	0.16 **	-1.21	0.16 **	-1.10	0.15 **	-1.29	0.15 **
Number of observations	1992		1992		1992		1992	
Init log-likelihood	-5968		-5968		-5968		-5968	
Final log-likelihood	-3617		-3617		-3626		-3617	
Rho-square	0.394		0.394		0.392		0.394	

	Government							
	Model I		Model II		Model III		Model IV	
Variable	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Migration attribute								
Distance to original loc.[$km^{1/2}$]	-2.05	0.16 **	-2.05	0.16 **	-2.03	0.16 **	-2.06	0.16 **
Infrastructure proximity								
α-location; near trainstation [-]	0.11	0.37	0.11	0.37	0.15	0.37	0.12	0.36
β-location; near trainstation & highway onramp [-]	0.23	0.22	0.23	0.22	0.26	0.22	0.22	0.22
γ-location; near highway onramp [-]	0.08	0.19	0.08	0.19	0.04	0.19	0.08	0.18
ρ-location; neither [-]	-0.42		-0.42		-0.45		-0.42	
Urbanisation economies								
Logsum business and commuting trips [-]	-0.003	0.015	-0.002	0.015	-0.002	0.015	-0.003	0.015
Diversity attributes								
Diversity Rb < 7,5 min. [-]	0.03	0.78	0.04	0.78	0.15	0.77		
Diversity x Age [-]							-1.06	2.04
Diversity x Growth [-]								
Specialisation attributes								
Specialisation Rb < 7,5 min. [-]	-0.14	0.15	-0.14	0.15			-0.15	0.14
Specialisation x Age [-]					0.63	0.32 *		
Specialisation x Growth [-]			-0.109	0.283				
Centrality parameter								
Teta [-]	-0.26	0.49	-0.26	0.49	-0.59	0.46	-0.21	0.45
Number of observations	185		185		185		185	
Init log-likelihood	-554		-554		-554		-554	
Final log-likelihood	-347		-347		-346		-347	
Rho-square	0.373		0.373		0.375		0.373	

Table 4: Estimated parameters Financial services and General services.

	Finance							
	Model I		Model II		Model III		Model IV	
Variable	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Migration attribute								
Distance to original loc.[km$^{1/2}$]	-2.31	0.12 **	-2.31	0.12 **	-2.31	0.12 **	-2.31	0.12 **
Infrastructure proximity								
α-location; near trainstation [-]	0.39	0.22	0.39	0.22	0.39	0.22	0.39	0.22
β-location; near trainstation & highway onramp [-]	0.21	0.18	0.21	0.18	0.21	0.18	0.20	0.18
γ-location; near highway onramp [-]	-0.20	0.12	-0.20	0.12	-0.20	0.12	-0.20	0.12
ρ-location; neither [-]	-0.40		-0.40		-0.40		-0.39	
Urbanisation economies								
Logsum business and commuting trips [-]	0.036	0.008 **	0.036	0.009 **	0.035	0.008 **	0.036	0.009 **
Diversity attributes								
Diversity Rb < 7,5 min. [-]	0.37	0.61	0.37	0.61	0.27	0.57		
Diversity x Age [-]							0.31	2.15
Diversity x Growth [-]								
Specialisation attributes								
Specialisation Rb < 7,5 min. [-]	-0.08	0.09	-0.09	0.09			-0.06	0.09
Specialisation x Age [-]					-0.21	0.35		
Specialisation x Growth [-]			0.070	0.202				
Centrality parameter								
Teta [-]	-1.97	0.44 **	-1.97	0.44 **	-2.05	0.41 **	-1.94	0.43 **
Number of observations	427		427		427		427	
Init log-likelihood	-1279		-1279		-1279		-1279	
Final log-likelihood	-658		-658		-658		-658	
Rho-square	0.486		0.486		0.485		0.485	

	General services							
	Model I		Model II		Model III		Model IV	
Variable	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Migration attribute								
Distance to original loc.[km$^{1/2}$]	-2.15	0.09 **	-2.15	0.10 **	-2.14	0.09 **	-2.15	0.09 **
Infrastructure proximity								
α-location; near trainstation [-]	-0.07	0.32	-0.07	0.32	-0.06	0.33	-0.08	0.32
β-location; near trainstation & highway onramp [-]	0.26	0.19	0.26	0.19	0.30	0.19	0.27	0.19
γ-location; near highway onramp [-]	0.08	0.14	0.08	0.14	0.09	0.14	0.09	0.14
ρ-location; neither [-]	-0.28		-0.28		-0.32		-0.28	
Urbanisation economies								
Logsum business and commuting trips [-]	0.025	0.010 *	0.025	0.010 *	0.026	0.010 **	0.025	0.010 *
Diversity attributes								
Diversity Rb < 7,5 min. [-]	-0.71	0.52	-0.71	0.52	-0.73	0.52		
Diversity x Age [-]							-0.30	1.83
Diversity x Growth [-]								
Specialisation attributes								
Specialisation Rb < 7,5 min. [-]	-0.12	0.17	-0.12	0.17			-0.13	0.17
Specialisation x Age [-]					0.87	0.44 *		
Specialisation x Growth [-]			-0.021	0.430				
Centrality parameter								
Teta [-]	-0.66	0.37	-0.65	0.37	-0.81	0.36 *	-0.78	0.35 *
Number of observations	442		442		442		442	
Init log-likelihood	-1324		-1324		-1324		-1324	
Final log-likelihood	-710		-710		-710		-711	
Rho-square	0.463		0.463		0.464		0.463	

Table 5: Estimated parameters for Health services.

	Health services							
	Model I		Model II		Model III		Model IV	
Variable	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Migration attribute								
Distance to original loc.[$km^{1/2}$]	-2.66	0.10 **	-2.66	0.10 **	-2.66	0.10 **	-2.66	0.10 **
Infrastructure proximity								
α-location; near trainstation [-]	-0.06	0.24	-0.06	0.24	-0.05	0.24	-0.05	0.24
β-location; near trainstation & highway onramp [-]	0.37	0.15 *	0.37	0.15 *	0.35	0.15 *	0.36	0.14 *
γ-location; near highway onramp [-]	-0.19	0.12	-0.19	0.12	-0.19	0.12	-0.20	0.12
ρ-location; neither [-]	-0.12		-0.12		-0.11		-0.11	
Urbanisation economies								
Logsum business and commuting trips [-]	0.023	0.007 **	0.024	0.007 **	0.023	0.007 **	0.023	0.007 **
Diversity attributes								
Diversity Rb < 7,5 min. [-]	0.41	0.49	0.41	0.48	0.42	0.48		
Diversity x Age [-]							-1.59	1.60
Diversity x Growth [-]								
Specialisation attributes								
Specialisation Rb < 7,5 min. [-]	0.06	0.14	0.05	0.15	0.00	0.00	0.07	0.14
Specialisation x Age [-]					-0.28	0.58		
Specialisation x Growth [-]			0.175	0.436				
Centrality parameter								
Teta [-]	-1.23	0.36 **	-1.24	0.36 **	-1.27	0.36 **	-1.10	0.35 **
Number of observations	742		742		742		742	
Init log-likelihood	-2223		-2223		-2223		-2223	
Final log-likelihood	-894		-894		-894		-894	
Rho-square	0.598		0.598		0.598		0.598	

5. Conclusion

The presented analysis included a firm level analysis of relocating firms in a spatially disaggregated environment. First of all, the relocation probability proved to be influenced by firm attributes mainly, which is in line with firm demographic literature. Bigger firms are less likely to relocate (Carroll and Hannan, 2000; Brouwer et al., 2002) and firms with relative large growth rates are more likely to relocate (Carroll and Hannan, 2000; Pellenbarg 1996; Louw, 1996). The relocation probability varies across industry sectors, but accessibility appears to have a limited influence. Agglomeration however, does have an effect: firms at diverse locations are more likely to relocate. This is interpreted as a pattern of successful firms that leave their breeding areas.

When firms relocate and search for a new location, they have a significant preference for locations in the proximity of their original location. This is interpreted as evidence for keep-factors: a relocating firm strives to maintain their existing spatial network. Moreover, the spatial clustering of location alternatives proves to have a significant influence on the choice behaviour of firms: alternatives that are clustered in space, individually have a smaller choice probability. This is in line with findings by Fortheringham and Pelligrini (2002). Furthermore, the location preference for highway and/or train station proximity proves to differ across industry sectors. Moreover, all industry sectors have a preference for locations with a good accessibility to labour markets and the workforce (urbanisation economies). The estimations provide strong evidence that firms in Business services prefer locations that have a relatively high representation of firms from their own industry sector. This is interpreted as evidence for the existence of Marshall externalities and consistent with the findings of Duranton and Puga (2000).

In general the estimations provide a consistent pattern that can be understood from an agglomeration and life cycle perspective on firms, similar to Duranton and Puga (2000). Diverse environments are regarded as breeding areas where firms start up. When firms are successful they grow and relocate to more specialised locations. Diverse locations are mainly the breeding areas for young firms and high dissolution probabilities. However, if firms are successful and grow, they decide to relocate to specialised locations.

The findings identify important location factors that can help urban planners in anticipating on expected demand for industrial or office locations. The analysis has shown that the sector and life cycle of firms determine whether firms seek specialised locations, locations in the proximity of train stations or other typical locations. If planners want to provide a suitable supply for the current firm population or for new firms in future years, they should account for the composition of the firm population that is expected.

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