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The Spatial Organization of Multinational Firms*

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Abstract

Using six years of firm-level data covering 224 regions of the enlarged European Union, we evaluate the importance to a firm of locating its activities (production, headquarters, R&D, logistics and sales) close together. We find that, after controlling for regional characteristics, being closely located to a previous investment positively affects firm location choice. However, the impact of distance is dependent on the type of investment (production or service). The impact dies out faster for service activities. Finally, we show that a surprisingly positive effect comes from locating a new production plant close to an existing production investment, but in another country.

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1 Introduction

Falling trade and communication costs have been one major component of the ongoing process of globalization (Fujita and Thisse, 2006). As a result, it is now increasingly possible to spatially separate production stages by task (Grossman and Rossi-Hansberg, 2008) or function (Duranton and Puga, 2005). We thus observe the international *slicing up of the value chain* (Krugman, 1995), whereby multinational firms break down their value chain into various stages spread across different countries or regions due to factor price and endowment differences. Nevertheless, firms still tend to seek geographical proximity when setting up new activities. As noted in the *World Investment Report* (UNCTAD, 2004, page 152): "*Face-to-face interaction is still required at many points in the value chain of developing, marketing, delivering and maintaining a variety of services. [S]ome processes are hard to manage cross-nationally*". Proximity between activities allows communication and transport costs to be reduced. However, the nature of these costs depends on the type of activity under consideration (production or services). Whereas splitting up the production of a good across locations implies transport (or trade) costs from one location to another, a stand-alone service activity will cost more in terms of coordination costs than will integrated services.

In this paper, we analyze the spatial organization of multinational firms and the incentives for firms to locate activities close to each other. Our contribution is to consider the spatial dependencies between existing elements of the firm's value chain and its location choice for a new activity. We show that multinational firms locate close to existing investments, even after controlling for regional characteristics.

To show this, we make use of a recently-collected data set from the consulting group Ernst & Young on the location choice of multinational firms over the 1997-2002 period. Three pieces of information are of particular interest for us. First of all, we are able to identify the parent company associated with each investment. Not only can we control for the agglomeration effects *across* firms, but this information allows us to study the location choice of activities *within* a firm. Secondly, we are able to identify the exact location of each investment in a set of 224 NUTS-2 European regions[1]. This very detailed geographical level enables us to study in detail the within-firm spatial dependencies between past location and new location choice. In particular, we are further able to distinguish between regional co-location, i.e. the location by a firm of two investments in the same region, and location in neighboring regions to an existing investment (but not in the same region) of the same firm. In most of the previous literature, the analysis of the geographical organization of multinational firms has been limited to the study of the co-location of investments. For example, using data on Japanese foreign investments in the United States and European regions respectively, Head et al. (1995) and Head and Mayer (2004) find that the regional co-location between affiliates of the same industrial *Keiretsu* is an important determinant of firms' location choices. Only Smith and Florida (1994) have considered the influence of distance to Japanese assembly plants on the location choice of Japanese Auto-related parts suppliers. Finally, the data set provides information not only at the firm level but also on the type of activities. In this study, we consider the location choice of both production and service activities of manufacturing firms, starting at conception (headquarters and R&D centers) and ending with delivery (logistics and sales offices). The existing works have focused on production-plant location only. Recent contributions have extended these analyses to the international

[1]For each EU member country, a hierarchy of NUTS (Nomenclature of Units for Territorial Statistics) levels has been established by Eurostat. NUTS-2 regions correspond to a population between 800,000 and 3,000,000 people. For example, England is divided in 25 NUTS-2 regions, wherein London accounts for two regions. The Netherlands is divided into four NUTS-2 regions while Estonia, Lithuania, Luxembourg, and Latvia only account for one NUTS-2 regions.

location of service activities by multinational firms. Using the same dataset as in this study, Defever (2006) shows that firms tend to locate different activities within the same country, specially R&D and production. Using a more detailed geographical level, Basile et al. (2009) analyze the location of production and service investments in European regions. To take into account spatial autocorrelation, they use spatial econometrics. The drawback of this methodology is the need to aggregate data on the number of investments, which prevents the analysis of individual firm effects.[2]

To analyze the *within-firm* spatial organization of both production and service activities, we start by setting out a simple model of the relationship between activity location and firm performance. For each type of activity, a multinational firm chooses a location, considering characteristics such as factor prices, access to intermediate service inputs and agglomeration effects. In addition, the multinational firm is likely to spatially organize its production process and take into account its existing investment locations. We here evaluate how transport/communication costs may prevent firms from setting up activities in remote locations and lead them to locate their functions within a spatially-limited area.

Using conditional and mixed logit models, we examine the regional determinants of location for both production and service activities by non-European multinational firms (mostly American and Japanese). Our main results are as follows:

Firstly, we show that firms' location decisions depend strongly on the geography of its prior investments. More precisely, prior service or production investments located in the 75-mile area around a location affect positively

[2] Work on the location choice of service activities has also appeared in Urban Economics. Henderson and Ono (2008) and Aarland et al. (2007) consider the location choice of Headquarters, and the choice between co-locating with production plants or locating in a remote large city to gain access to a variety of service inputs. Strauss-Kahn and Vives (2009) study the relocation of headquarters to another city, and find that distance to the historical location plays an important role in the new location choice.

and significantly the probability that a multinational firm will choose this location for a new investment.

Secondly, we distinguish between regional within-firm co-location, i.e. the location of two firm investments in the same NUTS-2 area, and location in neighboring regions to an existing investment of the firm (but not in the same region). We find that the co-location of firm activities in the same region turns out to be very important for all functions, except for sales and marketing activities which are spread across locations. However, the location in a different, but neighboring region to an existing investment, plays no role in the location of service activities, and existing service investments do not affect firms' location choices. Neighboring investments only matter for the location of production, and only if the existing investment is also a production unit.

Finally (and quite surprisingly), we show that an additional positive effect comes from locating a new production plant close to an existing production investment, but in another country. It is possible that firms locate their production plants in different countries to benefit from their respective comparative advantages, but that they nevertheless choose locations that are relatively close together in order to minimize transport costs.

Our study is relevant for policy makers as it helps to understand the location process of multinationals at the regional level for both their production and service units. The attraction of multinational activity is a policy concern not only for country but also for regional authorities. As noticed by Harding and Smarzynska-Javorcik (2010), in 2001, there existed more than 160 national investment promotion agencies but over 250 sub-national agencies around the globe. In addition, investment promotion agencies target not only production investments but also the establishment of service units. As mentioned in the 2010 annual report of the Invest In France Agency (p. 19), "the presence of R&D centers and company headquarters or registered offices of multinational groups has a domino effect on the rest of the economy in terms of knowledge and technology transfers. As such, investment projects like these deserve recognition as *strategic activities*". An interesting policy implication of our study is that firms tend to locate services activities, including headquarters and R&D, close to existing production units. Therefore, investment promotion agencies may have little scope to attract specific services activities unless conditions are also conducive to investment in production.

The remainder of the paper is organized as follows. Section 2 describes the data. Section 3 outlines a simple model and explains the construction of the dependent and explanatory variables. The estimation results are presented in Section 4, and Section 5 concludes.

2 Definition and descriptive statistics

This section provides an overview of the different activities of the firm's value chain, and presents some empirical evidence of location geography.

2.1 The data

We exploit a database developed by Ernst & Young, called the EIM (European Investment Monitor), which identifies project-based foreign inward investment announcements. The main sources of information are newspapers, financial information providers (such as Reuters), and national investment agencies (such as the Invest in France Agency).[3] When a new project is discovered, they track it in order to determine the exact location at the city level. The dataset is mainly purchased by economic development agencies

[3]Projects included in the database have to comply with several criteria to be considered as international investments. The database excludes acquisitions, license agreements, and joint ventures (except in the case where these operations lead to an extension or a new establishment). It also excludes retail, hotel and leisure facilities, fixed infrastructures, extraction facilities, and portfolio investments.

wishing to identify trends, significant movements in jobs and industries at the local level. Regarding the representativeness of the dataset - there are no minimum size criteria stated for selecting investment announcements, however the number of investments where less than 10 jobs are created turns out to be very low. In addition, the newspaper announcements are likely to mainly focus on large projects of large multinational firms. As a result, our empirical evidence probably identifies the location strategies of major multinational companies, while smaller multinationals could follow different strategies.

The database covers multinational firms' location choices over the 1997-2002 period in 23 countries of the enlarged European Union, including the members that entered the EU in May 2004, but excluding Malta and Cyprus. The investment-project data provide information at individual-firm level on multinational-firms' investments in Europe. In this paper we only consider investments from non-European multinational-firms and not investments from European firms. A major reason of this restriction is that the dataset does not include information on European multinational-firms investments in their own home country. Considering only the investments from non-European multinational-firms enables us to obtain a coherent and homogeneous subset of data.[4] In addition the location of investments from non-European multinational-firms - mostly American and Japanese in the dataset - in Europe is unlikely to be determined by the distance between the home country of investors and the region of location of investments. So considering investments from non-European multinational-firms only, enables us to study the location choice independently from home-country characteristics.[5] This is relatively common in the literature. For example, Head

[4]As we do not observe investments in the home country, we would have to introduce an asymmetry between European and non-European investments.

[5]The location choice may still depend on common characteristics between the home country and the country of destination such as a "Common Language". We will address this issue in section 3.2

et al. (1995) consider Japanese investment in the US, while Head and Mayer (2004) consider Japanese investment in Europe.

The data set includes the name of the firm, the name and origin of the parent firm and the sector of the firm's main activity. Further, we have information on the function of each investment. We consider only firms whose main activity is classified as Manufacturing and consider five different functions: *Headquarters (HQ)*, which corresponds to administration, management and accounting activities; *Research & Development centers (R&D)*, which encompasses both fundamental scientific research and applied development; *production plants*, covering anything related to the physical production of goods; *logistics* refers to all activities linked to the transport of goods, including warehousing; and *sales & marketing offices*, which includes both wholesale trade and business representative offices. Finally, and most importantly from our point of view, the dataset provides the exact location of each investment and the corresponding NUTS-2 unit. The EIM data set aggregates some of the NUTS-2 regions up to a more aggregated classification (NUTS-1).[6] All specific locations (islands and overseas locations) are excluded from the sample.[7] Our final sample includes 224 regions.[8]

2.2 Descriptive statistics

At the regional level, Table 1 shows the ranking of the top 10 locations in terms of the number of new projects over the 1997-2002 period for each function. There are significant differences between locations for production

[6]The thirteen Greek NUTS-2 regions are aggregated up to three NUTS-1 regions. In the UK, Inner and Outer London are aggregated. This is also the case for the Provincia Autonoma Bolzano-Bozen and the Provincia Autonoma Trento in Italy, and Stredn Morava and Moravskoslezsko in the Czech Republic. In Germany, (i) Brandenburg-Nordost and Brandenburg-Sdwest and (ii) Chemnitz, Dresden and Leipzig are aggregated.

[7]These are: the Balearic Islands, the Canary Islands, Ciudad Autnoma de Ceuta, and Ciudad Autnoma de Melilla (Spain); Corsica, and the four French overseas regions (France); Guernsey (UK); Azores and Madeira (Portugal); and Aland Island (Finland).

[8]The complete database is composed of 13109 projects (extension of existing site and new creation), including all of the countries and functions available.

plants and service activities. Five of the top 10 locations for production plants are in Central and Eastern Europe, while the ranking for HQ and R&D centers includes only Western European locations. For example, London and the Parisian region (Ile de France) are in the top 10 location for the four service functions but do not appear in the production ranking.

Maps of the regional distribution of the five functions are presented in Figure 1. To correct for different regional size, we calculate the number of investments for each function (between 1997 and 2002) divided by regional population (in 2000). The concentration levels are not the same for the five functions. Whereas HQ and R&D centers are highly concentrated in only a few locations, production plants are more widely dispersed.

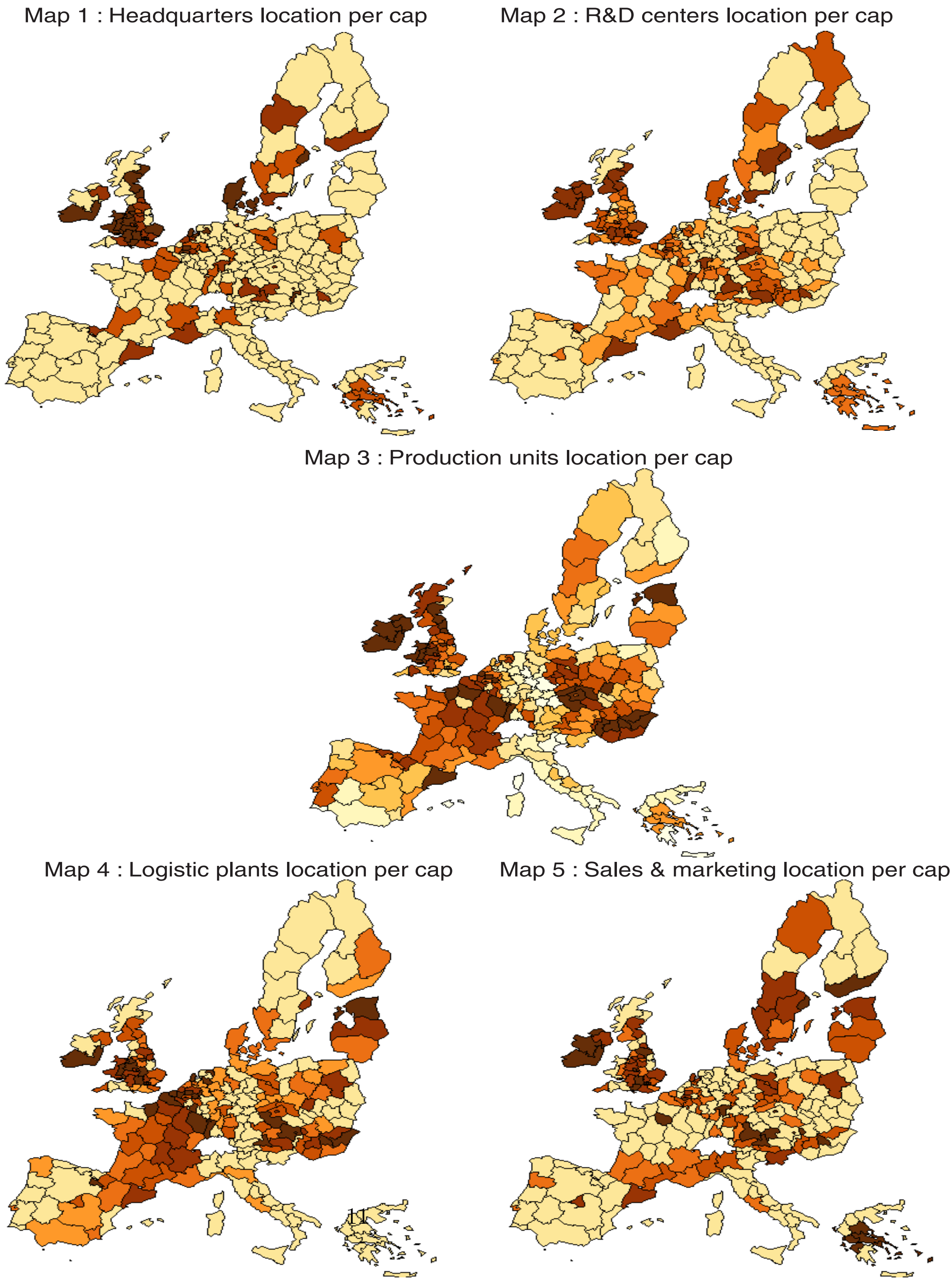
At the firm level, of the 1452 non-European parent companies in the manufacturing sectors that created new overseas establishments in the enlarged EU in 1997-2002, 1254 created new establishments for only one function. Of the other 198 firms, 125 carried out investments in two types of activities, 48 in three, 10 in four, and 15 invested in all five of the functions under consideration. Some firms invest abroad a great deal. For example, over the 1997-2002 period, Ford Motor Co was responsible for 38 new establishment announcements in the enlarged EU respectively. The ten largest parent companies (in terms of number of new foreign establishments), covering 10.5% of all new investments in the manufacturing sector, established a substantial number of new service activities to support their European production. Together, they represent 17.5% of new investments in R&D, but only 9.7% of investment in production plants.

Table 1: Top 10 overseas locations by function

Region	NUTS 2	Country	Nb of projects
	Headquarters		
London	*uki**	UK	30
Denmark	dk00	Denmark	10
Brussels	be10	Belgium	10
Ile de France	fr10	France	10
Southern and Eastern Ireland	ie02	Ireland	7
Gloucestershire, Wiltshire and North Somerset	ukk1	UK	7
Berlin	de30	Germany	7
Berkshire, Bucks and Oxfordshire	ukj1	UK	7
Vienna	at13	Austria	6
Zuid-Holland	nl33	Netherland	6
	R&D centers		
Southern and Eastern Ireland	ie02	Ireland	21
London	*uki**	UK	20
Stockholm	se01	Sweden	17
Catalonia	es51	Spain	16
Provence-Alpes-Cote d'Azur	fr82	France	15
East Anglia	ukh1	UK	14
Oberbayern	de21	Germany	11
Berkshire, Bucks and Oxfordshire	ukj1	UK	11
Ile de France	fr10	France	10
South Western Scotland	ukm3	UK	10
	Production plant		
Southern and Eastern Ireland	ie02	Ireland	50
Catalonia	es51	Spain	36
Kozep-Dunantul	hu21	Hungary	36
Kozep-Magyarorszag	hu10	Hungary	34
Border, Midlands and Western	ie01	Ireland	32
Gloucestershire, Wiltshire and North Somerset	ukk1	UK	28
Severozapad	cz04	Czech rep	27
West Wales and The Valleys	ukl1	UK	23
Severovychod	cz05	Czech rep	23
Eszak-Magyarorszag	hu31	Hungary	22
	Logistics		
Antwerpen	be21	Belgium	15
Southern and Eastern Ireland	ie02	Ireland	11
Ile de France	fr10	France	10
Rhone-Alpes	fr71	France	10
Limburg	be22	Belgium	8
London	*uki**	UK	7
Noord-Holland	nl32	Netherland	7
Berkshire, Bucks and Oxfordshire	ukj1	UK	6
Nord - Pas-de-Calais	fr30	France	5
Catalonia	es51	Spain	4
	Sales & marketing		
London	*uki**	UK	86
Ile de France	fr10	France	40
Stockholm	se01	Sweden	21
Darmstadt	de71	Germany	19
Oberbayern	de21	Germany	18
Berkshire, Bucks and Oxfordshire	ukj1	UK	17
Vienna	at13	Austria	12
Brussels	be10	Belgium	12
Mazowieckie	pl12	Poland	12
Southern and Eastern Ireland	ie02	Ireland	11

New foreign investments of non-European firms in the 224 regions of 23 countries of the Enlarged European Union (EU15 and CEE8) for the five functions over the 1997-2002 period in manufacturing sectors. Notes: * indicates the use of NUTS-1 classifications instead of NUTS-2.

Figure 1: Number of investments by function as a share of regional population in the Enlarged European Union.



Notes: These maps show nine quantiles, with darker colours representing a higher investment/population ratio. New overseas creations in the manufacturing sector in the 23 countries of the Enlarged European Union (EU15 and CEE8) over the 1997-2002 period.

3 Empirical Implementation

3.1 The Model

To help structure the discussion, we follow Duranton and Puga (2005) and Henderson and Ono (2008), and outline a simple model describing the contribution of an outlet to a firm's performance. Let $R = (1, ..., r, ...n)$ be the set of possible locations. A firm's activity $k = \{p, s\}$ can be either a production plant p or a service unit s. Both type of activities are carried out using low-skilled labor with a wage ω_r, in addition to a certain number of varieties of skilled labor h_r and a certain number of varieties of intermediate services m_r available at location r. We assume that, at a given period of time, a firm calculates the outlet's contribution to its overall profit for each activity k and in each location r independently. We can write an ad-hoc contribution of an outlet located at r to the overall profit of firm i as:

$$\pi_{ri}^{k} = A(E_{r}^{k}, L_{ir}, D_{ri}^{k'}, \mu_i)(\omega_r)^{-\beta_l^k}(h_r)^{\beta_h^k}(m_r)^{\beta_m^k} \qquad \text{with} \quad k' \in \{p, s\} \quad (1)$$

This equation can be derived from maximization of the contribution of an outlet located in r to the overall profit of a price-taking firm using a Cobb-Douglas production function for the activity k, in which the amount of high-skilled and intermediate-service inputs enter into the production in a Dixit-Stiglitz-Ethier fashion and the β's represent the relative importance of each factor (see Defever, 2010). In addition, we assume that production is subject to a Hicks-neutral shift factor $A(.)$, which is itself a function of a number of other variables, which would be assumed to be separable.

We first have evidence that related multinational firms tend to cluster in the same regions due to the presence of externalities, such as information spillovers. Duranton and Puga (2005) consider two possible forms of agglomeration: the agglomeration of firms belonging to the same sector and the agglomeration of outlets belonging to the same function (or activity, e.g. headquarters' activity). We define E_r as the number of outlets with the same function k of other multinational firms belonging to the same sector as firm i at location r.

Second, L_{ir} captures the communication cost between the main Headquarter of the parent company, located in its country of origin, and the outlet.

Third, we have the geographical relationship between the activity's location and the existing activities of firm i. Denote by $D_{ir}^{k'}$ the distance matrix summarizing the geographical relationship between firm i's activities k located at r and the location of the firm's existing activities $k' \in \{p, s\}$ located in all other regions $r' = (1...j...n)$. Distance between the firm's activities naturally increases the transport (trade) costs of the inputs that are physically shipped; it also affects how efficiently each activity can be supported, managed and monitored by service activities.

Fourth and last, we have unobserved firm characteristics, μ_i.

3.2 Empirical strategy

Under the assumption of separability within A(.), taking natural logs of the equation (1) leaves the profit ranking between locations unchanged and allows us to obtain a simple expression for profitability.

$$\ln(\pi_{ir}^{k}) = -\beta_l \ln(\omega_r) + \beta_h \ln(h_r) + \beta_m \ln(m_r) + ln(E_r) + ln(L_{ir}) + \ln(D_{ir}^{k'}) \quad (2)$$

Equation (2) expresses the profitability of activity k located in region r. The firm looks across feasible locations and chooses the location which maximizes the outlet's contribution to its profits. Firm characteristics μ_i do not vary across location and will not affect the ordering of profits over alternative locations. Thus, while the profit depends on firm characteristics μ_i, we can omit μ_i from equation (2) since in a conditional logit unobserved firms' characteristics do not interact with the location choice. However, in the estimations, we will consider a special case where the unobserved characteristics of the firm are correlated across alternative location choices (by using mixed logit estimation). Our dependent variable consists of real creations (also known as *greenfield*)[9] carried out by non-European (mostly American and Japanese) multinational firms in manufacturing sectors over a set of 224 European regions. This leaves us with 2621 investments. Each location decision is a discrete choice made among several alternatives.

Profit π_{ir} is decreasing in local wages and increasing with the availability of high-skilled workers and intermediate inputs in the local market. However, the relative importance of both types of labor and intermediate service inputs largely depends on the type of outlet. The coefficients reflecting high-skilled labor (β_h) and intermediate inputs (β_m) are likely higher for service than for production activities, because the latter uses more low-skilled labor.[10] We expect the location of service activities to be influenced by local human capital and other intermediate service inputs, so the corresponding coefficients for the four service functions should be higher than those for production. Since labor costs are the most important factor for production plants, we expect this variable to have a negative and significant effect on location choice. In our empirical implementation, local labor cost is measured by *Unit Wage Costs*, which is total wages and salaries in the manufacturing sectors per worker divided by productivity (value added per head) at the NUTS-2 level. The *Education* variable corresponds to the percentage of 25 to 64 year-olds with tertiary education.[11] We use the *Density* of population of each region as a proxy for access to intermediate service inputs. Being located in large cities can be advantageous for service activities since it fa-

[9]The expansion of existing sites represents one-third of the total number of projects. These expansions are not directly linked to location choice. Consequently, we use only real creations for the construction of the dependent variable.

[10]This is in line with the stylized facts in Maurin and Thesmar (2004), that both upstream and downstream service activities are skill-intensive.

[11]Groups 5-6 in the International Standard Classification of Education (ISCED).

cilitates face-to-face relationships (see Holmes and Stevens, 2004). All of these variables are provided by Eurostat.

Profit π_{ir} also increases in the number of other local outlets E_r, due to positive scale *e*xternalities. The agglomeration variable, *function-sector count*, is defined as the logarithm of the stock of foreign establishments in the region r of all firms in the same sector and function as the new investment.[12] However, using a log approximation is problematic as in numerous regions, the function-sector count is zero or a small, positive number. To solve this problem, we follow Head and Ries (2001), and decompose the agglomeration variable into two parts: a dummy variable (E_r^d) to capture the impact of the first investment and the log of the count (E_r^c) for positive investment counts. The latter variable is set equal to zero when the count is zero. By doing that, we can examine whether the first investment had a different effect than subsequent investments.

Profit π_{ir} may increase with the decrease in communication cost between the country of origin of the parent company and the outlet. As we only consider non-European firms in our sample (mostly American and Japanese), the choice of location is probably unaffected by the distance to the home country. In addition, as the European countries share the same tariffs, this traditional determinant is also unlikely to affect the location choice. However, a *common language* between the country of origin of the investor and the country of destination could be an important determinant. For example, American investors could be more likely to invest in Ireland or in the UK. We set L_{ir} to be equal to one if the country of origin of the parent company and the region of destination have a common official language.

Finally, π_{ir} varies with firm-region variables, $D_{ir}^{k'}$, which characterize each county's geographical relationship to the other outlets of firm i. Vertical linkages between the different stages of the value chain are likely to

[12] The construction of the stock of previous investments is described in the Appendix.

encourage multinational firms to locate their activities close to each other, in order to reduce transport and communication costs. In a first specification, we capture this spatial dependence in a very simple way by considering the influence of nearby existing firm investments. D_{ir} is set equal to 1 if an activity was previously set up by the parent company in a region whose centroid is less than d miles away. This picks up the impact of prior investments for various values of d.[13] To estimate the respective impacts of *p*roduction and *s*ervice activities, we construct two distinct variables, D_{ir}^{p} and D_{ir}^{s}, reflecting the type of the prior investment $k' \in \{p, s\}$.[14]

In a second specification, we decompose the different effects between co-location in the same region, location in a neigboring region (but not in the same region), and prior location in a neigboring region but in another country. More precisely, the variable $C_{ir}^{k'}$ (for *C*o-location) equals 1 if an activity k' was previously set up by the parent company in the same NUTS-2 region, and $N_{ir}^{k'}$ (for *N*eighbor) captures location in a region whose centroid is less than a certain number of miles from the centroid of the region r under consideration, but in a different NUTS-2 region. Neighboring locations which are in a different country to the prior investment are picked up by $F_{ir}^{k'}$, for *F*oreign neighbor; this will reflect any additional effect due to the presence of a national border.

3.3 Econometric implementation

We now present an econometric model of firm-location choice. The most widely-used econometric technique for this type of problem is the conditional logit model (CLM) of McFadden (1984). The CLM focuses on the attributes of the choices in the set: here the characteristics of the NUTS-2 regions of the

[13]The construction of the bilateral distances between each pair of regions is described in the Appendix.

[14]Service activities consist of the four service functions described above, plus all other service functions, e.g. call centers.

European Union. These attributes can be constant across all investors, such as wages or average education, or can vary across firms, such as their own prior investments in the same or neighboring regions. The conditional logit model is specified as follows. While the true profits from different locations $R = (1, ..., r, ...n)$, are not observed, we do see firms' actual choices and the characteristics of the alternative locations. Each location is associated with a profit of π_{ir} such that:

$$\pi_{ir}^{k} = \theta_r + \delta D_{ir}^{k'} + \varepsilon_{ir}, \qquad \text{with} \quad k' \in \{p, s\} \tag{3}$$

with $\theta_r = \beta X_r$, where X_r are region r-level control variables common to all firms (e.g. regional wage), $D_{ir}^{k'}$ is a vector of firm-region independent variables (e.g. the firm's prior investments in the vicinity),[15] and ε_{ir} is the error term. Following Carlton (1983), the error term ε_{ir} can be considered as a firm-activity location specific effect, capturing the unique advantages of the location for each activity of a firm.

As previously mentioned in section 3.1, we assume that, at a given period of time, the firm calculates the outlet's contribution to its overall profit independently for each activity in each location and for each period of time. Let us spell out clearly the implications of these assumptions: (i) We assume that the profit contribution is calculated for each function independently. We can, therefore, estimate the location model of each activity separately. We estimate 5 independent regressions; one for each of the five functions. By doing that, we implicitly assume that there is no firm-region specific advantages affecting simultaneously all the different activities of the same firm.[16]

[15]We could have dealt with spatial autocorrelation between investments via spatial econometrics, as in Bloningen et al. (2007) and Basile et al. (2009). Contrary to the approach here, these latter use aggregate data to create the dependent variable. As noted by Fleming (2004), spatial econometrics with qualitative dependent variables is still developing, which prevents us from using it here.

[16]In this paper we do not consider regional policies. Nevertheless, local policy makers can provide subsidies to a firm for locating several of its activities over few years in the

(ii) As we assume that the firm calculates outlet' profit contribution independently for each location, we also rule out the possibility for cross-regional firm specific advantage affecting various activities of the same firm in different location.[17] (iii) Assuming that outlet's profit contribution is calculated independently for each period, we can estimate the effect of prior investments in a simple cross section and abstract from possible inter-temporal discrete choices made by the firm.[18]

From equation 1, π_{ir} also depends on firm characteristics μ_i; but our imposition of separability within A(.) implies that these will not influence location decisions. However, in the case where the unobserved characteristics of the choosers are correlated across alternative location choices, this heterogeneity will affect the error term and produce inconsistent estimates; it will in fact lead to violation of the Independence from Irrelevant Alternatives (IIA) assumption. Taking this problem seriously, we introduce individual random effects into the estimation via a Mixed Logit Model (MLM): (Train, 2003). In this case, the return to firm i from choice r is as specified in equation (3), but now with $\theta_r = \beta_i X_{ir} = \beta' X_{ir} + \mu_i X_{ir}$, where the β_i is now assumed to be a random coefficient and can be decomposed into its mean β' and deviations μ_i. In this case, $\mu_i X_{ir}$ represents the correlation between the unobserved firm characteristics μ_i and the regional characteristics X_r. This is equivalent to a random-parameter model where the coefficients on X_{ir} can be thought to vary randomly with mean β' and the same distribution, given by μ_i, around this mean. We estimate the β' and μ using

same region. In this case, we would attribute the co-location of activities in the same region over time to vertical-linkages, while the firm is simply facing a cost advantage affecting all its activities. While such policies may account for part of the effect we find, they are unlikely to fully drive our results.

[17]Here again, policy action could be a source for cross-regional firm specific effects. For example, national policy makers could provide subsidies to a firm for locating several of its activities in different regions but in the single country (over several years). In section 4.3, we will evaluate the impact of national borders.

[18]This assumption also rules out dynamic investment strategies of firms as, for instance, the case of investment under uncertainty. See Dixit and Pindyck (1994).

simulation methods, under the assumption that μ is normally distributed.[19] We now turn to the estimation of the coefficient δ in equation (3). As D_{ir} represents the prior location choice of the firm i in region r, the variable varies over firms. Then, it would not make sense to estimate δ as a random coefficient affected by unobserved firm characteristics. Instead, we estimate δ as a fixed coefficient as in a standard logit model (see Defever, 2006 and Basile et al., 2008, for recent applications of the mixed logit model to the location of multinational firms).

Another strategy is to capture the regional characteristics θ_r via fixed effects for locations (these pick up the attraction of location r that is common to all investors, independent of the parent company's prior investments). This also removes some forms of bias which potentially arise from the IIA assumption.

The coefficient vectors θ_r (and the β that they represent) and δ are estimated by maximum likelihood. The firm chooses to locate in r if the profit there is higher than that obtained in any other location. Assuming a Type I extreme-value distribution for the error term, ε_{ir}, we obtain the simple probability of choosing r:

$$P_{ir} = \frac{e^{\theta_r + \delta D_{ir}}}{\sum_{j=1}^{n} e^{\theta_j + \delta D_{ij}}}. \tag{4}$$

The firm-specific dummy variable D_{ir} can be interpreted as an odds-ratio. Everything else equal, this is the probability ratio of choosing region r, for a firm i with an existing investment in the neighborhood, over the probability of another firm i' choosing the same region, but without any existing investment in the neighbor.

$$\frac{P_{ir}/(D_{ir}=1)}{P_{i'r}/(D_{i'r}=0)} = \frac{e^{\delta D_{ir}}}{e^{\delta D_{i'r}}} = \exp[(D_{ir} - D_{i'r})\delta] = \exp[\delta]$$

[19] These estimations result from 50 simulations.

The exponential of δ underlines how much more likely it is for a region to be chosen for a new investment by a firm with a prior investment in a neighboring region, relative to the probability to be chosen by a firm with no close prior investment.

4 Econometric results

Section 4.1 presents the results of Conditional Logit Model (CLM) and Mixed Logit Model (MLM) regressions which estimate the role played by the different regional and firm-region variables (in equation (2) of Section 3) in multinational firms' new investment location choices. We then explore in Section 4.2 various distance bands for the firm-region variables via CLM estimation with region fixed-effects. Finally, Section 4.3 distinguishes between co-location, neighboring locations and foreign neighbors.

4.1 Basic specification

The regression results in Table 2 show the effect of education, unit wage, population density and an agglomeration variable on location choice for each function using CLM. Table 3 presents the Mixed Logit Model estimation results: these are mostly similar to those from CLM.[20]

Regional characteristics The positive and significant *Education* coefficient in columns 1, 2, 4 and 5 shows that service activities are located in more skilled regions. This variable is negative and significant at the 10 percent level only for production. This is consistent with our prior expectation. *Unit wage cost* does not significantly affect location choice for services, but is strongly negative and significant with respect to (labor-intensive) production. However, the introduction of a simple East-West dummy or coun-

[20]As we do not interpret the heterogeneity terms here, they are not shown in the table. The results are available upon request.

try fixed-effects render wages insignificant.[21] The negative wage coefficient essentially reflects the wage gap between Central and Eastern European (CEE8) and Western European countries.[22]

The coefficient on *population density*, used as a proxy for urban economies, is positive and significant for all service activities, but not for production. The Urban Economics literature, such as Duranton and Puga (2005), has highlighted the importance of a large, service-oriented area in order to benefit from local service input suppliers. The importance of density in the location of upstream stages was also highlighted by Holmes and Stevens (2004), who argue that service activities largely depend on face-to-face relationships. For downstream activities, such as Sales & Marketing, the result is, unsurprisingly, due to the advantage of being located close to demand.[23] This is also consistent with Holmes and Stevens (2004) and the results in Holmes (2005) regarding the location of Sales offices.[24]

The *Common Language* variable, L_{ir}, is significant (at least at the 10% level) for all the activities in the Conditional Logit Model (see Table 2), while the variable is never significant in the Mixed Logit (see Table 3).

As in previous work, e.g. Head et al. (1995), we find that *agglomeration*

[21]The estimation results are not presented for space reasons.

[22]Wage is also negative for Sales & Marketing. This function is largely located in countries with high demand-potential, such as Ireland, Greece, and Hungary (See Table 1).

[23]There are a number of arguments in the literature underlining the importance of market size for upstream activities. In particular, the literature on the internationalization of R&D centers by multinational firms (Kuemmerle, 1997) suggests that centers can be dedicated either to creating new products or adapting existing products to the local market. For the latter, market size may be an important determinant of R&D location choice.

[24]A market-potential variable would also capture the importance of being close to markets, especially for downstream activities. To calculate regional potential demand, we use the simple methodology inspired by Harris (1954), which consists of the sum of the GDPs of all other countries weighted by their distance to the chosen location. We then add the internal distance, as in Head and Mayer (2004). As was the case for density, market potential is strongly significant for all service activities, but not for production. This result contrasts with Head and Mayer (2004), who find a very significant market-potential coefficient when considering the production-plant location of Japanese firms in Europe. The fact that we also consider Central and Eastern European countries largely explains this difference.

regarding the prior location of multinational firms' investments plays an important role in location choice for all functions, except for the Logistic function. We find that the dummies (E_r^d) and the continuous variables (E_r^c) are positive and significant for R&D, production and sales, while only the dummy variable is significant in the case of the HQs, which seems mainly affected by the first investment. As we consider the sector-function count of previous investments, this highlights both the functional and sectoral dimension of agglomeration, in line with Duranton and Puga (2005).

Prior firm investments in the vicinity: The two last variables in Table 2 are the firm-region variables. The first controls for prior service investments located in the 75-mile area around the chosen location, while the second considers analogous prior production investments. The coefficients are interpreted as odds ratios. In the last line of column 3 of Table 2, the probability that a multinational firm locates its new production plant in region r increases by a factor of $\exp(1.65) \simeq 5.2$ if the firm had previously located a production investment in region r or one of the surrounding regions i within a radius of 75 miles. The analogous probability factors for locating a HQ, an R&D center or a logistic plant in r are $\exp(0.96) \simeq 2.6$, $\exp(0.54) \simeq 1.7$, and $exp(0.96) \simeq 2.6$ respectively for there having been a prior production investment in the vicinity. Prior service activity also positively affects the probability that a multinational firm locate an R&D center, production plant or logistic plant in the vicinity (see the variable D_{ir}^s in Table 2). Sales & Marketing is the only function whose location choice is independent of prior local investments.

Table 2: Conditional Logit Model.

		Dependent Variable: Location choice				
		HQ	R&D	Production	Logistics	Sales
Education (%)	h_r	0.09[a]	0.05[a]	-0.01[b]	0.04[a]	0.06[a]
		(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Log (unit cost)	w_r	0.23	-0.11	-0.43[a]	-0.21	-0.45[a]
		(0.26)	(0.21)	(0.12)	(0.26)	(0.17)
Log (density)	m_r	0.50[a]	0.14[a]	-0.02	0.30[a]	0.42[a]
		(0.05)	(0.04)	(0.03)	(0.06)	(0.04)
Function-sector	E_r^d	0.82[a]	0.83[a]	0.57[a]	-0.47	0.95[a]
dummy		(0.26)	(0.20)	(0.09)	(0.55)	(0.15)
Log (function-sector	E_r^c	0.24	0.69[a]	0.85[a]	1.47[b]	0.43[a]
count +1)		(0.18)	(0.14)	(0.05)	(0.57)	(0.08)
Common Language	L_{ir}	0.76[a]	0.23[c]	0.21[a]	0.39[b]	0.27[b]
		(0.16)	(0.12)	(0.08)	(0.17)	(0.11)
		Firm - Region level				
Prior service activity	D_{ir}^s	0.38	0.66[a]	0.50[a]	0.86[a]	0.06
in a 75-mile vicinity		(0.30)	(0.17)	(0.14)	(0.25)	(0.21)
Prior production plant	D_{ir}^p	0.96[a]	0.54[a]	1.65[a]	0.96[a]	0.13
in a 75-mile vicinity		(0.31)	(0.20)	(0.09)	(0.23)	(0.24)
Observations		230	389	1264	217	521
Log likelihood		-1014	-1863	-6075	-1084	-2323

Table 3: Mixed Logit Model.

		Dependent Variable: Location choice				
		HQ	R&D	Production	Logistics	Sales
Education (%)	h_r	0.09[a]	0.05[a]	-0.01[b]	0.04[a]	0.06[a]
		(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Log (unit cost)	w_r	0.17	-0.14	-0.44[a]	-0.24	-0.49[a]
		(0.27)	(0.21)	(0.12)	(0.27)	(0.17)
Log (density)	m_h	0.48[a]	0.14[a]	-0.02	0.31[a]	0.41[a]
		(0.06)	(0.04)	(0.03)	(0.06)	(0.04)
Function-sector	E_r^d	1.06[a]	0.92[a]	0.65[a]	-0.22	0.97[a]
dummy		(0.39)	(0.25)	(0.12)	(1.09)	(0.18)
Log (function-sector	E_r^c	-0.17	0.60[a]	0.90[a]	0.59	0.44[a]
count +1)		(0.47)	(0.20)	(0.05)	(1.42)	(0.11)
Common Language	L_{ir}	1.36	0.14	-0.18	0.07	-2.48
		(3.15)	(0.18)	(0.24)	(0.69)	(3.34)
		Firm - Region level				
Prior service activity	D_{ir}^s	0.60[c]	0.70[a]	0.53[a]	0.82[a]	0.17
in a 75-mile vicinity		(0.33)	(0.18)	(0.14)	(0.27)	(0.24)
Prior production plant	D_{ir}^p	1.09[a]	0.55[a]	1.73[a]	1.04[a]	0.16
in a 75-mile vicinity		(0.34)	(0.20)	(0.10)	(0.25)	(0.26)
Observations		230	389	1264	217	521
Log likelihood		-1006	-1861	-6065	-1084	-2317

Notes. Standard errors in parentheses. [a], [b] and [c] represent respectively the 1%, 5% and 10% significance levels. Dependent variable: Location choice in the 224 regions of the Enlarged European Union (EU15 and CEE8) for the five functions over the 1997-2002 period. New creations of non-European firms in the manufacturing sector.

Table 4: Conditional Logit Model with region fixed-effects.

		Dependent Variable: Location choice				
		HQ	R&D	Production	Logistics	Sales
		Firm - Region level				
Prior service activity	D^s_{ir}	0.33	0.61^a	0.57^a	0.75^a	0.06
in a 75-mile vicinity		(0.29)	(0.18)	(0.14)	(0.25)	(0.22)
Prior production plant	D^p_{ir}	1.02^a	0.61^a	1.80^a	0.71^a	0.29
in a 75-mile vicinity		(0.30)	(0.20)	(0.09)	(0.23)	(0.25)
Region fixed-effects		Yes	Yes	Yes	Yes	Yes
Observations		230	389	1264	217	521
Log likelihood		-873	-1588	-5790	-881	-2018

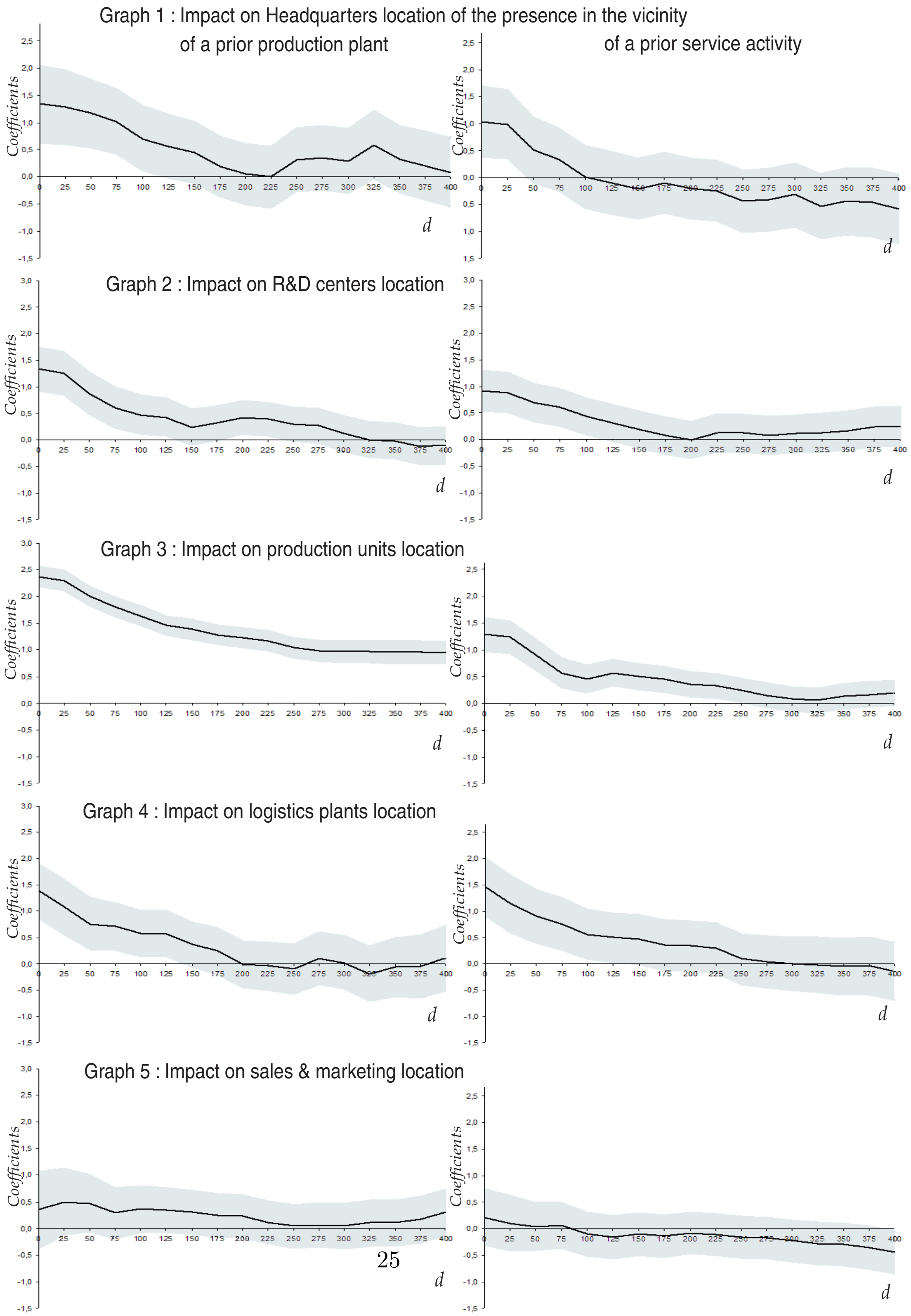
Notes. Standard errors in parentheses. ^{a}, ^{b} and ^{c} represent respectively the 1%, 5% and 10% significance levels. Dependent variable: Location choice in the 224 regions of the Enlarged European Union (EU15 and CEE8) for the five functions over the 1997-2002 period. New creations of non-European firms in the manufacturing sector.

4.2 Different distance bands

Table 4 presents a CLM with region fixed-effects, which capture the regional characteristics analyzed in the previous subsection, in addition to the two *prior investment in a 75-mile vicinity* firm-region variables. The results are robust to this specification change. Of course, the choice of the 75-mile radius is arbitrary, and it is possible that the coefficients on *prior production in the vicinity* and *prior service in the vicinity* depend on the size of the area under consideration. To check, we repeat the analysis in Table 4 with different distance bands, ranging from 0 to 400 miles, in 25-mile steps. The co-location of activities in the same region is considered to represent zero distance.

The coefficients from these regressions for different distance bands are depicted in Figure 2. The left-hand side panel of Graph 1 depicts the impact of prior production plants on the location of a new headquarter, depending on distance; the right-hand side of Graph 1 repeats the analysis for prior service activities. The ensuing graphs then consider the impact of prior pro-

Figure 2: Impact of prior local investments, depending on the radius d of the area considered.



Notes. The graphs show the coefficient estimates for each distance area with the 5% confidence intervals from conditional logit regressions with region fixed-effects. New creations of non-European firms in the manufacturing sector in the 23 countries of the Enlarged European Union (EU15 and CEE8) over the 1997-2002 period.

duction/service investments on the location of R&D, Production, logistics and sales offices location.

For a distance of zero, i.e. regional co-location, and short distances, multinational firms seem to place a great deal of importance on prior investments. Only Sales & Marketing is unaffected by previous investments, whatever the distance (see Graph 5 in Figure 2). As distance increases, both the coefficients and their significance fall. Beyond 125 miles, the area is too large and prior investments are irrelevant for the location choice of headquarters, R&D centers and logistics (see Graphs 1, 2 & 4 in Figure 2).

When considering an area with a radius superior to 125 miles, only the location of production plants exhibits spatial dependence to the geographical distribution of prior investments. From the left panel of Graph 3 in Figure 2, we can see that if region r has at least one production plant in the radius of a maximum of 200 miles, its probability of being chosen by the firm for the location of a new production plant increases by $\exp(1.23) \simeq 3.4$. Even when considering a wider area of 400 miles, the probability still rises by $\exp(0.97) \simeq 2.7$. This implies that a region located less than 200 miles from the previous investment has only a 25% higher chance of attracting the new investment than one located between 200 and 400 miles away.

4.3 Co-location, neighbors and foreign neighbors

In this section, we first distinguish between co-location and neighboring locations. We then focus on production-plant location, and identify the impact of neighboring locations on another country.

Co-location versus neighboring firm investment: Despite our efforts to carry out our analysis at a detailed geographical level, our measure of vicinity is still broad. Some regions, for example in Spain, are very large, which makes it difficult to evaluate precisely the impact of small distances. However, the considerable heterogeneity in our sample in terms of region

Table 5: Distinction between co-location and neighborhood.

		Dependent Variable: Location choice					
		HQ	R&D	Production		Logistics	Sales
		Firm - Region level					
Service co-location	C^s_{ir}	1.03[a]	0.93[a]	1.23[a]	1.25[a]	1.46[a]	0.21
$d = 0$		(0.34)	(0.19)	(0.16)	(0.16)	(0.28)	(0.27)
Production co-location	C^p_{ir}	1.32[a]	1.34[a]	2.37[a]	2.37[a]	1.38[a]	0.34
$d = 0$		(0.37)	(0.21)	(0.10)	(0.10)	(0.26)	(0.37)
Neighbor service	N^s_{ir}	-0.15	0.24	0.06	0.12	0.04	0.02
$d > 0$ & $d <= 75$ miles		(0.36)	(0.23)	(0.18)	(0.20)	(0.31)	(0.25)
Neighbor production	N^p_{ir}	0.42	-0.46	0.51[a]	0.37[a]	0.03	0.12
$d > 0$ & $d <= 75$ miles		(0.36)	(0.34)	(0.13)	(0.14)	(0.29)	(0.29)
Foreign (Service)	F^s_{ir}				-0.20		
					(0.38)		
Foreign (Production)	F^p_{ir}				0.63[b]		
					(0.26)		
Region fixed-effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		230	389	1264	1264	217	521
Log likelihood		-869	-1566	-5692	-5690	-867	-2018

Notes. Standard errors between parentheses. [a], [b] and [c] represent respectively 1%, 5% and 10% significance levels. Dependent variable: Location choice in the 224 regions of the Enlarged European Union (EU15 and CEE8) on the five functions during the period 1997-2002. New creations of non-European firms in the manufacturing sector.

size and the significant number of small regions, allows us to observe nearby locations between prior and new investments which are not necessarily in same region.

Table 5 therefore includes four different dummy variables for the location of prior investments: *service co-location* ($d = 0$), *production co-location* ($d = 0$), *neighbor service* ($0 < d <= 75$ miles), and *neighbor production* ($0 < d <= 75$ miles). As a result, the table distinguishes co-location of activities within a region from location of two activities in two different but neighboring regions. Results show that the possibility of co-locating with a service or a production activity strongly affects the probability of choosing this specific region for all functions, except for sales & marketing offices. However, the presence of a service or a production activity in a different but neighbor region does not affect the location choice of service activities.[25] When looking at the impact of prior production plants on the location of new production units, the picture looks different. In particular, column 3 shows that the location choice of a new production unit is affected by the presence of a prior production plant located in a different but neighboring region. Contrary to service activities, production plants are spatially organized by the firm, with their location being more detailed than a simple binary choice of co-locating in the same region or not.

Production plant networks and national borders: Distance to previous production investments matters when firms spatially organize their production network. National borders may also affect the likelihood of choosing a region in the neighborhood of a prior production investment but in an adjacent country.

Column 4 of Table 5 is identical to column 3 except that we add two new variables: Foreign (service) F^s and Foreign (production) F^p. These are equal to 1 if the firm's prior service/production investment in the neighborhood was in an adjacent country. Column 3 of Table 5 shows that the location choice of new production plants is not affected by the location of prior service investments in neighboring regions, and, logically, the border effect of *foreign (service)* in column 4 is also insignificant. The results are very different regarding the influence of prior production plants in the neighborhood. An existing local production plant is more likely to attract a new production plant if it is located in an adjacent country. The coefficient on the variable F^p is positive and significant at the 2% level, which means that there is an additional positive effect from the prior production plant being located in an adjacent country[26]. This result is surprising. Firms find it

[25]We also carried out estimations considering a distance between regions of 50 miles or less, obtaining the same results. Distances of less than 50 miles are difficult to estimate due to the relatively few regions in this narrow distance band.

[26]The variable *foreign (production)* is only significant at the 10% level when considering a distance of $0 < d <= 125$ miles to calculate neighboring investments, and is insignificant

profitable to fragment their production process on both sides of the border. One possible explanation is that multinational firms locate their production plants in different countries to benefit from their respective comparative advantages, but close to each other to reduce transport and communication costs. [27]

The choice of location of General Motors (GM) in Hungary provides a good example of this strategy. Historically, the group owns a plant in Austria, in a suburb of Vienna (Aspern). In addition to the historical location, GM established 3 new production plants in the city of Szentgotthrd in Hungary (Western Transdanubia) between 1997 and 2002. This region is at the border with Austria and less than 75 miles away from Vienna. The choice to set up a production plant in Hungary, just across the Austria border, was probably (at least partially) dictated by the needs of component supply. Indeed the Hungarian plants are assembling Opel cars and the Australian outlet produces Opel transmission/powertrain components. This is similar to vertical specialization, where the production of a final good is made via multiple stages located in multiple countries. Hummels et al. (2001) identify this phenomenon as a major aspect of modern international trade.

5 Conclusion

This paper extends the existing literature on the location choices of multinational firms by studying at a detailed geographical level both upstream and downstream production and service activities. Focusing on 224 regions of

for $0 < d <= 175$. We do not show these estimations for space reasons.

[27]This empirical finding could also be explained by the profit-seeking motivation. A firm may strategically choose to locate plants on both sides of a border to maximize rents to be extracted from local public authorities of the two countries. In this case, the firm will have a credible bargaining tool with authorities when deciding which of its existing production sites to expand. The profit-seeking motivation has already been identified has an important factor in the MNEs location choice. See for example Bond and Gresik (1996).

the enlarged European Union over a period of 6 years, we show that multinational firms locate close to existing investments, even after controlling for regional characteristics.

Firms' location decisions depend strongly on the geography of prior investments, and firms tend to reinvest in the same region as before. However, the location in a different, but neighboring region to an existing investment, plays no role in the location of service activities. Neighboring investments only matter for the location of production, and only if the existing investment is also a production unit. Finally, firms locate their production plants on either side of national borders but still close to each other, possibly to benefit from the respective comparative advantages but to minimize transport and communication costs.

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Appendix

A Distance matrix between regions

Bilateral distances between each pair of regions are calculated as great circle distances between the centroid of each region. The EIM data set provides the exact coordinate for each investment. We simply take the average longitude and latitude of investments in each region and use this as the centroid. For the few regions without any investment, we consider the coordinates of the biggest city of the region.

B History of past investments

We construct the past investment history for each parent company and for each function in all regions r. In order to study precisely the history of location of a specific site, we consider for each function only one possible investment by each parent company and for each city.[28]

We then construct the stock of investments carried out by multinational firms between 1997 and 2002. We take into account all the projects of the sample (greenfield and expansion of existing sites). More precisely, we include all the established extensions (which represent about one third of the total number of projects) carried out in the 1997-2002 period and which were not created during this period. We have to be careful not to consider the same project more than once. For example, a site extended in 2000 with no project creation reported during the period 1997-2002 would be considered as anterior to 1997. However, a production plant created in 1999 and extended in 2001 has to be treated as existing since 1999. A shortcoming of our data is that we do not observe plant exit. We thus assume that any created and/or expanded activity is active over the whole period.

This allows us to consider these investments as anterior, to which we add the new establishment creations carried out during the years before the specific investment under consideration. This allows us to construct the stock of investments. *Joint ventures* are considered as a previous investment for each parent company engaged in this investment. Finally, we exclude all projects carried out by affiliates of the parent company of the firm making the investment.

[28]We count as just one investment all the projects in a specific function and in a particular city (the most detailed geographical level) for each parent company. For example, if a firm decides to locate two production plants in the same city, we only consider this investment once. The problem arises if we observe a firm carrying out a number of extensions within the same city. We do not know whether this reflects a number of extensions of the same site, or a number of different sites. This allows us to establish an investment history at the city level, and to avoid double counting.

C Variable Definitions

Table 6: Dependent and independent variable definitions

Variable		Definition	Origin
Y		Location choices among 224 regions (*greenfield* only) of non-European firms from manufacturing sectors.	EIM
		Regional variables (NUTS-2)	
Unit Wage Cost	w_r	Total wages and salaries per worker divided by value added per worker.	Eurostat
Education	h_r	% of 20 to 65 year olds with tertiary education levels (ISCED 5-6)	Eurostat
Population density	m_r	Population divided by land area.	Eurostat
Function-sector dummy	E_r^d	1 if another firm realized an investment in the same function and in the sector of the investing firm (both *greenfield* and expansion of existing sites) and 0 otherwise.	EIM
Log (Function-sector count +1)	E_r^c	Log of the Stock (plus one) of firms location in the same function and in the sector of the investing firm (both *greenfield* and expansion of existing sites).	EIM
Common Language	L_{ir}	1 if the country of origin of the parent company and the country of destination have a common official language.	Cepii
		Firm-region variables. Distance to other functions	
Prior investment in the vicinity (e.g. $d <= 75$ miles)	D_{ri}	1 if prior investment located in the vicinity (in a radius of d miles) and 0 otherwise.	EIM
Function Co-location $d = 0$	C_{ri}	1 if prior investment located in the same region and 0 otherwise.	EIM
Neighbor firm investment (e.g. $d > 0$ & $d <= 75$ miles)	N_{ri}	1 if prior investment located in a neighboring region (in a radius of d miles) but not in the same region ($d > 0$) and 0 otherwise.	EIM
Foreign neighbor	F	1 if *neighbor* equals 1 and if the prior investment in the neighboring region was carried out in a different country and 0 otherwise.	EIM