Empirical Literature on Location Choice of Multinationals

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Abstract The location choices of multinational enterprises have been the center of attention both empirically and theoretically in international and regional economics during the last 20 years. Different approaches and methods have been employed to examine foreign firms' location decisions. We make a critical assessment of these approaches and their contributions to our understanding of dispersion of multinational activities across space. We start from the most influential theoretical contributions which have addressed the motivation of MNEs to be engaged in a horizontal or a vertical FDI and provide a list of the large number of foreign firms' location determinants considered in the literature. Then, we discuss the various econometric specifications used in the empirical literature to test the hypotheses on these determinants. Finally, we discuss issues for further development specifically for modeling multinationals' economic activity in space.

1 Introduction

Understanding the determinants of business location choice has traditionally been the subject of a large body of theoretical and empirical literature. Recently, there has been a growing interest in the location determinants and the spatial distribution of foreign firms operating in both manufacturing and service sectors. The focus on foreign firms' location choice (rather than on local firms) is mainly justified by three different reasons. First, the potential role of foreign firms for the economic development of a country or a region is now highly recognized. In particular, the benefits deriving from foreign firms within a country or a region

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are well known: job creation, development of subcontracting relationships with local small and medium-sized firms, introduction of new technologies, skills and capital (Castellani and Zanfei 2006). Second, as many theoretical contributions to the New Economic Geography (NEG) literature have suggested, processes of increasing regional integration, such as the ongoing enlargement of the European Union, may reshape the spatial distribution of economic activity. Since multinational enterprises (MNEs thereafter) are the main actors in the process of relocation and dislocation of economic activity, foreign firms' location behavior becomes a central topic in the empirical economic geography literature. Third, the increasing attention on foreign firms is justified by the availability of new dataset on location choices of MNEs' affiliates.

The huge amount of empirical contributions to this literature is characterized by a certain degree of heterogeneity with regards to the econometric methodology used, the choice of the dependent variable and the spatial scale adopted. Most of the advanced studies of foreign firms' location choice are now based on the *Random Utility Model* (RUM), where the industrial location decision is cast as a discrete choice problem in which profit (utility) maximizing firms select sites from a distinct set of regions. In this context, the researcher uses historical data that depict actual choices (revealed preferences) and intend to identify the factors influencing choices.[1] Within this context it is possible to distinguish two approaches. The first one focuses on the location choices made by new starting firms within a set of geographical alternatives and proceeds through discrete choice analysis. These studies use micro data (that is information on the location choice of each single foreign firm among a set of possible regional alternatives) and adopt conditional, nested or mixed logit models specified using a set of explanatory variables that intend to capture the importance of cost factors, demand variables and agglomeration economies for the business site selection process. The second approach is based on aggregated data, which count the number of new foreign entrants within each region and adopt Poisson (count) models to test the effect of the independent variables. This last approach has also found its microeconomic justification on the RUM framework, given the equivalence of the likelihood function of the conditional logit model and the Poisson regression model.

A further stream of literature uses aggregate data on inward and outward foreign direct investment (FDI) flows and stocks. These kinds of data, very popular within the international trade literature, are available also at local level for some countries (for example, for Italian provinces and for the states of USA). Linear static or dynamic panel data methods are typically used to test the effect of regional (or country) characteristics on FDI (bilateral) flows and stocks. The compatibility

[1]Some empirical research on the determinants of location choice follows the survey method. In this case, firms are required to identify the determinants of its actual location (stated preferences). The survey method allows us to obtain very rich data and to understand the ranking among alternatives, being extremely relevant when historical information is unavailable. However, the stated preferences about location may differ from the real ones, while the results are highly responsive to sample characteristics.

of this approach with the profit maximization framework (RUM) has not been clarified. Notwithstanding, within this stream of literature, we find some interesting alternative competing analytical frameworks: (1) the gravity model and (2) spatial econometric models.

In this chapter, we intend to review the empirical literature on foreign firms' location choice putting our attention on econometric methods to analyze foreign firms' location behavior. We also try to identify gaps in the literature and valuable future areas of research.

The remainder of the paper is organized as follows. In Sect. 2 we recall the most influential theoretical contributions which have addressed the motivation of MNEs to be engaged in a horizontal or a vertical FDI; we also provide a list of the large number of foreign firms' location determinants considered in the literature. Then, we discuss the various econometric specifications used in the empirical literature to test the hypotheses on these determinants (Sect. 3). Specifically, we start from discrete choice and count data models, used when foreign firms' location choices are measured by qualitative variables (dummies or counts). Then, we move to econometric specifications used to model quantitative FDI flows and stocks (Sect. 4). In this case, we start with the gravity equation and its usage in location choice literature; then we discuss recent applications of spatial econometric models to analyze FDI determinants taking spatial interaction effects (or *third country effects*) into account. Finally, we mention some issues for further development in the analysis of location choice concentrating more on the spatial approach. The chapter concludes with a short summary (Sect. 5).

2 Motivations and Types of FDI

In this section we briefly review the main economic theories developed to motivate the existence of MNEs (Sect. 2.1), then we present a classical taxonomy of FDI types (Sect. 2.2), and finally we will list the factors that attract FDIs (Sect. 2.3).

2.1 Motivations

The emergence of transnational or multinational corporations results from a number of motivations. In addressing these, Dunning (1997) proposes the OLI framework, which bases the FDI on ownership (O), location (L) and internalization (I) advantages that these firms want to pursue.[2] In the original view of Dunning, *ownership advantages* define the competitive advantages a MNE possesses *vis-à-vis*

[2]See also Dunning (1981, 1986, 1988, 2000), Dunning and Narula (1996), and Dunning et al. (1996).

the competitors in terms of tangible assets, such as scale economies or preferential access to raw materials and/or to markets. *Location advantages* stem from features of possible investment locations, such as market size, distance and labor market features, infrastructure, and identify the attractiveness of a specific location relative to others. Lastly, the *internalization advantages* arise when a firm prefers to exploit the ownership advantages in the international markets itself instead of selling, or franchising them to destination country firms.

Other approaches to the motivations of firms in engaging FDI concentrate around Krugman's (1983) proximity-concentration model (Brainard 1993) or around Markusen's (1998) knowledge-capital model. The former claims that the decision to engage in FDI is in fact optimization of the proximity to consumers and concentration of production in a location to exploit scale economies. In a comparative survey of the theories of FDI, Faeth (2009) suggests that, instead of searching for a single theory to explain FDI, a broader approach developed as a "combination of ownership advantages or agglomeration economies, market size and characteristics, cost factors, transport costs and protection and risk factors and policy variables" is more appropriate. In this regard, the knowledge-capital model provides one of the most influential explanations of the MNEs' behavior.[3]

The notion of ownership advantages is extended by Markusen (1998) to include more intangible assets such as human capital, patents and blueprints, trademarks, brand names and reputations; in a nutshell *knowledge capital*. These intangible ownership advantages have two main features, i.e. conveyability and public-good attribute within the firm. The first refers to the ease of transportation of knowledge capital to foreign affiliates with respect to physical capital, while the second has to do with the joint usage of blueprints and brand names by affiliates in various locations, once produced. Thus, the MNEs become exporters of knowledge-based assets such as managerial and engineering know-how, reputations and trademarks.

The most abstract of advantages, i.e. internalization, arises from the same public-good attribute of knowledge that creates ownership advantages. Firms prefer to establish foreign affiliates to prevent the risk of asset depletion when transferring knowledge capital through arm's length subsidiaries.

Under the assumption of plant-level scale economies, in the knowledge-capital model location advantages can be attributed to two different sources. The first one is the presence of transport costs between the market and the MNE's home country. In the absence of transport costs, the production would concentrate in a single location and all markets would be served through exports. Although transport costs are considered as the main source of location advantages in most of the models, differentiating between actual transport costs and other forms of transaction costs such as tariffs, duties or even commissions paid for bank transfers would be more beneficial in portraying the role of *distance-cum-location* accurately. A second

[3]The ideas combined in the knowledge-capital model are developed in several previous works (see, i.a., Helpman 1984, 1985; Horstmann and Markusen 1987, 1992; Ethier and Markusen 1996; Markusen and Venables 1998).

source of location advantage arises from the differences of factor intensities between source and destination countries. This is mainly valid for *cost-minimizing* MNEs or MNEs that *fragment* the production process into stages with different levels of factor intensities to exploit the factor-price differences across locations.

The general perception on location advantages recognizes that firms choose the alternative that embraces the features mostly sought by MNEs. Some of the firms may be more *cost-oriented* than others and, thus, prefer locations providing a cost advantage, be it in terms of labor, transportation or other costs. Firms with orientations such as access to technology, or access to raw materials, pick locations that would meet these needs (e.g. Buckley et al. 2007; Kumar 2007; Tolentino 2010; Zhang and Daly 2011; De Beule and Duanmu 2012; Kolstad and Wiig 2012).

More *market-oriented* firms would choose to locate in large markets (e.g. Goh and Wong 2011) or close to large markets (e.g. Chudnovsky and López 2000; Daniels et al. 2007) in order to address the need to access and/or penetrate targeted countries/regions. Maintaining export markets is another important motivation of FDI, especially from developing countries, since in most cases exports precedes outward FDI (Wells 1983). Difficulties in access to export markets such as trade barriers, access to distribution channels and consumers, and obstacles in penetrating to the markets cause firms from developing countries to become transnationals (e.g. Gang 1992; Kim and Rang 1997). Therefore, for most developing country firms, foreign investment is not a substitute for exports but a strategy to feed the export markets (e.g. Ellingsen et al. 2006).

2.2 Types of FDI

As discussed above, FDI flows between countries or regions are motivated by several reasons. Stylized general-equilibrium models of FDI focus, however, on market-access and cost-reduction motivations. Here, it is important to distinguish between *two-country* and *multi-country general equilibrium models*. The combination of different hypotheses (two-country vs. multi-country frameworks and market-access vs. cost-reduction motivations) gives rise to a simple taxonomy of FDI types as depicted in Table 1.

Development of formal MNE theory with a bilateral framework stems from Markusen (1984) and Helpman (1984). The first author provides a general equilibrium model where MNEs arise due to a market-access motive to substitute for export flows (when trade or tariff costs in a host country are too high), or what is termed *horizontal FDI*. The decision to undertake horizontal FDI is governed by

Table 1 Taxonomy of FDI types

Model framework	Market-access	Cost-reduction
Two-country	Horizontal FDI	Vertical FDI
Multi-country	Export-platform FDI	Vertical-specialization FDI

the *proximity-concentration trade-off* in which proximity to the host market avoids trade costs but incurs the added fixed cost of building a second production facility. If trade barriers between the parent country (where the MNE is located) and host country (where the MNE would like to make its products available) are too high, the MNE could decide to build a plant in the latter country to avoid export costs but at the expense of building a new production plant.

Alternatively, Helpman (1984) develops a general-equilibrium model where MNEs arise due to the desire to access cheaper factor inputs abroad, or what is termed *vertical FDI*. A MNE evaluates all potential destination markets to find the one that is the lowest-cost provider of the activity it wishes to relocate. MNEs will make vertical FDI if they want to access to cheaper factor inputs for their products. Both are developed in a two-country framework and have spawned significant theoretical work on MNEs.

Recent theoretical work has begun to relax the two-country assumption, leading to the development of alternative motivations for FDI. Ekholm et al. (2007), Yeaple (2003) and Bergstrand and Egger (2007) develop multi-country models of *export-platform FDI*, where a parent country invests in a particular host country with the intention of serving 'third' markets with exports of final goods from the affiliate in the host country. In this case, the motivation for FDI occurs if trade barriers between a set of destination markets are lower than trade frictions between these destination markets and the parent country. In that setup, a MNE could decide to build a plant in a host country and export to other markets. Note that using a single, well-located subsidiary provides a great deal of the proximity benefits of the pure horizontal firm without incurring additional plant-level fixed costs.

Alternatively, an MNE may set up its vertical chain of production across multiple countries to exploit the comparative advantages of various locales (Baltagi et al. 2007): *complex vertical* or *vertical specialization* FDI. Within that framework the MNE decides to split its vertical chain of production among possibly several host countries (*fragmentation*), to benefit from the comparative advantage of the hosts. Thus, complex-vertical MNE activity would be associated with exports of intermediate inputs from affiliates to third market for further (or final) processing, before being shipped to its final destination.

While both the export-platform and the complex-vertical FDI involve exports to third markets, the difference arises from the shipment of intermediate and final goods, respectively.

2.3 Factors Attracting MNEs

The factors that are expected to attract MNEs can be classified according to their relevance for the specific types of FDI, namely those that affect horizontal, vertical, export-platform or complex-vertical (see Table 2). As explained before, horizontal FDIs target the destination country market. Therefore, the location factors affecting this kind of FDIs are mainly related to market conditions. In the export-platform FDI, instead, MNEs choose a location mostly for its proximity to potential markets

Table 2 Factors that attract MNEs for different types of FDI

FDI types	Horizontal FDI	Vertical FDI	Export-platform FDI	Complex-vertical FDI
Type-specific factors	Market size, privatizations, concentration in host country, market access, distribution channels	Labor costs, infrastructure quality, human capital, natural resources, energy availability and energy costs, unionization, production costs at home country, land cost	Market potential, trade agreements, tariffs/non-tariff barriers, openness	Tariffs, non-tariff barriers, transport infrastructure quality, unionization, labor force, labor costs
Common factors	Transport costs, distance (to source country)			
Control variables	Political and economic stability, institutions, common language, legal system, free economic zones, investment promotion, corporate income taxes, government policies, international schools and hospitals, country risk, development level of banking sector, geographical characteristics (coast etc.)			

other than the host country itself. Hence, the characteristics of those potential markets, in addition to those of the destination country, are considered by MNEs. On the other hand, vertical and complex-vertical FDIs have cost minimization as their main motivation. The sources of cost minimization can arise from easier access to raw materials or cheaper labor costs with respect to the home country of the MNEs. The main difference between vertical and complex-vertical types comes from the choice of the MNE to produce the good in a single host country or in various countries, which in that case requires transport of intermediate goods to a final production location. As the number of separate locations increases, total cost of transportation incurred escalates. Therefore, in addition to other transaction costs, costs and quality of transport infrastructures become more compelling determinants under complex-vertical FDIs.

No matter the type of FDI, there are two highly impactful factors, i.e. distance and transport costs. In terms of horizontal and export-platform FDI, distance and transport costs influence the decision to invest or export while for vertical and complex-vertical FDI, these factors actually determine the production costs.

In estimating the determinants of FDI, empirical studies also control for the influence of a number of factors including political and economic stability, institutional environment, governance, etc. These control factors help the researchers to correctly identify the effect of main sources of MNE activity and henceforth the type of FDI.

3 Models for Discrete Data

In this section we discuss various econometric specifications used in the empirical literature to test the hypotheses on the determinants of foreign firms location choice. We start from discrete choice models (Sect. 3.1) and then present count data models (Sect. 3.2).

3.1 Discrete Choice Models

Recent studies on foreign firms' location choice make large use of micro datasets developed in different public and private institutions which provide information on the location decision of a large number of affiliates of MNEs. These studies usually appeal to discrete-choice models that rely on the Random Utility Maximization (RUM) framework developed by McFadden (1974).

In this context, usually multinomial, conditional, nested or mixed logit models are utilized depending on the availability of data and the research question at hand. Multinomial logit is used to model the relationship between the individual decision maker's characteristics and the likelihood of a certain choice being made. If the research question is related to the effects of the characteristics of the choice set on the decision, then conditional logit models are applied. Due to difficulty in obtaining data on the characteristics of decision makers, numerous studies focus on the characteristics of the alternative host locations rather than the attributes of the investors and/or their perceptions of alternative locations. Therefore, such studies employ the conditional logit model of McFadden (1974) in their analysis and mainly use micro datasets that report the specific features of locations. Conditional logit and multinomial logit models have the same mathematical formulation but the former considers only the alternative-specific attributes, whereas the latter may include both individual-and alternative-specific characteristics.

In these models, a choice j made by an investor i means that the utility (or expected payoff) of the firm has been maximized with that choice. Hence, the utility obtained from j is greater than any other alternative (host country) k and these models determine the probability of j giving a higher utility then any k. Let Y_i be a random variable that indicates the choice made by i. When there are $M > 2$ alternatives or categories, each category is evaluated with respect to the reference category. If the first category is the reference then for $j = 2, \ldots, M$ the multinomial logit model estimates

$$\ln \frac{P(Y_i = j)}{P(Y_i = 1)} = \alpha_j + \sum\nolimits_{k=1}^{K} \beta_{jk} x_{ik} = Z_{ji} \tag{1}$$

and thus $(M - 1)$ equations that describe the relationship between dependent and independent variables are predicted. The predicted log odds of category j to be chosen is

$$P(Y_i = j) = \frac{exp(Z_{ji})}{1 + \sum\nolimits_{h=2}^{M} exp(Z_{hi})} \tag{2}$$

and the odds for the reference category is

$$P(Y_i = 1) = \frac{1}{1 + \sum\nolimits_{h=2}^{M} exp(Z_{hi})} \tag{3}$$

Studies that employ discrete choice models find factors such as agglomeration effects (Carlton 1983; Luger and Shetty 1985; Coughlin et al. 1991; Friedman et al. 1992; Wheeler and Mody 1992; Woodward 1992; Head et al. 1995; Devereux and Griffith 1998; Crozet et al. 2004), access to input and output markets (Coughlin et al. 1991; Woodward 1992; Kang and Lee 2007), factor costs especially labor costs (Crozet et al. 2004; Barrios et al. 2006; Kang and Lee 2007), transport infrastructure (Barrios et al. 2006), government policies either in terms of tax structure and tax differentials between alternative locations (Coughlin et al. 1991; Friedman et al. 1992; Woodward 1992; Devereux and Griffith 1998) or in terms of other investment promotion measures such as the free economic zones in Russia or economic zones in China (Kang and Lee 2007) to be among the most examined and decisive factors that reflect the motivations of foreign investments in terms of location choice.

Most of the early models that address the MNEs' location choice in the US are based on the characteristics of alternative states and, thus, adopt the conditional logit structure (such as Coughlin et al. 1991; Friedman et al. 1992; Head et al. 1995). Devereux and Griffith (1998) put US as the source country and examine the location choice of US firms in Europe to find agglomeration as an effective determinant as in the previously mentioned works. In fact, analogous to the US case, studies on Japanese investments reveal that agglomeration effect explains a significant part of location choice whether the location chosen is a country in Europe or China (Head and Mayer 2004; Cheng and Stough 2006). On the other hand, Blonigen et al. (2005) find that affiliation to an industrial grouping is influential on the location choice by Japanese firms. In an attempt to unfold the reasons behind the geographical dispersion of Japanese R&D activities, Shimizutani and Todo (2008) employ multinomial logit model and find that basic/applied research locates where the foreign advanced knowledge is and development/design activities locate where the market is. Investigating the potential determinants of location choice by South Korean investors in China, Kang and Lee (2007) find market size, quality of labor, transport infrastructure and government policies to be positively related to location.

Research on investment decisions in European countries have been put into spotlight by works of Crozet et al. (2004), Barrios et al. (2006) and Basile et al. (2008), which employ similar kinds of logit models in explaining location and agglomeration of multinationals in France, Ireland and eight EU countries, respectively. As data on other country firms became available, location choice of Greek (Louri et al. 2000), German and Swedish multinationals (Becker et al. 2005), French investments in Eastern and Western Europe (Disdier and Mayer 2004) were analyzed with logit models taking the alternative-specific rather than agent-specific characteristics as independent variables. In two papers examining the Portugese inward and outward FDI, Guimaraes et al. (2000) and Figueiredo et al. (2002) explore the impact of networks and social capital on inflows and of agglomeration effects on the spatial choice for foreign plants with the conditional logit model. The data used in all of these studies is location specific and do not reflect the perspectives of the managers and that is why the conditional logit not the multinomial logit model is employed.

Although outnumbered by analysis that employ conditional logit models, there are some studies, which apply multinomial logit models to explain location choice of large MNEs (Lankes and Venables 1996; Brush et al. 1999) using individual/agent-specific characteristics for various countries such as Eastern European and former Soviet Union countries (Lankes and Venables 1996), Greece (Iammarino and Pitelis 2000; Louri et al. 2000), Taiwan (Aw and Lee 2008) and Turkey (Kayam et al. 2011).

3.2 Count Data Models

Discrete choice models described so far are particularly appealing because they are obtained directly from the framework of random utility (profit) maximization and allow modeling the probability that a specific firm chooses a specific location site for its activity. In some cases, however, information on each foreign firm's location choice is not available. Rather, one might have aggregate information on the total number of new foreign firms of a specific sector entering a specific location (count data). Moreover, in practice, even when firm or establishment level data are available, the implementation of discrete choice models presents problems when one has to manage complex scenarios with a large number of spatial alternatives (for example, all municipalities or all Metropolitan Statistical Areas within a country). Finally, in some cases one needs to estimate the gap between the effective and the potential attractiveness of a region and, thus, one needs to estimate the probability that a specific location attract a certain number of foreign firms (Basile 2004; Basile et al. 2006).

Under these circumstances, the dependent variable used in the econometric analysis (the number of firms acquired or created by foreign firms operating in sector s in each region j) assumes discrete values, that is non-negative integer values (count data). The standard model for count data is the Poisson regression model, according to which the probability that the number of foreign firms operating in sector that chooses location j is n_{js} is given by:

$$P(n_{js}|\beta X_{js}) = \frac{e^{-\lambda_{js}}\lambda_{js}^{n_{js}}}{n_{js}!} \tag{4}$$

where λ_{js} is the conditional mean. Fortunately, Guimaraes et al. (2004) have demonstrated that the coefficients of the conditional logit model can be equivalently estimated by using a Poisson regression which takes n_{js} as a dependent variable and includes as explanatory variables a vector of sectoral dummy variables.[4] That is, we will obtain the same results of the conditional logit model if we admit that n_{js} follows a Poisson distribution with

$$\lambda_{js} = exp(\boldsymbol{\beta}\mathbf{X}_{js} + \boldsymbol{\theta}\mathbf{y}_s) \tag{5}$$

where $\mathbf{y}_s$ includes a set of sectoral dummies. However, the Poisson regression model assumes that the conditional mean λ_{js} equals the conditional variance (*equidispersion* condition). In practice, however, empirical inward FDI counts exhibit *overdispersion* and/or excess number of zeros.

[4]Recently, a large number of studies have been carried out by means of count data models (Coughlin and Segev 2000; Guimaraes et al. 2003, 2004; Figueiredo et al. 2002; Basile 2004; Basile et al. 2006; De Propris et al. 2005).

Overdispersion occurs when the variance is larger than the mean, so that the model generates consistent but inefficient estimates. In the case of location choice analysis, overdispersion is generally observed due to the concentration of foreign firms in a few areas. A way of dealing with overdispersed count data is to assume a negative binomial distribution for n_{js} which can arise as a gamma mixture of Poisson distributions.

Zero-inflation may occur when the zero outcome (that is no announcement to invest in a region) can arise from two underlying responses. On the one hand, some regions may never attract a greenfield investment, thus the outcome will be always zero. On the other hand, if the region is an attractive one, the zero outcome may be just the number of investments attracted in a given (sample) period and the response might be some positive number in a different period.

Even though negative binomial regression models capture overdispersion quite well, they are not always sufficient for modeling excess zeros. Mullahy (1986) and Lambert (1992) have addressed this problem by introducing zero-augmented models that incorporate a second model component capturing zero counts. Zero-inflation models (Lambert 1992) are mixture models that combine a count component and a point mass at zero. Hurdle models (Mullahy 1986) take a somewhat different approach and combine a left-truncated count component with a right-censored hurdle component. Examples of applications of Zero-inflated Poisson (ZIP) and Zero-inflated Negative Binomial (ZINB) models to FDI location analyses are in Tadesse and Ryan (2004), Basile (2004) and Tomlin (2000).

4 Models for FDI Flows and Stocks

More traditional studies on MNEs location decisions make use of quantitative measures of bilateral or unilateral outward FDI flows or stocks. When dyadic (i.e. bilateral) information is available, the empirical literature on the determinants of FDI deploys the services of the gravity model (Sect. 4.1), while more recent studies have used unilateral outward FDI data to apply spatial econometric techniques and test the *third-country* hypothesis (Sect. 4.2).

4.1 Gravity Models

First applied by Pöyhönen (1963) to explain international trade, the gravity model[5] rests on the conjecture that the volume of trade between two countries is directly

[5]This model is based on Newton's law of universal gravitation where the force of gravitational attraction depends directly on the masses of the objects and inversely on the distance between their centers. The formula is $F = GmM/d^2$, where F denotes the gravitational force, m and M are the masses and d is the distance between the masses. G is named as the gravitational constant.

related to the size of the economic activity indicated by their incomes and inversely related to the distance, which reflects cost of transportation, between them. Since the level of income is not sufficient to explain the purchasing power in partner economies, Linnemann (1966) suggests that population should also be taken into consideration. Thus, the traditional gravity model can be expressed as

$$T_{ij} = AY_i^{b_1} Y_j^{b_2} P_i^{b_3} P_j^{b_4} d_{ij}^{b_5} \tag{6}$$

where T_{ij} is the bilateral trade volume between countries i and j. The gravity variables (Y_i and Y_j) denote incomes, A is a constant term; P_i, P_j and d_{ij} indicate population and the distance between countries i and j, respectively. More recently, the services of the gravity model have been employed to explain bilateral trade, trade diversion or creation effects of various policies and to analyze regional integration effects (Frankel and Wei 1993; Sayan 1998; Di Mauro 2000; Feenstra et al. 2001; Nitsch 2000).

The success of the gravity model in explaining various facets of trade has attracted economists working on multinational activities and particularly on location choice of FDI (Stone and Jeon 2000; Loungani et al. 2002; Razin et al. 2003). In econometric analysis of location choice of MNEs, the log linearized form of the gravity equation estimated is given below:

$$\begin{aligned} \ln FDI_{ij,t} = {} & \ln A + \beta_1 \ln Y_{i,t} + \beta_2 \ln Y_{j,t} + \beta_3 \ln P_{j,t} \\ & + \beta_4 \ln d_{ij} + \ln \mathbf{X}_{ij,t} \Gamma + \varepsilon_{ij,t} \end{aligned} \tag{7}$$

where $FDI_{ij,t}$ shows the FDI flows (or stocks) from source country i to destination country j at period t. The gravity variables denoted by $Y_{i,t}$, $Y_{j,t}$, $P_{j,t}$ and d_{ij} are the GDP or GDP per capita for source and destination countries, the population of the destination country at time t and the distance between source and destination countries, respectively. Other regressors capturing labor market conditions, infrastructure, institutional environment and economic stability can be included in $\mathbf{X}_{ij,t}$. Finally, $\varepsilon_{ij,t}$ is an idiosyncratic error term. Being all variables in logs, estimated $\boldsymbol{\beta}$ and Γ parameters can be interpreted as elasticities.

The gravity variables constitute the core of this approach. The parameter associated to the income of the destination country is an indicator of the type of FDI. A positive coefficient is expected for market-seeking FDI, to be showing that as income of the destination country increases then more FDI flows take place. Most common measures of income used in the literature are GDP (Brenton et al. 1999; Buch et al. 2001, 2003; Cieślik and Ryan 2004) and GDP per capita (Andreff 2002; Buch et al. 2003b).

Population is included in the gravity equation as a measure of market size, which also accounts for the purchasing power if GDP per capita is used instead of GDP as the measure of market depth. If FDIs are of the market-seeking type, then MNEs prefer to invest in a host country, where the market is large for a given level of purchasing power. Therefore, the parameter estimate is expected to be positive if

GDP per capita is used. On the other hand, if the population is large for a given level of GDP, meaning a lower purchasing power, then MNEs prefer to invest in an alternative host country. In that case, FDI is expected to decrease with population.

The distance variable, accounting for the cost of transportation, is expected to have a negative effect on trade. However, when included in the FDI gravity equation, distance has a slightly more complex impact which depends on the type of FDI (Egger 2008). If the main motivation of FDI is the market access (market seeking or horizontal FDI), then for relatively nearby destinations the MNEs could, ceteris paribus, prefer exports to FDIs; but over a certain distance-threshold, FDIs increase with the distance between source and host countries. In case of vertical FDI, MNEs actually try to decrease production costs by outsourcing parts of the production process or by acquiring cheaper raw materials, consequently distance has an increasing impact on production costs and, thence, FDI decreases with distance.

Recent studies on FDI determinants focus on transition economies and emerging markets. Most of the gravity models used in these studies employ analogous perspectives to trade studies. For example, Brenton et al. (1999) assess the relationship between trade and FDI *vis-à-vis* complementarity-substitutability and whether liberalization in Central and Eastern European Countries (CEEC) has any diversion effect on FDI to other European countries. In a similar study to trade diversion, Buch et al. (2003) address diversion of FDI from South to East European economies taking account not only of the physical distance but also of the social distance usually measured by commonality of language, history, legal system and so on. Bevan and Estrin (2004) inquire the FDI flows from West to CEECs using a gravity model enriched with transition country variables. In addition to relative market size and unit labor costs, proximity is a non-trivial factor in determining FDI flows and it influences Western European FDI in a negative fashion. Other recent country studies, which employ the gravity model to examine FDI outflows, are by Ellingsen et al. (2006) for Singapore, and by Cross et al. (2007) on China. The analysis of the outward FDI from Turkey reveal the importance of push factors for developing countries and market-seeking pattern with foreign markets being substituted for domestic market by Turkish firms (Kayam and Hisarciklilar 2009a).

4.1.1 Market Potential

As discussed above, basic gravity models are mainly oriented to test the hypothesis that FDI flows between two countries are affected by the relative size of the markets ("the mass of the objects") and by the inverse distance between the two economies. This two-country framework implies that a shock in the market size in a dyadic spatial unit ij would only affect the outcome of that dyadic unit (i.e. the bilateral FDI flow between i and j) ruling out any "third-country" effect (i.e. the effect of a shock in the market size of a country different from i and j on FDI_{ij}). As we will show in Sect. 4.2, "third-country" effects typical of a multi-country framework can be captured by using spatial econometric tools. Before that, however, it is important to introduce the notion of market potential firstly proposed by Harris (1954). He defines market potential of an economy i ($MKTP_i$) as a weighted average of the GDP of all economies $j \neq i$:

$$MKTP_i = \sum_{j=1} \frac{GDP_j}{d_{ij}} \tag{8}$$

where GDP_j is the GDP of the country j, which is bordering to host country i and d_{ij} is the distance between the (centroids of the) capitals of the host country i and country j, measured in kilometers. Distance should be evaluated as a proxy of transportation costs (market accessibility) as it is generally accepted in the literature (Krugman 1992).

In analyzing the market potential within the MNE context, a variety of potential measures have been used. Head and Mayer (2004) look at the determinants of agglomeration for Japanese-owned affiliates and measure potential with the demand from various locations while discounting the demand using a parameter obtained from the estimation of bilateral trade flows between the locations. Carstensen and Toubal (2004) use the region-to-region transportation costs to weigh the output of all countries in the CEE sample they consider in their quest of explaining the differences between FDI inflows to these countries. Altomonte (2002) employs three different market potential definitions: the first one is based on the interaction of the size of the neighboring markets with the degree of trade integration between countries; the second one assumes that the local markets are segmented at the country level; the last one is the traditional definition of Harris (1954). He concludes that the market accessibility is an important FDI determinant. The degree of trade integration is used to weight the market size in the standard market potential calculation instead of distance. Crozet et al. (2004) define the market potential as the sum of the local and neighboring GDPs weighted in the traditional way with inverse of the distance between locations in investigating the determinants of location choice by foreign investors in France.

Employing the potential index in a study on MNEs' location choices in the MENA region, Kayam and Hisarciklilar (2009b) expand the market potential by introducing the presence of interaction between neighboring economies. According to the authors, market potential of a country does not only stem from the size of economic activity of its neighbors, but also from interaction with those economies, i.e. trade. The economic spillover generated by a country to its neighbor will be negligible if these countries do not trade at all. Especially for the MENA region, where many countries had or still have some disputes with their neighbors, such as Israel, Qatar and Syria, Kayam and Hisarciklilar (2009b) claim that market distance does not matter when locations are segregated. They decompose the market potential index into three parts (domestic market, export and import potential indexes), making use of bilateral trade figures to measure non-domestic potential of the host country.

4.2 Spatial Econometric Models

The market potential index described above represents a means to capture spatial contagion effects of country-specific demand shocks. When included in an empirical location model, the market potential index allows us to assess the effect on the FDI attractiveness of a spatial unit i of a change (a shock) in the market size occurring not only in the same unit i, but also in all other spatial units in the system taking a distance decay effect into account. In this way, the assumption of spatial independence which characterizes many empirical analyses of FDI location choice is somehow relaxed.

More generally, in modeling FDI flows (using either unilateral or dyadic outward flows), we can include spatial interaction (or spatial dependence) effects for all the characteristics (not only the market size) of the countries or regions included in the sample. In fact, a change in the unemployment rate or in the infrastructural endowment of a region would not only influence the amount of FDI in that region, but also in all other regions in the system. However, this influence attenuates over space (distance decay effect). Failing to address this spatial dependence in the data would lead to inconsistent and inefficient parameter estimates. Spatial econometrics (Anselin 1988; LeSage and Pace 2009) provides very useful tools to model spatial dependence both in cross-section and panel data (static and dynamic) contexts.

Imagine that the objective of our analysis is to model unilateral outward FDI (for example, the outward FDI stocks from the US to all other countries in the World in a given period). In this case, a linear parametric Spatial Durbin Model (SDM) may represent the most general form to start with:

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \rho\mathbf{W}_n\mathbf{y} + \mathbf{W}_n\mathbf{X}\boldsymbol{\theta} + \boldsymbol{\varepsilon} \tag{9}$$

where $\mathbf{y}$ is the $(n \times 1)$ vector of observations of the explained variable on the n spatial units (countries or regions), $\mathbf{X}$ is a $(n \times K)$ matrix of observations of the explanatory variables on the same regions and $\boldsymbol{\varepsilon}$ is a $(n \times 1)$ vector of random shocks. Moreover, $\mathbf{W}_n$ is a $(n \times n)$ weighting matrix measuring the influence received by region i from region j. The SDM encompasses the other three spatial econometric models usually applied in the literature that is the Spatial Autoregressive Model (SAR), the Spatial Lag of X Model (SLX) and the Spatial Error Model (SEM) (see the chapter from Basile et al. 2015, in this book for more details).

A few studies have used spatial econometrics to explain the location choice of MNEs. The pioneering study in this regard is by Coughlin and Segev (2000). The authors analyze the geographic distribution of FDI within China with a spatial error model. Baltagi et al. (2007) analyze the "third-country" effects of US outward FDI in different industries to various host countries and find evidence for spatial correlation in independent variables and error terms. Garretsen and Peeters (2009) explore the third-country effects for Dutch outbound FDI. A significant and positive spatial lag coefficient implies that spatial linkages influence the location choice of

Table 3 Expected sign for spatial lag and surrounding-market potential variables

FDI motivation	Sign of spatial lag	Sign of surrounding-market potential variable
Pure horizontal	0	0
Export-platform	−	+
Pure vertical	−	0
Vertical specialization	+	0

Source: Blonigen et al. (2007)

Dutch FDI. Not only the SAR model estimated for the full sample but also the SEM adopted to the sub-samples of industry and services emphasize the impact of spatial linkages. However, the most famous and influential spatial econometric study on FDI is the one proposed by Blonigen et al. (2007). They estimate a SAR model with a market potential variable and distinguish between four different types of FDI that MNEs can undertake and can be identified based on the sign of the spatial lag parameter and of the surrounding-market potential variable (see Table 3):

- In the case of *horizontal FDI*, no spatial autocorrelation between FDI should be observed since MNEs make independent decisions about serving a market either through exports or affiliate sales. Besides, for this basic form of FDI, no market potential effect of host country should be observed since the MNE looks for access to the considered market only;
- In the case of *export-platform FDI*, as the MNE will not build a production plant in each host country, a negative spatial autocorrelation between neighboring FDI locations is expected. However, a positive effect of the surrounding-market potential variable is expected since the MNE will locate its new plant in the host country which has access to the largest surrounding market;
- In the case of *pure vertical FDI*, host countries are in competition in terms of input factor prices to receive FDI. Hence, a negative spatial autocorrelation between FDI is expected. However, since the product is shipped back to the parent country to be further processed, not any effect from surrounding-market potential is foreseen;
- In the case of the more complex form of vertical FDI (*vertical specialization*), positive spatial autocorrelation should be observed due to possible agglomeration forces such as the presence of immobile resources, since the suppliers' presence in neighboring host countries is likely to increase FDI to a particular market. However, for the same reason as in pure vertical FDI, no surrounding-market effect is predicted.

Using outbound US FDI to 35 countries over the period 1983–1998, Blonigen et al. (2007) test the dominant type of FDI which characterizes US MNEs. Even though they find a positive and significant effect of surrounding-market potential on their full sample, the authors acknowledge the fragility of their results with respect to the countries considered. Besides, they could not conclude to the presence of spatial autocorrelation for the full sample when fixed effects are included in the specification. Garretsen and Peeters (2009) also test the dominant motivation for FDI using outward Dutch FDI to 19 countries from 1984 to 2004. When analyzing their complete sample, they not only find a positive and significant market potential effect but also positive and significant spatial autocorrelation among FDI.

The first application of spatial econometrics to the FDI in developing country context is by Kayam and Hisarciklilar (2009b), who investigate the motivation of foreign firms in the Middle East and North Africa (MENA) region by considering spatial interdependence and accounting both for horizontal/market-seeking and vertical/cost-reducing FDI. Their findings reveal that the FDI game in the MENA region is a zero-sum game both for oil and non-oil countries. Ledyaeva (2009) adopts the spatial econometric approach to examine the differences in FDI determinants in Russia between pre- and post-crises periods. She finds that spatial effects have a significant impact on FDI distribution particularly in the post-crises period. Regions in the proximity of Europe become advantageous after 1998. Kayam et al. (2013) analyze the determinants of the regional disparity in attracting FDI in Russia. The spatial distribution of FDI is investigated using regional and/or trans-regional factors. Their findings reveal that shocks in proximate regions have no effect on FDI inflows to the host region. However, FDI in a region depends on spatial lag variables such as the market size and endowment of natural resources as expected.

All in all, spatial econometric FDI models allow us to identify the "third-country" effect, that is effect of the interdependence between alternative hosts or proximate regions. The two-region framework, typical of standard gravity models, is therefore overcome in favor of a multi-region framework. However, it is worth noticing that spatial interdependence can also be introduced in a gravity model, following for example the contribution of Behrens et al. (2012) that is including the spatial lag of the dependent variable, **Wy**, on the right-hand-side of the gravity equation. This means that the FDI flow (of stock) $\mathbf{X}_{ij}$ from i to j also depends on all FDI flows (or stocks) from the other countries (regions) k to region j.

4.3 A Critical Decision in Modeling Spatial Interdependence: Weighting Matrix

A critical issue in spatial econometric analyses is the choice of the spatial weights matrix (**W**). The weights are used to position all alternative regions with respect to each other as elements of a symmetric matrix that includes all the regions in rows and in columns, i.e. the weighting matrix (**W**). In spatial econometrics analysis, the choice of **W** structure determines the way interaction between two regions is defined. There are a number of alternatives available in terms of defining **W**.

The two most extensively used symmetric weights matrices are the binary and the inverse-distance matrices. A binary symmetric spatial weights matrix assumes direct links among bordering regions (in the case of a contiguity matrix) or among regions whose distance is lower than a certain cut-off level. The neighbors are allocated

1 and all non-neighboring regions are given 0. In the inverse-distance weighting matrix, the matrix elements are the inverse distances between regions ($1/d_{ij}$). In this way, the influence of third-country characteristics declines with their distance to the host economy. A more complex spatial weights matrix is constructed by combining the full inverse-distance matrix and the binary cut-off distance matrix, i.e. defining an impact frontier (a cut-off distance) and ignoring the changes further away: the countries within this frontier would be weighted according to the distance from the target country and countries outside the frontier are not considered at all.

An inverse-distance spatial weights matrix has been adopted for example by Baltagi et al. (2007). In order to ensure robustness, they also use alternative weighting structures that coincide to various decay levels, i.e. a faster-decay with inverse of squared distances and a slower-decay using inverse of the square root of distances between alternatives. They also employ a trade-based weighting matrix, where the elements are the inverse of the averages of bilateral trade flows between alternative locations. The authors calculate these weights from the pre-estimation period data to avoid any endogeneity problem that may arise.

Trade-related weighting structures have also been used by Kayam and Hisarciklilar (2009b). Specifically, they propose two slightly different trade-based weighting matrices. The first one considers the ratio between the total volume of trade between two countries (VoT_{ij}) and the total volume of trade of country i (VoT_i) as weights:

$$w_{ij}(1) = \frac{VoT_{ij}}{VoT_i} \quad if \quad i \neq j \tag{10}$$

$$= 0 \qquad if \quad i = j \tag{11}$$

The second matrix considers distance-based neighborhood relationships in addition to the bilateral trade flows. Here, the matrix elements consist of the mean shares of neighboring countries in country i's volume of trade with all its neighbors. Hence,

$$w_{ij}(1) = \frac{VoT_{ij}}{VoTn_i} \quad \textit{if } j \textit{ is a neighbor of } i \tag{12}$$

$$= 0 \qquad \textit{otherwise} \tag{13}$$

where VoT_{ij} in the above expression denotes the volume of trade between countries i and j, and $VoTn_i$ is country i's total volume of trade with all its neighbors. If the mean share of neighbors in the host's trade volume is very small or zero as in the case of Israel, then the foreign firms will not consider these countries i and j as substitutes. Continuing with the Israel's example, foreign firms willing to supply the Israel's market will invest only in that country and nowhere else, because the neighboring countries cannot be used as an export-platform. On the other hand, if countries i and j have high bilateral trade volume then foreign firms willing to supply either or both of these markets have a choice between these two locations because either could be used as export-platform.

5 Comments and Conclusions

In this chapter we have tried to summarize some of the widely used approaches and methods that have been employed to examine foreign firms' location decisions. Our focus has mainly been on econometric methods that incorporate space either explicitly or implicitly into the investigation of MNEs' decision. In Sect. 2 we tried to give an overview of the basic motivations and types of FDI and to place them into the theoretical framework of the knowledge-capital model. Following sections reviewed the empirical methodologies used to explain the location choices of MNEs starting from discrete choice models, mainly the conditional logit model of McFadden and count data models. The gravity model, which has become the workhorse of empirical trade literature is given a considerable attention as a macro approach applied to location choice of MNEs. Either utilized together or separately with the gravity equation, the market potential models have been used to investigate the location decision for foreign investments. Therefore, we discuss the empirical studies that adopt the potential approach. There, we particularly emphasize that the standard definition of economic potential may not work in all contexts and a considerable attention has to be paid to that matter particularly when studying the location choice for horizontal FDI.

Including space into econometric analysis has been cumbersome in many areas of economics. Spatial econometrics constitute a recently acquired methodology that has the potential to dominate research on location choice of MNEs for its' convenience in exploring the impact of spatial linkages. The approaches taken in this literature are based on unilateral flows or stocks between source and destination countries. The empirical literature, as to our knowledge, has not attempted to estimate a spatial econometric model making use of dyadic data. We anticipate that as a result of such an investigation, the improvement in our understanding of the motivations and factors influencing MNEs' location decision will be notable. This should be perceived as a further issue to be developed.

Usage of dyadic data in spatial econometric models is not the only issue that is worth following. A relatively more addressed concern is the specification of the weighting or interaction matrix in spatial econometrics. Different types of weighting matrices used in location literature of FDI were given a considerable attention in the chapter. However, there are two aspects that requires further investigation. These are the choice of the weighting matrix and the conventional approach of using the same weighting matrix for both weighting the dependent and independent variables in the spatial econometric model. Above, we gave examples of context-dependent interaction matrices employed in the literature and mentioned that the studies, which choose to use separate matrices to weight dependent and independent variables. These issues, when explored in detail, has the potential of increasing the state of knowledge on not only location choice but also other space related inquiries.

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Appendix: A Sample of Studies on MNEs' Location Choice

Study	Method	Countries	Findings
Altomonte (2002)	PM	CEE countries	Market potential and accessibility
Andreff (2002)	OLM	176 countries	Level of development and industry distribution in the home country
Becker et al. (2005)	CLM	German and Swedish MNEs	Market size, labor skill, labor cost, trade and investing cots
Baltagi et al. (2007)	SE	US outward FDI	Third country effects, complex FDI
Barrios et al. (2006)	NL	Ireland	Agglomeration economies, regional policy, technology level
Basile (2004)	NB, ZIP	Italian provinces	Location determinants differ according to entry mode (greenfield vs. acquisitions); Infrastructures
Basile et al. (2006)	NB	8 EU countries	Country border effects, institutions
Basile et al. (2008)	MXL	8 EU countries	Structural and cohesion funds
Bevan and Estrin (2004)	GM	12 transition economies	Unit labor costs, market size and proximity, privatization, banking sector, liberalization and institutions
Blonigen et al. (2007)	SE	US outward FDI in OECD countries	Third country effects
Brenton et al. (1999)	GM	5 EU Eastern countries	Stocks of FDI in transition countries diverge little from the expected pattern
Brush et al. (1999)	MLM	73 US, European and Japanese MNEs	National and regional characteristics
Buch et al. (2003b)	GM	Outward FDI of 7 countries	No evidence of redirection. GDP, GDP per capita, legal system, language, distance and restrictions in the recipient country
Buckley et al. (2007)	Panel	Chinese outward FDI	Market size, natural resources
Carstensen and Toubal (2004)	Dynamic panel	CEEC	Market potential, unit labor costs, labor skills, endowments, country risk, privatization

(continued)

Cheng and Stough (2006)	CLM	Japanese FDI in China	Market size, labor, land, energy cost, infrastructure, incentives, agglomeration
Cieślik and Ryan (2004)	GM	Japanese FDI in Europe	Economic potential
Coughlin and Segev (2000)	SE	China	Agglomeration economies, market size, labor supply characteristics, infrastructure
Coughlin et al. (1991)	CLM	USA	Per capita incomes, density of manufacturing activity, taxes, wages, unemployment, unionization, infrastructure, investment promotion
Crozet et al. (2004)	CLM, NL	France	Market potential
De Beule and Duanmu (2012)	CLM	Chinese and Indian acquisitions	Indian firms utilize ownership advantages. Chinese FDI is more technology-seeking
De Propris et al. (2005)	NB	Italian provinces	Agglomeration economies
Devereux and Griffith (1998)	MLM	US MNEs in Europe	Profit taxes, agglomeration economies
Disdier and Mayer (2004)	CLM, NL	French MNEs in Europe	Agglomeration economies, institutional quality
Figueiredo et al. (2002)	CLM	Outward Portuguese FDI	Agglomeration economies
Friedman et al. (1992)	CLM	Japanese and European MNEs	Access to markets, labor market conditions, state and local taxes
Garretsen and Peeters (2009)	SE	Dutch FDI in 18 countries	Third-country effects
Head and Mayer (2004)	CLM, NL	Japanese firms in Europe	Market potential
Head et al. (1995)	CLM	Japanese FDI in USA	Industry-level agglomeration
Iammarino and Pitelis (2000)	MLM	Greek FDI in Bulgaria and Romania	Labor and trade costs, proximity to EU market, investment incentives, pace of transition, technology level
Kang and Lee (2007)	CLM	South Korean FDI in China	Market size and institutions
Kim and Rang (1997)	GM	Japanese and South Korean FDI	Exports and FDI substitutability vs. complementarity; market vs. cost orientation
Kolstad and Wiig (2012)	Panel	Chinese outward FDI	Natural resources, institutions

(continued)

Lankes and Venables (1996)	MLM	Western FDI in transition countries	Progress on structural reforms
Ledyaeva (2009)	SE	FDI in Russia	Market potential
Loungani et al. (2002)	MLM	Greek firms	Borrowing capacity, labor intensity, sales growth rate, firm size, familiarity with foreign markets
Razin et al. (2003)	GM	45 countries	GDP per capita, education distance, trade, setup costs, marginal productivity
Zhang and Daly (2011)	Panel	Chinese outward FDI	Market size, natural resources, trade, growth and openness

Notes: *CLM* conditional logit model, *GM* gravity model, *MLM* multinomial logit model, *MXL* mixed logit model, *NB* negative binomial model, *NL* nested logit model, *OLM* ordered logit model, *PM* probit model, *SE* spatial econometrics, *ZIP* zero-inflated Poisson model

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