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The role of geographical and temporary proximity in MNEs' location and intra-firm co-location choices

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ABSTRACT

This paper investigates the role of geographical and temporary proximity in the location and co-location decisions of new manufacturing activities by foreign multinational enterprises (MNEs). Empirical analysis confirms that foreign MNEs co-locate their new manufacturing plants with their plants already operating in the same activity, while geographical proximity exerts a much weaker role when the latter operate in other manufacturing and services activities. This is especially true in the case of knowledge intensive business services, where temporary proximity is more easily obtainable through the travelling and meeting of professionals. Moreover, a spatial econometric extension of our analysis confirms a geographical decay effect for intra-firm co-location with activities located in contiguous provinces.

INTRODUCTION

Location choices of multinational enterprises (MNEs) contribute to the asymmetrical distribution of economic activities between countries and regions (Alfaro & Chen, 2014). The evidence shows that MNEs concentrate their activities in regional clusters of industrial excellence and in metropolitan areas. Indeed, the search for agglomeration economies is a key determinant of the process (for a review, see Iammarino & McCann, 2013). Specifically, MNEs seek to access information and knowledge externalities by co-agglomerating with subsidiaries of other MNEs and with local companies from which they can benefit in terms of information, knowledge and innovation (Mariotti et al., 2010; Chang and Park, 2005; Arauzo-Carod et al., 2009; Nielsen et al., 2017); additionally, MNEs tend to agglomerate also with their pre-existing initiatives (Blanc & Sierra, 1999; Chan, Makino & Isobe, 2006; Defever, 2006; 2012; Alcácer & Delgado, 2016; Castellani & Lavoratori, 2020), especially if the latter are in the same activity, so to exploit economies of scale and scope, information exchanges, local knowledge transfer, internal labour market, and benefits associated to internal network economies (e.g., Chang & Park, 2005; Woo, Cannella & Mesquita, 2019).

The present study aims to analyse the role that proximity among intra-firm activities play in influencing location choices of foreign MNEs within a country. Our empirical analysis concerns foreign MNEs that have located their greenfield manufacturing initiatives in Italy in the period 1998-2012; namely, we consider MNEs with pre-existing initiatives - in the same activity or different manufacturing and services activities - already located in Italy.

In so doing, we test (i) that geographical proximity work for pre-existing initiatives (i.e. intra-firm co-location) in the same activity (of the focal greenfield investment), while it does not play a role when pre-existing initiatives concern different manufacturing and/or services activities, especially in knowledge intensive business services where temporary proximity mechanisms could substitute the need of permanent geographical proximity, and (ii) that the benefits of intra-firm co-location decline with the geographical distance, i.e. which are the boundaries of geographical proximity (Drucker, 2012).

In line with the literature on firm's location decision, we first perform a conditional logit model, and our econometric findings provide statistical evidence about our expectations on the MNEs' location and co-location choices. Additionally, we perform a spatial econometric model that takes into account the focal MNEs' pre-existing activities in provinces that are contiguous to the focal one. Estimated coefficients show that the presence of previous activities in contiguous provinces do not seem to play a role in the MNEs' location choices, thus confirming that co-location forces act within the province, but they decay when crossing the province borders.

The paper is organized as follows. The next section illustrates our conceptual framework about factors driving the location decision of foreign MNEs, focusing on geographical proximity (i.e. intra-firm co-location) with previous initiatives in the same or different activities, emphasizing the different role of permanent and temporary proximity. the data and the empirical strategy are then presented, before the discussion of econometric estimates and robustness checks. Lastly, conclusions provide a summary of main our findings, with policy considerations and suggestions for further research.

GEOGRAPHICAL AND TEMPORARY PROXIMITY AS DRIVERS OF MNES' LOCATION DECISION IN FOREIGN COUNTRIES

A large amount of theoretical and empirical literature assesses the positive role played by agglomeration forces, i.e. proximity with other companies in the same or other sectors of activity, in attracting foreign MNEs' investments (e.g. Head et al., 1995; Mariotti & Piscitello, 1995; Driffield & Munday, 2000; He, 2002; Barrios et al. 2006; Bobonis & Shatz, 2007; Debaere et al., 2010). The concept of agglomeration encompasses many interpretations and forms, but it inherently relies on geographical proximity among actors (Ellison et al., 2010; Combes & Gobillon, 2015).

However, much less attention has been devoted to the role of geographical proximity with respect to the MNEs' own activities already located in the foreign country (the intra-firm co-location phenomenon). In fact, the *expansion* of the activities at the level of the single plant could allow to exploit economies of horizontal integration (or internal economies of scale), economies of lateral integration (or internal economies of scope) and economies of vertical integration (Parr, 2002), and it reduces production and transport costs by using assets that are indivisible and/or fungible and/or spatially bounded by technologies that require production processes to be physically contiguous. Intra-firm co-location allows the company to share physical assets (plants and machineries), specialised people, teams, logistic and support services for geographically concentrated units (Alcácer & Zhao, 2012; Alcácer & Delgado, 2016). Additionally, both the agency theory and transaction cost theory[i] share the idea that costs concerning relations between economic agents are sensitive to geographical distance[ii]. In the agency theory, misaligned goals and principal-agent information asymmetries involve monitoring and control activities, whose costs are mitigated by geographical proximity. Similarly, according with transaction cost theory, internal coordination of transactions suffers from conditions of contractual incompleteness and opportunism (as it happens for market transactions), thus entailing costs that increase with geographical distance. The roots of this approach can be found in Coase (1937: 397), who acknowledges that "the cost of organising and the losses through mistakes will increase with an increase in the spatial distribution of transactions organised". In fact, coordination, monitoring and control of geographically dispersed activities is a key aspect for the efficiency and competitive advantage of the company (Howells & Bessant, 2012). Therefore, intra-firm co-location mechanisms can act as a substitute for the firm's lack of experience in coordinating dispersed and complex organisational structures, as well as when the firm relies relatively less on codified knowledge which is less easy to transfer across locations (Castellani & Lavoratori, 2020).

Other studies about intra-firm spillovers highlight also the beneficial effects of geographical proximity and co-location as factors that facilitate the sharing of experience, information and tacit knowledge between different functional units of the enterprise, with a positive impact on the latter's productivity. Liberti and Mian (2009), for example, find that the transfer and effective use of information depends both on organisational distance in internal hierarchies and on geographical distance between the agents, in presence of 'soft information' that is difficult to codify. Similarly, Rawley and Seamans (2015) find that co-location of new and existing units of the same enterprise increases their productivity, thanks to the two-way exchange of local knowledge and experience on the one hand, and innovation, new approaches and techniques, on the other. Ivarsson et al. (2016) underline that co-location generates scale economies, contributes to joint problem-solving and tacit knowledge transfers, both in an intra- and cross-functional perspective. Buciuni and Finotto (2016) suggest that the co-location of production and a few key development functions (such as prototype development), ensures the constant generation of innovation and maintains the control on innovative activities, since those require distinct manufacturing competences.

However, geographical proximity may play different roles in the location of manufacturing and services activities. Several authors have advanced the notion of temporary proximity (Torre & Rallet, 2005; Gertler, 2008; Torre, 2008; Crone, 2012), i.e. the idea that actors need not be in constant geographical proximity when collaborating, because periodic meetings, short visits and project teams may suffice to develop other forms of proximity. The advantages and diffusion of information and communication technologies, as well as progresses in transport technologies and infrastructure and the decline in transport costs, can reduce the need of physical proximity and facilitate cooperation between units across distance. Medium- and short-term visits can be sufficient for face-to-face exchanging of information and knowledge, through the professional mobility of individuals (Torre, 2008). The temporary proximity is facilitated by a shared organizational proximity across subsidiaries within the same firm, where the definition of rules and resources/capabilities for sharing knowledge makes possible to establish profitable long-distance relationships (Torre & Rallet, 2005) and trust (Growe, 2019). Previous empirical studies (e.g. Mariotti et al., 2015) have already shown that although temporary geographical proximity may affect interactions between manufacturing firms, it is likely to be more relevant in the knowledge-intensive service activities (KIBS) rather than in the manufacturing ones (Wood, 2012; Muller & Zenker, 2001; Muller & Doloreux, 2012). Indeed, assets of service activities tend to be relatively mobile, largely immaterial, and embodied in modular bundles of specialized and relational-dedicated human resources (e.g., staffs of professionals and consultants), thus reducing the need for permanent physical proximity (Crone, 2012) as temporarily sharing face-to-face time, even irregularly, is conducive to a heightened level of knowledge sharing and leads to superior final outcomes (Choudhury, 2017). Conversely, benefits of co-location for manufacturing activities are more frequently associated with the locations of physical assets, and with the related knowledge, technology and dedicated human resources, as well as the generation of economies of scale and scope. Furthermore, the preferred locations for knowledge intensive activities (e.g. research and development, headquarters) can be closer to universities, research centres and specialised areas with high-skilled human capital (Cantwell & Piscitello, 2005), and a higher degree of international connectivity, such as in global cities. Whereas manufacturing activities are more likely to be located in peripheral or metropolitan areas surrounding a city, requiring larger spaces and benefiting of lower wages and rents, as well as easier access to raw materials and suppliers (Henderson & Ono, 2008; Goerzen at al., 2013; Belderbos et al., 2017). Temporary proximity mechanisms can facilitate the coordination and communication between different activities in different locations.

EMPIRICAL ANALYSIS: DATA AND METHOTOLODY

Data and descriptive statistics

We rely on detailed cross-sectional and firm-level data on greenfield investments[iii] undertaken in Italy by foreign MNEs during the period 1998 - 2012. Data are drawn from the database REPRINT, developed at Politecnico di Milano (for more details, see Mariotti et al., 2015). The database records 447 new greenfield investments in manufacturing activities (excluding the expansion of the existing establishments), undertaken by 384 foreign MNEs in Italy, and for each new investment reports detailed information about the location where the investment takes place, the activity, and the home country of the MNEs.

Additionally, the database reports information about the prior investments undertaken by the same MNEs inside the country, regarding the activity involved, the year of the investment and the location. Thus, we refer to the NACE (rev. 1.1) classification and distinguish between:

- *Manufacturing activities*, corresponding to NACE 15-37.
- *Knowledge intensive business services (KIBS).* According to previous empirical studies (e.g. Wood, 2012; Muller and Zenker, 2001; Muller and Doloreux, 2012), we refer to computer and related activities (NACE 72), research and development (NACE 73), other business activities (NACE 74), such as legal, accounting, tax, business and management consultancy, and management activities relating to holding companies (74.1), with the exclusion of labour recruitment and provision of personnel (74.5), investigation and security activities (74.6), industrial cleaning (74.7) and miscellaneous business activities (74.8).

- *Other services activities*, corresponding to all the other activities (mainly wholesale trade, NACE 51, and transport, storage and communication, NACE 60-63)[iv].

Given the purpose of our study (i.e. the role played by intra-firm co-location as a factor driving new MNEs' location choices), we restricted our analysis only to those new greenfield investments undertaken by MNEs that are already present in Italy before the focal investment. Thus, we focus on 263 new investments in manufacturing activities, undertaken by 206 MNEs during the considered period[v]. Each observation captures the establishment of a new plant and it refers to one-time event (the location decision event)[vi].

As far as the geographical unit to which the concept of agglomeration and co-location should be operationally applied, we acknowledge that underlying mechanisms of agglomeration are spatially bounded and depend both on density of interactions between people, enterprises and economic and social organisations, and on internal demands for coordination and monitoring within MNEs. The rapid decay of agglomeration effects is solid evidence in the field of regional sciences (Duranton & Puga, 2004; Rosenthal & Strange, 2004; Drucker, 2012; Combes & Gobillon, 2015). Accordingly, we consider the level of the Italian province, corresponding to the NUTS-3 level of the Eurostat classification[vii] (Eurostat, 2011). Italy is divided in 110 provinces; their average extension is 2,746 square kilometres, and the average distance between their capitals is 40 kilometres.

Figure 1 illustrates the spatial distribution of greenfield investments considered in the main provinces.

[Figure 1 about here]

The 263 new investments in manufacturing activities take place in 74 out of 110 Italian provinces, about 60% of total initiatives is located in the first 18 provinces as reported in table A.1 in the Appendix.

Moreover, and crucially for our investigation, focal MNEs present a total of 2,181 pre-existing initiatives in the country, where 1,274 (58%) are manufacturing activities taking place in 95 provinces, 187 (9%) refer to knowledge intensive business services (KIBS) in 35 provinces, and 720 (33%) to other service activities, in 86 different provinces. Table 1 reports the geographical distribution of these prior investments across provinces. As expected, manufacturing activities tend to be more geographically dispersed compared to knowledge intensive business services activities, which present a strong concentrated pattern (the 68.9% of prior investments in KIBS is located in only four provinces, i.e. Milan, Rome, Turin and Florence). Whereas other services activities present a mixed geographical pattern.

[Table 1 about here]

Whereas, figures 2-4 in the Appendix graphically show the geographical distribution of these prior presences.

Empirical strategy

We develop a location choice model through a Conditional Logit model (McFadden, 1974), that estimates the profitability of choosing a specific location (among a set of possible alternatives) by taking into account the attributes of the locations considered, in line with the literature on firm's location decision (for recent reviews, see Arauzo-Carod et al., 2010; Nielsen et al., 2017). Each location is associated with a profit and we assume that the firm chooses the location that maximizes this profit. In other words:

$$\pi_{ifls} = \sum \beta Coloc_{fls} + \sum \delta Controls_{ls} + \varepsilon_{ifls} \qquad (1)$$

Where π is the profit of the investment i (location event), made by the company f in the location l, in the activity s.

As profits associated to different locations are not directly observed, we observe the characteristics of the chosen location vs. the characteristic of the alternative choices (in our case the other provinces). In the conditional logit model (CLM) the profit is explained as a function of observed firm-location and location characteristics (Z_{fl}) and error term ε_{fl}

$$\pi_{fl} = V_{fl} + \varepsilon_{fl} = \beta Z_{fl} + \varepsilon_{fl} \quad (2)$$

Firm *f* will choose location *l** that maximizes its profit on a set of *l* possible alternatives, formally $\pi_{fl*} > \pi_{fl} \;\; \forall l \neq l*$ (l = 1, …, L-1).

As shown in McFadden (1974), under suitable assumptions on ε_{fl} and the independence of irrelevant alternatives (*IIA*) property, the probability that a location *l* results in the highest profitability for an investment can be represented by the following logit expression:

$$P_{fl*}^{CLM} = \frac{\exp(\beta Z_{fl*})}{\sum_{l=1}^{L-1} \exp(\beta Z_{fl})}, \forall l \neq l^* \; (l = 1, \dots, L-1) \qquad (3)$$

This function can be estimated using maximum likelihood techniques and the estimates of β can be used to test if various characteristics significantly affect the probability of choosing a greenfield investment location.

The variables

The Location choice (dependent variable)

Our dependent variable refers to the location decision (event) of a new greenfield investment undertaken by firm *f* in manufacturing activity *s*, in location *l*, in a certain year (throughout 1998 and 2012). The variable assumes value 1 for the location chosen and zero for the other alternative locations. The 110 Italian provinces compose our location choice set. The total number of observations is 28,930 where each investment is replicated for the possible alternative location choices (namely: 263*110 = 28,930).

Explanatory variables

Intra-firm co-location

Following our theoretical conceptualisation, the main explanatory variables refer to intra-firm co-location, defined as the previous presence of the focal firm *f* in province *l*, in the year before the new location decision. Specifically, we distinguish the co-location with previous activities as follows:

- *Colocation_Manuf* is a dummy variable that assumes value one if the focal MNE has a prior manufacturing plant in the province, and zero otherwise. Then, we split this variable controlling for prior presence in the same manufacturing activity (*Colocation_same_Man_activity*), and in other manufacturing activities (*Colocation_other_Man_activity*);
- *Colocation_KIBS* is a dummy that equals one in case the MNE has a previous presence in KIBS activities, in the province, and zero otherwise;
- *Colocation_Other_Services_activity* is a dummy that equals one when the MNE's previous presence in the province concerns other services activities, and zero otherwise, as a control variable.

Looking at the data, we find that 86 out of the new 263 greenfield investments considered (i.e. the 32.7%) are located in a province where the MNE had already another activity, these are co-location cases; specifically, in 63 cases the previous initiative is in the same activity of the focal one; in 41 cases it refers to other activities, while only in 17 cases it refers to KIBS. It is worth observing that each MNE can present more than one prior presence, even in different activities, in Italy and in the focal province. That explains why the sum of the previous presences do not equal the number of investments with previous presence in the province (86). Indeed, in 31 cases (11.17%) the MNEs have more than one prior initiative in the year before the new investment, in different activities simultaneously. Moreover, an in-depth analysis highlights that in 7 cases co-location happens in provinces where the MNE is already present only with KIBS activities, without prior investments in other activities ("pure KIBS" areas). This happens in five provinces (Benevento, Biella, Genova, Rome and Varese). The number of cases increases when we look at prior investments in other services activities (14), without any prior co-location with manufacturing activities and/or KIBS activities. These initiatives are located in seven provinces (Bolzano, Milan, Turin, Verona, Monza/Brianza, Bergamo and Varese). Finally, we have 34 cases of co-location in a province where the MNE is present only with prior manufacturing activities (in 22 provinces, e.g. Padua, Milano, Rome, Turin, Pisa, Cesena, Modena, Varese, Lodi).

Control variables

To account for other characteristics of the provinces that have been already shown to influence MNEs' location choices within a country (Nielsen et al., 2017), we control for the following variables.

Specialisation Index. In order to proxy specialisation agglomeration economies (Marshall, 1920) that are associated to the industrial specialisation in a given geographical area, we calculate the degree of specialisation in province *l* in each manufacturing activity *s*, as the share of firms operating in activity *s* in province *l* compared with the share of firms operating in activity *s* in Italy. Formally:

$$Specialisation_{ls} = \frac{N_{ls} \;/\; \sum_s N_{ls}}{\sum_l N_{ls} \;/\; \sum_l \sum_s N_{ls}}$$

where N_{rs} is the number of local firms operating in activity *s* in province *l* in 2001, provided by ISTAT (the Italian National Institute of Statistics). The activity *s* is defined by the three-digit classification of economic activities in the European Community (NACE Rev. 1.1).

Diversification Index. To proxy the diversification/urbanisation agglomeration economies (Jacobs, 1969) that are associated to the industrial diversification in a specific geographical area, we compute the degree of diversification in each province *l* using the traditional entropy index (Batty, 1976):

$$Diversification_l = \left(\sum_s x_{ls} \log \frac{1}{x_{ls}} \right)$$

where $x_{ls} = N_{ls}/\Sigma_s N_{ls}$ and N_{ls} is the number of firms operating in each manufacturing activity *s* in province *l* in 2001, provided by ISTAT.

Population density of a province is defined as the resident population divided by the area of the province. On the one hand, a higher population density reflects a greater presence of agglomeration and urbanisation economies; on the other hand, a higher level of population density reflects higher congestion costs producing a discouraging effect in the attraction of foreign investments.

Global City. To identify those provinces corresponding to the metropolitan areas where both the effects of liability of foreignness can be mitigated and the archipelago economies can be captured by MNEs, we refer to the classification proposed by the Globalisation and World Cities Research Network (Taylor, 2005). This worldwide classification identifies 315 global cities with a different degree of global connectivity: ‘Alpha’ and ‘Beta’ cities are the more global ones, ‘Gamma’ cities are those with an intermediate level of global connectivity, and ‘Sufficiency’ cities present the lower degree of global connectivity. Thus, we define *Primary_GlobalCity* those provinces including cities that are classified as ‘Alpha’ and ‘Beta’ in 2000, namely Milan and Rome. Likewise, we define *Secondary_GlobalCity* those provinces including cities classified as ‘Gamma’ and ‘Sufficiency’, namely Bologna and Turin.

We also include a dummy variable '*North*' in order to control for unobserved factors and given the high concentrations of investments in that area.

Table 2 reports a detailed description of our explanatory and control variables as well as the relevant sources of data.

[Table 2 near here]

Table 3 and 4 report some descriptive statistics and the correlation matrix for our dependent and independent variables.

[Table 3 and 4 near here]

ECONOMETRIC RESULTS

We investigate the factors driving the MNE's location choice for new greenfield investments in manufacturing activities through conditional logit models, and our findings are reported in Table 5. The majority of MNEs undertakes just one new investment in the considered period (170 out of 206), while 33 MNEs have between 2 (11.65%) and 4 (0.49%) new investments, and there are only 3 companies with 5-6 new investments. For taking into account this fact, we cluster the standard errors by MNE[viii]. The coefficients are calculated as odds ratio to facilitate interpretations and comparisons.

[Table 5 near here]

Model (1) reports the estimated coefficients for the control variables associated to the location characteristics of the provinces, i.e. *Specialization, Diversification, Primary Global City, Secondary Global City*, *Population density* and *North*. They all come out positive and significantly different from zero (at $p<.01$), confirming that the location endowment is a strong external driver for the location of a new MNE's greenfield investment.

In line with the empirical studies on Marshallian and Jacobsian externalities, the variables *Specialization* and *Diversification* have a positive and significant coefficient in each specification, with a higher effect for diversification (the coefficient of *Diversification* is always higher than the coefficient of *Specialization*). Similarly, both the variables capturing the global city status have a positive effect on the MNE's location decision, confirming that a greater degree of global connectivity increases the province attractiveness for foreign investments (Goerzen et al. 2013). The positive coefficient of *Population density* confirms the importance of urbanisation economies in attracting foreign investments.

Model (2) adds to external location characteristics, the proxies for the MNEs' intra-firm co-location, i.e. the focal company's prior presence in manufacturing, KIBS and other services activities (*Colocation_Manuf; Colocation_KIBS* and *Colocation_Other_Services_activities*). It is worth noting that the inclusion of intra-firm co-location factors increase the fit of the model: the *log-likelihood* increases to -1006.92, and the *pseudo* R^2 to 0.1855 compared to Model (1), confirming the role of intra-firm co-location as a driver of MNEs' location choice. Thus, we conclude that MNEs' location choice of a new manufacturing investment in a given province is strongly driven by their own previous presence there when the latter concerns manufacturing activities, and other services activities (*Colocation_Manuf* and *Colocation_Other_Services_activities* are both positive and significant at $p<.01$), with a non-significant effect for the previous presence in KIBS (*Colocation_KIBS,* although positive, does not come out significant*).*

Interestingly, results in Models (2) and (3) show that the MNE's prior presence in manufacturing activities (*Colocation_Manuf)* in a given province increases the probability for the MNE to choose that province for the new manufacturing investment, because the need for logistic coordination and transaction costs that are sensitive to spatial contiguity are possibly higher for manufacturing activities. In addition, in Model (3) we introduce the decomposition of co-location with previous initiatives in the same manufacturing activity of the focal initiative (*Colocation_same_Man__activity)* and in other manufacturing activities (*Colocation_ other_Man_activities*). Results suggest that the mentioned positive and significant effect is strongly driven by prior presence in the same activity, and that co-location can facilitate information exchanges and local knowledge transfer (Rawley & Seamans, 2015; Alcácer & Delgado, 2016), as well as the creation of scale and scope economies (Parr, 2002). In addition, prior manufacturing activities are likely to involve high fixed plant capital and capital-intensive investments and related sunk costs that could limit the firm subsequent location decisions. Likewise, MNEs' location choices are significantly attracted in those provinces where the MNEs have a previous presence in other services activities (*Colocation_Other_Services_activities* is positive and significant at $p<.01$ in both model 2 and 3), because of factors related to vertical integration and logistic costs. However, it may be worth observing that the probability in the first case is almost six times the case in which the previous presence is in the other services activities (in Model 3 the coefficients of the two variables are 12.31 and 1.87, respectively). On the contrary, the MNE's prior presence in KIBS activities (*Colocation_KIBS*) in a given province is not a factor increasing the probability for the MNE to choose that province for the new investment in manufacturing. This result highlights the reduced role of permanent geographical proximity when knowledge-intensive activities are involved, and the substitute role played by temporary proximity mechanisms (e.g., Knoben & Oerlemans, 2008; Mariotti et al., 2015a). Interactions and exchange of knowledge (even of tacit nature) with intra-firm KIBS activities can be frequently exploited through professional mobility and dedicated temporary inter-organisational mechanisms (periodic meetings, project teams, etc.), that are routines less sensitive to spatial permanent proximity, at least until a regional threshold (e.g., Torre, 2008).

In Model (4) we regress our dependent variable on intra-firm co-location variables, but substituting our external variables with fixed effects, which control for any unobserved characteristics at province level. Comparing the model fit (*log-likelihood* and *pseudo* R^2) between Model (1) and (4), results underline that our variables capture most of province characteristics as the fixed effects. Finally, we check for multicollinearity using the VIF (Variance Inflation Factor) test. We find a mean VIF value of 1.32 (with values between 1.03 for 'Specialisation' economies, and 2.1 for 'North'), thus our variables could not be considered as a linear combination of other variables.

In order to test whether the benefits stemming from intra-firm co-location decay with distance - as in the case of external agglomeration forces (Combes & Gobillon, 2015; Cantwell & Piscitello, 2005; Paci & Usai, 1999), we develop a new specification that includes the MNEs' previous presence in provinces that are contiguous to the focal one. Specifically, we introduce the spatial lags of the explanatory variables capturing firm's previous investments. The new variables are the followings: *Colocation_same_Man_activity_lag*, *Colocation_ other_Man_ activity_lag*, *Colocation_KIBS_lag*, and *Colocation_Other_services_activities_lag*.

We generate a spatial weight matrix with a binary measure of proximity: a contiguity-based neighbourhood, where two provinces are neighbour if they share a common boundary. We create a row-normalized weight matrix[ix] using the queen-contiguity technique, and in a first order of contiguity. Results are reported in the last column (Model 5) of Table 5. Our estimates show that the MNE's prior presence in the contiguous provinces does not have any significant effect on the probability of choosing a province for a new manufacturing investment, both in a within- and across-activity perspective, in fact none of the spatially lagged variables come out significant. This confirms that the benefits of co-location with previous activities are limited within the boundaries of the province, largely because of the need of achieving economies of scale and reducing transport costs. Moreover, findings strengthen the result from previous models that co-location with previous KIBS activities do not seem to influence the MNEs' location behaviour in a foreign country.

Robustness checks

We tested the applicability and the accuracy of Conditional Logit models in our analysis. Specifically, the CLM exhibits the important assumption of independence of irrelevant alternatives (IIA). This restrictive property determines that the odds ratio of choosing one alternative rather than another is independent of the characteristics of any other alternative in the choice set. The insertion of a new alternative or the change in the characteristics of a third one does not change the odds ratio between pairs of alternatives (Train, 2003). If the IIA property is not satisfied, the conditional model produces biased estimated results. Considering this problem, we estimate also a Mixed Logit model (MLM) that overcomes the IIA assumption, introducing all the variables as random parameters (with the only exception of 'North' dummy, included as a fixed parameter for convergence issues). Another advantage of this estimation model is that the MLM directly address the unobserved heterogeneity across location alternatives. Results of MLM are mostly similar to those from CLM, supporting our arguments and the relevance of the empirical methodology adopted. Results are available under request to the authors.

Furthermore, we are aware of possible endogeneity issues given that previous FDI location decisions (intra-firm co-location variables) could have been affected by unobserved location-specific characteristics in the host location and we are not directly controlling for them, thus omitted attributes related to the previous location decisions can be correlated with the error term breaking an assumption of the model. Due the cross-sectional structure of our data, we cannot rely upon more sophisticated techniques for addressing this issue, as normally done in a panel data setting; thus, we suggest different alternative methods.

First, in Model 4 (table5) we include province fixed effects that capture all the observed and unobserved characteristics in each host location. Our main results persist, suggesting that adding more controls does not affect the significance of our results.

However, in order to further control for endogeneity, we adopt a control function (CF) approach that has been suggested to correct for endogeneity (Heckman, 1978; Hausman, 1978) in a discrete choice environment (firm location decision), as in Petrin and Train (2010). This procedure is composed of two stages. First, the endogenous variable is regressed on a set of observed characteristics as well as the instruments, and the control function is calculated using the residuals from the first regression. Second, the choice model (second-stage) is estimated including the control function as an additional variable.

Since our main estimation contains several variables that are potentially endogenous (namely, all the intra-firm co-location variables in different activities), we create a new variable that consider all the activities (either in manufacturing, KIBS or other activities) of the focal firm in a given province in the year before the new investment decision, and we estimate the first–stage regression. However, as CF estimation may not work properly with models that are nonlinear in parameters (as in the case of a probit model), we also build the dependent variable as a continuous one (i.e. counting the number of activities of the focal firm in the focal province), and we estimate an ordinary least square in the first stage.

Moreover, crucial assumptions for a good instrumental variable require that the instrument has to be an observable variable, not included in the main equation, correlated with the endogenous variable, but uncorrelated with the error term in the main equation (Wooldridge JM, 2002, p.83-84). The last assumption complicates the selection of an instrument since we can expect that location factors affecting past location decisions can have an effect also in the current location choice. We regress the endogenous variable on a rich set of province and firm-province characteristics, namely the number of graduated students, the expenses in R&D (log), the number of patents per inhabitant, the border effect (i.e., whether the province shares a common border with another European country), the presence of an industrial district in the province, the number of municipalities within the province, the size of the area (in square kilometres), the metropolitan nature of the province (i.e., whether the province is classified as metropolitan city, e.g. Bari, Bologna, Cagliari, Florence, Genoa, etc..), and the number of the MNE's prior investments in provinces different than the focal one. We also include the same factors included in the second stage, such as agglomeration economies, primary and secondary global cities, population density, the dummy North, as well as sectoral dummies. Results of the first stage are reported in table A.2 in the Appendix.

We estimate a conditional logit model as for the second stage, as well as a mixed logit model according to Petrin and Train (2010), using both binary and continuous intra-firm co-location variables as predictors respectively, in order to control for possible inconsistency in the specification with discrete endogenous regressors. We compute bootstrapped standard errors to take into account that in the second stage we include an estimation component (i.e. the residuals) from the first stage (Petrin and Train, 2010). All our main results in the specifications with and without spatial lags persist, as shown in table A.3 and A.4 in the Appendix

DISCUSSION

The geographical structure of the MNE in the host country significantly influences its subsequent location choices, as it encourages co-location between old and new activities, giving rise to a centripetal effect in geographical terms. The inclusion of intra-firm co-location in the location choice model significantly improves its fit and hence our understanding of the choices made by MNEs, even if the external agglomeration factors continue to play the positive role attributed to them in the traditional literature, location choices of MNEs that are already present in the country are dominated by the logic of intra-firm co-location.

Following this insight, our econometric findings provide an initial response to the research questions set out in the introduction to this paper. Namely:

(i) MNEs' location choices are likely to be attracted in those provinces where they already have a previous presence in the same manufacturing activity, and in activities such as sales and distribution. These results confirm the role of intra-firm co-location for activities that share physical assets, specialised people, teams, logistics and support services, and that exploit economies of scale, scope and vertical integration (Rawley & Seamans, 2015).

    Moreover, MNEs' location choices are not driven by the presence of their own KIBS activities in the same province, supporting the idea of a different need of permanent geographical proximity across different activities (Torre, 2008; Mariotti et al., 2015; Woo et al., 2019).

(ii) The benefits of co-location for new manufacturing plants with previous manufacturing activities and with other activities decline with distance, as they seem to disappear outside the borders of the focal province. Interestingly, from a different perspective, this result may be also related to the recent evidence about manufacturers increasingly buying, instead of making, their service provision by locally outsourcing their service function, wherever the market potential is higher. Thus, the importance of close interactions between manufacturing activities and service providers may vary (Lafuente, Vaillant & Vendrell-Herrero, 2019).

These results are based on an empirical analysis referred to the Italian case. Relevance and potential for generalizability are reasons for considering this case an ideal test bed. Italy is a major pillar of the international production. According to the UN National Accounts Main Aggregates Database, it has the second and the seventh largest manufacturing base in Europe and in the world, respectively. Its industry is largely diversified and strongly integrated in the worldwide production chain. Thus, Italy serves arguably as a particularly relevant case-study to investigate the mechanisms of location and colocation of manufacturing activities of both MNEs and indigenous firms.

Further, the high generalizability is due at least to two factors. First, Italy possesses an industrial structure densely populated by spatial clusters of activities. Much of the scholars' knowledge on industry agglomeration has historically built on an abundance of analyses of what has been referred to as `the holy trinity' of economic geography: the Third Italy (i.e. "industrial district"), Silicon Valley, and Baden-Württemberg, three success stories which since the 1980s had been regarded as paradigmatic of agglomeration in various respects (Malberg & Maskell, 2002). Second, during the observed period of our research, in the new context of globalization, the Italian industrial districts have encountered many changes in the socio-economic structure, as well as in its internal and external relations with other territories and firms, including MNEs (Degli Ottati, 2018). Given the increasing worldwide integration of production, these changes are part of a more general evolution of industries in both advanced and developing countries, of which Italy can be seen as an excellent generalizable case-study.

CONCLUSIONS

We believe our findings shed additional light inside the factors driving the firms' location decisions, by introducing the intra-firm co-location and considering a specific firm's heterogeneity, i.e. its multinational status. With specific reference to MNEs, our results contribute to the recent call on the need of broadening the analysis of the location determinants of their investments "in order to account for a wider set of attraction factors and for their changing role in the location of investments at different stages of the value chain" (Crescenzi et al., 2014: 1054). Indeed, while some studies have already started to clarify how the drivers traditionally identified in the literature (mainly associated to external agglomeration economies) influence the location of the different activities in the MNEs' value chain (e.g. Crescenzi et al., 2014; Defever, 2006, 2012), these analyses have insofar largely overlooked the role of intra-firm co-location within- and across-activity along the value chain in MNEs' location choices.

Specifically, despite some studies recognize that geographical proximity between R&D and manufacturing is key to preserving the innovative capabilities of firms (Mariani, 2002; Tecu, 2003; Ketokivi & Ali-Yrkkö, 2009; Gray et al., 2015) and that, conversely, the positive effects of R&D on the productivity of manufacturing decrease as the geographical distance between the two activities increases (Adams & Jaffe, 1996), our result seem to confirm the need of better investigating the mutual interdependence between innovation and manufacturing activities, possibly at a finer level of analysis. In fact, innovation and manufacturing comprise a wide variety of activities and the debate on co-location and geographical proximity can be advanced by analysing the interplay between innovation and manufacturing sub-activities, as well as specific firm and industry characteristics (Ketokivi & Ali-Yrkko, 2009; Buciuni & Finotto, 2016; Castellani & Lavoratori, 2020). Additionally, our evidence could be interpreted through the notion of temporary proximity (Torre & Rallet, 2005; Gertler, 2008; Torre, 2008; Crone, 2012), i.e. the idea that actors need not be in constant geographical proximity when collaborating, as meetings, short visits and temporary co-location may suffice to develop other forms of proximity (e.g., organizational), which subsequently enable collaboration over large geographical distances. In fact, our results seem to suggest that non-geographical forms of proximity can compensate for a lack of geographical proximity because non-geographical forms of permanent proximity reduce the need for face-to-face interactions (Boschma, 2005; Davids & Frenken, 2018) in case of knowledge-intensive activities, where assets are relatively mobile and largely immaterial (Crone, 2012; Mariotti et al., 2014).

The paper offers also policy implications for public decision makers that aim to implement effective measures and practices for attracting MNEs' investments. In the light of our findings, a comprehensive FDI strategy needs not only to take into account that inward investment frequently originates from MNEs already located in the country, but that their location decisions are heavily influenced by co-location phenomenon. Thus, aftercare services (OECD, 2015; UNCTAD, 2007) should become core functions in FDI promotion. Regional investment promotion agencies should leverage the MNEs' marked sensitivity to internal co-agglomeration, by offering them support for re-investment, so to embed MNEs more strongly in the area (Phelps & Fuller, 2001). Indeed, the MNEs' awareness that the agencies will provide effective support in meeting any difficulties that arise can be a critical factor in winning an investment (Loewendahl, 2001), especially for those areas that can hardly offer external agglomeration economies (for a recent analysis of the links between localized regional assets and socio-institutional features with global connectivity and FDI, see Crescenzi & Iammarino, 2016).

Finally, our results stimulate further research efforts, as they pave the way to further develop conceptually more detailed hypotheses regarding internal relations in the various phases of the value chain that influence co-location choices.

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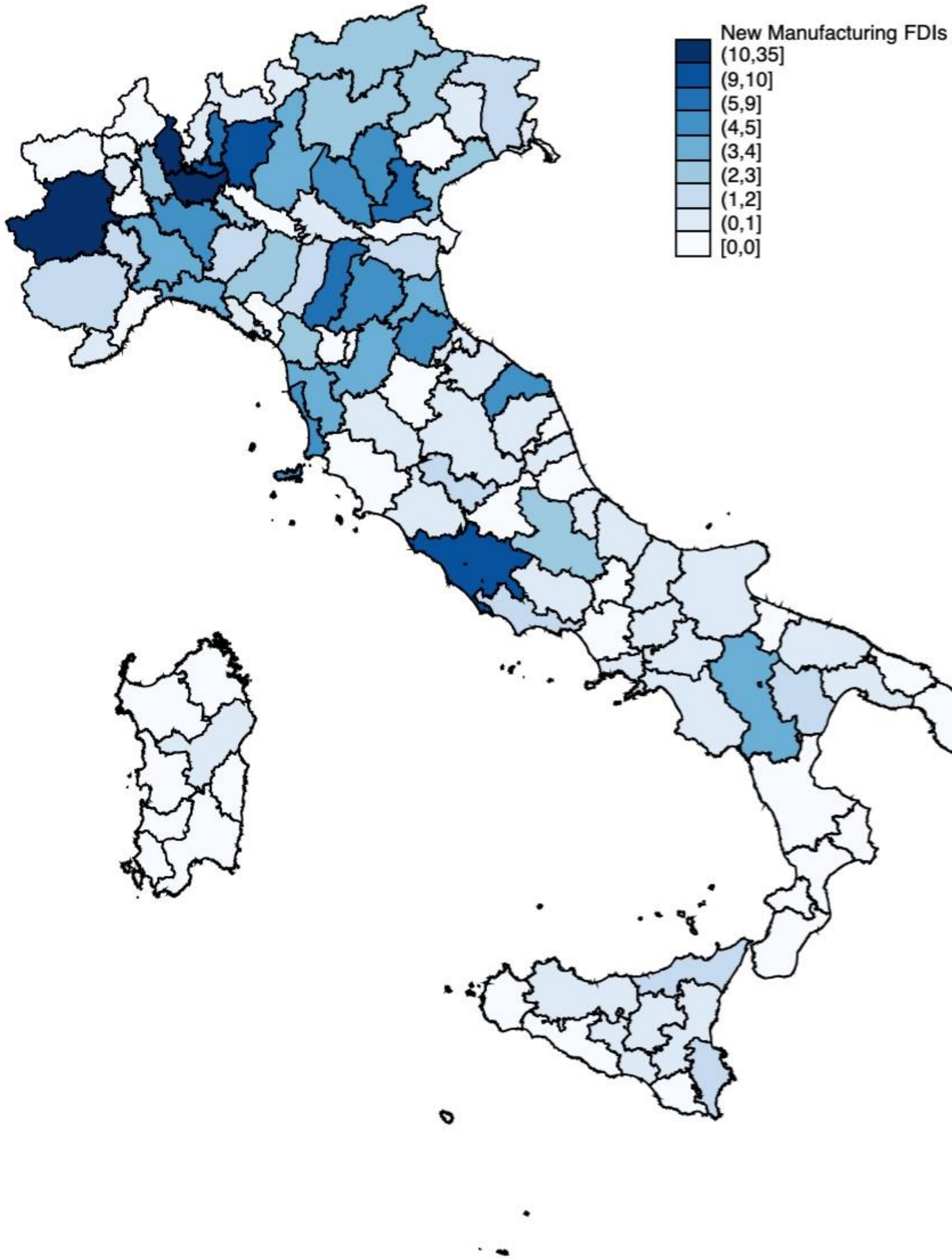
Figure 1. Spatial distribution of manufacturing greenfield investments, by province (1998 – 2012)



Source: authors' elaboration from REPRINT-Politecnico di Milano

Table 1. Geographical distribution of pre-existing greenfield investments in Italy, by province

Province (NUTS-3)	**Manufacturing No.**	**Province (NUTS-3)**	**KIBS No.**	**Province (NUTS-3)**	**Other No.**
Milan	250	Milan	72	Milan	243
Turin	92	Rome	23	Rome	67
Monza/Brianza	59	Turin	18	Monza/Brianza	30
Rome	45	Florence	10	Turin	27
Bergamo	40	Genova	6	Florence	21
Varese	39	Monza/Brianza	6	Genova	20
Florence	37	Varese	5	Alessandria	19
Padua	37	Bologna	4	Varese	18
Vicenza	24	Vicenza	4	Naples	15
Modena	23	Bolzano	3	Bologna	14
Venice	22	Padua	3	Brescia	12
Verona	22	Terni	3	Como	11
Novara	21	Alessandria	2	Venice	11
Genova	20	Benevento	2	Vicenza	11
Terni	20	Brescia	2	Padua	10
Cuneo	19	Como	2	Verona	10
Forlì-Cesena	19	Livorno	2	Caltanissetta	9
Bologna	17	Reggio Emilia	2	Modena	9
Other*	468	Other**	18	Other***	163
Total	**1,274**	**Total**	**187**	**Total**	**720**

Source: authors' elaboration from REPRINT-Politecnico di Milano
*77 Provinces receive the remaining number of prior presences in manufacturing activities
**17 Provinces receive the remaining number of prior presences in KIBS activities
***68 Provinces receive the remaining number of prior presences in other services activities

Table 2. Descriptions and sources of variables

Variables	Source	Descriptions	Type
Location	REPRINT	Location decisions of new investment in Manufacturing among 110 Italian Provinces (1998 - 2012); dummy = 1 if the firm chooses province r, zero otherwise	Firm-Province
Intra-firm Colocation			
Colocation Manuf	REPRINT	Dummy=1 if the firm has a prior presence in the province in manufacturing activities, zero otherwise	Firm-Province
Colocation KIBS	REPRINT	Dummy=1 if the firm has a prior presence in the province in KIBS activities, zero otherwise	Firm-Province
Colocation Other services activities	REPRINT	Dummy=1 if the firm has a prior presence in the province in the other services activities, zero otherwise	Firm-Province
Control variables			
Specialisation	ISTAT	Industrial specialisation of province r in the manufacturing activity s, calculated in 2001	Province
Diversification	ISTAT	Entropy index in the province r, calculated in 2001	Province
Population density	ISTAT	Resident population per squared kilometre (linear, in natural log)	Province
Primary GlobalCity	GaWC	Dummy=1 if the province is Milan or Rome, zero otherwise,	Province
Secondary GlobalCity	GaWC	Dummy=1 if the province is Bologna or Turin, zero otherwise	Province
North	ISTAT	Dummy=1 if the province is located in the North, zero otherwise	Province

Note: The number of observations is 28,930: 110 Italian provinces are the choice set.
The number of location decisions in manufacturing activity is 263.
Unless differently stated, independent variables are measured at the year before the new location decision under investigation.

Table 3. Descriptive Statistics of dependent and independent variables

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Location Choice	28,930	0.009	0.095	0	1
Colocation Manuf (total)	28,930	0.029	0.168	0	1
Colocation same Manuf activity	28,930	0.011	0.106	0	1
Colocation other Manuf activity	28,930	0.020	0.142	0	1
Colocation KIBS	28,930	0.006	0.075	0	1
Colocation Other services activity	28,930	0.014	0.118	0	1
Specialisation	28,930	0.023	0.960	-0.800	45.233
Diversification	28,930	0.000	1.000	-6.358	1.605
Primary GlobalCity	28,930	0.018	0.134	0	1
Secondary GlobalCity	28,930	0.018	0.134	0	1
Population density (log)	28,930	5.142	0.810	3.434	7.866
North	28,930	0.427	0.495	0	1
Colocation same Manuf activity spatial lag	28,930	0.013	0.058	0	1
Colocation other Manuf activity spatial lag	28,930	0.022	0.081	0	1
Colocation KIBS spatial lag	28,930	0.006	0.039	0	0.6
Colocation Other Services activity spatial lag	28,930	0.016	0.063	0	1

Source: authors' elaboration from REPRINT-Politecnico di Milano

Table 4. Correlation of dependent and independent variables

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Location Choice	1															
2	Colocation Manuf (total)	0.12	1														
		0.00															
3	Colocation same Manuf activity	0.16	0.62	1													
		0.00	0.00														
4	Colocation other Manuf activity	0.06	0.83	0.16	1												
		0.00	0.00	0.00													
5	Colocation KIBS	0.08	0.24	0.20	0.22	1											
		0.00	0.00	0.00	0.00												
6	Colocation other services activity	0.11	0.27	0.21	0.23	0.25	1										
		0.00	0.00	0.00	0.00	0.00											
7	Specialisation	0.11	0.07	0.06	0.06	0.03	0.05	1									
		0.00	0.00	0.00	0.00	0.00	0.00										
8	Diversification	0.06	0.10	0.06	0.09	0.06	0.08	0.13	1								
		0.00	0.00	0.00	0.00	0.00	0.00	0.00									
9	Primary GlobalCity	0.11	0.15	0.11	0.15	0.25	0.26	0.04	0.12	1							
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								
10	Secondary GlobalCity	0.06	0.09	0.06	0.08	0.03	0.05	0.07	0.13	-0.02	1						
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
11	Population density (log)	0.08	0.14	0.10	0.13	0.12	0.16	0.09	0.27	0.32	0.09	1					
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
12	North	0.06	0.09	0.06	0.08	0.05	0.07	0.13	0.30	0.02	0.16	0.24	1				
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
13	Colocation same Manuf activity spatial lag	0.01	0.14	0.14	0.09	0.05	0.09	0.05	0.06	0.01	0.00	0.07	0.12	1			
		0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.93	0.00	0.00				
14	Colocation other Manuf activity spatial lag	0.02	0.20	0.09	0.20	0.07	0.08	0.03	0.06	0.02	-0.01	0.07	0.16	0.22	1		
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.00	0.00	0.00			
15	Colocation KIBS spatial lag	0.01	0.11	0.06	0.09	0.10	0.04	0.02	0.07	-0.01	-0.01	0.07	0.11	0.24	0.31	1	
		0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.08	0.00	0.00	0.00	0.00		
16	Colocation Other Services activity spatial lag	0.01	0.12	0.09	0.09	0.03	0.11	0.04	0.08	0.00	-0.01	0.11	0.16	0.29	0.29	0.27	1
		0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.02	0.00	0.00	0.00	0.00	0.00	

Note: statistical significance (p-value) is reported under the related correlation coefficient.

Table 5. Estimates from the location models of new manufacturing greenfield investments

	Mod. 1	Mod. 2	Mod. 3	Mod. 4	Mod.5
Intra-firm colocation					
Colocation Manuf		5.4756***			
		(1.5598)			
Colocation same Manuf activity			12.3207***	11.0500***	12.4100***
			(3.9214)	(3.2586)	(3.7899)
Colocation otherManuf activity			1.0212	1.0534	0.9969
			(0.3634)	(0.3322)	(0.3573)
Colocation KIBS		0.9845	0.945	0.9703	0.9425
		(0.3798)	(0.4173)	(0.3938)	(0.4138)
Colocation Other Services activity		2.1750**	1.8743*	1.9983**	1.8784*
		(0.6820)	(0.6327)	(0.6077)	(0.6268)
Control variables					
Specialisation	1.3331***	1.2945***	1.2954***		1.2944***
	(0.0551)	(0.0520)	(0.0575)		(0.0575)
Diversification	1.5905***	1.5049***	1.5209***		1.5200***
	(0.1814)	(0.1592)	(0.1642)		(0.1641)
Primary GlobalCity	3.0988***	1.7409*	1.9009*		1.9026*
	(0.8258)	(0.5687)	(0.6276)		(0.6354)
Secondary GlobalCity	3.0865***	2.3749***	2.4903***		2.5311***
	(0.6877)	(0.5505)	(0.5849)		(0.6051)
Population density (log)	1.4868***	1.3692***	1.3768***		1.3811***
	(0.1352)	(0.1278)	(0.1268)		(0.1265)
North (dummy)	1.8044***	1.7132***	1.7379***		1.7120***
	(0.3168)	(0.2931)	(0.3047)		(0.2952)
First Order Lagged Colocation					
Colocation same Manuf activity lag					0.5926
					(1.0882)
Colocation other Man activity lag					3.473
					(3.4086)
Colocation KIBS lag					2.1433
					(2.8308)
Colocation Other Services activity lag					0.3455
					(0.4153)
Fixed Effect (Province)	**No**	**No**	**No**	**Yes**	**No**
No. of obs	28,930	28,930	28,930	28,930	28,930
No. of MNEs	206	206	206	206	206
Pseudo R^2	0.151383	0.185492	0.200496	0.24494	0.201761
Log-likelihood	-1049.08	-1006.92	-988.37	-933.43	-986.8

Note: The dependent variable is the location decision of a new manufacturing investment *i* in the Province *r*. The total number of investments is 263. Choice set: 110 provinces. The coefficients of Conditional Logit model are reported as *odds ratio*. Standard errors are clustered by firm and reported in parentheses. Asterisks denote confidence levels: *p<0.10, **p<0.05 and ***p<0.01.

[i] On the similarities and differences between agency theory and transaction cost theory, see Williamson (1996).

[ii] Accordingly, the economic geography literature has studied the relationship between external agglomeration and distance-based transaction costs (McCann and Shefer, 2004; Wood and Parr, 2005).

[iii] Our analysis focuses on choices relating to the location of new investments, as opposed to the acquisition of already existing activities in the country. Indeed, in the case of acquisitions, location alternatives are restricted to the places in which the potential target firms are already located. In addition, location will be just one of the possible variables that come into play in the selection of target firms, together with other significant firm-specific factors, such as internal resources, technologies and other tangible and intangible assets (Head et al., 1995).

[iv] It is worth noting that other studies (e.g. Gallego and Maroto, 2013) include NACE-74 among KIBS. However, they acknowledge (p. 647) that "the inclusion of 'other business activities' within the KIBS category leads one to account for a number of business services such as labour recruitment (74.5), investigation activities (74.6), industrial cleaning (74.7) and other miscellaneous business activities (74.8), such as industrial design, which are not identified by literature as KIBS". Therefore, we prefer to consider a different category (*Other*) for these activities.

[v] However, it is worth observing that to provide a robustness check and control for a possible sample selection bias, we estimated the models considering all the 447 manufacturing greenfield investments undertaken by foreign MNEs in Italy in the period 1998-2012. Results are available under request to the authors.

[vi] A company can have more than one location decision (event) throughout the period, and we properly take into account this in our econometric analysis with clustered standard errors by MNE.

[vii] A hierarchy of NUTS (Nomenclature of Units for Territorial Statistics) levels, for each European country, has been established by Eurostat. The current NUTS nomenclature (applicable from 2012) subdivides the economic territory of the EU into 97 regions at NUTS-1 level, 270 regions at NUTS-2 level and 1,294 regions at NUTS-3 level. NUTS-3 areas correspond to a population between 150,000 and 800,000 people. For example, Germany is divided in 412 "Kreise", France in 100 "Départements" and Sweden in 21 "Län".

[viii] Moreover, we estimate our models without those three companies in order to control for possible biases driven by the outlier cases. Findings are similar to the other specifications. Results are available under request to the authors.

[ix] A row-normalized weight matrix is scaled by the row's sum, namely each value in the matrix is divided by the sum of values in its row

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The role of geographical and temporary proximity in MNEs' location and intra-firm co-location choices

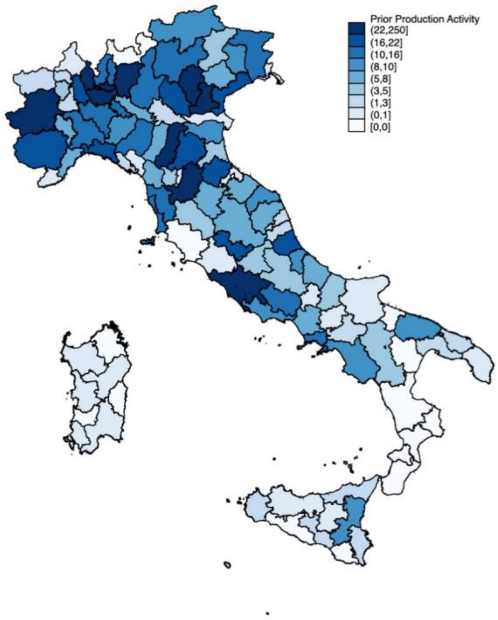
Appendix

Table A.1. Geographical distribution of greenfield investments, by province

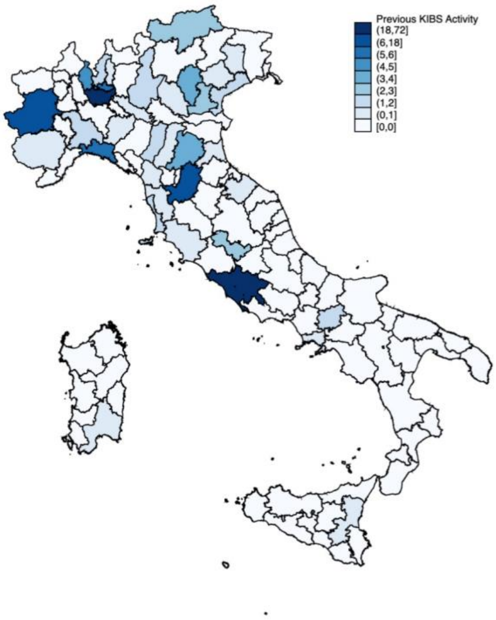
	Manufacturing	
Province (NUTS-3)	**No.**	**%**
Milan	35	13.31
Turin	22	8.37
Monza-Brianza	10	3.8
Varese	12	4.56
Rome	10	3.8
Bergamo	10	3.8
Padua	9	3.42
Lecco	6	2.28
Modena	6	2.28
Pisa	4	1.52
Vicenza	5	1.9
Ancona	5	1.9
Bologna	5	1.9
Florence	4	1.52
Forlì-Cesena	5	1.9
Livorno	5	1.9
Pavia	5	1.9
Verona	5	1.9
Other*	100	38
Total	263	100

* 61 Provinces receive the remaining number of investments.
Source: elaboration from REPRINT-Politecnico di Milano

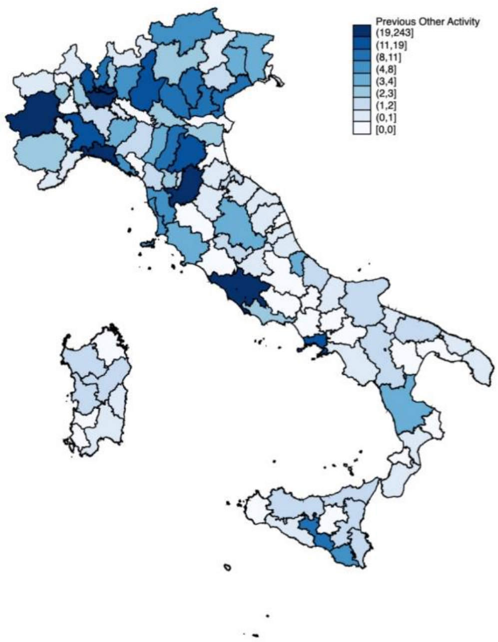
Figure 2-4. Geographical distribution of greenfield investments, by province



(2) Previous investments in manufacturing activities



(3) Previous investments in KIBS activities



(4) Previous investments in Other service activities

Source: elaboration from REPRINT-Politecnico di Milano

Table A.2 First stage – Modelling intra-firm presence in a province

	(1) Mod Probit	(2) Mod OLS
	Binary variable	Continuous variable
Border effect	-0.1297*	0.0311*
	(0.0747)	(0.0186)
Industrial District	-0.0363	-0.0661***
	(0.0380)	(0.0093)
Patents per inhabitant	0.0117***	0.0098***
	(0.0021)	(0.0006)
No. of graduated students	0.0517***	-0.005
	(0.0147)	(0.0040)
Expenses in R&D (log)	0.1383***	-0.0895***
	(0.0471)	(0.0102)
Area in square kilometres (log)	-0.0026	-0.0418***
	(0.0642)	(0.0142)
No. of municipalities	0.0030***	0.0017***
	(0.0004)	(0.0001)
Metropolitan	0.0043	0.0798***
	(0.0692)	(0.0171)
No. of firm prior investments in other provinces	0.0303***	0.0060***
	(0.0013)	(0.0003)
Diversification	0.0902***	0.0270***
	(0.0271)	(0.0050)
Specialisation	0.0985***	0.0338***
	(0.0126)	(0.0045)
Primary GlobalCity	0.4371***	1.3646***
	(0.1056)	(0.0377)
Secondary GlobalCity	-0.2465**	-0.0893**
	(0.1183)	(0.0401)
North (dummy)	0.1245**	-0.0004
	(0.0542)	(0.0129)
Population density (log)	0.1806***	0.0462***
	(0.0603)	(0.0136)
Constant	-5.5845***	0.9153***
	(0.5737)	(0.1319)
No. of obs	26832	27352
R-squared		0.136
Pseudo R-squared	0.293	

Note: The dependent variable is (1) having or not a prior investment in the province; (2) the number of prior investments in the procince. Standard errors are clustered by firm and reported in parentheses. Asterisks denote confidence levels: *p<0.10, **p<0.05 and ***p<0.01.

Table A.3. Second stage – Conditional Logit Model, correcting for endogeneity

	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
	Binary colocation. variable		**Continuous colocation variable**			
Intra-firm colocation						
Colocation same Manuf activity	13.5350***	13.8278***	1.8468***	2.1925**	1.9317***	2.2996***
	(4.8676)	(5.1421)	(0.3390)	(0.7201)	(0.3463)	(0.6621)
Colocation otherManuf activity	0.8972	0.8889	0.9438	1.0744	0.9304	1.0279
	(0.3337)	(0.3832)	(0.1103)	(0.2703)	(0.1209)	(0.2311)
Colocation KIBS	1.0412	1.0881	1.0115	1.6028	1.0097	1.575
	(0.4801)	(0.5944)	(0.4058)	(0.9340)	(0.4765)	(0.8173)
Colocation Other Services activity	2.1562*	2.2556**	2.6752***	3.3853***	2.6476***	3.2762***
	(0.9589)	(0.9095)	(0.9594)	(1.4309)	(0.9927)	(1.2645)
Control variables						
Specialisation	1.3225***	1.3162***	1.3058***	1.3030***	1.3037***	1.3004***
	(0.0560)	(0.0629)	(0.0554)	(0.0652)	(0.0594)	(0.0553)
Diversification	1.5567***	1.5429***	1.5213***	1.5688***	1.5216***	1.5622***
	(0.1716)	(0.1891)	(0.1669)	(0.1583)	(0.1591)	(0.1675)
Primary GlobalCity	2.0274	2.0094	1.9409**	1.9151	1.9675**	2.035
	(1.1125)	(0.9595)	(0.6374)	(0.9265)	(0.6325)	(0.9141)
Secondary GlobalCity	2.4877***	2.5122***	2.8751***	2.8545***	2.9226***	2.9574***
	(0.7525)	(0.7807)	(0.6440)	(0.6933)	(0.7162)	(0.7013)
Population density (log)	1.2142	1.206	1.4012***	1.2624**	1.4000***	1.2625**
	(0.1462)	(0.1600)	(0.1280)	(0.1201)	(0.1249)	(0.1218)
North (dummy)	1.5951**	1.5505**	1.7668***	1.6791***	1.7425***	1.6537**
	(0.3200)	(0.2875)	(0.3055)	(0.2781)	(0.2611)	(0.3281)
First Order Lagged Colocation						
Colocation same Manuf activity lag		0.156			0.1794	0.0421
		(0.2605)			(0.4005)	(0.0946)
Colocation other Man activity lag		4.1588			5.3500**	6.3900**
		(3.6120)			(4.3272)	(5.5674)
Colocation KIBS lag		4.6908			3.389	7.5258
		(7.8013)			(6.1140)	(15.2635)
Colocation Other Services activity lag		0.3888			0.368	0.4631
		(0.4790)			(0.6056)	(0.6330)
Residual for Colocation (from first stage)	0.8996	0.8734		0.8584		0.8766
	(0.3026)	(0.2957)		(0.1820)		(0.1695)
Pseudo R-squared	0.2083049	0.2108227	0.1801182	0.1851499	0.1827065	0.1896667
No. of obs	25064	25064	28930	25584	28930	25584
Log-likelihood	-886.1429	-883.3247	-1013.56	-930.9826	-1010.36	-925.8221

Note: The dependent variable is the location decision of a new manufacturing investment *i* in the Province *r*. Choice set: 110 provinces. The coefficients of Conditional Logit model are reported as *odds ratio*. Standard errors are clustered by firm and reported in parentheses. Asterisks denote confidence levels: *p<0.10, **p<0.05 and ***p<0.01.

Table A.4. Second stage – Mixed Logit Model, correcting for endogeneity

	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
	Binary colocation. variable		**Continuous colocation variable**			
Mean						
Intra-firm colocation						
Colocation same Manuf activity	3.8828***	3.7994***	1.5727***	1.4470***	1.5764***	1.9180***
	(0.5708)	(0.5341)	(0.2401)	(0.3229)	(0.2583)	(0.4123)
Colocation otherManuf activity	0.9275*	1.2375**	-0.0943	0.1491	0.0538	0.0662
	(0.4940)	(0.5422)	(0.1497)	(0.3123)	(0.1498)	(0.3598)
Colocation KIBS	0.2706	0.0806	0.0405	-1.1158	-0.5252	0.8544
	(0.6964)	(0.6929)	(0.5375)	(0.9533)	(0.7062)	(0.8196)
Colocation Other Services activity	0.9938*	1.4548***	0.5003	0.3431	0.5955	-0.2935
	(0.5128)	(0.5578)	(0.5020)	(0.6670)	(0.5441)	(0.7342)
Control variables						
Specialisation	0.2368***	0.2339***	0.3135***	0.3293***	0.3200***	0.3311***
	(0.0568)	(0.0615)	(0.0488)	(0.0485)	(0.0454)	(0.0519)
Diversification	0.4413***	0.4524***	0.5563***	0.6043***	0.5925***	0.6497***
	(0.1546)	(0.1608)	(0.1308)	(0.1394)	(0.1355)	(0.1489)
Primary GlobalCity	-1.0132*	-1.3761**	-0.2462	0.5242	-0.4349	-0.5864
	(0.6008)	(0.6877)	(0.6192)	(0.5909)	(0.6259)	(0.7788)
Secondary GlobalCity	-0.3675	-0.3118	-0.0532	-0.4363	0.1113	0.5098
	(0.5483)	(0.5527)	(0.6798)	(0.8242)	(0.6635)	(0.5098)
Population density (log)	-0.1067	-0.191	0.3375***	0.2198*	0.3233***	0.2100*
	(0.1459)	(0.1521)	(0.1018)	(0.1195)	(0.1042)	(0.1242)
North (dummy)	0.0615	-0.0172	0.5080***	0.4644**	0.5287***	0.4368**
	(0.2030)	(0.2106)	(0.1736)	(0.1811)	(0.1810)	(0.1859)
First Order Lagged Colocation						
Colocation same Manuf activity lag		-3.1526			-2.9284	-2.0047
		(2.8291)			(2.4890)	(1.9719)
Colocation other Man activity lag		1.2479			1.6378	-0.8094
		(1.1609)			(1.1412)	(1.8256)
Colocation KIBS lag		1.1979			0.0109	0.9137
		(2.1562)			(2.1244)	(2.0963)
Colocation Other Services activity lag		0.0162			-1.0075	-1.8943
		(1.3840)			(1.8624)	(2.2369)
Residual for Colocation (from first stage)	-1.1892***	-1.3924***		0.0922		-0.1656
	(0.3037)	(0.3145)		(0.2734)		(0.3044)
Standard Deviation						
Residual for Colocation (from first stage)	0.6954***	0.5647**		1.1459***		0.9522***
	(0.2024)	(0.2397)		(0.1789)		(0.1963)
Colocation same Manuf activity	3.0038***	3.0928***	1.7201***	1.6484***	2.1864***	1.9414***
	(0.8360)	(0.8938)	(0.3452)	(0.3324)	(0.3760)	(0.4956)
Colocation otherManuf activity	-0.7222	-0.9852*	-0.5268***	-0.3092	0.4964**	-0.1308
	(0.4627)	(0.5901)	(0.1613)	(0.2728)	(0.2123)	(0.1634)
Colocation KIBS	4.1226***	4.9841***	2.0476***	5.1355***	-3.2922***	-4.0311***
	(0.9720)	(1.1122)	(0.4939)	(1.2459)	(0.9242)	(1.2773)
Colocation Other Services activity	3.2382***	3.3547***	3.2284***	-2.2809***	3.0522***	-3.1695***
	(0.6092)	(0.6300)	(0.7179)	(0.5905)	(0.7845)	(0.7876)
Primary GlobalCity	1.5688**	2.1805**	-2.3028***	0.1936	-2.5378***	-2.4153***
	(0.6705)	(0.9545)	(0.7468)	(0.8587)	(0.5616)	(0.8874)
Secondary GlobalCity	-1.4399**	-1.2789**	1.7953***	2.1521***	1.7614**	1.0895*
	(0.5816)	(0.6504)	(0.6398)	(0.7752)	(0.7808)	(0.5606)
Specialisation	-0.0565	-0.0558	0.0831	0.1047	0.0669	0.0957
	(0.0592)	(0.0622)	(0.0550)	(0.0705)	(0.0442)	(0.0649)
Diversification	-0.3534**	-0.4059***	-0.2408	0.2596	-0.2977*	0.3192
	(0.1562)	(0.1297)	(0.1816)	(0.1935)	(0.1786)	(0.1995)
Population density (log)	-0.0941	-0.2485	-0.1957	-0.1171	0.0659	0.2138
	(0.2032)	(0.2123)	(0.2218)	(0.1815)	(0.1783)	(0.1868)
Colocation same Manuf activity lag		5.9325*			6.5909***	2.5246
		(3.4911)			(2.0903)	(2.9280)
Colocation other Man activity lag		-3.6403***			4.3159***	6.3737***
		(1.3536)			(1.1839)	(2.2511)
Colocation KIBS lag		3.9251			1.053	1.7867
		(3.3480)			(2.9216)	(2.9952)
Colocation Other Services activity lag		0.8573			3.5155	5.6097
		(2.9258)			(3.8729)	(3.7368)
No. of obs	25064	25064	28930	25584	28930	25584
Log-likelihood	-857.3939	-848.804	-970.5873	-890.1103	-959.1807	-881.5889

Note: The dependent variable is the location decision of a new manufacturing investment *i* in the Province *r*. Choice set: 110 provinces. Std err. are clustered by firm and reported in parentheses. Asterisks denote confidence levels: *p<0.10, **p<0.05 and ***p<0.01.