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FULL ARTICLE

Tracking the Van: The role of forward linkages in logistics MNEs' location choices across European NUTS 3 regions

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Abstract

Logistics firms play a crucial role in overcoming time and distance constraints in supply chain management. However, little is known about their location patterns. This paper fills the gap by studying the logistics of multi-national enterprises' location choices across 380 NUTS 3. Using data on 1777 foreign direct investments (FDIs), our findings reveal that forward linkages with a region's retail and wholesale industry exert a stronger impact than intermediate production demand. Results are robust to the inclusion of standard FDIs' determinants and to controls for spatial dependence. Findings suggest that intersectoral demand from downstream sectors positively affect logistics operators independently from the manufacturing base.

KEYWORDS

FDIs, forward linkages, logistics services, regional specialization

JEL CLASSIFICATION

F23, L80, R12

1 | INTRODUCTION

The logistics services arrange the linkages between production, suppliers, and the end market. Because of the increasing fragmentation of industrial production processes, logistics play a crucial intermediate role by organizing the linkages from the different *loci* of production to the different *loci* of consumption, domestically or internationally.

As an intermediate player in the supply chain (Bowen, 2008; Mariotti, 2014; Rocha & Perobelli, 2020), this industry has been experiencing increasing demand from the upstream and downstream value chain segments (Hesse & Rodrigue, 2004). However, more needs to be said in the empirical literature about logistics' location behaviour, even more so in the case of multinational firms. We decide to focus our study on inward foreign direct investments (FDIs), addressing the location decisions of logistics multi-national enterprises (MNEs). Here we define the logistics industry as the "part of the supply chain that plans, implements, and controls the efficient […] flow and storage of goods, services and related information between the point of origin and the point of consumption to meet customer's requirements" (Council of Supply Chain Management Professionals, 2014 in Verhetsel et al., 2015:110). From this definition, we position logistics firms among those supplying intermediate services.

The focus on MNEs is explained by multinationals being the most international of all businesses. As such, a strategic decision they have to make is where to locate and which host economy has the location advantage yielding the highest net profits. The wider literature on MNEs' location choices is extensive and has identified, among others, three main channels that push firms to invest in foreign markets: (i) market-seeking; (ii) efficiency-seeking; and (iii) strategic-asset seeking. In the first case, firms venture overseas markets to gain market share, this has been typically associated with production and logistics firms. In the second case, firms seek to reduce their overall costs, for instance labour costs. In the latter, firms are motivated by the investor interest in acquiring strategic assets, for example, human capital and technology, that will enable a firm to compete in a given market (Dunning & Lundan, 2008). Despite the recent advances in the theory of location, studies investigating the role of sectoral linkages have been paid much attention to Knowledge-Intensive Business Services (KIBS, e.g., financial services) surrounding production activities (Castellani et al., 2016; Evangelista et al., 2013; Meliciani & Savona, 2015) while considering location decisions in logistics as merely determined by production. In other words, logistics services are assumed to "follow" manufacturing activities wherever these take place.

Other studies have investigated the location determinants of service functions within the manufacturing sector (Defever, 2006, 2008). Findings show that: (i) within-firm vertical linkages push firms to co-locate their service functions in countries with a production plant; and (ii) manufacturers have a positive impact on services employment in local labour markets (Ascani & Iammarino, 2018).

Concerning logistics services, Holl and Mariotti (2018a) approach their location determinants through the lens of transport accessibility. Here, the authors stressed the need for more focused research on their location determinants. Rocha and Perobelli (2020) echo these results in investigating Brazil's spatial distribution of logistics firms. They tested a theoretical new economic geography (NEG) model starting from the typical assumption that logistics is assumed to follow manufacturing plants. However, they found that the logistics sector is moving closer to the sources of consumption, that is, at the end of the supply chain. Sakai et al. (2020) reveal that wholesale job availability and accessibility to infrastructures positively impact logistics firms in locating in the Paris region. Their recent work supports our argument on assessing logistics' location choices where the end market is a key determinant.

We respond to this call, and differently from previous research, our paper aims to investigate the specificities in the location determinants of a particular branch of services, considering their special nature of being "intermediate". Logistics services are experiencing outstanding demand growth in advanced economies, increasing time-sensitiveness deliveries and generating higher demand for these services independently from the pre-existing manufacturing base (Haddad & Araújo, 2021; Holl & Mariotti, 2018a; McKinnon, 2009). Firms are now concentrating more on specific consumers' requests, particularly the increasing demand for faster goods deliveries (Bonacich & Wilson, 2008). Consumers' pressure for quicker distribution services can thus create increasing market opportunities for logistics service suppliers. Scholars reckon this phenomenon as the gradual shift towards a consumer-oriented economy, which makes the management of the supply chain even more complex, bringing the strategic focus of firms from a "supply-push" to a "demand-pull" economy (Fernie et al., 2019; Holl & Mariotti, 2018b; Lu et al., 2010; Mangan, 2019; McKinnon, 2009; Sakai et al., 2020). Coping with this increasing consumer demand can be a challenge for firms, particularly for MNEs, which manage geographically dispersed value chain activities and increasingly move downstream to respond to consumers' demand (Wiesmann, 2011). On top of this, logistics providers have been optimizing their services in the last decade to meet increasingly technology-driven retail consumption. The outstanding growth of eCommerce offers excellent opportunities for growth in modern logistics real estate, such as mega-distribution centres, smaller urban facilities within city limits and click-and-collect pick-up points. Increasing complexity in customer requirements concerning availability, choice, speed, and flexibility creates the need for additional points in the logistics supply chain.

To address this gap, we emphasize the role of intersectoral demand generated by retailers and wholesalers across European NUTS 3 regions. We rely upon the theoretical contribution of Hirschman (1958) on the concept of forward linkages, which will be thoroughly developed in the next section.[1] We will contribute to the current literature investigating MNEs' location decisions (Arauzo-Carod et al., 2010; Ascani et al., 2016; Ascani & Iammarino, 2018; Ribaudo, 2021) and shed light on the attractive factors that attract investments in logistics, a quite overlooked industry in the regional and business literature.

European regions are a particularly suitable context for this study. The logistics industry in Europe represented a market volume of circa €878 bn in 2012 (Analysis of the Logistics Sector, European Commission, 2017) and 7% of EU 27 GDP. In the same year, among European Countries, Finland, Germany and The Netherlands score the highest *Logistic Performance Index*[2] (henceforth, LPI – 4.05, 4.05 and 4.02 out of 5 respectively), while countries like Poland, the Czech Republic, and Hungary are experimenting a dynamic trend in the logistics industry and may be profitable markets (Satta, 2011). Still, little is known in terms of logistics location decisions in Europe. We also believe that including the retail and wholesale industry in the analysis might be worth it given the increasing global trend of retailers to hold their inventory and integrate with logistics providers to meet customers' demand for quicker deliveries (Mangan, 2019; McKinnon, 2009; Mesic, 2015; O'Connor et al., 2012).

We use investment-level data on 1,777 greenfield FDIs in 380 NUTS 3 regions drawn from fDi Markets. Our results show that foreign MNEs in logistics are attracted more from forward linkages with the retail and wholesale sectors. This effect is stronger when the retail market is more prominent and competitive.

The remainder of this paper is organized as follows: in Section 2, we review the literature. In Sections 3 and 4 we present the data and the empirical methodology. Finally, in Sections 5 and 6 we present the results and further discussions.

2 | BACKGROUND LITERATURE

Many studies have been conducted to analyse sectoral linkages in the context of a national economy. The pioneering theoretical literature is mainly related to the Lewis dual economy model (Lewis, 1954) and Hirschman's theory of "unbalanced growth" (Hirschman, 1958; see section 2.1). The relevance of intersectoral connectedness is shown in many empirical studies, and the empirical literature tends to stress links between agriculture and industry. Less attention is paid to models of the behaviour of services in this process, with a few pioneering exceptions (Holl & Mariotti, 2018a; Rocha & Perobelli, 2020). However, the literature has a significant gap because these studies on intersectoral linkages focus mainly on national economies, or they mostly focus on financial services (Castellani et al., 2016; Meliciani & Savona, 2015). Yet, the location determinants of logistics firms are strongly affected by the nature and intensity of supplier-user interactions. To assess whether forward linkages positively affect the location

[1] It is critical to note that Hirschman's theoretical contribution on forward and backward linkages is based on the fact that once FDIs are located, they create forward and backward linkages with upstream and downstream activities active on the territory. However, past research emphasized how even pre-existing input–output relations may attract international investments, which is the focus of our analysis. Although the seminal contribution of Hirschman may signal reverse causation (from location decisions to linkage creation), we bank upon past research (Castellani et al., 2016; Meliciani & Savona, 2015) to suggest that the actual and potential vertical linkages may act as an attractor of investors in downstream industries (in the case of backward linkages), and in upstream industries (in the case of forward linkages). Past input–output relationships at the regional level can thus explain the location of FDIs in business services in the same regions. To circumscribe the impact of possible reverse causation, we use input–output data in 2010, thus before investments which we observe in the subsequent period.

[2] For more information see worldbank.lpi.

decisions of multinational firms in logistics, we argue that sectoral interdependencies with retailers and wholesalers are crucial in attracting logistics MNEs at the NUTS 3 level. This hypothesis is based on the evidence that the growth of services is mainly due to the increasing intermediate demand by other industries.

Past literature may be summarized in two blocks. The first and main block addresses firms' location choices and productivity spillovers, mostly between manufacturing and KIBS FDIs, by looking at the impact of intermediate manufacturing demand on such decisions (Ascani & Iammarino, 2018; Castellani et al., 2016; Mariotti et al., 2013; Meliciani & Savona, 2015; Nefussi & Schkellnus, 2010; Venables, 1996). This stream of studies will be addressed more in-depth in subsection 2.1.

The second block stresses the role that transportation infrastructures and accessibility to markets have as drivers influencing logistics firms' decisions, that is, assuming that transport infrastructures function as main determinants in location choices (Bowen, 2008; Holl, 2004; Holl & Mariotti, 2018b; Mariotti, 2014; Rivera et al., 2014, 2016; Sakai et al., 2020; Sheffi, 2012).

Bowen (2008) examines the changing geography of warehouses in the US between 1998 and 2005. Results show that the number of establishments located in 143 metropolitan areas in 2005 and the rate of growth of the number of establishments between 1998 and 2005 were strongly correlated with the county-level measures of accessibility in air, highways and, to a lesser extent, rail network. Holl and Mariotti (2018a, 2018b) implement an indicator of market potential to approach the relationship between access to markets and logistics location decisions. The authors found that the higher the market potential in Spanish urban areas, the higher the probability of a logistic firm locating in those areas. Also, closeness to major transportation infrastructures makes logistics firms more productive, hence helping explain location decisions where there exist higher quality connections with both suppliers and customers (Bowen, 2008; Hong, 2007; Hong & Chin, 2007; Mariotti et al., 2015; O'Connor et al., 2012). Sakai et al. (2020) analysed location decisions for logistics facilities in the greater Paris region from 2003 to 2013 for about 826 firms. Their results show that logistics is driven by the availabilities of wholesale jobs, access to autoroutes and zoning regulations. Rocha and Perobelli (2020) echo these findings. They tested a theoretical NEG model to investigate the spatial distribution of logistics providers in Brazil. Results show that logistics companies in Brazil tend to locate downstream, closer to retailers and wholesalers.

Against this backdrop, we shed light on a less explored aspect in the literature that analyses the existing input–output relationship between logistics and vertically related sectors, such as manufacturing and retail, in explaining the location determinants of logistics MNEs.

2.1 | Forward linkages and Firms' location choices

The bulk of the literature point back to the work of Hirschman in 1958 on the creation of linkages due to the presence of MNEs in the territory.[3] In The Strategy of Economic Development (1958), Hirschman introduced the linkage concept and generalized the observation that ongoing activities "induce" agents to take up new activities. Here the author distinguished two types of spillover: *backward linkages* and *forward linkages*. The former effects are associated with activities that provide inputs to economic activities, drawing towards the clients' location. The latter concerns activities that use outputs from new activities or existing activities that draw them towards locations where these existing activities are already represented (McCann & Van Oort, 2019). Here we focus on the latter aspect, that is, forward linkages, related to output utilization, namely, the outputs from a given activity will induce attempts to use this output as inputs in some new activities (Hirschman, 1958). Over the last decades, scholars have built upon Hirschman's work to understand the complex relationships between economic actors and regional dynamics. Most

[3]As presented in Hirschman, the linkages will be created after the occurrence of an investment. However, past research used the antecedent (concerning the location of the FDI) input–output relationship to explain the localization of MNEs (Castellani et al., 2016). Here we are aware of a possible problem of reverse causation stemming from a theoretical background that assumed a different temporality in creating linkages; therefore, we use data previous to the investment to infer the location determinants of logistics FDIs.

of the empirical work built upon the theoretical and empirical framework presented above has addressed, among others, how FDIs affect the creation of external linkages and, through that mechanism, the productivity levels of domestic firms (Alfaro et al., 2004; Giroud, 2007; Javorcik, 2004; Mariotti et al., 2013).

A pioneering contribution can be found in Javorcik (2004). The author used firm-level data for Lithuania to focus on the intraindustry spillovers from FDI to domestic industries. The findings show a productivity effect that originates from foreign investments with joint foreign and domestic ownership, but not from greenfield FDI. Positive productivity spillovers materialize through backward linkages in upstream sectors, but no evidence of horizontal or vertical linkages. Mariotti et al. (2013) dealt with backward and forward linkages stemming from MNEs in service sectors and their impact on local manufacturing firms' productivity. Using data on MNEs in Italy over the period 1999–2005, they found that vertical linkages positively influence local customer firms because of the increased competition in the sector. Ascani and Iammarino (2018), study the linkages established by MNEs with service providers through outsourcing in UK local labour markets. They found a local multiplier effect that foreign manufacturers have on services employment. Using data from the ARD, a business-level database in the UK from 1997 to 2007, findings suggest that MNEs in manufacturing function as a catalyst for regional structural changes by stimulating employment in intermediate services via demand linkages. Elekes et al. (2019) assess how FDI induces more related or unrelated diversification *vis-à-vis* domestic companies in 67 regions in Hungary from 2000 to 2009. Their results show that foreign firms are agents of regional structural change by bringing more unrelated diversification, that is, new activities.

Castellacci (2008) investigated sectoral patterns of innovation combining manufacturing and service industries and presenting a new sectoral taxonomy that builds upon the vertical linkages that tie them together. Using data from the Community Innovation Survey (CIS) in 2002 and 2004 for 24 European countries, the author stresses that national innovation systems should develop both a mass manufacturing base and advanced services to sustain long-term growth by supporting stronger linkages with more technologically advanced branches of the economy. Evangelista et al. (2013) echo these findings. Using data from CIS in 1998–2000 and 2002/2004, OECD input–output tables for Germany, France, Italy, Spain and the UK they show that business services have an impact on the innovation performance of manufacturing industries and thus into their sectoral growth.

Meliciani and Savona (2015) studied sectoral specialization in KIBS services (BS) across the European NUTS 2 regions over the period 1999–2003 as determined by: agglomeration economies, the magnitude of intermediate linkages, technological innovation, and knowledge intensity, and the presence of these factors in neighbouring regions. The empirical results drew upon Eurostat Symmetric input–output table in 2000 and show that, besides urbanization economies, the spatial structure of intermediate sectoral linkages and innovation, notably in the information and communication technologies (ICTs), are important determinants of specialization in KIBS services. On location decisions, Castellani et al. (2016) focused on the role of forward linkages with manufacturing sectors and other services as attractors of business services FDIs at the NUTS 2 level over the period 2003–2008. Drawing data from fDi Markets and the Eurostat Symmetric input–output table in 2005, the authors found that regions with higher intersectoral linkages with manufacturers attract more KIBS FDIs than other regions.

Overall, the synthetic literature reported here suggests a growing interest in services. Yet, empirical studies mostly look at KIBS services, largely neglecting those engaged in distributing goods and freight.[4]

3 | DATA

In order to study the effect of forward linkages and accessibility as determinants for the location choices of inward logistics FDIs, the empirical analysis is based on fDi Markets[5] data, a commercial online database produced by fDi

[4]As Philip McCann argues about logistics and distribution activities, "Understanding the modern role played by these activities, therefore, calls for a renewed effort at building the research base in these arenas [...] and until recently in fields such as economic geographic and regional science there has been insufficient interest… even though the movement of goods and people is so central" (McCann, 2014, p. 7 in Mariotti, 2014).

[5]www.fdimarkets.com.

Intelligence, a special division of the *Financial Times*, which provides information on FDI projects. Relying on media sources and company data, fDi Markets collects detailed information on cross-border investments. Data are based on the announcement of the investment and are updated daily. For each project, fDi Markets reports information on the industry and primary business activity involved in the project, the location where the investment takes place (host country, regions, and cities), and the name and location of the investing company (home). The database contains around 203,360 investment projects referring to the period 2003–2018 in 197 countries, covering several business activities, such as R&D, production, headquarters (HQs), business service, ICT, logistics, marketing, education and training and technical support and associated 2-digit NACE Rev.2 codes. For this paper, we rely on the information on a total of 1777 international investments projects in the logistics industry from 2011 to 2018 made by 817 MNEs in 380 NUTS 3 regions. Our sample covers 6% of total inward FDIs in Europe over the same period and 40% of geographical coverage with respect to the total NUTS 3 in Europe that received new FDIs. For this analysis, we rely on logistics operators and transport operators handling freights and cargo according to past literature; we, therefore, excluded all passenger carriers (Holl & Mariotti, 2018a, 2018b; Mariotti, 2014). As in Holl and Mariotti (2018a, 2018b), we identify Logistics as H49-H52, excluding all passengers related to transport and postal and courier activities as we focus specifically on logistics firms. This group does not include transport operators. The top five regions hosting FDIs are Germany, the United Kingdom, the Netherlands, Romania, and Italy. We identify the retail sector as those firms in G45 and G46. NACE rev. 2 sector[6] Tables A1 and A3 provide the list of variables included in our econometric excercise and a correlation matrix, respectively. A list of countries included in the dataset can be found in Appendix Table A4.

3.1 | Variables

3.1.1 | Dependent variable

The dependent variable is the location choice for a new investment project. This is a dummy variable assuming value one if a given project *i*, made by firm *f* is in NUTS 3 *j*, and zero for all the other NUTS 3 regions (not chosen) $j \neq j^*$.

3.1.2 | Forward linkages

Our main explanatory variable measures forward linkages with the retail, wholesale, and manufacturing sectors. We built our indicator following Guerrieri and Meliciani (2005), Meliciani and Savona (2015) and Castellani et al. (2016) using a weighted share of employment in the retail and wholesale, and manufacturing sectors. Following this methodology, we take a vector measuring the use of logistics services on output for retail and wholesale and manufacturing sectors and, for each region, we multiply it by the total employment in each respective sector (retail and wholesale/manufacturing); this number is then divided by the region's total employment (see Equation (1)). This measure of forward linkages was first developed in Guerrieri and Meliciani (2005) to examine the interdependencies between manufacturing and production activities. Their measure however is calculated for those sectors that are above-average users of services. The idea behind this is that some sectors contribute more than others to the economy, bringing a competitive advantage from the type of specialization within the manufacturing sector (i.e., *hysteresis* in the development of producer services). The rationale is that it is more likely for countries with a high share of activities in those service industries that are intense users of producer's services to develop an international competitive advantage in producer services themselves (e.g., a self-reinforcing mechanism). However here, we do not primarily aim to test regional specialization, but the intensity of linkages with end-market that drive logistics

[6] EUROPA - Competition - List of NACE codes.

MNEs in regions. We also assess a smaller number of sectors, therefore taking only those above average will create a bias towards more specialized regions:

$$FL_j = \frac{\sum_{s=1}^{n} W_s E_{sj}}{\sum_{s=1}^{n} E_{sj}}, \tag{1}$$

where j denotes the region, s the sector (retail and wholesale, manufacturing), n is the total number of sectors, E is employment and W is the weight given by the value of logistics services used as inputs by sector s, computed within the Eurostat National symmetric input-output (I-O) tables 2010[7] as a share with respect to total industry output. The indicator is an increasing function of the regional employment in retail/manufacturing sectors that are users of logistics services to total regional employment.[8] In other words, we regionalize the national I-O coefficients by multiplying (numerator) and dividing (denominator) them by the employment in each sector considered, namely, retail and wholesale, and manufacturing sectors. The indicator varies by each NUTS 3 region to which employment data refer to. Table 1 reports the coefficients used as weights to build our indicator.[9]

3.1.3 | Control variables

Agglomeration economies and isomorphism in location choices

According to past literature, we compute a measure of past stock of greenfield FDIs over the period 2006 to 2010 drawing data from our main dataset, fDi Markets. Because of our rich dataset of investment-level data, we can control both for the presence of MNEs in logistics and in other activities given by the number of greenfield FDIs. These variables aim to capture *isomorphism* in MNEs' location decisions—that is the tendency of MNEs to follow other multinationals (Piscitello et al., 2010). Additionally, we can control for the presence of domestic logistics firms by drawing data from Amadeus[10] over the same period. This variable aims to capture the effect of agglomeration economies are positively associated with MNEs investments that benefit from them (Piscitello et al., 2010). We expect a positive effect of these variables on the location choices of logistics MNEs.

Accessibility and market Size

According to past literature on MNEs' location choices, we control for a set of independent variables capturing the market size, namely, *Gross Domestic Product*, and other locations' characteristics, for example, population density, in 2010 for which data are available for all the NUTS 3 regions included in our sample. This variable aids in identifying market-seeking channels. We also consider the presence of a capital city within the NUTS 3. We create a dummy variable taking value 1 if a capital city falls within region and 0 otherwise. In addition, we control for the gross value added (GVA) per each region. The GVA is a proxy for a market competition effect and allows us to observe one of the stylized facts in economic geography studies, that is: firms' location behaviour is mainly driven by the competition effect in which firms can access a larger market with a more even distribution of economic activity in space, enjoy lower trade costs, and larger market demand (Ascani et al., 2012). Finally, we control for the level of labour

[7]The Symmetric input-output tables are retrieved from Eurostat [naio_10_sms]. For further details please visit Supply, use and Input-output tables (naio_10) (europa.eu). The table is a product-by-product or industry-by-industry matrix describing the domestic production processes. It distinguishes 64 industries following the NACE rev 2 and CPA 2008. The value of industry use is expressed in million units.

[8]The indicator does not have a specific range, the higher its value, the higher the intensity of linkages between sectors.

[9]These have been obtained by regressing the share of logistics services on total industry output and industry dummies for all the European countries included in the analysis in the year 2010. The regression has shown that there are industry effects in explaining the use of logistics services across countries ($R^2 = 0.35$ – significant at 1%).

[10]Amadeus is a firm-level dataset provided by Moody's Analytics/Bureau van Dijk that contains data on the population is a database of comparable financial and business information on Europe's 560,000 public and private companies by total assets. Forty three countries are covered. The database provides standardized annual accounts (consolidated and unconsolidated), financial ratios, sectoral activities, and ownership data. of firms located in Europe.

TABLE 1 Share of logistics users in total industry output in 2010, average across European countries.

Industries (2 digit)	Use of logistics services (%)
Manufacturing	
Furniture and other manufactured goods	10,8
Machinery and equipment n.e.c.	9,03
Other transport equipment	8,4
Wholesale and retail trade and repair services of motor vehicles and motorcycles	8
Basic pharmaceutical products and pharmaceutical preparations	7,97
Repair and installation of machinery equipment	7,56
Coke and refined petroleum products	7,34
Textiles, wearing apparel, leather and related products	7,31
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	6,39
Rubber and plastic products	5,93
Food, beverages and tobacco products	5,66
Motor vehicles, trailers and semi-trailers	5,25
Other non-metallic mineral products	3,36
Paper and paper products	2,7
Basic metals	2,34
Fabricated metal products, except machinery and equipment	2,08
Printing and recording services	1,39
Chemicals and chemical products	1,15
Computer, electronic and optical products	1,14
Electrical equipment	0,23
Retail trade	
Wholesale trade services, except of motor vehicles and motorcycles	7,65
Retail trade services, except of motor vehicles and motorcycles	6,57

Source: Authors' Elaboration based on Eurostat Regio Database. Average is 5.37, Std. Dev. Is 2.98.

cost[11] at the national level to test the cost-saving motives in MNEs' decisions. The labour cost index (LCI) measures the cost pressure arising from the production factor "labour". This variable allows to find evidence of a possible efficiency-seeking channels in MNEs' location decisions.

Market potential-weighted spatial lag. The cost of logistics services is positively correlated to the distance travelled, which supports the argument of geographical proximity to markets and infrastructures (i.e., ports and airports) as determinants to be included in our study (Holl & Mariotti, 2018a; Markusen et al., 2005). We use geocoded data at the investment level[12] to calculate the exact distance between the FDI and the NUTS 3[13] region for each logistics

[11]The LCI is a Laspeyres price index of labour costs per hour worked. For more information please see Labour cost levels by NACE Rev. 2 activity (lc_lci_lev) (europa.eu).

[12]We processed geocoded data using QGIS 3.10.

[13]We drew geo data from Eurostat (https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts) using NUTS 3 2010 classification; notably, we worked on the multi polygons regions. More detailed information can be found in the metadata pdf file here http://ec.europa.eu/eurostat/web/nuts/overview.

FDI. The variable, also known as market potential (Harris, 1954), is simply a measure of aggregate accessibility, where accessibility is determined by the distance to (and the size of markets in) alternative locations. Market potential in location *j* is the sum of the market sizes, measured as the NUTS 3 GDP in all other locations divided by their inverse squared distance d_{ij} to *k*. Distance is measured as Euclidean distance between each NUTS 3 centroid and other NUTS 3 regions. First, we built a spatial weight matrix **W**, imposing a structure in terms of what are the neighbors for each location. Then we assigned weights that measure the intensity of the relationship among spatial units; in our case, the weights are a function of the distance between NUTS 3 regions *i* and NUTS 3 *j*, d_{ij}. d_{ij} has been computed as the distance between their centroids. Second, we computed the inverse distance:

$$\mathbf{w}_{ij} = \frac{1}{d_{ij}^{\alpha}} \; if \; i \neq , \tag{2}$$

where $\alpha = 2$. As the last step, we calculated our market potential measure as follows:

$$MP_j = \sum_{j=1}^{J} w_{ij} x_j, \tag{3}$$

where *x* is the value of the GDP in location j, we measured market potential by building upon past empirical literature (Bruinsma et al., 1996; Holl & Mariotti, 2018b; Weibull, 1980). The measure aims to reflect the volume of economic activity in each location and its accessibility in terms of distance. The idea is that closer markets shall be preferable over farther ones. Similar to GDP, this control may identify market-seeking channels in location's decisions.

Distance to key infrastructures and borders. Drawing data from GISCO database – Eurostat[14] we were able to geocode each international port and airport within the NUTS 3 region using QGIS. We then computed distance matrices for each pairwise combination of regions' centroid–port (airport). While McKinnon (2009) and Hong (2007) found a positive effect of higher proximity to ports in the UK and China, respectively, Bowen (2008) found no significant effect in the USA.[15] We expect that logistics firms show higher sensitiveness to proximity to ports (airports); therefore, the higher the distance, the lower the attractiveness of that NUTS 3 (Giuliano et al., 2007, 2012; Ribaudo, 2021). Lastly, we computed a measure of proximity to country borders as the shortest distance from where the investment is located and the neighbouring (s) country's border(s). The variable should capture the fact that logistics MNEs, as actors involved in the movement of goods and an integral part of the global value chain, may well be attracted by regions that share a border with a foreign country and therefore enjoy easier physical access to that market. Since we expressed this variable as distance in KM, we expect a negative impact.

3.1.4 | Infrastructures' capacity

Additionally, given the primary nature of logistics firms to move goods in different *loci* of consumption, we also included in our model variables accounting for the road freight flows in each NUTS 3, and port freights stock in the greater NUTS 2 region[16] measured in thousands tonnes (data on port freights are not available at a smaller geographical level nor as twenty equivalent foot). The idea is to consider how busy a port is, thus, accounting for

[14]https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/transport-networks.

[15]The distance to the port may affect the investments in inland regions as well because of the increasing trend in Europe in the development of dry ports, see also (Rodrigue & Notteboom, 2012).

[16]Data on port freight are not available at the NUTS 3 level.

differences between very busy ports like Rotterdam or Antwerp (among the biggest in Europe) and smaller ones like Luneburg in Germany. We also control for the total freights transported via road in each NUTS 3. We expect a positive impact of freight stock since they may generate a higher local demand for distribution activities within the region.

3.1.5 | Innovative capability

We also account for the innovative capacity of regions as they may act as a strong determinant in attracting inward foreign investments (Crescenzi et al., 2014). We use two variables both based on patent count by priority year filed at the European Patent Office (EPO) in 2010. Particularly we take the total number of patents per each NUTS 2 (patent data are not available at the NUTS 3 level) in selected technologies classified under the IPC[17] related to transport and operations for which data are available. Notably, patents under the B61 class—railways, B62—land vehicles, B63—ships or other waterborne vessels, B64—aircraft, B65—packing, storing, and handling, B66—hosting, lifting, and hauling, namely, in transport and operations (T&O) (Stefan et al., 2016). We also consider the total number of patents (excluding those listed above) in all other technological classes. We do not posit a specific effect of innovation on the location of logistics activities, particularly in technological classes that concerns transporting operations. Highly innovative regions can be an attractive factors for firms, but this may imply higher start-up costs and pose barriers for new entrants, especially in high appropriability conditions (Malerba & Orsenigo, 1995). Higher innovative capabilities may be evidence of a strategic asset-seeking channel.

Table 2 provides descriptive statistics for all the variables included in the model.

4 | ESTIMATION METHOD

To capture the role of forward linkages in logistics FDIs' location decisions among a set of locations, we implement a conditional logit model (CLM) (McFadden, 1974) coherent with past empirical literature investigating location choices (Ascani et al., 2016; Belderbos et al., 2017; Benfratello et al., 2022; Castellani et al., 2021; Goerzen et al., 2013). As profit-maximizing economic actors, firms will choose the location yielding the highest net profits. While it is not possible to observe directly the profit associated with each location, we can observe the chosen location's characteristics and the characteristics of all the choices, NUTS 3 regions in our case. We assume that if investment *i* locates in NUTS *j*, then *j* must be the location yielding the highest net profit. The conditional logit model builds on the assumption that only location (in this case) characteristics influence the firms' decision making. The CLM estimates the probability with which the firm will choose for the investment *i* the NUTS *j* with the highest net profits (Greene, 2012). This can be formally expressed as:

$$P_{ij} = \frac{\exp\left(\beta \mathbf{X}_{ij}\right)}{\sum_{l=1}^{n} \exp\left(\beta \mathbf{X}_{ij}\right)}, \tag{4}$$

where X is a vector of location characteristics at the NUTS 3 level. Robustness checks include spatial lag in market size and distance measures which reduce possible biases resulting from the spatial correlation. Studies on European regions argue that the ongoing trade liberalization and unification has led to increasing similarities across neighbouring regions and a decreasing relevance of national borders (Overman & Puga, 2002).

[17]For more information, please see IPC Publication (wipo.int).

TABLE 2 Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
FL with retail and wholesale	120,703	0.022	0.019	0	0.098
FL with manufacturing sectors	120,703	0.217	0.346	0.02	3.521
GDP at current market prices by NUTS 3	120,703	138,921.94	815,270.41	1090.57	10,407,941
Market potential	120,703	2851.812	27,824.737	2.244	373225.53
Port freight NUTS 2	120,703	15,863.504	30,365.158	0	160,016
Population density by NUTS 3	120,703	727.446	1229.489	2.6	12,441.4
Stock of past FDIs over 2006–2010	120,703	113.215	199.743	0	1,042
Stock of past logistics FDIs over 2006–2010	120,703	0.872	5.164	0	112
Road freight in 1000 tonnes per NUTS 3	120,703	29,863.799	39,779.429	807	135,420
Min. distance to port in KM from FDI	120,703	158.791	65.476	0.32	249.979
Distance (KM) to country borders	120,703	252.874	212.592	0.175	2230.781
Distance (KM) to closest Freight	120,703	1491.455	1427.594	1.289	12,079.373
Stock of domestic logistics firms over 2006–2010	120,703	0.259	4.004	0	137
# Total patents in T&O	120,703	5.313	9.129	0	66
# Total patents—all IPC classes	120,703	70.283	101.342	.25	712.6
MNEs past investments in NUTS 3 over 2006–2010	120,703	0.605	0.511	0	3
Gross value added in NUTS 3	120,703	18,117.69	23,369.19	754.04	181,114.2
Labour cost index	120,703	22.948	8.360	2.6	32.9

Source: Author own elaboration based on fDi Markets and Eurostat data.

CLM models allow exploring the effect of alternative-specific attributes on the probabilities that firms select a particular location among the set of alternatives. The main assumption in the CLM is the independence of irrelevant alternatives (IIA), which implies that the error term ε_{ij} is independent across locations. An extension of the analysis of MNE location behaviour is developed by implementing a mixed logit model (MXL). This is basically a generalization of the standard logit and offers the possibility to relax completely any restriction associated with the IIA. The existing literature on MNEs' location choices has rarely employed MXL, despite the advantages associated with it. Notable exceptions are relatively recent and include works by Defever (2006), Ascani et al. (2017) and Benfratello et al. (2022). The present analysis implements a random-coefficient derivation of the MXL, in line with Defever (2006) and Ascani et al. (2017) and Benfratello et al. (2022) with the aim of analysing whether MNEs have heterogeneous preferences over location attributes when they strategically select a location for greenfield investment. Accounting for heterogeneity of MNE locations' characteristics formally means that the parameter β, associated with an observable characteristic *x* of location *j*, can vary randomly across MNEs. Formally, the profit equation that each firm maximizes when investing abroad can be specified as:

$$\pi_{ij} = \beta_i' X_{ij} + \varepsilon_{ij}, \tag{5}$$

where the vector of parameters β' for firm i reflects the firm's preference over observable location attributes *x*, thus, in the random-coefficient MXL, parameters β are not fixed as in CLM, but they can reveal MNEs' taste variation regarding location characteristics. Coefficients vary across MNEs in the population with distribution density $f(\beta)$. Following Train (2009), each MNE knows its β_i (as well as ε_{ij}) for all alternatives and selects the location that offers higher profit. However, random coefficients β_i remain unobserved, and it is only possible to specify a distribution. By doing this, parameters θ (i.e., mean *b* and standard deviation *s*) of the coefficients β_i can be estimated. This article specifies a normal distribution for random coefficients associated with forward linkages. Thus, the analysis will inform whether MNEs exhibit heterogeneous tastes over different magnitudes of intersectoral demand.

5 | RESULTS

To address logistics MNEs' location choices, we run different regressions, testing the role those forward linkages with retail and wholesale, and manufacturing sectors have in determining such strategic decisions, controlling for agglomeration, accessibility, and other locations' characteristics. To do this, we begin our empirical exercise by estimating a conditional logit model that allows us to include NUTS 3s' characteristics as independent variables. We estimate different model specifications. Table 3 reports the model estimates for inward FDIs directed to the logistics industry, using NUTS 3 as the geographical unit of analysis. In Table 4 we present our full and preferred specification that includes the whole set of control variables included in this study.

TABLE 3 Logistics MNEs' location choices—conditional logit model.

Variables	Mod. 1	Mod. 2	Mod. 3—baseline
FL of logistics users in the retail & wholesale	5.826**		7.250***
	(2.487)		(2.519)
FL logistics users in the manufacturing sectors		0.267***	0.281***
		(0.0472)	(0.0478)
ln GDP at current prices by NUTS 3	−0.0360	−0.0210	0.00944
	(0.0328)	(0.0317)	(0.0335)
ln weighted spatial lag–GDP based	0.0863***	0.0795***	0.0509*
	(0.0273)	(0.0268)	(0.0283)
ln port freight NUTS2	0.0427***	0.0453***	0.0360***
	(0.00983)	(0.00911)	(0.00969)
ln population density	−0.0695***	−0.0508*	−0.0567**
	(0.0266)	(0.0274)	(0.0273)
Stock of past FDIs over 2006–2010	0.00275***	0.00206***	0.00201***
	(0.000125)	(0.000175)	(0.000176)
Stock of past logistics FDIs over 2006–2010	0.0115***	0.0109***	0.0113***
	(0.00316)	(0.00314)	(0.00315)
ln total freight flows in 1000 tonnes by NUTS 3 via road	0.0216	0.0119	0.0268*
	(0.0153)	(0.0142)	(0.0153)
Min. distance to port in KM from FDI	−0.000422	−0.000435	−0.000418
	(0.00120)	(0.00120)	(0.00120)
Distance (KM) to country borders	−0.00145	−0.00149	−0.00149
	(0.00107)	(0.00110)	(0.00110)
Distance (KM) to closest freight airport	0.0562	0.0562	0.0564
	(0.0602)	(0.0602)	(0.0602)
Observations	119,405	119,405	119,405

Notes: Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

TABLE 4 Logistics MNEs' location choices—conditional logit model.

Variables	Mod. 4	Mod. 5	Mod. 6
FL of logistics users in the retail & wholesale	7.456***	−5.457	6.710**
	(2.455)	(3.396)	(2.623)
FL Logistics users in the manufacturing sectors	0.358***	0.457***	0.366***
	(0.0532)	(0.0698)	(0.0540)
FLM * GVA in manufacturing		−0.544	
		(1.596)	
FLR * GVA in retail		64.99**	
		(32.57)	
share GVA in manufacturing		−0.786	
		(0.770)	
share GVA in retail & wholesale		3.856***	
		(1.118)	
ln GDP at current prices by NUTS 3	−0.0614	0.0756**	−0.0463
	(0.0432)	(0.0378)	(0.0470)
ln weighted spatial lag—GDP based	0.0879***	0.0265	0.0857***
	(0.0323)	(0.0346)	(0.0325)
ln port freight NUTS2	0.0193*	0.0225**	0.0179*
	(0.0103)	(0.0109)	(0.0105)
ln population density	−0.0433	0.0305	−0.0344
	(0.0361)	(0.0344)	(0.0375)
Stock of past FDIs over 2006–2010	0.00186***	0.00133***	0.00184***
	(0.000198)	(0.000234)	(0.000199)
Stock of past logistics FDIs over 2006–2010	0.00843	0.00421	0.00794
	(0.00513)	(0.00524)	(0.00518)
lntal Freight flows in 1000 tonnes by NUTS 3 via road	0.0157	0.00126	0.0154
	(0.0162)	(0.0169)	(0.0162)
Min. distance to port in KM from FDI	−0.000408	−0.000460	−0.000412
	(0.00120)	(0.00120)	(0.00120)
Distance (KM) to country borders	−0.00152	−0.00163	−0.00152
	(0.00116)	(0.00117)	(0.00116)
Distance (KM) to closest freight airport	0.0564	0.0555	0.0563
	(0.0601)	(0.0605)	(0.0601)
capital_city = 1	−0.498***	−0.715***	−0.485**
	(0.189)	(0.203)	(0.190)
Stock of logistics firms over 2006–2010	−0.00846	−0.00713	−0.00819
	(0.00754)	(0.00731)	(0.00748)
# total patents in T&O	−0.0764***	−0.0591***	−0.0754***
	(0.0150)	(0.0154)	(0.0151)
# total patents in T&O^2	0.00106***	0.000818***	0.00106***
	(0.000255)	(0.000261)	(0.000255)

(Continues)

TABLE 4 (Continued)

Variables	Mod. 4	Mod. 5	Mod. 6
# total patents—all IPC classes	−0.101*	0.0842	−0.136*
	(0.0552)	(0.0516)	(0.0694)
MNEs past investments in NUTS 3 over 2006–2010	0.326***	0.287***	0.335***
	(0.106)	(0.105)	(0.107)
ln gross value added in NUTS 3	0.444***		0.446***
	(0.0868)		(0.0869)
Labour cost index			0.00702
			(0.00853)
Observations	119,405	119,405	119,405

Notes: Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

In Table 3 we first test our indicators of forward linkages (FLs) separately. Overall, results show that logistics FDIs are attracted by stronger forward linkages with the retail and wholesale sector. The size of markets in an alternative location, that is, weighted spatial lag, does influence location decisions, meaning that, firms show lower sensitivity to distance with markets outside the chosen location. In other words, regions that allow access to a larger market have a higher probability to attract FDIs. Multinationals investing in the logistics sector tend to value the local market in which they will embed themselves and the potential market they can access from, reasonably investing in a national hub to reach distant markets.

Mod. 3, is the baseline specification upon which we test the full set of controls included in Table 4 Mod. 4 and Mod. 5 (Appendix Table A2 reports results with partial controls).

In Table 4 we add several controls. Most notably, we add a dummy variable if a capital city falls within a NUTS 3; the baseline is 0, meaning that reported coefficients refer to the regions that are not or do not host a capital city. Being a capital city does not accrue any attractiveness *per se* to logistics firms, that are found to be negatively affected by higher congestion costs (De Marco et al., 2018; Montoya-Torres et al., 2016). We also control for the presence of domestic firms in the same sector. The coefficient is not significant across the board, meaning that logistics MNEs are driven by the presence of international firms, and they tend to "follow their peers" (Mariotti et al., 2013). We can observe that, consistently with previous literature, multinationals are positively driven by the presence of other multinationals in their chosen location, either in the same industry or in the other industrial sectors, namely, *isomorphism* in location choices (Mariotti et al., 2010). Also, we may observe a path dependency in the in choice of location given by the past experience that MNEs have in the same region.

Consistently with past research we control for the level of technological innovation within the region as a factor impacting the region's attractiveness for FDIs (Crescenzi et al., 2014). To the best of our knowledge there is no work addressing logistics location choices that controls also for innovation capacity. Given the inverted U-shape relationship between innovation, economic performance, and market competition (Aghion et al., 2005; Polder & Veldhuizen, 2012; Tingvall & Poldahl, 2006), we control for the number of patents in T&O and its squared value. We also control for the number of total patents in all technological classes[18] (excluding the ones in T&O). Here we observe that patents in T&O do exert a negative effect, but its squared value is statistically significant and different from zero, meaning that regions that are very innovative are able to attract more FDIs in logistics.[19] Firms are more likely to enjoy knowledge spillovers and take advantage of innovative activities within the region. However, a

[18]We also test this variable along its squared value, results are consistently not significant.

[19]To test this quadratic relationship, we calculate the vertex point and we contend that for values under 34, increasing innovative activities is associated with a lower region's attractiveness. For values above 34, further increases in innovative activities are associated with higher probability of locating within the region. The value falls within the range of our observed data, therefore we can confidently confirm a U-shape relationship.

negative impact can reasonate with the fact that when firms are not neck-to-neck, increased competition will tend to discourage innovation by laggard firms as it decreases the short-run extra profit from catching up with the leader. This has interesting policy implications, since logistics is most often considered a low-value added activity that pools low-skilled labour force. Given this interesting result, we also control for the gross value added in the region. As pioneering studies pointed out, the U-shape relationship is most often observed between innovation and market competition (Aghion et al., 2005). The value of GVA is a proxy for a market competition effect, is positive confirming findings in past literature. Controlling for a competition effect allow us to observe one of the stylized facts in economic geography studies, that is, firms' location behaviour is mainly driven by the competition effect in which firms can access a larger market with a more even distribution of economic activity in space, enjoy lower trade costs, and larger market demand (Ascani et al., 2012). Finally, we wanted to test whether regions with a higher competition within the retail and wholesale sector are more likely to attract logistics firms. To do so, we interact the value of FL with the industry gross value added.[20] We find that regions where the share of retail sector[21] in the local economy is higher—meaning more competitive (above the average)—are more likely to attract logistics MNEs. The higher the level of sectoral competition the greater the difference between regions. Overall, it can be further argued that there is evidence of a market-seeking and strategic asset seeking motives given by the positive effect of market potential and the role of regional's innovative activities, namely, patents. We do not find evidence of the efficiency-seeking channel, as labour cost effect is not statistically significant different from zero across the board.

5.1 | MNEs' preference heterogeneity: mixed logit model

Following McFadden (1974) and Alcácer et al. (2018), the vast majority of economic studies on firms' location choices imply that MNEs' strategies are fundamentally driven by individual profit-maximizing choices. That is, MNEs select the location based on the expected profit that each location yield upon certain location's characteristics. Relaxing the IIA assumption (see Section 4) allows us to model the heterogeneity in the effects of the regressors and interpreting them as random parameters is equivalent to allowing some locations to be closer substitutes than other (Train, 2009). In MXL we let the coefficients of FLs vary random across firms. It is important to add that standard deviations of a random parameter significantly different from zero display heterogeneity in the extent to which the variable associated with that parameter can explain the location of inward FDI in European regions. (Train, 2009). This also allows us to control for correlation in profits among regions which would be more affected by the unobserved shocks that are not controlled for (Basile et al., 2008).

Given that from Figures 1 and 2 investments seem to be geographically concentrated, it is worth exploring whether logistics MNEs show patterns of heterogeneity in their decision making. In this econometric exercise we are able to allow for repeated choices.[22]

In Table 5 we observe that our CLM results hold with MXL. Strong intersectoral demand between logistics and the end market sectors result in higher probability of MNEs locating in those regions. We detect this from a significant mean *b*. However, it is possible to detect that firm heterogeneity in locational behaviour there exist and is identified in a statistically significant standard deviation *s*. Across the board, firms prefer to locate in regions with higher forward linkages with retail, while for the manufacturing sector we do not detect any heterogeneity. Overall, about

[20]We centred our variables to observe the main effect of FLs when the region has an average level of sectoral competition as measured by the GVA. Centering is useful when variables are continuous (Afshartous & Preston, 2011; Echambadi & Hess, 2007)

[21]Share is calculated as the total GVA in retail and wholesale (G sector) over the total GVA in each NUTS 3 region.

[22]All mixed logit models were run in Stata using the user-written command mixlogit (Hole, 2007), implemented in each case using 500 Halton draws, and taking into consideration the occurrence of repeated location choices of different investments by the same firm. Alternatively, allowing for repeated choices we account for the fact that a company returning to the same city does not necessarily behave like one going there for the first time. This is key, because we reckon that firms that have already invested in a NUTS 3 in the past will not choose the same location on different determinants. 0.0107% of the total sample of firms had already invested in the same NUTS 3 after 2011.

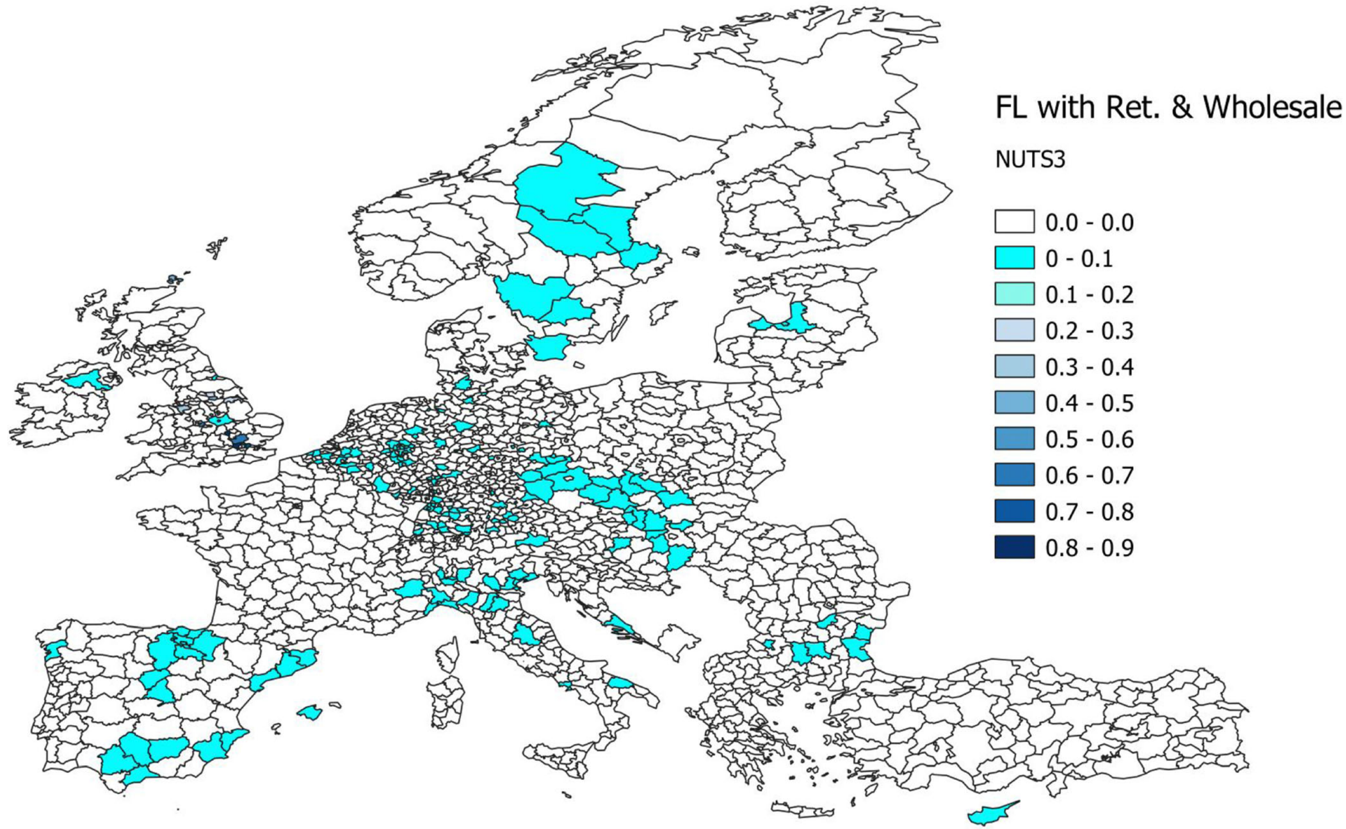

FIGURE 1 Forward linkages with retail & wholesale across NUTS 3 regions. The map shows the geographical distribution of the forward linkages with the retail & wholesale sector coefficients used in the empirical analysis. *Source*: own elaboration based on the Eurostat Symmetric Input–Output Tables in 2010.

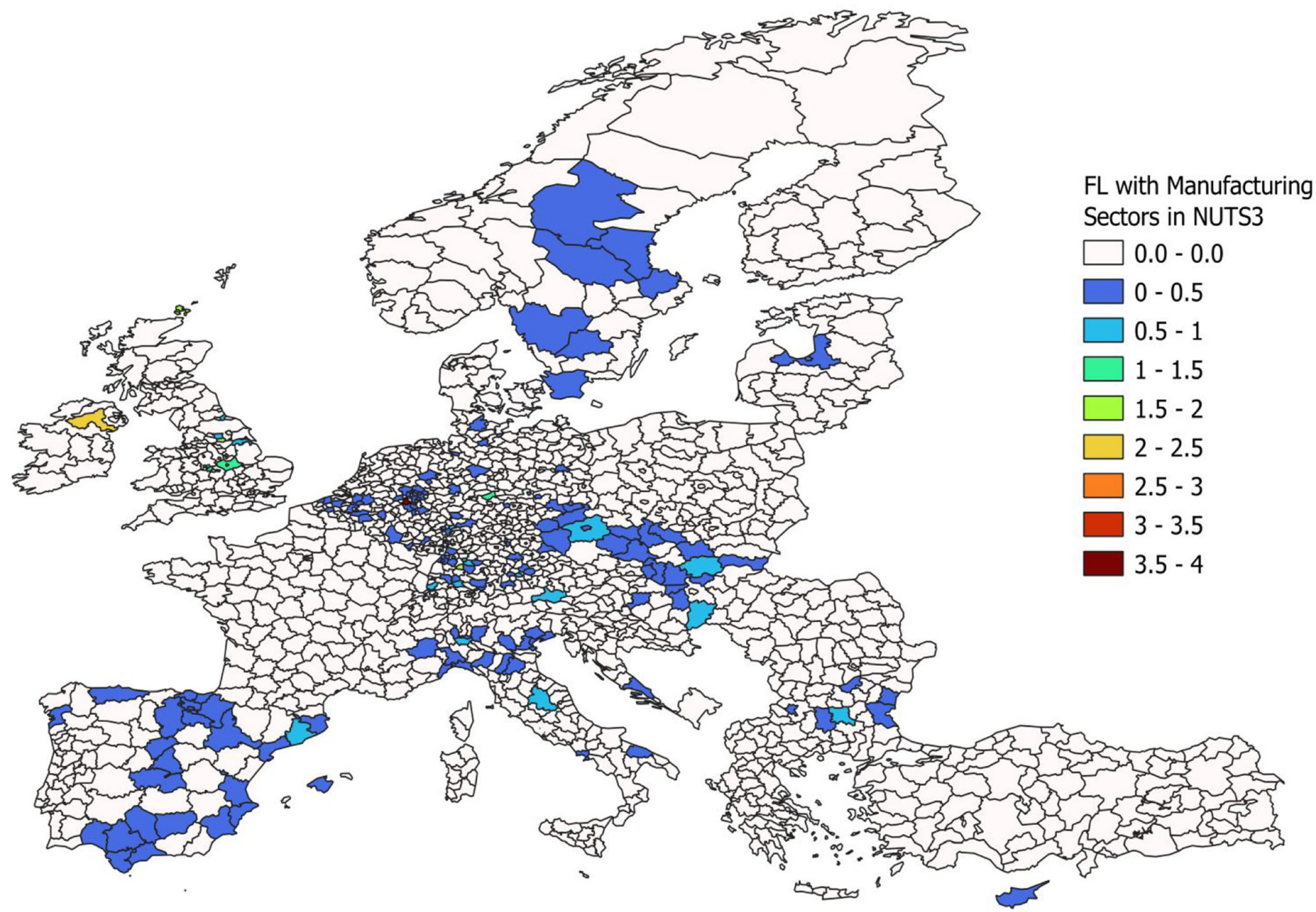

FIGURE 2 Forward linkages with manufacturing sectors across NUTS 3 regions. The map shows the geographical distribution of the forward linkages with the manufacturing sector coefficients used in the empirical analysis. *Source*: own elaboration based on the Eurostat Symmetric Input–Output Tables in 2010.

TABLE 5 Mixed logit model of logistics MNEs location behaviour.

Variables		Mod. 1 MXL	Mod. 2 MXL	Mod. 3 MXL	Mod. 4 CLM
ln GDP at current prices by NUTS 3		0.0398	−0.0458	−0.0266	−0.0439
		(0.0363)	(0.0451)	(0.0480)	(0.0478)
ln weighted spatial lag - GDP Based		0.0179	0.0590*	0.0578*	0.0830**
		(0.0300)	(0.0333)	(0.0321)	(0.0341)
ln port freight NUTS 2		0.0291***	0.0208*	0.0197*	0.0163
		(0.0102)	(0.0118)	(0.0109)	(0.0121)
ln. population density		0.0207	−0.0251	−0.0133	−0.0347
		(0.0342)	(0.0364)	(0.0377)	(0.0375)
Stock of past FDIs over 2006–2010		0.00204***	0.00179***	0.00180***	0.00177***
		(0.0002)	(0.000323)	(0.000207)	(0.000318)
Stock of past logistics FDIs over 2006–2010		0.0107**	0.00922	0.00879*	0.00733
		(0.0049)	(0.0057)	(0.00512)	(0.00564)
ln Ffreight flows in 1000 tonnes by NUTS 3 via road		−0.00406	0.00874	0.00839	0.0157
		(0.0171)	(0.0167)	(0.0168)	(0.0163)
Min. distance to port in km from FDI		−0.00038	−0.000394	−0.000404	−0.000403
		(0.00121)	(0.0012)	(0.00120)	(0.00120)
Distance (km) to country borders		−0.00151	−0.00152	−0.00153	−0.00146
		(0.00114)	(0.00117)	(0.00115)	(0.00118)
Distance (km) to closest freight airport		0.0569	0.057	0.0575	0.0547
		(0.0602)	(0.0605)	(0.0601)	(0.0604)
Stock of logistics firms over 2006–2010		−0.012	−0.0113	−0.0109	−0.00800
		(0.00776)	(0.00763)	(0.00748)	(0.00758)
MNEs past investments in NUTS 3 over 2006–2010		0.408***	0.340***	0.351***	0.335***
		(0.102)	(0.106)	(0.107)	(0.107)
# total patents in T&O		−0.0585***	−0.0724***	−0.0718***	−0.0735***
		(0.014)	(0.0166)	(0.0149)	(0.0168)
# total patents in T&O^2		0.000865***	0.00102***	0.00102***	0.00103***
		(0.00024)	(0.000267)	(0.000251)	(0.000271)
# total patents—all IPC classes		0.0636	−0.0634	−0.110	−0.139**
		(0.0477)	0.0582)	(0.0714)	(0.0700)
ln gross value added		0.351***	0.351***	0.356***	0.392***
		(0.0924)	(0.0929)	(0.0923)	(0.0841)
Labour cost index				0.00922	0.00709
				(0.00836)	(0.00854)
FL logistics users in the retail & wholesale	b	0.975	6.556**	5.583*	6.749**
		(3.245)	(3.068)	(3.215)	(2.627)
	s	21.97***	7.053	7.048	
		(4.755)	(10.64)	(10.69)	

TABLE 5 (Continued)

Variables		Mod. 1 MXL	Mod. 2 MXL	Mod. 3 MXL	Mod. 4 CLM
FL logistics users in the manufacturing sectors	b	0.295***	0.354***	0.367***	0.357***
		(0.0496)	(0.0629)	(0.0538)	(0.0623)
	s	0.0486	0.0845	0.0877	
		(0.0629)	−0.211	(0.196)	
Residuals (FL with retail)	b		0.769		1.981
			(7.923)		(7.341)
	s		−1.265		1.981
			(10.55)		
Observations		120,703	120,703		119,405

Notes: Standard errors in parentheses. The mixlogit command in Stata does not allow for factor variables—capital_city—to be included in the model. Number of MXL draws (500).
***p < 0.01, **p < 0.05, and *p < 0.1.

97% of our firms[23] prefer to locate in regions with higher intersectoral demand with the end-market. Following Alcácer et al. (2018), in Mod. 2 we test a second-stage regression in which we include the residual of the FL with retail sectors variable[24] As a robustness we include the residual in a CLM model (see also Benfratello et al., 2022). Since the coefficient does not have a statistically significant mean and standard deviation,[25] we can conclude that our model already addresses potential sources of heterogeneity (Alcácer et al., 2018), and that demand-driven linkages exert a positive effect across the board. Our estimates are consistent with results presented in Tables 3 and 4 thus we conclude that the CLM has full explanatory power in our empirical exercise.

5.2 | Sensitivity check

As a further sensitivity check, we control for the quality of economic institutions following Ascani et al. (2016; see Table 6). Given the data availabilities issues[26] and being Europe our geographical focus (we cover European countries that are both in the EU 19—the Eurozone—and countries that have not yet adopted the euro as common currency). To control for the importance of economic institutions that play a key role in facilitating the flow of capital and goods in Europe, we test a CLM with interaction terms and then we use a linear hypotheses after test estimation.[27] The use of CLM here allows factor variables, that is, dummy variables, to be estimated in the model and test the statistical difference between the two subsamples of countries—notably those that belong to the Eurozone and those that do not. Being in the eurozone accrues certain advantages to members such as the access to a larger market: over 500 million consumers live in the EU 19, making it one of the largest in the world. This means the opportunity to serve a large customer base. Additionally, lower transaction costs. Using a single currency, business does not incur the costs associated with currency exchanges leading to saving costs and increased efficiency (European

[23]This approximation of the expectation of $\Phi(\beta_k/S_k)$ follows Hole (2007)

[24]The FL with manufacturing does not report a significant standard deviation, therefore only the FL with retail and wholesale is included in this model. This also lightens the computational

[25]The sign of the estimated standard deviations is irrelevant (Hole, 2007).

[26]Data on the quality of institutions for our wider sample over the period are not available for each country and/or at the regional level, therefore by splitting the sample we aim to account for the importance of such institutions among European countries.

[27]We reject the null hypothesis—FL measures in EU 19 vs. non-EU 19 are equal—at p-values of 0.028 and 0.0023 respectively, we thus conclude that the two set of countries are statistically different.

TABLE 6 Conditional logit estimation—logistics MNEs location behaviour in EU 19 vs. non-EU 19.

Variables	(1) Mod. 1 -CLM	(2) Mod. 2 -CLM
FL of logistics users in the retail & wholesale	6.993***	7.486***
	(2.705)	(2.877)
EU 19 = 1	−0.0130	−0.204
	(0.237)	(0.419)
1.eu19#FL of logistics users in the retail & wholesale		−4.013
		(8.554)
FL logistics users in the manufacturing sectors	0.363***	0.380***
	(0.0546)	(0.0576)
1.eu19#FL logistics users in the manufacturing sectors		−0.146
		(0.130)
ln GDP at current prices by NUTS 3	−0.0466	−0.0536
	(0.0727)	(0.0812)
ln weighted spatial lag—GDP based	0.0869***	0.0850***
	(0.0325)	(0.0328)
ln port freight NUTS 2	0.0179*	0.0191*
	(0.0105)	(0.0106)
ln population density	−0.0386	−0.0420
	(0.0380)	(0.0384)
Stock of past FDIs over 2006–2010	0.00186***	0.00184***
	(0.000200)	(0.000202)
Stock of past logistics FDIs over 2006–2010	0.00782	0.00768
	(0.00518)	(0.00517)
ln total freight flows in 1000 tonnes by NUTS 3 via road	0.0163	0.0170
	(0.0164)	(0.0166)
Min. distance to port in km from FDI	−0.000421	−0.000417
	(0.00120)	(0.00120)
Distance (km) to country borders	−0.00152	−0.00150
	(0.00116)	(0.00115)
Distance (km) to closest freight airport	0.0563	0.0563
	(0.0601)	(0.0602)
capital_city = 1	−0.495***	−0.431**
	(0.190)	(0.201)
Stock of logistics firms over 2006–2010	−0.00831	−0.00894
	(0.00749)	(0.00763)
# total patents in T&O	−0.0759***	−0.0743***
	(0.0151)	(0.0155)
# total patents in T&O^2	0.00106***	0.00105***
	(0.000255)	(0.000258)
# total patents—all IPC classes	−0.137*	−0.136*
	(0.0702)	(0.0700)

TABLE 6 (Continued)

Variables	(1) Mod. 1 -CLM	(2) Mod. 2 -CLM
MNEs past investments in NUTS 3 over 2006–2010	0.334***	0.331***
	(0.107)	(0.107)
ln gross value added in NUTS 3	0.449***	0.444***
	(0.111)	(0.114)
Labour cost index	0.00656	0.00553
	(0.00916)	(0.00920)
Observations	119,405	119,405

Notes: Standard errors in parentheses. The binary variable EU19 is codified as 0 being in the EU19 and 1 otherwise. Countries not in the EU 19 are AL, CH, CZ, DK, HR, HU, IE, ME, PL, RO, RS, SE, TR, UK. Countries in the EU19 are AT, BE, DE, EL, ES, FI, FR, IS, IT, LU, LV, MK, MT, NL, NT, PT, SI, SK.
***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Commission, 1990). For consistency we test also a dummy *EU19*[28] in the CLM. Here results show that the effect of FL with retailers is even stronger in regions that are within the Eurozone. Results are confirmed in both estimations.

6 | CONCLUSIONS AND POLICY IMPLICATIONS

A large body of the literature investigating firms' location decisions devoted attention to the location of production activities, while little evidence has yet been provided on the logistics industry. In the last two decades, much attention has been paid to business services surrounding production activities (Castellani et al., 2016; Meliciani & Savona, 2015) while considering location decisions in logistics as merely determined by production. In other words, logistics services are assumed to "follow" manufacturing activities wherever these take place. The empirical literature has started to investigate logistics services' location decisions (Holl & Mariotti, 2018a, 2018b; Mariotti, 2014; Rocha & Perobelli, 2020), yet forward linkages, particularly with the retail and wholesale sector, have been largely neglected. However, we argue that intersectoral demand from retail and wholesale trade sector might affect logistics operators independently from the manufacturing base already present in the local context (Holl & Mariotti, 2018b; Meliciani & Savona, 2015).

Our results answer the call made by Rocha and Perobelli (2020) who find that logistics services are increasingly moving downstream in the supply chain, being more sensitive to sectors closest to the end-market, namely, retail trade. To assess whether forward linkages with the retail and wholesale sector positively impact FDIs in NUTS 3 regions, we rely on one main dataset: fDi Markets, running separate conditional logit models from 2011 to 2018 for 1777 FDIs located in 380 NUTS 3 regions. Consistently with past literature,

Our paper contributes to the current empirical literature and to the ongoing debate addressing logistics multinationals' location choices, unpacking those determinants that attract services FDIs into European NUTS 3 regions. We believe that our results may provide some contributions to the current dialogue between economic literature and business practitioners arguing a gradual shifting toward a demand-driven economy in which keep up with consumers' preferences for differentiated products delivered in a shorter amount of time may be a source of competitive advantage for MNEs. This may have important policy implications in building a competitive service economy independently from the pre-existing manufacturing base across European regions.

[28]The dummy takes value 0 if a country belongs to the Eurozone, and 1 otherwise. Countries are reported in Table 6.

We are aware that our work may present some limitations. Particularly given our source of investment data, our analysis is limited only to greenfield investments and does not help understand whether within region forward linkages are equally important in the case of other forms of foreign market entry, such M&As or joint ventures. Admittedly, this can be a problem in light of the importance of these entry modes in certain contexts. However, it need not be overstated, considering that factors related to the availability of target/partner companies may be more important than some locational characteristics in these cases. A second issue with our analysis is related to the fact that we do not have any information on the exact location of the investment within the region. That is, we cannot precisely disentangle MNEs' location within the NUTS 3 (e.g., urban core vs rural). Additionally, given the source of our data we could not break down the logistics sector more than 2-digit NACE code, thus we also believe that a future interesting research avenue could address the distinction of the logistics sectors based on their knowledge intensity.

Let us conclude with some reflections on the implications of our findings. Our results may open new avenues for future research concerning the location decisions of logistics MNEs and may support the need to shape more tailored policies devoted to attracting logistics firms regardless of the manufacturing base within the region in light of the increasing trend of a customer-based supply chain. Forward linkages with the retail and wholesale sectors exert a much stronger effect in luring logistics operators in NUTS 3 regions. This result may aid the current debate in the literature arguing the shifting towards a demand-driven economy, in which consumers' preferences for quicker deliveries are paving the way to a more customer-based supply chain. Indeed, higher sectoral interconnectedness, with those business actors closer to the end market, is likely to be a stronger attractive factor for FDIs in the logistics industry across European regions. Also, to the best of our knowledge this study is the first to test the role of regional innovation capacity in logistics firms' decision making. Results show that highly-specialized regions attract FDIs. Logistics firms need to be highly adaptable in using technology in new ways. Consider the case of "pop up stores" in the US, companies like UPS and FedEx have invested great resources to establish packaging and services for stores (Amling & Daugherty, 2020). Logistics firms have always been at the forefront of industrial innovation. Logistics were the first in which many technologies have been introduced (such as the first experiments with self-driven vehicles in warehouses) or as radio-frequency identification (RFID) (Lagorio et al., 2022).

Being innovative it is not a sufficient condition to attract firms, because this can deter firms in entering the market. A negative impact can indeed reasonate with the fact that when firms are not neck-to-neck, increased increased competition will tend to discourage innovation by laggard firms as it decreases the short-run extra profit from catching up with the leader (Aghion et al., 2018). This has interesting policy implications, because firms in competitive industries are characterized by a stronger impact of innovation inputs (Castellacci, 2011). Public intervention is key. Logistics already, largely relies on transport infrastructure investments, and zoning regulations. Our results show that patent activity in T&O technologies are key to attract competitive firms. Our results also show that where the retail sector is prominent, and above average, probability to locate is higher. This is interesting and echoes the fact that to keep up with increasing demand, especially from e-commerce firms, regions need to invest in warehouses and distribution centres. Due to this increasing demand, logistics companies seek innovative solutions such as artificial intelligence (AI) (e.g., forecasting capacity and predict vehicles' needs), automation technologies for transporting goods and streamlining of operations to increase efficiency, robotics and 3D printing that can be used to spare parts on goods on-demand and last mile delivery services.

Although our period of analysis does not cover the pandemic period, we can reckon that the impact of the pandemic, among others, has been to boost e-commerce demand and logistics firms had to meet such demand. On top of that, logistics outsourcing among retailers is increasing. Here linkages are crucial and are gaining momentum (Maersk, 2021).

In conclusion, it is key for regions to have a clear and attractive offering for foreign firms. In the current economy landscape, retailers and logistics are essential components of the modern global economy, they facilitate the movements of goods around the world and they have been greatly transformed by advances in technology, such the widespread adoption of the Internet and AI. From the policy point of view, the European Cohesion Policy 2021–2027[29]

[29]For more information see European Parliament – Cohesion Policy.

already provides support for logistics projects concerning transport infrastructure, but it can also include support to logistics-related technologies, particularly for those regions that need to catch-up with more innovative ones and promote skills and competencies to develop digital systems for tracking and managing the movement of goods for example.

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APPENDIX

TABLE A1. List and description of variables.

Variable	Description	Source
Location choice	Dummy variable taking value 1 if the given project i is located in region j, 0 otherwise	Author elaboration based on fDi Markets
Forward linkages with the retail sector	Weighted share of employment in retail and wholesale industries that are users of logistics services over total employment	Symmetric input–output tables 2010. Eurostat [naio_10_cp1700]
Forward linkages with the manufacturing sector	Weighted share of employment in manufacturing industries that are users of logistics services over total employment	Eurostat. Symmetric input–output tables, ESA 2010 [naio_10_cp1700]
Gross domestic product	Gross domestic product per NUTS 3 in million units at current market prices	Eurostat [nama_10r_3gdp]
Market potential—weighted spatial lag	Market potential in location *j* is the sum of the market size, measured as the NUTS 3 GDP in all other locations divided by their inverse squared distance to alternative location.	Author elaboration based on calculated Euclidean distance and GDP at the NUTS 3 level
Population density	Population/land area (km^2)	Author elaboration based on Eurostat [demo_r_d3dens]
Stock of past logistics FDI over 2006–2010	Stock of past FDI from 2006 to 2010. Count of each FDI per NUTS 3 polygon in QGIS	Author elaboration based on fDi Markets
Stock of past FDIs (all industry sectors, excl. logistics) over 2006–2010	Stock of past FDI from 2006 to 2010. Count of each FDI per NUTS 3 polygon in QGIS	Author elaboration based on fDi Markets
MNEs' experience	Stock of MNEs' past FDI in the same NUTS 3 from 2006 to 2010.	Author elaboration based on fDi Markets
Total freight stock by Port and per NUTS 2	Sum of inward and outward flow of goods handled by each airport and port NUTS2 Region level over 2010—thousands of tonnes	Author elaboration based on Eurostat (Maritime transport of freight by NUTS 2 regions [TGS00076])
Total freights stock by road per NUTS 3	Total flow of goods distributed via road at the NUTS 3 region level 2010—thousands of tonnes	Author elaboration based on Eurostat [road_go_na_rl3g]
Patents in transportation and operations	Total patents in B61-B66 technological classes defined according to the IPC classification by priority year across each NUTS 3 region	Author elaboration based on Eurostat [pat_ep_ripc]
Patents in all technological classes—exc. transportation and operations	Total patents in all technological classes as defined by the IPC classification by priority year across each NUTS 3 region	Author elaboration based on Eurostat [pat_ep_ripc]
Capital city	Binary variable defined as 1 if the region is or hosts a capital city and 0 otherwise.	Author own elaboration based on Eurostat list of capital cities
Gross value added	Gross value added in each NUTS 3 region.	Eurostat [nama_10r_3gva]
Distance (km) from local logistics to international airports	Distance from each firm/FDI to each NUTS 3's airport in km	Author elaboration using QGIS Distance Matrix based on GISCO – Eurostat GIS shapefile

(Continues)

TABLE A1. (Continued)

Variable	Description	Source
Distance (km) from local logistics to port	Distance from each firm/FDI to each NUTS 3's Port in km	Author elaboration using QGIS Distance Matrix based on GISCO – Eurostat GIS shapefile
Distance (km) to country borders	Distance from each FDI to country borders. (Islands included)	Author elaboration using QGIS
Labour cost index	Labour cost index includes total average hourly labour costs and to the labour cost categories wages and salaries and employers' social security contributions plus taxes paid minus subsidies received by the employer.	Eurostat [lc_lci_lev]

Note: Eurostat dataset's name is reported in square brackets.

TABLE A2. Conditional logit estimation—partial adding of controls.

Variables	(1) Mod. 4	(2) Mod. 5	(3) Mod. 6	(4) Mod. 7
FL of logistics users in the retail & wholesale	7.207***	7.014***	6.431**	7.456***
	(2.539)	(2.536)	(2.554)	(2.455)
FL Logistics users in the manufacturing sectors	0.269***	0.270***	0.290***	0.358***
	(0.0486)	(0.0486)	(0.0495)	(0.0532)
ln GDP at current prices by NUTS 3	0.0160	0.0162	0.0731**	−0.0614
	(0.0337)	(0.0338)	(0.0355)	(0.0432)
ln weighted spatial lag—GDP based	0.0531*	0.0506*	0.0358	0.0879***
	(0.0288)	(0.0288)	(0.0317)	(0.0323)
ln port freight NUTS 2	0.0348***	0.0357***	0.0351***	0.0193*
	(0.00970)	(0.00973)	(0.0101)	(0.0103)
ln population density	−0.0589**	−0.0576**	0.00713	−0.0433
	(0.0273)	(0.0272)	(0.0328)	(0.0361)
Stock of past FDIs over 2006–2010	0.00207***	0.00210***	0.00225***	0.00186***
	(0.000180)	(0.000181)	(0.000191)	(0.000198)
Stock of past logistics FDIs over 2006–2010	0.0110***	0.0111***	0.00979*	0.00843
	(0.00316)	(0.00316)	(0.00514)	(0.00513)
ln total freight flows in 1000 tonnes by NUTS 3 via road	0.0297*	0.0295*	0.0133	0.0157
	(0.0155)	(0.0155)	(0.0169)	(0.0162)
Min. distance to port in km from FDI	−0.000423	−0.000417	−0.000437	−0.000408
	(0.00120)	(0.00120)	(0.00121)	(0.00120)
Distance (km) to country borders	−0.00148	−0.00148	−0.00148	−0.00152
	(0.00110)	(0.00109)	(0.00110)	(0.00116)
Distance (km) to closest freight airport	0.0558	0.0557	0.0557	0.0564
	(0.0602)	(0.0602)	(0.0601)	(0.0601)
capital_city = 1	−0.251	−0.185	−0.171	−0.498***
	(0.179)	(0.179)	(0.176)	(0.189)

TABLE A2. (Continued)

Variables	(1) Mod. 4	(2) Mod. 5	(3) Mod. 6	(4) Mod. 7
Stock of logistics firms over 2006–2010		−0.0119	−0.0112	−0.00846
		(0.00751)	(0.00805)	(0.00754)
# total patents in T&O			−0.0555***	−0.0764***
			(0.0143)	(0.0150)
# total patents in T&O^2			0.000809***	0.00106***
			(0.000251)	(0.000255)
# total patents—all IPC classes			0.0310	−0.101*
			(0.0469)	(0.0552)
MNEs past investments in NUTS 3 over 2006–2010				0.326***
				(0.106)
ln gross value added in NUTS 3				0.444***
				(0.0868)
Observations	119,405	119,405	119,405	119,405

Notes: Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

TABLE A3. Correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FL of logistics users in the retail & wholesale	1.000									
FL logistics users in the manufacturing sectors	−0.017	1.000								
ln GDP at current prices by NUTS 3	−0.111	0.135	1.000							
ln weighted spatial lag—GDP Based	0.182	0.150	0.427	1.000						
ln port freight NUTS2	0.189	−0.199	0.070	−0.362	1.000					
ln population density	0.199	0.024	−0.011	0.283	−0.069	1.000				
Stock of past FDIs over 2006–2010	0.002	0.595	0.236	0.097	−0.119	0.109	1.000			
Stock of past logistics FDIs over 2006–2010	0.113	0.104	0.068	0.070	0.166	0.123	0.133	1.000		
ln total freight flows in 1000 tonnes by NUTS 3 via road	−0.316	0.048	0.103	0.019	−0.030	0.052	0.093	0.018	1.000	
Min. distance to port in km from FDI	−0.004	−0.015	0.008	0.000	0.006	0.008	−0.032	0.004	−0.001	1.000
Distance (km) to country borders	−0.005	−0.002	0.002	0.001	−0.000	0.004	−0.008	0.001	−0.001	−0.027
Distance (km) to closest freight airport	0.008	0.004	−0.007	−0.004	0.001	−0.009	0.015	−0.000	0.008	−0.005
Capital city	−0.001	0.035	0.138	0.156	−0.079	0.057	0.206	−0.025	0.094	0.000
Stock of logistics firms over 2006–2010	−0.027	0.059	0.047	−0.015	0.012	0.021	0.181	0.050	0.030	0.001
# total patents in T&O	0.145	0.308	0.260	0.210	0.105	0.248	0.300	0.390	−0.204	0.005
# total patents in T&O^2	0.102	0.186	0.212	0.139	0.143	0.135	0.230	0.486	−0.194	0.003
# total patents —all IPC classes	0.230	0.308	0.133	0.433	−0.063	0.489	0.206	0.122	−0.107	0.004
MNEs past investments in NUTS 3 over 2006–2010	0.032	0.195	0.272	0.083	0.155	0.002	0.346	0.129	0.070	−0.007
ln gross value added in NUTS 3	0.037	0.191	0.480	0.184	0.262	0.371	0.333	0.165	−0.005	0.006
Labour cost index	0.403	0.048	−0.266	0.205	0.033	0.293	−0.020	0.098	−0.165	−0.003

TABLE A3. (Continued)

Variables	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
FL of logistics users in the retail & wholesale										
FL logistics users in the manufacturing sectors										
ln GDP at current prices by NUTS 3										
ln weighted spatial lag—GDP Based										
ln port freight NUTS2										
ln population density										
Stock of past FDIs over 2006–2010										
Stock of past logistics FDIs over 2006–2010										
ln total freight flows in 1000 tonnes by NUTS 3 via road										
Min. distance to port in km from FDI										
Distance (km) to country borders	1.000									
Distance (km) to closest freight airport	0.012	1.000								
Capital city	0.001	−0.006	1.000							
Stock of logistics firms over 2006–2010	0.004	−0.001	0.151	1.000						
# total patents in T&O	0.002	−0.006	0.000	0.109	1.000					
# total patents in T&O^2	0.001	−0.004	0.003	0.084	0.904	1.000				
# total patents —all IPC classes	0.003	−0.005	0.036	0.043	0.558	0.308	1.000			
MNEs past investments in NUTS 3 over 2006–2010	−0.004	0.005	0.149	0.051	0.173	0.147	0.051	1.000		
ln gross value added in NUTS 3	−0.000	−0.000	0.184	0.093	0.539	0.367	0.635	0.320	1.000	
Labour cost index	0.000	0.003	−0.119	−0.040	0.242	0.099	0.668	−0.149	0.234	1.000

TABLE A4. Countries by number of greenfield FDIs in logistics.

Country	#FDIs	%
Albania	2	0.11
Austria	61	3.43
Belgium	77	4.33
Bulgaria	21	1.18
Croatia	18	1.01
Cyprus	4	0.23
Czech Republic	56	3.15
Denmark	32	1.8
Finland	41	2.31
France	126	7.09
Germany	287	16.15
Greece	11	0.62
Hungary	31	1.74
Iceland	1	0.06
Ireland	25	1.41
Italy	65	3.66
Latvia	6	0.34
Lithuania	17	0.96
Luxembourg	7	0.39
Malta	2	0.11
Montenegro	2	0.11
Netherlands	90	5.06
North Macedonia	7	0.39
Norway	20	1.13
Poland	130	7.32
Portugal	25	1.41
Romania	68	3.83
Serbia	22	1.24
Slovakia	26	1.46
Slovenia	7	0.39
Spain	150	8.44
Sweden	25	1.41
Switzerland	27	1.52
Turkey	55	3.1
UK	233	13.11
Total	1777	100