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Damioli, G., Vertesy, D., Castellani, D.

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Contact information
Name: Giacomo Damioli
Address: Via E. Fermi 2749, Ispra (VA), 21027, Italy
Email: giacomo.damioli@ec.europa.eu
Tel.: +39 0332 78 3547

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Authors

Giacomo Damioli, Dániel Vértesy, Davide Castellani

Abstract

The internationalization of highly knowledge-intensive activities of multinational enterprises (MNEs) has triggered competition at multiple, interrelated geographical levels. Not merely countries, but urban areas within countries, and regional integration blocs compete to attract activities such as research, development, design or testing. This study assesses the role of local, national and supranational factors influencing MNEs' decisions about where to locate knowledge-intensive foreign direct investments. In order to better understand the complex nature of competition, we compiled socio-economic information for 277 comparable urban areas – cities and their agglomeration, with a population of at least half a million – located in 28 countries across the world. Estimating nested logit models with different nesting structures, we show that supranational integration blocs' borders do matter when firms decide the location of their knowledge-intensive activities. Both supranational and national borders play an important role in Europe, while national borders seem more relevant in North America. The findings support the role of EU policy instruments, such as the European Research Area (ERA), aimed at creating an integrated research and innovation area in Europe.

1 Introduction

The internationalization of research and development (R&D), and more in general knowledge-intensive (K-I) business activities has seen an unprecedented increase in the last decades. While multinational enterprises (MNEs) traditionally maintain the bulk of K-I activities in the home country (Patel and Pavitt 1991 and 1999; Belderbos et al. 2013), a large body of evidence indicates that today MNEs not only produce and sell but also increasingly innovate in foreign countries (Belderbos et al. 2016, Dachs 2017, Iverson et al. 2017). Within this evolving context, there is a fierce, multi-level competition in which cities, countries and regional economic integration blocs seek to attract K-I investments from abroad, expecting spillover effects to increase their productivity and foster growth and job creation.

Indeed, recent studies have highlighted that MNEs are attracted by the characteristics of narrowly defined territories (Nielsen et al., 2017), spurring research on the role of regions (e.g. Head and Mayer, 2004; Basile et al., 2009; Siedschlag et al. 2013, Belderbos et al. 2014, Belderbos and Somers 2015 and Damioli and Vértesy 2017) and cities (Goerzen et al. 2013, Belderbos et al. 2016, Cook and Pandit, 2018, Castellani and Lavoratori 2018a and 2018b) as the unit of analysis for location decisions of MNEs.

This study contributes to the literature on the role of sub-national characteristics in attracting MNEs K-I activities, but in a broader context that allows to assess the relative importance of local, national and supranational economic integration boundaries matter for the location of K-I foreign investments worldwide. We define K-I activities as those business activities, namely research and development (R&D) and development, design and testing (DDT), that typically are at the top of MNEs value chain (followed by manufacture, distribution, marketing, sale and post-sale activities, while headquarters, human resources and finance could be considered as transversal activities similarly cutting along the value chain). These are the activities in which knowledge use and production are the most concentrated, and the most likely to be linked to innovation.

By providing new original evidence on the role of subnational, national and supranational factors, this study perfectly fits the research agenda proposed by Beugelsdijk and Mudambi (2013): "We suggest moving from the current dominance of analyses based on country means to a study of [international business] activities where the complex intermingling of different geographic scales (global, supra-regional, national and subnational) is taken into account." (Beugelsdijk and Mudambi 2013, p. 415). This study extends existing knowledge along two key intertwined dimensions. First, it places Europe and European countries in a broader context of global competition by including North American (Canada, Mexico and US) and Far Eastern (Australia, Japan and South Korea) countries.[1] Second, the extension of the geographical coverage allows assessing the role of supranational integration blocs in MNEs location choices.

While previous studies (Head and Mayer 2004, Basile et al. 2009, Crescenzi et al. 2014 and 2016) focused on assessing the role of national effects in the attraction of FDI in any business activity along the value chain (i.e. K-I as well as manufacture, marketing, business services and headquarters, just to name those accounting for the largest shares of total FDI), the role of supranational economic integration has been overlooked to date. It was shown that membership in regional economic integration blocs help countries attract FDI in general (Ethier, 1998), and the positive overall effect was shown also when considering both potential investment creation and diversion effects (Kreinin and Plummer, 2008). To our knowledge, however, there is a gap in the literature on the effect of supranational integration blocs on MNEs' location choices with regards to knowledge-intensive FDI.

(1) While important emerging countries increasingly engaged in K-I activities such as Brazil, China and India are excluded from the analysis, the coverage of the study allows a very comprehensive geographical set-up. Iverson et al (2017) estimated that 2013 MNEs expenditure in R&D in the US and the European Union (ignoring inter-European globalization) to be respectively just under 40 billion euros and about 28 billion euros, as compared to about 4.3 billion euros in China.

Supranational effects are of particular interest in the case of European Union (EU) Member States. In comparison to other regional integration blocs, such as the North American Free Trade Area (NAFTA), which had the main goal of eliminating barriers to trade and investment, the degree of economic and political integration in the EU achieved unmatched levels. Of particular interest in the context of knowledge-intensive investments are the efforts to realize the European Research Area, an integrated research market in which scientific knowledge, technology and researchers could circulate freely. As observers suggested, the strategic aim of the ambition is to move from "science in Europe" to "European Science" (Nedeva and Stampfer, 2012). Since its inception in 2000 and formal incorporation in the 2007 Lisbon Treaty, the European Commission and the Member States have repeatedly demonstrated their willingness to develop the ERA in a number of policy initiatives.[2] Yet, while these initiatives appear valuable steps on which further progress can be built, some observers argue on the basis of the study of (co-)patenting and (co-)publication activities that the efforts are ineffective in creating an integrated European innovation system (Chessa et al. 2013, Morescalchi et al. 2015).

The success of integrating the research and innovation in the ERA has typically been assess based on changes in scientific and technological collaboration and mobility patterns (see also Hoekman et al, 2010; Hoekman et al 2013; Boyle, 2013; Chessa et al, 2013; Morescalchi et al, 2015; Doria Arrieta et al, 2017). The present study contributes to understanding the effects of EU efforts to strengthen to cross-border knowledge-intensive flows from a different angle. While publication and patent data are widely accepted measures of R&D output, K-I FDI constitute a similarly widely accepted measure of R&D input. As the empirical strategy allows testing for the importance of supranational factors in Europe and elsewhere in the location choice of K-I FDI, we aim at complementing and qualifying existing evidence on the role of the ERA. The results could confirm the finding of lack of integration in the European Union and the ineffectiveness of the ERA, if supranational factors are found to be similarly relevant in Europe and other macro-areas. By contrast, they may indicate that MNEs perceive Europe as an integrated destination area, in the case supranational factors are more relevant in Europe than elsewhere.

The research question we address is whether MNEs consider local areas within the same countries and macro-areas as closer substitutes than those located in other countries and supranational macro-areas. Or, in other words, if territories compete relatively more with other territories within the same countries and/or macro-areas (e.g. Europe or North America) or rather if competition spans national and supranational borders. The basic geographical unit of analysis is the functional urban area (FUA), a category developed by the EU and the OECD combining demographic and economic criteria to refer to cities and their agglomerations, to account for an extremely large portion of K-I FDI worldwide. The study assesses whether a FUA (e.g. Berlin) competes for attracting K-I investments more with other FUAs within the same country (e.g. Munich) than those having similar characteristics in other countries (Paris) or macro-areas (Chicago).

Different scenarios can be hypothesised. At one extreme, national as well as supranational borders may not play any role in MNEs' location choices conditional on local characteristics of potential destination areas (i.e. FUAs). In other words, only local FUA attributes matter in location choices and would imply that competition for the attraction of K-I activities is "truly" global, i.e. FUAs similarly compete with each other

(2) For example, the ERA is part of the Innovation Union Flagship Initiative and thus an objective of the comprehensive Europe 2020 Strategy, which provides the basis and direction for European policy. The EU Research Framework Programmes were explicitly designed to support the creation of ERA. Initiatives launched in conjunction with the 7th Framework Programme (2007-2013), such as the institution of the European Research Council and the creation of the European Institute of Innovation and Technology should also have an important impact on the European research landscape and play a substantial role in creating world-class 'knowledge and innovation communities'. Finally, the EU cohesion policy and its financial instruments - the Structural Funds - give strong priority to the development of research and innovation capacities, particularly in less developed regions. Together with the priority given in most Member States' internal policies, this can help the whole of Europe to participate in and derive full benefit from the ERA.

independently on where they are located. At the other extreme, both national and supranational borders may play an important role in addition to local factors. This would mean that competition is higher with FUAs within the same country and macro-area than with FUAs outside them. A large number of intermediate scenarios lie in between these two extremes, with some national and supranational borders playing a role and some other not.

The answer to the question has very important policy implications, since it allows understanding the importance of the various overlapping levels of governance in the promotion and support of territories as destination of MNEs knowledge-related investments. In the absence of national and supranational effects, policies would be effective in enhancing the attractiveness of a FUA only to the extent that they directly improve its characteristics and appeal. That would reduce the appeal of other FUAs in a similar way independently on where they are located, i.e. in the same or different countries and macro-areas. In the presence of national and supranational effects, on the contrary, competition also happens between countries and macro-areas. There is therefore scope for policies that promote the attractiveness of a nation or macro-area as a whole, i.e. to increase the appeal of its own FUAs, also of those whose attributes are not directly affected by policy.

We estimate nested logit models of the probability to locate MNE K-I activities in 277 FUAs in 28 countries worldwide, using data on 1,830 greenfield investment projects from the fDi Markets database. Results indicate that simple one-level nesting structures ignoring supranational borders are not consistent with MNEs profit maximizing behaviour in a setting that includes countries from different macro-areas. European FUAs are found to compete relatively more with other European rather than with North American ones. On the contrary, North American FUAs similarly compete with FUAs of other North-American countries as European ones. The role of country factors is significant in both North American and most European countries. Models imposing nesting structures that include Australia, Japan and South Korea as an additional macro-area are not consistent with MNEs profit maximization behaviour, suggesting that a larger geographic coverage is needed to accurately characterise the location behaviour in Asia and Oceania. The findings are consistent of a positive scope for policy tools, such as the ERA, promoting an integrated research area in Europe.

The remaining of the paper is divided in other four sections. Section 2 introduces some background literature. Section 3 describes the empirical strategy and in particular the choice of the geographic unit of analysis (i.e. the FUA), the data, the sample and the econometric model. Section 4 presents and discusses findings. Section 5 concludes.

2 Background Literature

The attraction of R&D foreign activities has been the object of considerable research in recent years. This study hinges on at least two streams of literature interrelated literature, the one on the attributes making local areas attractive for K-I FDI and the one on the role of local and national attributes in the location choice of FDI in any business activity along the value chain (i.e. K-I as well as manufacture, marketing, business services and headquarters, just to name those accounting for the largest shares of total FDI). This study bridges these two streams and, in doing so, extend the frontier of existing knowledge in a number of ways.

The literature has recognised that MNEs pay attention to the local features of the specific place within a country they choose as investments location (Beugelsdijk & Mudambi, 2013; Iammarino & McCann, 2013). Previous studies found a number of determinants that make European regions attractive for K-I FDI. Siedschlag et al. (2013) provide evidence for the relevant role of agglomeration economies, proximity to centers of research excellence and the research and innovation capacity of destination regions as well as its human capital endowment. Belderbos et al. (2014) specifically highlight the role of regional academic strength, and point out that a major mechanism through which academic research attracts foreign R&D is the supply of graduates with a PhD. Belderbos and Somers (2015) focus on the role of technological concentration and show that, while the regional technology is an attracting factor, local technological concentration due to the presence of regional technology leaders in the industry of the investment deters K-I FDI. Damioli and Vértesy (2017) show that the fiscal regime and the market size of regions as well as the sharing of a common language in the sending and receiving regions are the most important determinants, while labour costs, technological strength and R&D expenditure, especially performed by the higher education sector, are also important, yet to a lower extent.

Yet, few studies used subnational sites as the basic unit of analysis when examining MNE choice of the location of K-I FDI, while having a global outreach encompassing local areas located in more continents. Belderbos et al. (2016), Castellani and Lavoratori (2018a, 2018b) constitute notable exceptions. They present empirical evidence on the global patterns and trends of MNE K-I investments using cities around the world as the set of alternative destinations. They study "pull" and "push" factors of K-I foreign investments and their colocation along the global value chain. The present study provides complementary evidence by focusing on the importance of local, national, and, additionally, supranational determinants, using a wider set of local destinations that cover a larger share of K-I investments.

As for the second literature stream, existing studies focused on assessing the strength of national effects in FDI location choices. The potential role of supranational boundaries has not been the object of analysis yet, and the focus has not been placed on K-I investments.

Head and Mayer (2004), who studied the location choice of Japanese-owned affiliates in Europe, show that Europe supports a country-region nesting structure, thus indicating a significant role of national borders. Basile et al. (2009) studied the role of national borders in the five largest European countries. They find that MNEs, and especially European ones, perceive Europe as an integrated market where regions (in different countries) compete with each other. They also find an important role of the North (France, Germany and UK) vs. South (Italy and Spain) divide, indicating that European MNEs first decide whether to locate in the North or South of Europe, and subsequently in what region within the North/South nests. They also show that national borders play a significant role in choices made by non-European MNEs, meaning that non-European MNEs first decide in what European country to locate, and subsequently in what region within that country. Complementary and partially contrasting evidence is more recently found in Crescenzi et al. (2016), who focus on the location strategy of emerging countries' MNEs in comparison to European and North American ones using a sample of

FDI directed to European countries. They find that national borders influence the FDI location choice in many European countries, and emerging countries' MNEs attribute less importance to national borders of European countries (especially Germany and the UK and, to a lower extent Belgium, Italy and the Netherlands) than American and European MNEs.

The importance of supra-national regional integration blocs has been studied in relation to inward FDI in general, and not – to our knowledge – from the perspective of location choice of MNEs, nor specifically to K-I FDI. Available evidence shows a beneficial effect of membership in regional economic integration to inward FDI (Ethier, 1998; Kreinin and Plummer, 2008). In the case of NAFTA[3], Feils and Rahman (2008) addressed heterogeneity with respect to the level of development within the integration bloc. They found a positive impact of integration on total inward FDI into the overall region over the 1981-2001 period, which, however, occurred in an unbalanced way, as gains accrued to the US and Canada, but not to Mexico.

In the EU, policy instruments, such as Structural and Cohesion funds allocated by the EU to laggard regions were shown to have contributed to attracting MNEs to invest in these regions (Basile et al, 2008). Yet, there is little evidence on the impact of EU efforts aimed at strengthening research and innovation capacities on location choices for knowledge-intensive investments. It is noteworthy in this respect that some observers argue that the efforts are ineffective in creating an integrated European innovation system. For instance, Chessa et al. (2013) and Morescalchi et al. (2015) provide evidence that European Member States experienced a degree of integration in patenting and publication that is comparable across the initial decade of the 2000s to the degree of integration observed for non-European countries (the US and Japan, in particular), arguing that "Europe remains a collection of national innovation systems" (Chessa et al. 2013, p. 650).

[3] The Agreement entered into force in 1994, and by the end of 2004, tariffs were eliminated on 99% of internally traded goods, and FDI policy was liberalized in a way that intra-NAFTA investors treated equally with domestic investors for most manufacturing and a few service sectors. The agreement also established dispute settlement procedures and provisions regarding government procurement, IPR and rules of origin.

3 Empirical Strategy

3.1 The choice of the geographic unit of analysis

The choice of the geographic level of analysis deserves particular attention. The literature reached a consensus on the fact that many characteristics of local destination areas play a crucial role in MNEs location choices, and large geographical units (i.e. nation-states) are often too coarse to provide an accurate picture. Previous works on the location of K-I foreign investments selected the geographic unit of analysis according to political/administrative or functional criteria. Several studies on Europe used regional administrative borders, such as Siedschlag et al. (2013), Belderbos et al. (2014), Belderbos and Somers (2015) and Damioli and Vértesy (2017). Yet, one disadvantage in the use of administrative borders, which has been typically prompted by reasons related to data availability, is that they are likely to not be able to accurately capture global and local economic activities and interactions. In the words of Belderbos and Somers (2015, p.1817) "a future challenge for research clearly is to work with 'economic areas' in Europe based on actual agglomeration and commuting patterns." Belderbos et al. (2016), in the vain of the functional tradition in urban studies (e.g. Friedman 1986, Sassen 2001, Goerzen at al. 2013), used global cities, i.e. major metropolitan areas characterized by a high degree of interconnectedness to local and global markets, a cosmopolitan cultural environment, and a strong concentration of multinational activity.

The present study adopts the Functional Urban Area as the basic geographical unit of analysis. In order to increase the scope of the international comparability of social and economic performances, the European Commission (Eurostat and DG REGIO) and the OECD developed a common definition of metropolitan areas (OECD, 2012 and 2013). The issue of comparability of metropolitan areas hinges on a series of factors spanning the criteria (administrative boundaries, continuity of the built-up area or functional measures such as commuting rates) to choose the basic geographic unit of analysis and their aggregation, the availability of demographic and socio-economic data and the degree of international comparability of the different parameters. FUAs are "functional economic units" based on density and commuting patterns of the smallest administrative units for which national commuting data are available (LAU2 in Europe and the smallest administrative units for which national commuting data are available in non-European countries, such as counties in the US). These criteria allow overcoming previous limitations linked to administrative criteria.

In more detail, the methodology used to identify the functional urban areas consists of three different sequential steps. First, gridded population data are used to identify urban cores, i.e. high-density clusters of contiguous grid cells and filled gaps. Second, non-contiguous urban cores are considered an integrated (polycentric) one if more than 15% of the residence population of any of the cores commutes to work in the other core. This recognizes the existence of polycentric urban areas, i.e. those that are physically separated, but economically integrated. Third, an urban hinterland is associated to every urban core. Urban hinterlands aim at capturing the worker catchment area of the urban core labour market, and are defined as all municipalities with at least 15% of their employed residents working in the urban core.

For the purpose of this paper, we geo-locate the destination area of K-I greenfield investments and identify if they lie outside or inside 277 FUAs with 500,000 or more inhabitants spanning 28 countries in four continents. **Table 1** and the map in **Figure 2** show the share of K-I FDI falling within FUAs by country and macro-area. Overall, destination areas located within FUAs account for 72.4% of all K-I recorded between 2009 and 2015, which is the temporal window used for estimation (FDI occurred between 2003 and 2008 as used to build indicators measuring past FDI made by MNEs to FUAs and FUAs agglomeration activities). Some heterogeneity is observed across and within macro-areas. The share of K-I FDI in FUAs is equal to 65.4% in Europe, quite smaller than the 82.6% and 88% share recorded respectively in North America and the Far East. Europe is, moreover, characterised by larger fluctuations between countries in the share

of K-I FDI directed to FUA. For instance, the shares are among the lowest ones in Switzerland (47.1%) and the UK (47.4%), and among the largest ones in France (85.2%) and Poland (92.7%).

The comparatively low European shares and their large cross-country heterogeneity could be arguably attributed to historical factors resulting in a larger presence of high-density economic and knowledge hubs with a relatively small population (smaller than 500,000 inhabitants) in Europe than elsewhere. While the issue would definitely deserve a deeper look, which is beyond the scope of this study and is left for future research, the use of FUAs allows covering a substantial share of K-I FDI in all countries (and nearly their totality in some cases). With respect to a recent attempt to study global patterns and trends of MNE K-I FDI, the 57 global cities studied by Belderbos et al. (2016) cover much lower shares of K-I FDI than those covered in this study, i.e. about 30% between 2008 and 2011 in Europe and North America, 56% in Australia and 63% in Japan (see Belderbos et al. 2016, Table 3 p. 19). All in all, the geographic scope and the coverage unit of analysis are reassuring on the generality of the findings of the analysis.

Table 1 Knowledge-Intensive FDI falling within Functional Urban Areas between 2009 and 2015 by country and macro-area

Area	Number of all K-I FDI	K-I FDI directed to FUA		Area	Number of all K-I FDI	K-I FDI directed to FUA	
		Number	Share			Number	Share
All areas	**2,520**	**1,830**	**72.6%**				
Europe	**1,550**	**1,019**	**65.7%**	**Europe (ctd.)**			
Austria	26	19	73.1%	Slovakia	12	4	33.3%
Belgium	53	28	52.8%	Slovenia	6	5	83.3%
Czech Republic	37	29	78.4%	Spain	119	91	76.5%
Denmark	17	10	58.8%	Sweden	29	26	89.7%
Estonia	16	15	93.7%	Switzerland	17	8	47.1%
Finland	41	27	65.8%	United Kingdom	405	192	47.4%
France	142	121	85.2%				
Germany	243	184	75.7%	**Far East**	**206**	**179**	**86.9%**
Greece	4	3	75.0%	Australia	79	69	87.3%
Hungary	34	24	70.6%	Japan	61	55	90.2%
Ireland	159	87	54.7%	South Korea	66	55	83.3%
Italy	37	28	75.7%				
Netherlands	42	23	54.8%	**North America**	**764**	**632**	**82.7%**
Norway	8	2	25.0%	Canada	156	119	76.3%
Poland	96	89	92.7%	Mexico	81	79	97.5%
Portugal	7	4	57.1%	United States	527	434	82.3%

Source: fDi Markets dataset.

3.2 The econometric model

In line with a large body of empirical literature on the location decisions of MNEs, we model the probability of MNEs choosing a given FUA to locate foreign K-I investments using nested logit regressions (McFadden 1984). Differently than in previous studies that typically considered one-level nesting structure (e.g. regions within countries such as in Basile et al. 2009 and Crescenzi et al. 2016), in this study, we estimate nested logit models, where 277 elemental choices (FUAs) are grouped into 28 countries (first-level nests) in different macro-areas (second-level nests). The selection process is conceived as involving the three simultaneous choices of the macro-area, the country in the chosen macro-area, and the FUA in the chosen country. Although simultaneous, these decisions are based on a heterogeneous set of characteristics because, given their likely dissimilar macro-area and national characteristics (from the degree of macro-area integration to

country-specific institutional conditions), FUAs in different countries and macro-areas cannot be ex-ante considered perfect substitutes.

In the nested logit model, the probability of a FUA being chosen as the destination of a K-I FDI is modelled as a function of FUA specific characteristics. In our setting, in line with previous work, macro-area and country-level observable and unobservable characteristics (such as the business climate, institutional conditions and infrastructural networks) are controlled for by the supranational and national 'nested' model structure. While, the degree of supranational- and national-level heterogeneity that can be captured with worldwide comparable quantitative indicators is limited, macro-area and national differences can be captured by treating them as unobservable factors, conceptually equivalent to 'macro-area' and 'country' fixed effects in location choices (Crescenzi et al. 2016), common to all the FUAs belonging to the same country and to all countries belonging to the same macro-area.

The key quantities of interest of this study are the inclusive value parameters (IVs) that, building on the methodological approach adopted by Basile et al. (2009), we use in order to assess the degree of substitution between and within nests. IVs reflect the degree of dissimilarity among location alternatives within a nest, with lower IVs indicating more similarity or, in other words, closer substitution (Train 2003). Specifically, IVs in the 0–1 interval imply that MNEs consider FUAs within the same nests (countries or macro-areas) as closer substitutes than alternative FUAs outside the nest. IVs equal to 1 indicate, by contrast, that MNEs consider FUAs within the same nests as attractive as outside-the-nest FUAs, and imply that the nested logit collapses into the conditional logit model. IVs greater than 1 indicate that FUAs are more similar across than within nests, and the model nesting structure is not coherent with MNEs rational behaviour, i.e. profit maximization (Herriges and Kling 1997, Train 2003). Furthermore, as shown in a Monte Carlo experiment by Herriges and Kling (1997), IVs greater than 1 imply also a significant bias in the coefficients estimated for the location determinants.

3.3 The data

The present study draws on data on cross-country K-I investments from the fDi Markets database maintained by fDi Intelligence, a division of the Financial Times Ltd, complemented with data on a broad variety of potential drivers of R&D location decisions from various data sources.

The fDi Markets database is an ongoing collection of information on the announcements of corporate cross-border greenfield investment projects covering all countries worldwide from 2003 to date, by relying on company data and media sources. Projects relate to either investments in a new physical project or expansions of an existing investment that create new jobs and increase invested capital. Mergers and acquisitions (M&A), privatization and alliances are not included in the data, while joint ventures are included when they lead to a new physical operation. In practical terms, a company has to be establishing or expanding a manufacturing plant, service or logistics function, extraction operation or building a new physical construction to be included as an FDI project in the fDi Markets data. The database contains information on the investing firms, the source and destination cities and countries, investment activities (R&D, design development and testing, manufacturing, distribution, retail and sales and marketing and others), investment industries, the date of announcement, the invested capital and the number of directly created jobs. The database is widely used in academic research to study the FDI location behaviour of MNE (e.g., Belderbos et al. 2014 and 2016, Belderbos and Somers 2015, Crescenzi et al. 2013 and 2016, Castellani et al., 2013; Castellani and Lavoratori 2018a and 2018b).

In line with previous research, the analysis makes only use of information on the number of FDI. It disregards, on the contrary, information on associated capital amounts and direct jobs. The number of investments is a more appropriate unit of analysis than their

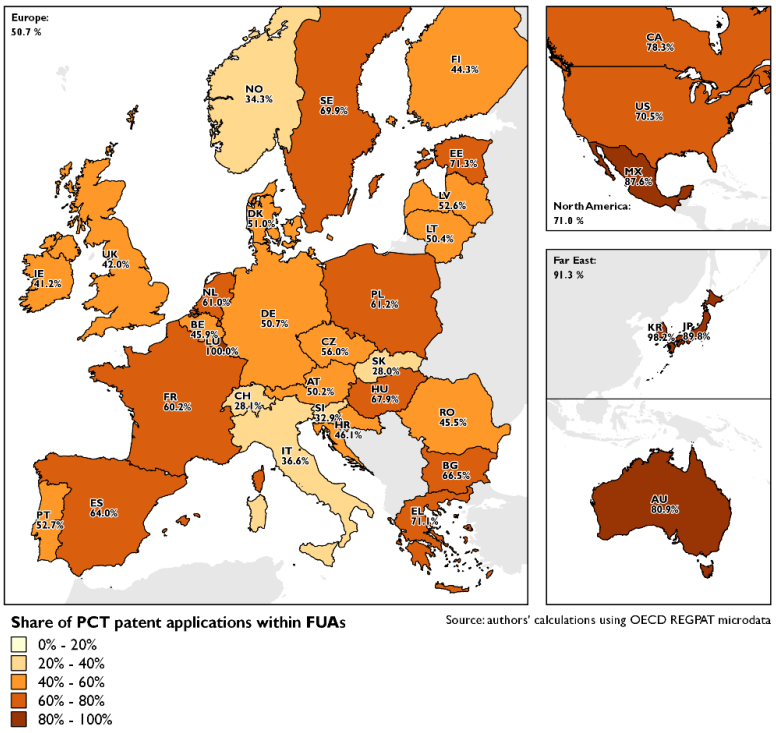
value when looking at MNE location strategies since the choice of a specific location is largely independent from the amount of capital invested (Sutherland and Anderson 2014, Crescenzi et al. 2016). Moreover, values vary largely across industries, with resource-intensive sectors having on average larger values than consumer goods and services sectors. From a practical point of view, moreover, investment values are imputed in a large number of cases, in particular in more than 50% of FDI in our estimation sample. Moreover, the last two years of the database are excluded from the analysis to allow an accurate identification of FDI that did actually occur. In fact, while data entries refer to FDI announcements, the database is regularly updated using post-announcements information to ensure that announced FDI did truly take place.

Project-level data are combined with information on potential determinants of local attractiveness at the FUA-level that we assembled from a variety of sources and we use as explanatory variables. For this study, we build on the established practice in the literature for selecting variables that were found relevant to explain MNEs' location choices (Siedschlag et al, 2013, Belderbos et al. 2014 and 2016, Belderbos and Somers 2015, Crescenzi et al. 2013 and 2016, Castellani et al., 2013; Castellani and Lavoratori 2018a and 2018b), but compiled a broader dataset at the FUA level. This involved geo-coding and allocating data such as university performance, patent applications or airports to FUA in the EU and OECD countries (**Table 2** provides a list of the variables and data used; see also **Figure 4-7** in the Appendix for a graphical overview of the distribution of selected variables across FUAs by country).

The model includes the number of industry-specific patent applications in every FUA from the OECD Patstat database, in order to capture the local technological strength that we expect to be the primary source of codified knowledge MNEs could expect to benefit from. As an additional form of codified knowledge, the model also includes the number of publications associated to universities in the 2017 Leiden Ranking.

Scientific, technological and creative activities have historically been concentrated in urban centers. For instance, one in two PCT patent applications in Europe between 2000 and 2015 were filed in FUAs with half a million inhabitants or more according to OECD data. The concentration over the period is even higher in North America (71%) and in many Far Eastern countries (i.e, 90% in Japan). Europe is rather heterogeneous: the share ranges from 28-37% in Slovakia, Switzerland, Slovenia, Norway and Italy, to 67-71% in Bulgaria, Hungary, Sweden, Greece and Estonia (see Figure 1). The relatively lower share of Europe is due to the specific, dispersed settlement patterns. Lowering the threshold to include FUAs with population below half a million would significantly increase the concentration rates for Europe while much less for other OECD countries.

Figure 1 Share of PCT Patent applications inside FUAs with 500,000 inhabitants or more (2000-15)



Various measures of agglomeration are then constructed in order to capture the tendency of foreign investment to 'cluster' in a limited set of locations. In particular, foreign investments recorded in the fDi Markets dataset between 2003 and 2008, that is before the estimation period, are used to construct four measures of agglomeration: the cumulated number of K-I FDI a FUA received in the same industry, the cumulated number of non-K-I FDI a FUA received in the same industry, the cumulated number of K-I FDI a FUA received in a different industry, and the cumulated number of non-K-I FDI a FUA received in a different industry. Pre-sample information from fDi Markets data is also used to capture the effect of the firm having already made a K-I investment in the FUA in the past.

The model also includes: a measure of FUAs connectedness, namely the number of air traffic passengers, gathered from Eurostat as well as various National Statistical Offices and Ministries of Transport; a measure of corporate taxation from the OECD Tax Database augmented with various national sources at the FUA-level in Canada, Germany, Switzerland and the United States; a measure of cultural proximity through language similarity between the MNE headquarters and FUAs (that in addition to official languages at the national level exploit within-nations variation in language in Belgium, Canada, Finland, Luxembourg and Switzerland); and standard control variables such as the (geodesic) distance between the (central points of) of MNEs city headquarters and FUAs in order to account for the geographical closeness between the origin and destination cities; per-capita GDP and unemployment rate, in order to respectively account for market size and the excess of labour supply over demand, both available at the FUA-level in the OECD Metropolitan Database. The lack of data about high education, labour costs and R&D tax incentives in a large number of FUAs precludes a direct control of the differential across FUAs, though a large part of these differences is represented by national differences and therefore accounted in the model by country-level nests.

All explanatory variables enter the model with a one-year lag in order to reduce the impact of simultaneity between the investment decisions and local economic conditions.

Besides, with the exception of the dichotomous dummy variables indicating if the FUA received in the past a K-I FDI from the investing MNE and if the FUA shares a common language with the MNE headquarters city, they enter the regression model after having been transformed using the inverse hyperbolic sine transformation, which is defined for any real value as $\log(x + (x^2 + 1)^{1/2})$. This transformation can be interpreted as a logarithmic transformation and has the advantage of allowing the transformed variables to assume values zero (Burbidge et al. 1988, Pence 2006).

Table 2 Variables and data sources used

Variable	**Sources**
Industry-specific PCT patent applications in previous 3 years	OECD PATSTAT microdata, 2017 ed.
Publications in top1000 universities	CWTS Leiden Ranking 2016 (geo-coded using ETER and US Dept. of Education data)
Agglomeration in K-I activities, same industry	Financial Times, fDi Markets
Agglomeration in K-I activities, other industry	Financial Times, fDi Markets
Agglomeration in non-K-I activities, same industry	Financial Times, fDi Markets
Agglomeration in non-K-I activities, other industry	Financial Times, fDi Markets
MNE previous K-I FDI	Financial Times, fDi Markets
Air passengers (connectedness)	Eurostat & national sources
Local corporate tax rate	OECD Tax Database & national sources
Unemployment rate	OECD Metropolitan Database
Per-capita GDP	OECD Metropolitan Database
Distance (geographical/cultural proximity)	CEPII / Authors' compilation
Same language as in MNE HQ: English	CEPII / Authors' compilation

Source: Authors' compilation

4 Results

In this section we assess whether national and supranational boundaries matter for MNEs location behaviour, that is, whether foreign investors consider FUAs within national and supranational borders closer substitutes than FUAs across borders. We answer this question by estimating nested logit models with different two-levels nesting structures and by looking at the estimated IV parameters, which indicate the degree of substitution between FUAs within and across nests.

The choice of the nesting structure to be imposed to the model is of crucial importance in this strategy. First, it must be clear that the purpose of this study is not to identify the best nesting structure among available alternatives. This would be a generally difficult task (Poirier 1996, Louviere et al. 2000, Hensher et al. 2005), and practically unfeasible in the current setting given the explosive number of potential alternatives (Verlinda 2005). Even more importantly, the best nesting structure is likely to combine multiple dimensions, and would be better identified by using mixed logit models, which are the most appropriate way to account for complex correlations among alternatives (for instance, overlapping nests). Nested logit models, by contrast, allow testing the coherence of meaningful but simple nesting structures, based on one dimension that is deemed of particular interest. In a follow-up of the study, we plan to extend the analysis by estimating mixed logit models on the same dataset and test what factors jointly contribute to explain substitution patterns among FUAs.

In the context of the present study, it is rather of particular relevance to consider meaningful aggregations of countries that could be thought to be characterized by a higher degree of internal similarity. In this respect, the geographical proximity of countries could be the first candidate nesting structure to be imposed model. We therefore group countries in our sample in three supranational blocs, namely Europe, North America and the Far East including Australia, Japan and South Korea. We expect these blocs to be characterized by a different degree of internal integration. European countries belong to the ERA, which is a rather unique attempt of creating a supranational integrated research space spanning several countries. Both European and North American countries are members of free trade agreements, the European Free Trade Area (EFTA) and the North American Free Trade Agreement (NAFTA) respectively, which provide broadly comparable provisions regarding among others the elimination of tariffs, FDI liberalization, IPR, dispute settlement, government procurement and rules of origin. Multi-country trade agreements, such as the EU, NAFTA, MERCOSUR and ASEAN, are typically thought to offer location-specific advantages to countries competing for FDI, even if countries may not benefit from it to the same degree (Ethier 1998, Kreinin and Plummer 2008).

Australia, Japan and South Korea, by contrast, are not part of any comparable supranational integration area. Free trade agreements came into force only on a bilateral basis and towards the end of the estimation period: the one between Australia and South Korea from 2014, the one between Australia and Japan from 2015, while negotiations about a possible free trade agreement between Japan and South Korea are still ongoing. Moreover, while the interdependence of East Asian countries in trade, direct investment and financial flows is increasing in recent years, formal institutions remain relatively underdeveloped due to low levels of political and cultural similarity (Capannelli et al. 2010). Besides, integration in East Asia mostly concerns the Association of South-East Asian Nations (ASEAN) countries, which exclude the countries available in our sample.

These considerations provide some concerns in considering Australia, Japan and South Korea being representative of any meaningful supranational bloc. In view of these concerns, we adopt two different nesting structures, one excluding and another one including the countries in the Far East. **Table 3** reports IVs parameters and associated robust standard errors clustered by MNEs for four nested logit models, which vary depending on the inclusion of supranational nests to the more customary country-level

ones, and on the inclusion or exclusion of K-I FDI directed to Australia, Japan and South Korea.

The most striking result is that, out of the four different nesting structures, only one is consistent with rational behaviour of MNEs. In fact, all IVs are not significantly higher than one only when considering supranational borders in addition to country-level ones and when excluding Far East countries. In the other nesting structures, IVs associated with Czech Republic and Poland are larger than one, indicating that FUAs in these countries are perceived by MNE as closer substitutes with FUAs in other countries than with FUAs different countries. IVs larger than one with analogous implications are found for the IVs associated with Mexico and the UK in the two models with nesting structures ignoring supranational borders. The key implication is that simple one-level nesting structures ignoring supranational borders is not consistent with MNEs profit maximizing behavior in a setting that includes countries from different macro-areas. In other words, either it has to be assumed that MNEs do not choose locations for their K-I foreign investments in line with a process of maximization of expected profits, or it has to be concluded that simple FUAs-countries nesting structures does not depict MNE location choice worldwide. Moreover, the inclusion of Far East countries is not supported by the data, most likely because we have an insufficient number of countries to populate a largely fragmented macro-area.

The multi-levels nesting structure allowing for supranational European and North American nests is, by contrast, consistent with MNEs rational behaviour, since all IVs are statistically equal to or smaller than one. More precisely, they are smaller than one in the case of the European macro-area, and in the large majority of countries, and, conversely, equal to one in the case of the North American macro-area, Czech Republic and Poland. The lack of a macro-area role encompassing North-American countries is compatible with previous evidence on the role of NAFTA on inward FDI evidence, which has been shown to have a positive impact of NAFTA into the region yet in an imbalanced way, as gains accrued to Canada and the United Sates, but not to Mexico (Feils and Rahman 2008). The results imply that both national and supranational borders play a significant role in the attraction of K-I FDI in Europe, while only national factors are considered important by MNEs in North America. This is a signal of a larger integration in research in Europe than in North America, as European FUAs compete more between each other than with those outside Europe, while North American ones compete similarly with FUAs within and outside North America, once national effects are taken into account.

Table 3 Inclusive value parameters of nested logit models

	Europe and North America				Europe, North America and Far East			
	Only countries		Countries and macro-areas		Only countries		Countries and macro-areas	
Macro-areas								
Europe	-	-	0.723***	(0.073)	-	-	0.880*	(0.061)
North America	-	-	0.937	(0.133)	-	-	1.137	(0.131)
Far East	-	-	-	-	-	-	0.839	(0.138)
Countries								
Austria	0.804	(0.164)	0.601***	(0.136)	0.814	(0.170)	0.737	(0.164)
Belgium	0.763	(0.144)	0.595***	(0.118)	0.765*	(0.134)	0.699**	(0.127)
Switzerland	0.396***	(0.078)	0.291***	(0.062)	0.388***	(0.077)	0.343***	(0.072)
Czech Republic	1.717***	(0.267)	1.291	(0.219)	1.829***	(0.260)	1.659***	(0.246)
France	1.009	(0.071)	0.764***	(0.082)	1.006	(0.068)	0.906	(0.077)
Germany	1.037	(0.046)	0.772***	(0.077)	1.050	(0.043)	0.941	(0.068)
Italy	0.745**	(0.101)	0.573***	(0.090)	0.728***	(0.099)	0.662***	(0.098)
Netherlands	0.786*	(0.125)	0.587***	(0.104)	0.805	(0.126)	0.722**	(0.119)
Poland	1.472***	(0.091)	1.097	(0.123)	1.493***	(0.089)	1.340***	(0.113)
Portugal	0.590*	(0.245)	0.478***	(0.202)	0.594*	(0.233)	0.556**	(0.220)
Spain	1.076	(0.087)	0.830*	(0.091)	1.036	(0.086)	0.940	(0.010)
Sweden	0.910	(0.139)	0.671***	(0.116)	0.917	(0.135)	0.818	(0.126)
United Kingdom	1.143***	(0.053)	0.861*	(0.085)	1.127**	(0.051)	1.015	(0.074)
Canada	1.034	(0.073)	0.591***	(0.093)	1.033	(0.070)	0.760**	(0.118)
Mexico	1.264**	(0.110)	0.740*	(0.146)	1.368***	(0.093)	1.049	(0.183)
United States	1.047	(0.041)	0.746***	(0.085)	1.023	(0.037)	0.899	(0.074)
Australia	-	-	-	-	1.144	(0.105)	0.989	(0.126)
Japan	-	-	-	-	0.615***	(0.062)	0.532***	(0.068)
South Korea	-	-	-	-	0.710***	(0.095)	0.613***	(0.091)
Log-likelihood	-7,283.803		-7,276.877		-8,248.124		-8,244.947	
FUAs	225		225		277		277	
FDIs	1,649		1,649		1,830		1,830	
Observations	327,437		327,437		452,648		452,648	

Robust standard errors clustered by MNE in parentheses. The symbol (*) denotes confidence levels for the hypothesis that *IV* parameters are equal to 1: * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. The inclusive values of Denmark, Estonia, Finland, Greece, Hungary, Ireland, Norway, Slovenia and Slovakia constrained to be equal to one as they are degenerate nests (i.e. they contain only one FUA).

Table 4 reports the full set of coefficients on location determinants of K-I FDI. We just report estimates of the nested logit model with nesting structure allowing for European and North American nests as nesting structures with IVs larger than 1 have been shown to lead to significant bias in the coefficients estimated for the location determinants (Herriges and Kling 1997). When interpreting the results, the focus is mainly on the sign and significance of the coefficients, rather than on the size of specific point estimates, and the estimated effects should not be interpreted in terms of causal relationships.

The estimated effects are typically statistically significant, and show the expected sign being aligned with previous studies on location determinants of K-I FDI (Siedschlag et al. 2013, Belderbos et al. 2014, Belderbos and Somers 2015, Belederbos et al. 2016 and Damioli and Vértesy 2017). Industry-specific patents and top-level publications

significantly increase the probability of a FUA to receive a K-I FDI, indicating the attracting role of codified knowledge. FDI agglomerations also play an important role, indicating the tendency of MNE to 'cluster' in a limited set of locations as to benefit from tacit knowledge as well as the potential role of imitation strategies aimed at reducing uncertainty. In addition to previous evidence, our results indicate the concomitant positive attraction effects of FDI agglomerations in the same and different business functions and industries. In particular, the results suggest a stronger role of previous K-I FDI in the same industry (as the one object of the investment), while the effects of previous K-I FDI in different industries and those of previous non-K-I FDI in the same industry are also positive and significant but to a reduced extent. The effect of previous non-K-I FDI in different industries is lower and at the edge of significance at standard confidence levels. The FUA having received one or more K-I FDI in the past from the investing company significantly increases the reception likelihood, indicating strong path-dependence in locational choice leading to co-location of activities within the same business function. The number of air passengers also significantly increases the probability of a FUA receiving K-I FDI, indicating the importance of global connectedness. Local corporate tax rates significantly reduce the probability of a FUA receiving K-I FDI in our sample, in line with the findings of several previous studies (e.g. Belderbos et al. 2016, Damioli and Vértesy 2017) but also in contrast with studies finding negligible effects (e.g. Siedschlag et al. 2013). Unemployment rates show a significantly positive effect, indicating that excess labour supply exerts an attraction effect on MNE. Per-capita GDP is not significant, suggesting that market-seeking is less important motive than knowledge-sourcing in K-I FDI. The distance between the FUA and MNE city HQ has a negative significant effect, yet at the edge of standard confidence levels, while the FUA sharing the language spoken in the city of MNE HQ has a significantly positive impact suggesting a stronger importance of cultural rather than geographical proximity. In addition to previous evidence, our results indicate that the FUA sharing the language spoken in the city of MNE HQ has a significantly positive effect only in the case of languages other than English, which suggest that MNE value languages facilitating cross-border communication on top of English, whose knowledge is given for granted at the corporate level.

Table 4 Determinants of K-I FDI location - nested logit model with countries as well as European and North American macro-area nests

	Coefficients	**Standard errors**
Patents in previous 3 years	0.265***	(0.034)
Publications in top1000 universities	0.024*	(0.013)
Agglomeration in K-I activities, same industry	0.234***	(0.047)
Agglomeration in K-I activities, other industry	0.120***	(0.030)
Agglomeration in non-K-I activities, same industry	0.116***	(0.030)
Agglomeration in non-K-I activities, other industry	0.038*	(0.020)
MNE previous K-I FDI	1.491***	(0.189)
Air passengers	0.047***	(0.016)
Local corporate tax rate	-0.663***	(0.134)
Unemployment rate	0.240***	(0.081)
Per-capita GDP	0.178	(0.131)
Distance	-0.081*	(0.044)
Same language as in MNE HQ: English	-0.006	(0.083)
Same language as in MNE HQ: French	0.753***	(0.196)
Same language as in MNE HQ: German	0.483***	(0.169)
Same language as in MNE HQ: other	1.080***	(0.256)

Robust standard errors clustered by MNE in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. To all explanatory variables – with the exception of the dummy variables measuring if the MNE made a previous investment in the FUA and if the FUA shares the same language as in MNE HQ – it is applied the inverse hyperbolic sine transformation.

5 Conclusions

This study deals in a novel way with the role of local, national and supranational factors in the MNE location choice of K-I FDI. By exploiting FUAs, worldwide comparable geographic local units developed by the EU and the OECD that combine demographic and economic criteria to identify cities and their agglomerations, it extends the geographical coverage of previous studies on location determinants of K-I FDIs to include countries in four different continents. This allows us to assess the role of supranational blocs, which has not been the object of previous research. We estimate nested logit models with different two-level nesting structures where 277 elemental choices (FUAs) are grouped into 28 countries (first-level nests) in different macro-areas (second-level nests) to analyse whether MNEs consider FUAs within the same countries and macro-areas closer substitutes than those located in other countries and supranational macro-areas.

The findings indicate that simple one-level nesting structures ignoring supranational borders are not consistent with MNEs profit maximizing behaviour in a setting that includes countries from different macro-areas. Both national and supranational borders play an important role in addition to local factors in Europe, while only national borders matter in North America. In other words, European FUAs are found to compete relatively more with other European rather than with North American ones. By contrast, a North American FUA competes similarly with FUAs in other North-American countries as with FUAs in European countries. Models imposing nesting structures that include Australia, Japan and South Korea as an additional macro-area are, by contrast, not consistent with MNEs profit maximization behaviour, suggesting that a larger geographic coverage is needed to accurately characterise the location behaviour in Asia and Oceania.

The results have important policy implications in terms of the various overlapping levels of governance in the promotion and support of territories as destination of MNEs knowledge-related investments. On the one hand, in the presence of national and supranational effects, as in Europe, policies that enhance the appeal of FUAs belonging to the same country and macro-area, also enhance the appeal of those whose characteristics are not directly affected by the policy. On the other hand, only national policies are effective in promoting FDI attractiveness in North America. The findings are at contrast with previous research based on innovations outcomes (patents and publications) that indicated that Europe has a similar degree of integration to non-European countries (Chessa et al. 2013, Morescalchi et al. 2015). It individuates a clear scope for policy instruments, such as the European Research Area or Innovation Union, aimed at promoting an integrated research and innovation area by boosting the free movement of scientific knowledge, technology and researchers.

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List of abbreviations and definitions

ASEAN	Association of South-East Asian Nations
CEPII	Centre d'Études Prospectives et d'Informations Internationales
DG	Directorate General
DDT	Design, development and testing
EFTA	European Free Trade Area
ERA	European Research Area
EU	European Union
FDI	Foreign Direct Investment
FUA	Functional urban area
IV	Inclusive value
JRC	Joint Research Centre
K-I	Knowledge-intensive
LAU	Local Administrative Units
MNE	Multinational Enterprise
NAFTA	North American Free Trade Area
OECD	Organization for Economic Cooperation and Development
PCT	Patent Cooperation Treaty
PPP	Purchasing Power Parity
R&D	Research and development

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Table 5 Determinants of K-I FDI location – all nested logit models

	Europe and North America		Europe, North America and Far East	
	Only countries	**Countries & macro-areas**	**Only countries**	**Countries & macro-areas**
Patents in previous 3 years	0.356*** (0.032)	0.265*** (0.034)	0.342*** (0.028)	0.303*** (0.033)
Publications in top1000 universities	0.040** (0.017)	0.024* (0.013)	0.051*** (0.017)	0.041*** (0.016)
Agglomeration in K-I activities, same industry	0.346*** (0.055)	0.234*** (0.047)	0.346*** (0.048)	0.293*** (0.051)
Agglomeration in K-I activities, other industry	0.173*** (0.036)	0.120*** (0.030)	0.144*** (0.033)	0.123*** (0.031)
Agglomeration in non-K-I activities, same industry	0.159*** (0.039)	0.116*** (0.030)	0.131*** (0.037)	0.116*** (0.033)
Agglomeration in non-K-I activities, other industry	0.050* (0.028)	0.038* (0.020)	0.055** (0.026)	0.049** (0.023)
MNE previous K-I FDI	2.029*** (0.169)	1.491*** (0.189)	1.864*** (0.158)	1.654*** (0.187)
Air passengers	0.071*** (0.022)	0.047*** (0.016)	0.068*** (0.021)	0.056*** (0.018)
Local corporate tax rate	-0.768*** (0.179)	-0.663*** (0.134)	-0.759*** (0.159)	-0.721*** (0.143)
Unemployment rate	0.329*** (0.103)	0.240*** (0.081)	0.471*** (0.085)	0.441*** (0.079)
Per-capita GDP	0.114 (0.190)	0.178 (0.131)	0.331*** (0.125)	0.384*** (0.120)
Distance	-0.114*** (0.039)	-0.081* (0.044)	-0.107*** (0.0345	-0.122*** (0.036)
Same language as in MNE HQ: English	0.041 (0.108)	-0.006 (0.083)	0.182* (0.101)	0.143 (0.091)
Same language as in MNE HQ: French	1.014*** (0.271)	0.753*** (0.196)	0.952*** (0.264)	0.816*** (0.232)
Same language as in MNE HQ: German	0.612*** (0.220)	0.483*** (0.169)	0.606*** (0.220)	0.541*** (0.199)
Same language as in MNE HQ: other	1.424*** (0.305)	1.080*** (0.256)	1.425*** (0.295)	1.276*** (0.292)

Robust standard errors clustered by MNE in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$. To all explanatory variables – with the exception of the dummy variables measuring if the MNE made a previous investment in the FUA and if the FUA shares the same language as in MNE HQ – it is applied the inverse hyperbolic sine transformation.

Figure 2 Share of inward knowledge-intensive FDI projects in a country inside FUAs of 500,000 inhabitants or more (2009-2015)

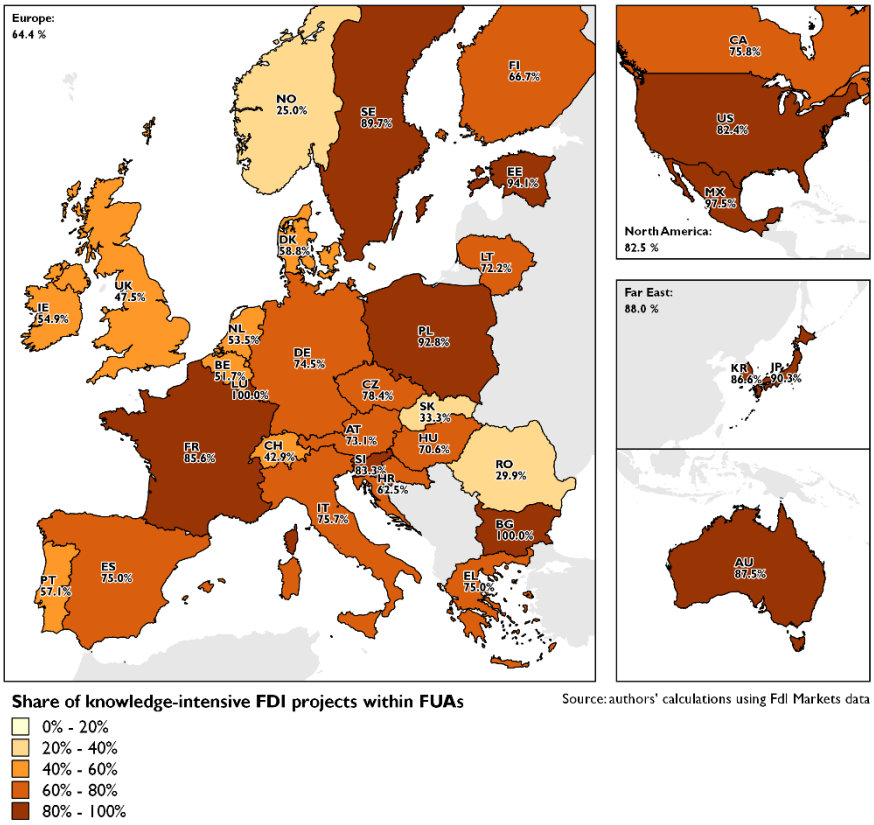
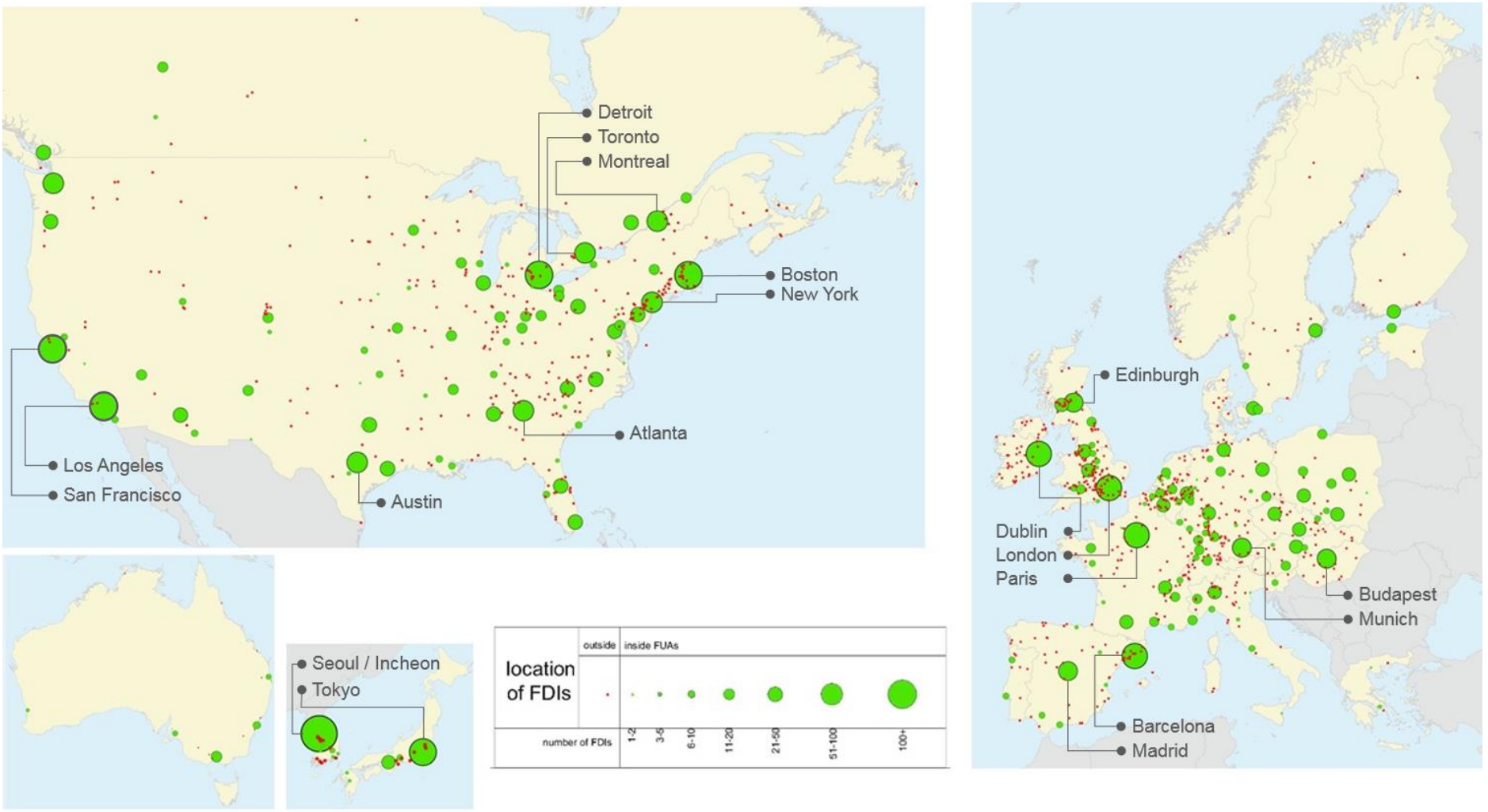
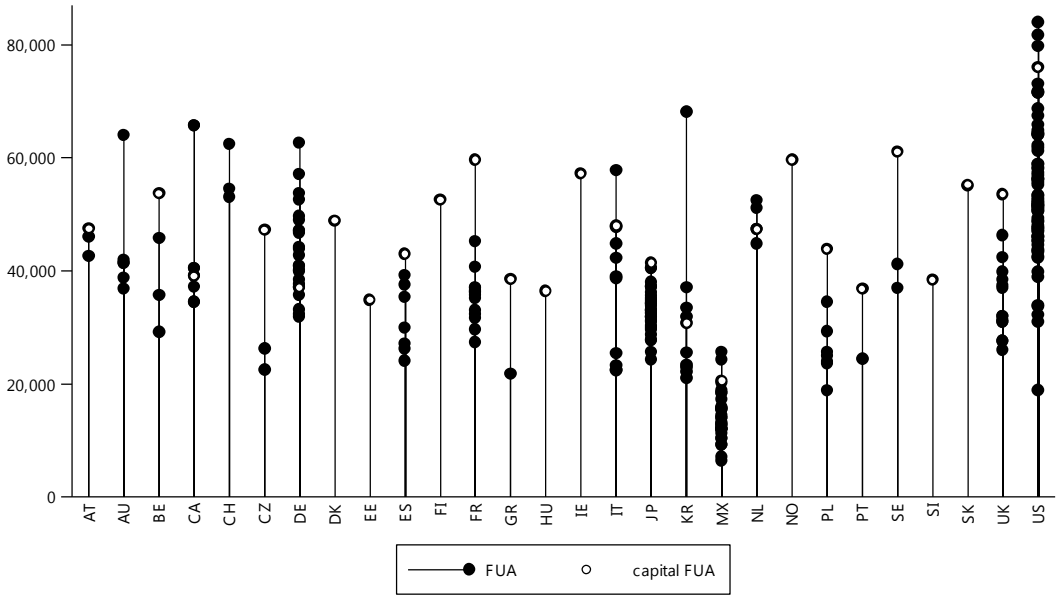


Figure 3 Map of the destination of knowledge-intensive, inward FDI projects between 2003-2015 in Europe, North America, Far East and Australia



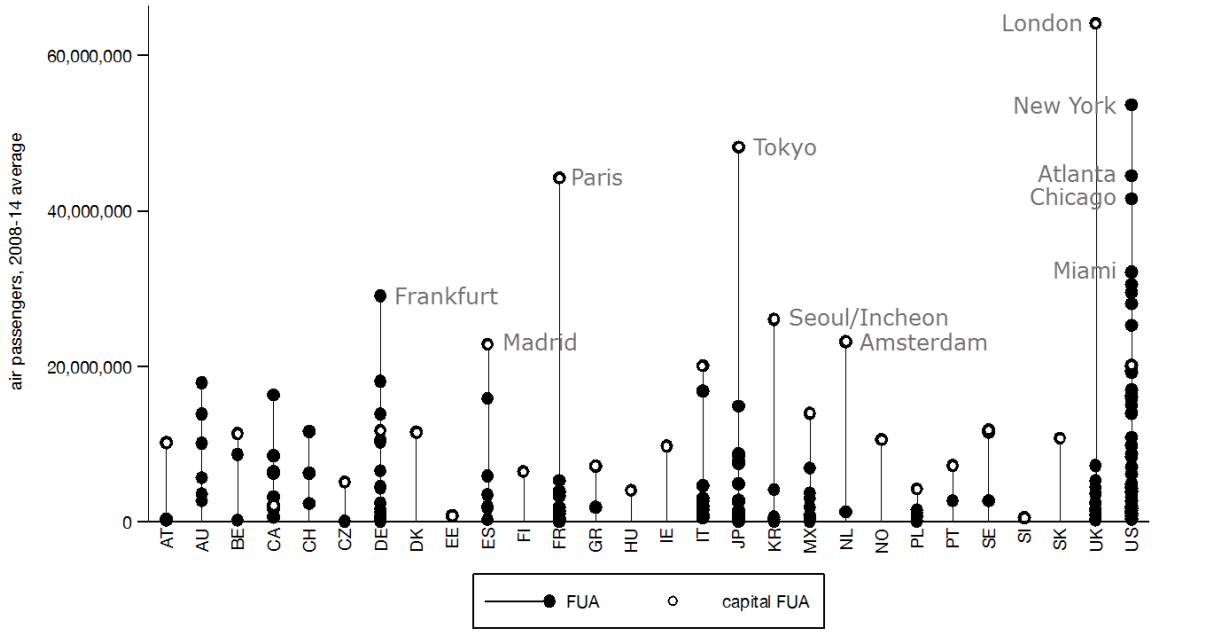
Notes: destinations inside FUAs are indicated with green circles, outside FUAs with red circle; area of circle indicates number of projects.

Figure 4 The distribution of GDP across FUAs, by country (USD PPP, 2008-14 average)



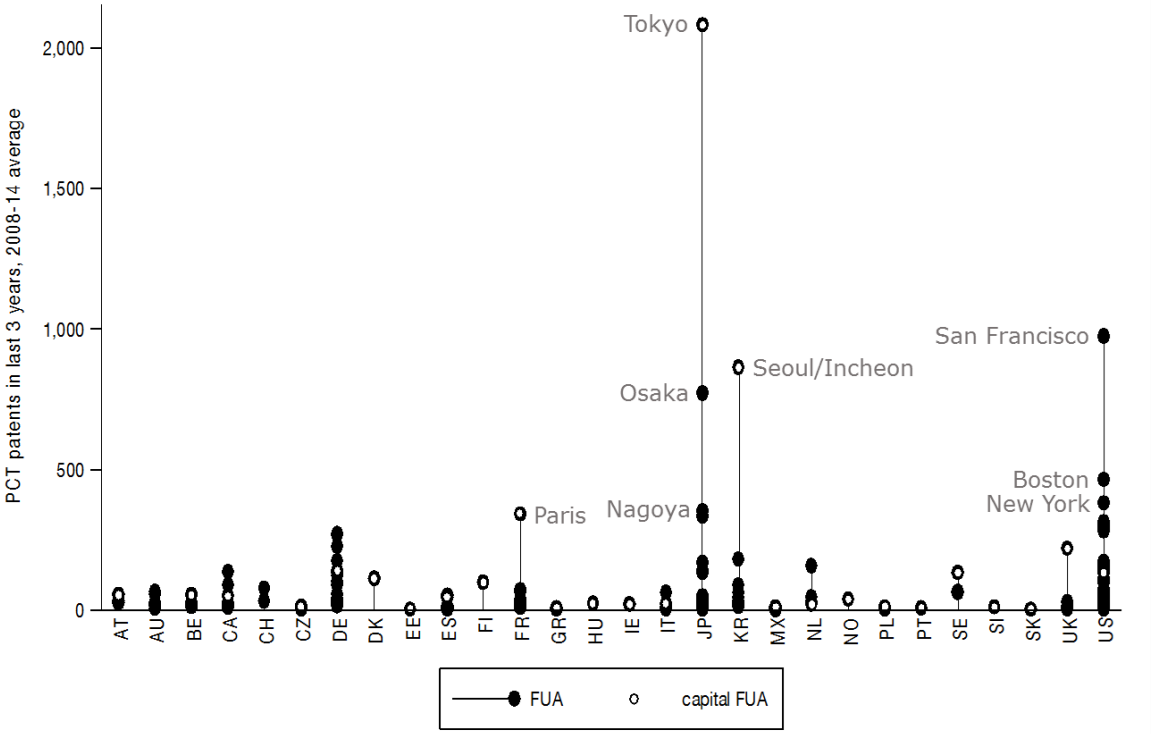
Source: OECD Metropolitan statistics and Eurostat

Figure 5 The distribution of the number of air passenger departures across FUAs, by country (2008-14 average)



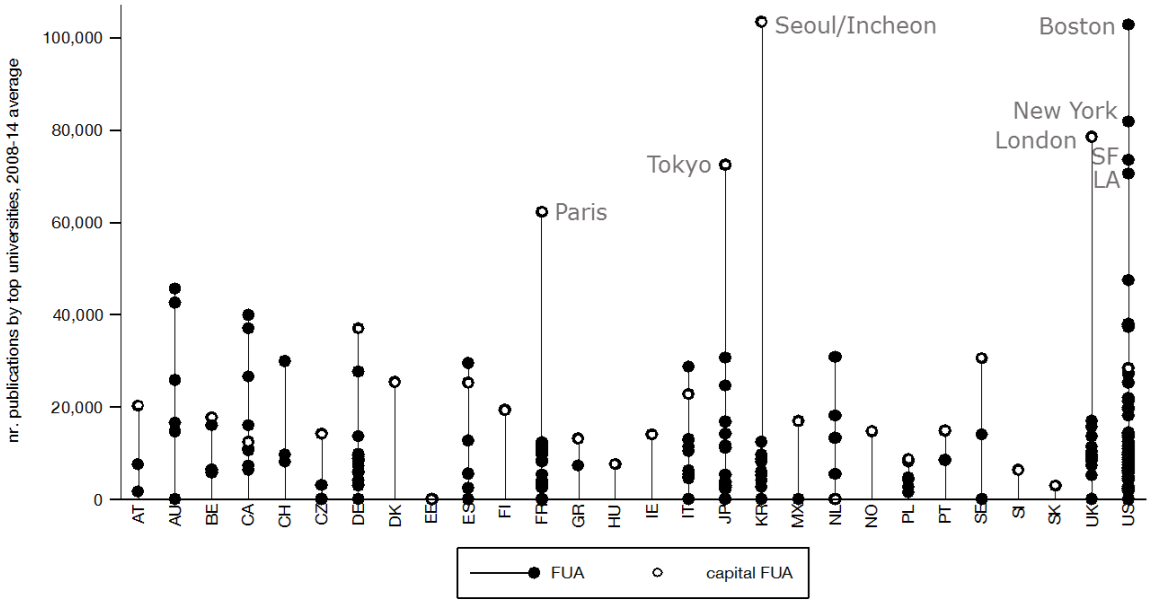
Source: Eurostat and national sources (airports, ministries, national statistical offices)

Figure 6 The distribution of PCT patent applications across FUAs, by country (filings over the past 3 years, 2008-14 average)



Source: Author's elaboration on OECD REGPAT micro-data

Figure 7 The distribution of the number of publications by top-universities across FUAs, by country (2008-14 average)



Source: CWTS Leiden Ranking 2016, authors' calculation

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