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The seductive power of Irish rain

Location determinants of foreign R&D investments in European regions

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Abstract

Foreign direct investments (FDI) in research and development (R&D) are important catalysts of economic development. Through a diversity of direct and indirect policy measures, governments compete in attracting such investments. Our study investigates the factors that affect the degree of attractiveness of European regions from the perspective of a company investing abroad based on evidence gathered from all the FDI in R&D realized between 2003 and 2014. We use mixed logit models to assess: i) the relative importance of the factors influencing the choice made by multinational firms about where to locate foreign R&D investments to European regions, and ii) how such influences vary according to timing, investments' area of provenience and industry. On average, the fiscal regime and the size of destination regions as well as the sharing of a common language in the sending and receiving regions are the most important determinants. Labor costs, technological strength and R&D expenditure, especially performed by the higher education sector, are also important, yet to a lower extent. The strength of determinants still varies greatly across considered breakdowns.

Keywords: Multinational firms; foreign direct investment; research and development; FDI in R&D; location choice; NUTS2 regions

JEL codes: F230; O320; R39

1 Introduction

Foreign Direct Investments (FDI) contribute to the economic development of recipient areas through technology spillovers, or by fostering human capital formation, and more competitive business environment (OECD 2002). FDI aimed in particular at research and development (R&D) can boost knowledge creation and diffusion. National and local authorities compete in attracting them, and promote the characteristics of their areas that they consider most good-looking to multinational enterprises (MNEs).

We study the mechanisms and factors that influence the choice by MNEs about where to make direct investments in R&D from abroad in European regions. The map presented in Figure 1 provides a graphical illustration of the degree of heterogeneity across European NUTS 2[1] regions in terms of attractiveness of inward FDI in R&D. We observe a concentrated distribution, with the majority (57.4%) of regions not receiving any or at most 1 FDI in R&D over the 12 years between 2003 and 2014, and about one out of seven (14.8%) regions being able to attract 6 or more FDI. Variability is also accentuated across contiguous regions within the same country and sub-country macro-regions, which justifies the focus on a granular level of geographical disaggregation. Regions in larger European countries are very different when it comes to attractiveness of FDI in R&D.

The increasing internalization of R&D activities since the mid-1980s is well documented (Guellec and van Pottelsberghe de la Potterie 2001, Criscuolo et al. 2005, Picci 2010), as well as the shift from home-base exploiting motives for foreign R&D investments – characterized by flows of knowledge and technology from the home R&D center to the foreign subsidiaries – towards home-base augmenting motives to also absorb foreign knowledge in the home R&D center (von Zedtwitz and Gassmann 2002, Cantwell et al. 2004, Todo and Shimizutani 2008, Moncada-Paternó-Castello et al. 2011). In this evolving scenario, recent evidence (Belderbos et al. 2016) suggests that Europe receives more international R&D FDI than America from the rest of the world, besides being the locus of a sizeable number of intra-European ones. Some European countries such as Germany and the United Kingdom, similarly to the United States, have attracted a growing number of investments after the financial crisis.

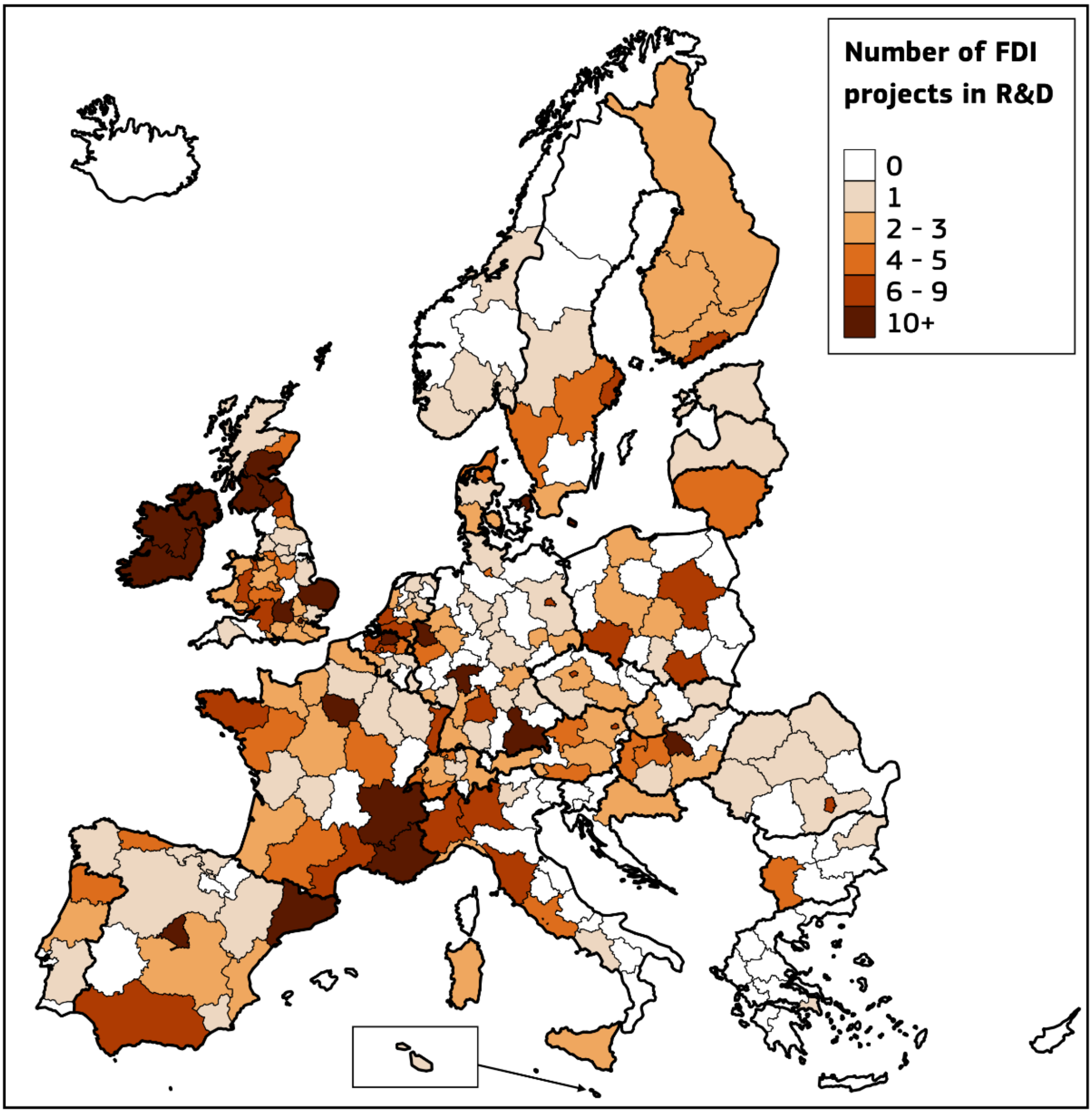
We analyze the impact of the main plausible determinants of location choices, documented by previous literature to be potentially important, and assess their relative importance. We distinguish between investments that took place before and after the crisis, those made by MNEs with headquarters in- and outside Europe, as well as those in the pharmaceutical, computer, electronic-and-optical manufacturing and ICT-services industries, which are the primary target industries for investors. With respect to previous work on location determinants of FDI in R&D in general, and towards Europe in particular, our study enlarges the geographical scope of the analysis, sharpens the level of geographical resolution, exploits the period of observation to assess the change in location determinants possibly occurred after the economic crisis, and differentiates determinants across sectors of economic activity.

Previous studies typically used more geographically aggregated data, considered pre-enlargement countries only, and overlooked potential differences across industries and structural shocks in MNEs behavior potentially occurred after the financial and economic crisis begun at the end of 2007. In particular, Siedschlag et al. (2013) studied determinants of location decisions of R&D activities by MNEs at the NUTS 2 level of geographic disaggregation for a large number (21) of EU countries, yet their analysis focuses on a pre-crisis temporal window and assesses determinants uniformly across industries. Belderbos et al. (2014) and Belderbos and Somers (2015) uses a broader geographical resolution – the NUTS 1 regional level – for FDI in R&D towards pre-enlargement European Union countries (EU15) occurring before the crisis. Since their focus is on the role of specific determinants – namely academic research and technological concentration respectively – they do not assess the heterogeneity of determinants across industries and time. The crisis made a significant impact on global FDI flows causing a steep decline and a slow recovery (see UNCTAD, 2010), warranting more in-

[1] NUTS stands for "the Nomenclature of Territorial Units for Statistics", which is a geographic coding system developed by the EU to reference administrative regions within its countries. Eurostat defines NUTS 2 regions as "basic regions for the application of regional policies". A detailed description of the regions classified as NUTS 2 is available at http://ec.europa.eu/eurostat/web/nuts/overview.

depth analysis. Belderbos et al. (2016) investigate the patterns of global investments in R&D and innovation at the city level between 2002 and 2012 including the role of pull location factors in attracting investments. Yet, the focus on cities implies the exclusion of about 70% of the investments directed to the EU15 and EFTA countries and an even larger amount of those directed towards post-enlargement EU countries (Belderbos at. 2016, Table 3 p. 19). To our knowledge, all other studies including European countries as destinations of FDI in R&D (e.g Falk 2012, Amoroso et al. 2015, Ciriaci et al. 2016) adopt, on the other extreme, a national level of geographic disaggregation, and do not focus on changes across time and industries.

Figure 1 The number of FDI in R&D across European regions, 2003-2014



Source: Financial Times Ltd, fDi Markets database

We use regression techniques in order to study the role of various potential determinants on the location choice of FDI in R&D. In particular, we apply mixed logit models to 855 FDI made by 555 MNEs between 2003 and 2014 directed to 279 NUTS 2 regions belonging to all European Union (EU28) and European Free Trade Association (EFTA) countries. We compare the results of models adopting a baseline specification including regional variables available for all FDI and destination areas and an augmented specification also including a set of institutional variables available at the country level for a relatively large subset of FDI and areas.[2] After having selected the benchmark specification in accordance with model results and statistical tests, we derive from the benchmark model point-estimates the elasticities associated with all potential determinants so as to assess their relative importance. We finally test for the presence of heterogeneous location choice determinants according to the timing, the country of the MNE headquarters and the industry of the investment.

Overall, the results of the analysis indicate that the fiscal regime and the size of destination regions and the sharing of a common language in the sending and receiving regions are the most important determinants. Labor costs, the technological strength and R&D expenditure, especially those performed by the higher education sector, are also important, yet to a lower extent. The strength of determinants typically varies across the various breakdowns. For instance, after the occurrence of the financial crisis, labor costs and unemployment rates cease to be significant deterring factors, R&D tax incentives no longer act as attracting factors, while the strictness of labor market regulation and the restrictiveness of market regulation start being significant deterring factors. More in general, our findings point out that regional governments have some room to create favorable conditions for FDI in R&D in the medium term, yet they also need to take into consideration the specificities of FDI in relation to regional characteristics, as the determinants of MNEs location choices vary over time and space as well as across industries.

The remainder of the study is structured as follows. Section 2 presents the debate on the determinants of inward FDI in R&D, with a focus on evidence regarding Europe as destination area. Section 3 describes the methodological approach and Section 4 the data, sample and model specification adopted in the empirical analysis. Section 5 discusses the results of the study and Section 6 its main conclusions and recommendations.

[2] The sample size in the augmented specification covers 801 FDI, 21 countries and 241 NUTS 2 regions out of out of the 855 FDI, 31 countries and 279 regions in the original sample.

2 The debate on the internationalization of R&D and the determinants of inward FDI in R&D

The economic literature has extensively investigated the internationalization of economic activity at the corporate level. It is well documented that since the inter-war and early post-war years, large companies broadened their technology knowledge by exploiting economies of scale, primarily through exports and subsequently through FDI in production functions (Carlsson 2006 provides a survey of the literature). The internationalization was aimed at the overseas exploitation of the core competence developed at home in foreign markets, and R&D functions were typically excluded or only limited to adapt products to foreign markets.

As economies of scale for production were gradually diminishing and the pace of technological change accelerated, multinational firms began to rely on international networks and invest abroad in order to absorb technology and broaden their competence. They began increasingly to make investments abroad in order to exploit the competence of foreign centers of excellence (Cantwell and Piscitello 2000, Carlsson and Mudambi 2003). Therefore, since the nineties, foreign R&D activities have largely been carried out within corporate networks clustered in certain geographic regions with the purpose of increasing technological competence rather than simply exploiting it abroad, yet typically less science-based than the R&D conducted at home apart than in fields outside companies' core competencies (Cantwell 1997, von Zedtwitz and Gassmann 2002, Criscuolo et al. 2005, Todo and Shimizutani 2008).

While the process of internationalization in R&D activities had traditionally regarded the 'triad' of the United States, Europe and Japan, in terms of booth origin and destination locations, since the mid-1990s an increasingly substantial share has been going to international centers of excellence within Asian markets, and emerging economies such as China and India have themselves increasingly invested in innovation activities abroad (Di Minin et al. 2012, Belderbos et al. 2016). In this evolving scenario, the share of foreign out of total business R&D expenditure has increased substantially in almost all European Union's countries, in reason of both the increasing outsourcing of R&D activities made by European firms and the increase in the flows of inward R&D towards Europe from abroad (Abramovsky et al. 2008, European Commission 2008 and 2012, Siedschlag et al. 2013). Recent evidence indicates that over the period 2003-2011 Europe attracted about one third of the overall technology-intensive foreign investments made by North-American MNEs and about 60% of those made by Asian ones, besides being the locus of a sizeable number of intra-European investments (Belderbos et al. 2016).

This increasing internationalization of R&D activities enhanced the diffusion of a large body of studies on a variety of topics including the role of attracting factors in inward flows (e.g. Shimizutani and Todo 2007) and deterring factors in outward flows (e.g. Lewin et al. 2009), the relationships between investments at home and abroad (e.g Belderbos et al. 2013) as well as between those in R&D and other functions within the value chain (e.g. Alcácer 2006), and the consequences of foreign investments in origin (e.g. Castellani and Pieri 2013) and destination regions (e.g. Liu 2008).

As for the determinants of the location choice of R&D activities (see OECD 2012 for a recent review of existing knowledge on the topics), which is the focus of this study, the purpose of existing R&D internalization - i.e. home-exploiting vs. home-augmenting purposes - has been shown to lead into different choices about the internationalization process including locational ones (Kuemmerle 1999). On the one side, foreign R&D activities are attracted by large and affluent markets since the proximity to them allows companies staying on the frontier of markets' requirements and clients' needs (Kumar 2001, von Zedtwitz and Gassmann 2002). On the other side, foreign R&D activities are attracted by the presence of specific technological strengths and specialization of countries and regions, which geographically cluster in most industries in a small set of regions (Feldman and Florida 1994, Audretsch and Feldman 1996), in order to benefit from agglomeration externalities and improve their innovative performance (Baptista and Swann 1998, Patel and Vega 1999, Shaver and Flyer 2001, Le Bas and Sierra 2002, Beaudry and Breschi 2003, Alcacer and Chung 2007, Baten et al. 2007). Moreover, important determinants for location choices of foreign R&D activities have been shown to be the abundance of skilled labor force (Thursby and Thursby 2006, Lewin et al. 2009), cost factors such as the cost of skilled labor force (Kumar 2001) and fiscal policies (Hall and Van Reenen 2000, Bloom et al. 2002, Mudambi and Mudambi 2005, Buettner and Wamser 2008), framework conditions (Amoroso et al 2015, Ciriaci et al. 2016) and the sharing of a language that can facilitate cross-border communication (Guellec and Van Pottelsberghe 2001, Belderbos et al. 2016). By contrast, geographical proximity has typically been not found to affect location choices of FDI in R&D (Castellani et al. 2013, Belderbos and Somers 2014).

A number of studies specifically dealt with the attraction factors of R&D foreign activities in Europe. Cantwell and Piscitello (2005) provide evidence for the relevant role of spillovers and externalities as prompted by inter- and intra-industry agglomeration of companies and scientific and educational institutions, as well as for the decline in the benefits from intra- and inter-industry spillovers with distance. Siedschlag et al. (2013) study at the NUTS 2 level of geographic disaggregation on the determinants of location decisions of R&D activities into 21 EU countries between 1999 and 2006 confirms the importance of agglomeration economies, the proximity to centers of research excellence and the research and innovation capacity of the region as well as its human capital endowment. They also point out that the role of effects of patents intensity and proximity to centers of research excellence are stronger in the case of investments from North American companies, while the effect of R&D expenditure intensity is significant only in the case of intra-European foreign investments. Some studies on the attraction factors of R&D foreign activities in Europe focused on specific determinants of the location choice process. Specifically, Belderbos et al. (2014) investigate the role of academic research in the R&D location choices using a sample FDI in R&D into pre-enlargement EU NUTS 1 regions between 2003 and 2008. They confirm the importance of region's 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) focused on the role of technological concentration respectively. Using a similar sample to the one of Belderbos et al. (2014), they confirm the attraction role of the strength of the local relevant technology, yet they provide evidence on the deterring role of the concentration of technology activities due to the presence of regional technology leaders in the industry of the investment.

There is a further discussion about macro-regional specificities of FDI and FDI in R&D in particular, addressing whether a "one-size-fits-all" model is valid for Europe given the characteristics of transition economies of the Eastern Member States of the EU (Szent-Ivanyi 2017). As recently articulated by Radosevic (2017), Central Eastern Europe and South East Europe have major structural differences in comparison with North Western Europe. These countries typically exhibit higher levels of public than private R&D, and have focused on the quantity rather than the quality of FDI. While much of the discussion about the need for demand-driven rather than supply-driven R&D in order to meet local needs of technology upgrading focuses on the impact of FDI rather than its determinants, given the active investment promotion activities by governments, it is a relevant debate whether the same factors drive FDI across all of Europe.

3 Methods

The empirical analysis models MNEs choices about where to set up a greenfield R&D activity abroad. In doing so, it makes use of the mixed logit model. The main advantage of this technique is the flexible structure of the error component that allows incorporating as special cases other discrete choice models - namely the conditional and nested logit models - which have been frequently used to study FDI location choices (e.g. Siedschlag et al. 2013). The mixed logit model is increasingly applied to the study of FDI location choices using large datasets (e.g. Chung and Alcacer 2002, Basile et al. 2008, Belderbos et al. 2014) because of both its flexibility in the modeling of the error term and also increase in computer speed, which allows overcoming the computational burden required to estimate parameters of interest.

We can specify the mixed logit model in the same form as a random utility model where the investing firm chooses a location r at time t for each investment project p as to maximize a general utility function $u_{pr,t}$ that depends linearly on observable attributes $X_{pr,t}$ varying across time, regions and projects, and a stochastic part ε_{pr}:

$$u_{pr,t} = \beta X_{pr,t} + \varepsilon_{pr} \tag{1}$$

A distinctive feature of the mixed logit model is to allow the vector of coefficients β to be normally distributed with a mean and standard deviation and to be accordingly decomposed into a fixed part and a random part that accounts for unobservable effects. The error term in (1) incorporates the random components of the coefficients by taking the following form:

$$\varepsilon_{pr} = \gamma_p Z_{pr,t} + u_{pr} \tag{2}$$

where $Z_{pr,t}$ is a vector of observable attributes varying across time, regions and projects, γ_p is a vector of randomly distributed parameters over all projects with density $g(.)$ and a mean equal to zero, and u_{pr} is an independent and identically distributed error term with type I extreme value distribution.

The structure of the error term allows relaxing the assumption of independence of irrelevant alternatives characterizing conditional logit models and requiring that for any two alternative destinations the ratio of location probabilities is independent of the characteristics of any other alternative in the location choice set (Stern, 2003). As explained in Basile et al. (2008), the error component specification in (2) is very general as various discrete choice models can be obtained as specific cases. The standard logit and the conditional logit model correspond to the specifications where, respectively, the parameters vector γ is observed and does not vary across projects, while an analogue of the nested logit model can be obtained by defining Z as a set of dummy variables d_{rk} that take value 1 for each alternative r in a nest k and zero elsewhere.

As the coefficients in the mixed logit model are random, the probability has to be calculated over all possible values of γ. The mixed logit unconditional probability $P_{pr,t}$ that the investing firm chooses a location r at time t for project p can be obtained by taking the integral of the multiplication of the probability conditional on γ_p - the term in squared brackets in (3) - with the density functions describing the random nature of the coefficients:

$$P_{pr,t} = \int \left[\frac{\exp\left(\beta X_{pr,t} + \gamma_f Z_{pr,t}\right)}{\sum_{r=1}^{R} \exp\left(X_{pr,t} + \gamma_p Z_{pr,t}\right)} \right] g(\gamma_p) d\,\gamma_p \tag{3}$$

There is no closed form solution for the integral in (3), so $P_{pr,t}$ is approximated by simulation techniques to obtain the simulated likelihood. In particular, values of γ_p are repeatedly drawn from its distribution and included in the likelihood function to compute the conditional probability. The simulated probabilities are then averaged to approximate the mixed logit probability.[3] The estimates of the random component allow testing whether the impact of characteristics changes or not across projects. When the random component of a variable is significant, the characteristic is not valued uniformly among projects.

Beyond presenting and discussing the sign and significance of the coefficients of potential determinants, we derive their associated elasticities and other relevant measures of impact for each determinant. The magnitude of the effects of potential determinants cannot be directly assessed through the parameters estimates due to the non-linearity of the mixed logit model. This is done, first, by calculating the predicted probabilities for the baseline scenario, where we set all characteristics at their average sample value. Second, predicted probabilities are computed for each region in a perturbed scenario in which the average sample value of the relevant characteristic is changed by an appropriate specific interval that may vary according to the unit of measurement or research purposes (i.e., 1% in the case of elasticities, from 0 to 1 for dummy variables, see Table 5 for other examples). We then obtain a difference between the baseline and perturbed scenarios for each region, so that the elasticity (or any other measure of interest) is the average of these differences over regions. The drawback of this method is that it does not provide standard errors. In principle one can bootstrap standard errors but given the time mixed logit models take to converge in our sample (about two hours) the bootstrap of this is not practical (expected execution longer than six months using 1000 replications).

[3] We apply this estimation technique to our sample using the *mixlogit* routine in Stata (Hole 2007) and follow the suggestion of Revelt and Train (1998) and previous praxis (e.g. Belderbos et al. 2014) by using 100 Halton draws for each firm to have confidence in the estimated results.

4 Data, sample and empirical strategy

4.1 Data on FDI projects

The analysis draws on data on R&D cross-country projects 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 the characteristics from various publicly available 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.[4] 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 sectors, the date of announcement, the invested capital and the number of directly created jobs. It is widely used by international organizations – for instance the United Nations Conference on Trade and Development (UNCTAD) uses it since 2009 as a key data source for its annually released World Investment Report – as well as increasingly used in academic research (e.g., Belderbos et al., 2014 and 2016; Castellani and Pieri, 2013 and 2016; Crescenzi et al., 2013).

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 as they are imputed by the data releaser using undisclosed methods in a large number of cases. In our sample, figures on capital and created jobs are imputed for respectively 64% and 55% of FDI. 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.

The basic unit of analysis of the sample is therefore the FDI in R&D announced between 2003 and 2014 and directed to any of the 279 NUTS 2 regions belonging to the European Union (EU28) and EFTA (Iceland, Norway and Switzerland) countries.[5] Since the interest of the study is on highly technology intensity FDI, we focus on the most research intensive function - i.e. R&D - out of the investment activities covered by fDi Markets. We therefore discard categories (such as the design development and testing one), which have been sometimes included in studies (e.g. Amoroso et al. 2015, Belderbos et al. 2016) adopting broader definitions of technology intensive FDI. An additional motivation for this choice is the difference in the observed patterns of change across time in the evolution of R&D versus design development and testing activities after the financial crisis: the number of global investments in the former function markedly fell while the one in the latter function kept virtually steadily growing (Chaminade and Gomez 2016).

As summarized in Table 1, the sample comprises 855 FDI in R&D announced by 555 companies, so that each NUTS 2 region received about 3.1 FDI and each company made about 1.5 FDI on average in the period. The distribution across regions is asymmetric and

[4] According to the Financial Times ltd., daily-updated information on investments comes from various publicly available sources including the Financial Times newswires, nearly 9,000 media, over 1,000 industry organizations and investment agencies, data purchased from market research and publication companies. Each investment project identified is cross-referenced against multiple sources, and over 90% of projects are validated with company sources. More information is available at www.fDimarkets.com.

[5] We exclude from the analysis 9 FDI projects since the region of destination is unknown at the NUTS 2 level, and Lichtenstein and regions in overseas countries from the set of destinations as information for most potential determinants is not available for these regions.

concentrated. While as said every region received about 3 FDI on average, a large percentage (35%) did not receive any FDI. Percentages monotonically decrease with the number of FDI from 23% of regions having attracted one FDI to 5% having attracted ten or more of them. The number of investments decreases markedly after the beginning of the economic crisis, with a drop by about 38% in the yearly number of investments in the period 2008-2014 as compared to 2003-2007. Intra-European investments account for about 40% of the total, those coming from the United States about 42%, and those originated in emerging markets for about 9%. The pharmaceutical manufacturing industry is the most largely represented accounting for 34% of all investments, followed by the Computer, Electronic & Optical Products manufacturing and the ICT Services with about 15%. The remaining quarter of FDI split across ten manufacturing and one residual service industries.[6] The geographical concentration appears comparable between the periods before and after the economic crisis and European and non-European areas of origin, while FDI in the ICT services industry look more geographically concentrated than those in other industries.[7]

4.2 Data on structural and institutional characteristics of regions

We complement the dataset on FDI projects in R&D with information from various data sources on regional and national characteristics of the covered destination regions and countries, which we adopt as independent variables in the regression models as summarized in Table 2.

The Eurostat online database is used to gather information at the regional level on the population, population density, per-capita gross domestic product (GDP), unemployment rate, total intramural R&D expenditure as percentage of GDP separately by sector of performance, i.e. by the government (GOVERD), higher education (HERD) and business enterprise sectors (BERD), the number of people with tertiary education and/or employed in science and technology (S&T), and gross labor costs per employee in companies with 10 or more employees at the NUTS 1 regional level.

We account for the geographical and cultural closeness between the origin and destination regions by constructing regional measures of geographical distance and language similarity. In particular, we compute the geodetic distance between the headquarters of all parent companies making at least a FDI and the central point of each NUTS 2 region potentially receiving it. As for language similarity, we enrich the measure of common official language between nations provided in the CEPII GeoDist[8] dataset with within-nations variation in language by taking into account region-specific languages in origin and destination regions. Specifically, we take into account of that multiple language are spoken within the country in Belgium, Canada, Finland, Italy, Luxembourg and Switzerland.[9]

[6] FDI are assigned to industries using a classification based on the Statistical Classification of Economic Activities in the European Community (2-digit NACE Rev 2.0), in a similar way as in Belderbos et al. (2014). We use two concordance tables to match each project with its own NACE industry at the 2 digits level, as documented in Table B1 in Annex B. The first one is provided by Financial Times Ltd and assigns projects to classes belonging to the North-American Industry Classification System (NAICS 2007), the second one is provided by the United States Census Bureau and links NAICS 2007 and ISIC Rev. 4 classes. We eventually exploited the fact that ISIC Rev. 4 and NACE Rev 2.0 classifications are identical at the two digits level.

[7] Annex A presents additional statistics related to the distribution of FDI across destination regions and countries, and by time, country of MNE headquarters and industry.

[8] Available online at http://www.cepii.fr/cepii/en/bdd_modele/bdd.asp.

[9] We also explored the possibility to test other measures of language skills (i.e., general proficiency in English) at the regional level over which policy has leverage, but we did not find to date any suitable variables in terms of geographic and time coverage.

Table 1 The distribution of FDI in R&D across destination regions (NUTS2) and investing companies (MNEs)

	Total	Before crisis (2003-2007)	After crisis (2008-2014)	Intra-European FDI	FDI with non-European origin	Pharmaceutical manufacturing	Computer, electronic and optical manufacturing	ICT services	Other industries
FDI (number)	855	459	396	341	514	289	127	131	308
FDI (share)	*100%*	*54%*	*46%*	*40%*	*60%*	*34%*	*15%*	*15%*	*36%*
FDI per year	71.25	91.8	56.57	28.42	42.83	24.08	10.58	10.92	25.67
Total NUTS2	279	279	279	279	279	279	279	279	279
FDI by NUTS2:									
0	*35%*	*47%*	*53%*	*53%*	*47%*	*65%*	*76%*	*78%*	*53%*
1	*23%*	*24%*	*22%*	*20%*	*25%*	*15%*	*14%*	*13%*	*23%*
2 or 3	*18%*	*18%*	*14%*	*19%*	*14%*	*13%*	*8%*	*5%*	*18%*
4 or 5	*9%*	*4%*	*4%*	*4%*	*7%*	*3%*	*1%*	*2%*	*4%*
6 or 9	*9%*	*4%*	*5%*	*2%*	*4%*	*3%*	*0%*	*1%*	*2%*
10 or more	*5%*	*3%*	*2%*	*1%*	*3%*	*2%*	*0%*	*0%*	*1%*
FDI per NUTS2	3.06	1.65	1.42	1.22	1.84	1.04	0.46	0.47	1.10
Coefficient of variation of FDI across NUTS2	2.01	2.10	2.10	2.11	2.18	2.28	2.51	3.19	1.88
Total MNEs	555	329	292	227	328	176	79	80	241
FDI by MNE:									
1	*78%*	*80%*	*81%*	*79%*	*77%*	*76%*	*75%*	*76%*	*83%*
2	*12%*	*11%*	*13%*	*10%*	*13%*	*12%*	*11%*	*14%*	*11%*
3	*4%*	*3%*	*1%*	*4%*	*3%*	*2%*	*8%*	*1%*	*3%*
4 or 5	*3%*	*4%*	*3%*	*4%*	*3%*	*5%*	*1%*	*5%*	*1%*
6 or more	*3%*	*1%*	*2%*	*3%*	*4%*	*5%*	*5%*	*4%*	*0%*
FDI per MNE	1.54	1.40	1.36	1.50	1.57	1.64	1.61	1.64	1.28
Coefficient of variation of FDI across MNEs	0.98	0.76	0.71	0.89	1.03	0.94	0.88	1.10	0.66

Source: Financial Times Ltd, fDi Markets database

We exploit the OECD REGPAT[10] and Science-Metrix Scopus databases in order take the technological attractiveness of destination regions into account. In particular, we construct industry-specific regional indicators of (patent applications-based) technological strength and concentration and (publications-based) academic strength. We first map patent applications and publications at the regional level into industries.[11] Two revealed advantage indices (RAI) are then created, one based on publications and another one based on patent applications to the European Patent Office, to measure the relative specialization of regions in science and technology (academic and technological strength) relevant for specific industries, following the method originally developed for trade by Balassa (1965). The indices are defined as a region's share of publication, or alternatively patent applications, in a particular industry divided by the region's share in all industries. They thus take the following form:

$$RAI_{ri,t} = \frac{n_{ri,t} / \sum_r n_{ri,t}}{\sum_i n_{ri,t} / \sum_r \sum_i n_{ri,t}} \tag{4}$$

where *n* is the number of publications, or alternatively patent applications, in region *r* and industry *i*. The index is equal to zero when the region holds no publication (patent application) in a given sector; is equal to 1 when the region's share in the sector equals its share in all fields (no advantage); and above 1 when a positive advantage is observed.

Patent applications data are also used to construct a Herfindahl-Hirschman index (*HHI*) in order to measure the industry-specific degree of technological concentration of each region. This technology concentration index measures the concentration of patent applications among firms based in the region and that applied at least for one patent in the relevant industry. It is the sum of squares of the patent applications shares *s* of applicant firms *a*:

$$HHI_{ri,t} = \sum_{a=1}^{A} s_{ari,t} \tag{5}$$

where *A* is the number of applicants, and ranges between *1/A* (all applicants have the same amount of patent applications) to 1 (one applicant is responsible for all the region's relevant patent applications). The index takes the value of zero in the combinations of regions *r*, industries *i* and periods *t* where no patent application occurs.

We make also use of national variables available for a subset of countries capturing relevant features of the institutional framework. In particular, we take into account heterogeneity in R&D relevant fiscal policies by using OECD indicators for (combined) corporate income tax rate and tax incentives for business R&D, the former indicator retrieved from the OECD online Tax Database and the latter one retrieved from OECD (2016, p. 108). We finally include OECD measures on the strictness of employment protection legislation – in particular the indicator on the individual and collective dismissals of employees with regular contracts – and statutory restrictions on foreign direct investment – as codified by the OECD FDI Regulatory Restrictiveness Index (RRI) (Koyama and Golub, 2006).

[10] In particular we exploit the part of the OECD REGPAT database, February 2016 release, derived from the European Patent Office's (EPO) Worldwide Statistical Patent Database (PATSTAT, autumn 2015).

[11] We rely on the Eurostat International Patent Classification (IPC)-NACE correspondence table (Eurostat 2014) for the mapping of patent applications into industries, and on the mapping of scientific subfields or journals to 28 selected economic industries carried out by Science-Metrix based on an analysis of publications of a sample of companies (Science-Metrix, 2014). As for the 25 FDI classified in the other services industry, which neither patent applications nor publications are available for, we impute the indicators of technological attractiveness with the median of the indicators at the country level of the FDI with industry belonging to the High-tech manufacturing industries and Knowledge-intensive services.

Table 2 Definition, unit of measurement, data source and geographic coverage of independent variables

	Unit of measurement	Source	Geographic coverage
Regional variables			
R&D expenditure performed by the government sector (GOVRD)	% of GDP	Eurostat	NUTS 2 regions of EU28 and EFTA countries
R&D expenditure performed by the higher education sector (HERD)	% of GDP	Eurostat	NUTS 2 regions of EU28 and EFTA countries
R&D expenditure performed by the business sector (BERD)	% of GDP	Eurostat	NUTS 2 regions of EU28 and EFTA countries
Geographic distance between origin city and destination regions	Kilometers	Authors' computation	NUTS 2 regions of EU28 and EFTA countries
Common language in origin and destination regions	Dummy variable	Authors' computation building on CEPII GeoDist national data	NUTS 2 regions of EU28 and EFTA countries
Unemployment rate	%	Eurostat	NUTS 2 regions of EU28 and EFTA countries
Persons with tertiary education and/or employed in S&T	% of active population	Eurostat	NUTS 2 regions of EU28 and EFTA countries
Per-capita GDP at 2015 prices	Euro	Eurostat	NUTS 2 regions of EU28 and EFTA countries
Total labour costs per employee	Euro	Eurostat	NUTS 1 regions of EU28 and EFTA countries
Industry-specific regional variables			
Technology strength: revealed specialization index based on patent applications	Continuous variable defined on [0, ∞)	Authors' computation on OECD REGPAT data	NUTS 2 regions of EU28 and EFTA countries
Technology concentration: H-H index based on patent applications	Continuous variable defined on [0,1]	Authors' computation on OECD REGPAT data	NUTS 2 regions of EU28 and EFTA countries
Academic strength: revealed specialization index based on publications	Continuous variable defined on [0, ∞)	Authors' computation using Scopus data attributed to industries by Science-Metrix	NUTS 2 regions of EU28 and EFTA countries
National variables			
Tax incentives for business R&D	% of GDP	OECD	EU28 and EFTA countries but BG, HR, CY, LV, LU, LT, MT, PL and RO
Corporate income tax rate	%	OECD	EU28 and EFTA countries but BG, CY, HR, LT, MT and RO
Strictness of Employment Protection Legislation (EPL): individual and collective dismissals (regular contracts)	Continuous variable defined on [0, 6]	OECD	EU28 and EFTA countries but BG, CY, EE, MT and RO
FDI Regulatory Restrictiveness Index (RRI)	Continuous variable defined on [0, 1]	OECD	EU28 and EFTA countries but BG, CY, HR and MT

4.3 Empirical strategy

The empirical analysis first adopts a *baseline* specification that includes the regional variables, i.e. the level of public and private regional expenditure in R&D, the technological strength and concentration, the strength of the research system, the availability, skills and cost of the regional labor force, and the geographic and linguistic proximity between sending and recipient regions. We next adopt an *augmented* specification that includes a set of institutional variables available at the country level for a relatively large subset of FDI and areas to assess the role of the labor and business regulations as well as the fiscal regime in attracting investments in R&D.

As institutional variables are only available for a subset of countries, the models adopting the augmented specification have to exclude Bulgaria, Croatia, Cyprus, Estonia, Lithuania, Latvia, Luxembourg, Malta, Poland and Romania, and all FDI directed to these countries, so as to cover 801 FDI, 21 countries and 241 NUTS 2 regions out of out of the 855 FDI, 31 countries and 279 regions in the original sample. The total size of the *reduced* sample used in the regression models accordingly diminishes from 230,949 to 186,272 observations. In the regression analysis we assess to what extent the change in results moving from the baseline to the augmented specification is either due to the inclusion of additional institutional variables in the augmented specification or to the reduction of the considered countries or to a combination of both factors.[12]

Variation of characteristics across time is accounted for by using separate values for the periods before (2003-07) and after (2008-14) the crisis and taking averages over the periods when more than one year is available. Averaging regional characteristics across years raises an issue of potential endogeneity due to the simultaneity between investment decisions and the local conditions. Yet, the time horizon that MNEs consider when taking their investment decisions is relatively long, especially in such activities such as R&D whose expected returns might take several years to have effect, so that it is plausible to argue that they consider the expected scenarios jointly with the recent past characterization of location alternatives. Moreover, from a practical point of view, averaging different years over the considered sub-periods allows us to consider potentially important location determinants that would otherwise had to be excluded from the analysis either completely or for some relevant region. For instance, data on labor costs per employee (as well as those on R&D expenditures in Switzerland) are available in 2004, 2008 and 2012, while data on R&D tax incentives are available just in 2006 and 2013.

We impute missing information at the NUTS 2 regional level with valid equivalent values at the NUTS 1 regional or national levels. The percentage of imputed values is typically low, i.e. less than 5% of NUTS 2 regions. Exceptions are the variables capturing R&D expenditure performed by the government and higher education sectors that have a slightly larger share of regions with imputed values, i.e. about 15% of NUTS 2 regions.[13]

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[12] We tested a range of other variables on the general institutional environment of destination countries. These included several institutional dimensions, i.e. (a) the influence of the justice system with European Commission for Efficiency of Justice (CEPEJ) [i) disposition time of civil and commercial litigious cases in first instance courts (pending to resolved cases), backlog ratio (pending cases to population), ii) first instance courts size (judges to courts rate), and litigation rate (the number of incoming first instance civil and commercial litigious cases per 100,000 inhabitants)] and World Bank Ease of doing business index data [the time (days) to enforce a contract and cost (Percentage of claims and number of procedures) of enforcing a contract]. The results provide typically not significant effects of these variables. We also tested (b) for the influence of product market regulation using the OECD Product market regulation index, and (c) for the cost of starting a business (% of income per capita) again using World Bank Ease of doing business index data. The results confirm the general conclusions outlined in the report, and summarized in the presentation, on the most relevant role of fiscal policy variables, and to a limited yet significant effect of the institutional setting, with labor market regulation (as captured by OECD employment protection legislation data) legislation slightly more relevant than product market regulation (as measured by OECD FDI RRI) in explaining location choices of multinational companies making FDI in R&D in Europe.

[13] We also considered including additional regional variables from Eurostat, such as the percentage of households with broadband access, measures of the volume of air transport and the number of PhD students. We eventually decided to exclude them given their absence in a significant number of NUTS 2 regions. The number of PhD student, for instance, is not available for regions in Germany, and for all other considered variables the number of NUTS 2 regions with missing information would to be imputed is larger than 20%.

All independent variables - but the dummy on the origin and destination regions sharing a common language - enter the regression model after having been transformed using the inverse hyperbolic sine transformation, which is defined for any real value as $\log\left(x + (x^2 + 1)^{1/2}\right)$. 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).[14]

Table 3 reports the correlation matrix of the independent variables estimated on the sample used in the augmented specification covering the subset of FDI and regions for which all independent variables are available.[15] Per-capita GDP and total labor costs per employee are the variables showing the largest correlation (0.660). In order to account for this in the regression analysis we adopt alternative specifications excluding in turn per-capita GDP and total labor costs per employee, as well as a specification including both variables.

We also notice that the variable measuring the number of people with tertiary education and/or employed in S&T is very highly correlated with the total population (0.95) and total GDP (0.96) as well as GDP-related measures of market potential such as GDP in that region and a distance-weighted sum of GDP in all other regions. This prevents us from using these variables jointly in the regression analysis. Regressions using either one or the other provide very similar results, i.e. the effect of the number of people with tertiary education and/or employed in S&T are nearly undistinguishable from the effects of the overall population and total GDP. The correlation with population is also high (higher than .90) when using alternative measures of skills abundance such as the number of people with tertiary education, the number of scientist and engineers, as well as the number of PhD student (which is available for a reduced set of regions, see footnote 13 for further details).

[14] As shown in Table B2, which reports some descriptive statistics of the independent variables, the three independent variables on R&D expenditures, those on the technological strength and concentration as well as the one on the strength of the research system assume value zero in some regions and periods.

[15] The correlation matrix of the regional independent variables estimated on the extended sample used in the baseline specification covering all FDI and regions is very similar to the one reported in Table 3, and is reported in Table B3 in Annex B.

Table 3 Correlations of independent variables over the reduced sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)	GOVRD	1															
(2)	HERD	.347	1														
(3)	BERD	.255	.340	1													
(4)	Geographic distance	.007	-.008	-.055	1												
(5)	Common language	-.057	-.041	.075	-.048	1											
(6)	Unemployment rate	.007	-.097	-.356	.066	-.143	1										
(7)	People with tertiary education and/or employed in S&T	.306	.214	.386	-.030	.064	.027	1									
(8)	Per-capita GDP	.261	.345	.472	-.046	.072	-.462	.304	1								
(9)	Total labour costs per employee	.030	.358	.448	-.049	.114	-.400	.192	.660	1							
(10)	Technology strength	.091	.067	.004	-.009	.040	.061	.146	.028	-.047	1						
(11)	Technology concentration	-.112	-.158	-.216	.023	-.046	.104	-.303	-.196	-.190	.124	1					
(12)	Academic strength	-.059	.052	.007	-.009	.019	.044	.061	-.002	.011	.206	-.006	1				
(13)	R&D tax incentives	-.091	-.003	.050	-.046	.111	-.036	.059	-.027	.007	.070	-.054	.078	1			
(14)	Corporate tax rate	.124	-.017	.012	-.018	-.075	.096	.155	.104	.344	-.064	-.076	-.026	-.019	1		
(15)	Strictness of EPL	.120	-.011	-.156	.010	-.472	.238	-.047	-.098	-.166	-.054	.038	-.016	-.147	.393	1	
(16)	FDI RRI	-.175	.066	.179	-.003	.176	-.356	-.171	.163	.347	-.052	-.030	-.066	-.020	-.172	-.448	1

Notes: the correlations are estimated on the reduced sample that comprises 186,272 observations covering the subset of FDI and destination regions for which all independent variables are available. All variables but the dummy on common language in origin and destination regions have undergone inverse sine transformation.

5 Econometric results

This section discusses the results of the regression analysis to assess the role of the potential determinants on the location choices of FDI in R&D. We first compare the results of mixed logit models estimated on the extended sample using the baseline specification (regional variables available for all FDI and destination regions) with those of mixed logit models estimated on the reduced sample using the augmented specification (regional and institutional variables available for a subset of FDI and destination regions and countries). A series of alternative specifications are analyzed in order to take into account potential multi-collinearity issues and the role of the reduction of FDI and destination areas in the augmented specification.

A benchmark model is then selected in accordance with the evidence arising from statistical tests. We next derive elasticities from the benchmark model point-estimates to assess the relative importance of the different potential determinants. We finally use the results of different models on various subsamples in order to test for the presence of heterogeneous location choice determinants according to the timing, the country of the MNE headquarters and the industry of the investment.

5.1 Attracting and deterring factors of FDI in R&D across European regions

In order to assess the role of potential determinants of location choices as indicated by the related literature, we start by comparing the results of several mixed logit models estimated using different samples and specifications, as shown in Table 4 reports the significance and sign of the effects of the potential determinants.[16] We face a trade-off given the data availability of relevant national institutional variables. As discussed in the previous section, these variables are only available for 21 countries out of the 31. We therefore decided to use both an extended and reduced samples, the former containing the full set of FDI and destination regions, the latter only a somewhat reduced subset. The reduced sample, in spite of the slight reduction of covered investments and regions, allows considering institutional determinants such as fiscal policy and labor and product markets regulations, which previous literature have shown to influence MNEs location choices. We refer to the specification that includes only regional variables as the baseline, and to the one that adds institutional variables as the augmented.

We further distinguish specifications (1) to (3) that differ for the inclusion of variables showing high correlations, namely per-capita GDP and total labor costs per employee, which have been alternatively excluded in specifications (1) and (2) as well as jointly included in specification (3).

In order to assess to what extent the eventual changes in results moving from the baseline to the augmented specification are due to the inclusion of additional institutional variables in the augmented specification or due to the reduction of the considered countries (or a combination of both factors), we also present estimation results obtained on the reduced sample using the baseline specification.

We observe the absence of multicollinearity issues in all models considered in Table 4. The variance inflation factors (VIFs)[17] associated to the linear regressions on the probability of a region receiving an FDI are low using both the baseline and augmented specifications. In particular, the average VIFs of the linear probability models estimated with the same specifications and samples as the different versions of the mixed logit models reported in Table 4 are lower than 2, and the maximum VIF value associated to a specific independent variable is lower than 4 - the largest average VIF being equal to 1.70 and the largest specific VIF being per-capita GDP equal to 3.73 in the linear probability model equivalent to the baseline specification (3) in the extended sample.

[16] Since the point-estimates do not have a clear interpretation in the mixed logit model as for its non-linearity, we show them (jointly with their standard errors) in Tables B4 and B5 in Annex B.

[17] The VIF quantifies the severity of multicollinearity in an ordinary least squares regression analysis. It provides an index that measures how much the variance (the square of the estimate's standard deviation) of an estimated regression coefficient is increased because of collinearity. A rule of thumb suggests the presence of severe multicollinearity for values higher than 10.

Table 4 Estimation results of mixed logit models on determinants of the location choice of FDI in R&D

	Extended sample and: all FDI and destination areas			Reduced sample: subset of FDI and destination areas					
	Baseline Specification			Baseline Specification			Augmented Specification		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Regional variables									
GOVRD	ns	ns	ns	ns	--	--	ns	ns	ns
HERD	+++	+++	+++	+++	+++	+++	+++	+++	+++
BERD	+++	+++	+++	+++	+++	+++	+++	+++	+++
Geographic distance	--	---	---	-	---	---	--	--	---
Common language	+++	+++	+++	+++	+++	+++	+++	+++	+++
Unemployment rate	--	--	-	--	---	---	ns	-	-
People with tertiary education and/or employed in S&T	+++	+++	+++	+++	+++	+++	+++	+++	+++
Per-capita GDP	ns	x	+	-	x	ns	--	x	ns
Total labour costs per employee	x	---	---	x	---	---	x	---	---
Industry-specific regional variables									
Technology strength	+++	+++	+++	+++	+++	+++	+++	+++	+++
Technology concentration	--	--	--	--	--	--	-	ns	-
Academic strength	+	+	+	+	ns	ns	ns	+	+
National variables									
R&D tax incentives	x	x	x	x	x	x	+++	+++	+++
Corporate tax rate	x	x	x	x	x	x	---	---	---
Strictness of EPL	x	x	x	x	x	x	ns	ns	-
FDI RRI	x	x	x	x	x	x	-	ns	--
Destination NUTS2 regions (countries)	279 (31)	279 (31)	279 (31)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)
FDI (companies)	855 (555)	855 (555)	855 (555)	801 (527)	801 (527)	801 (527)	801 (527)	801 (527)	801 (527)
Observations	230,949	230,949	230,949	186,272	186,272	186,272	186,272	186,272	186,272
Log-likelihood	8,381.84	8,358.83	8,356.53	7,629.25	7,579.40	7,582.93	7,434.36	7,418.73	7,420.69

+++, ++, + positive effect significant respectively significant the at 1%, 5% or 10% confidence level
---, --, - negative effect significant respectively significant the at 1%, 5% or 10% confidence level
ns effect not significantly different from zero
x independent variable not included in specification

Notes: all variables but the dummy on common language in origin and destination regions have undergone inverse sine transformation. Robust standard errors are clustered by company. Point-estimates and standard errors of the fixed and random components are shown in Table B4 in Appendix B.

In general, the effects of characteristics are significant and show the expected sign typically confirming findings of previous literature. Among regional characteristics, R&D expenditure performed by the higher education and business sectors, the size of the skilled labor force of the destination region, its technological strength in the industry of the investment, as well as the language in origin and destination regions being the same have a positive impact on the probability of the region being selected for the investment in all estimated models. Conversely, beside the already mentioned negative effect of the total labor costs per employee, the effect is negative across all models for the geographic distance between the origin and destination areas. The effect associated with the academic strength of the destination region has a positive effect (significant at the 10% confidence level) in most specifications. The effect associated with the R&D expenditure by the government sector of the destination region, not tested in the previous studies, is not significant in most specifications. The effects associated with the unemployment rate and technology concentration are typically negative in most specifications, but their significance reduces in the models using the augmented specification that includes institutional variables.

The significant effects of R&D expenditure, language similarities, technological and academic research strength and technological concentration are usual findings of the literature on attracting and deterring factors of R&D cross-border inflows to Europe (e.g. Siedschlag et al. 2013, Belderbos et al. 2014, Belderbos and Somers 2015). Similarly, our findings confirm existing evidence in that previous studies have typically found not significant effects for the unemployment rate and market potential. The negative effect of the distance between origin cities and destination regions contrast with the typically not significant effect of geographical proximity (Castellani et al. 2013, Belderbos et al. 2014).

As for the estimates associated with skilled human capital, the high correlation between the size of qualified labor force and the overall population (0.94) and total GDP (0.96) prevents us from precisely attributing the statistically significant positive size effect that we consistently observe in all specifications.[18] In principle, the population and GDP could be proxy for market potential, which could be interesting for those MNEs aiming at overseas exploitation, while the abundance of skilled labor can exert attractiveness on MNEs aiming at absorb technology and broaden their competence. In line with our specification no previous study jointly controlled for population and human capital abundance. Yet, previous studies on Europe report small size effects. In particular, Siedschlag et al. (2013) report a statistically insignificant effect for market potential, while Belderbos and Somers (2015) report a statistically insignificant effect for population.

As for institutional variables, they have significant effects in most specifications. In particular, tax incentives for business R&D in the destination region have a positive impact on the probability of receiving a FDI in R&D in all models, consistently with analogous results as in Belderbos et al. (2014). The rate of the corporate income has a negative impact. The evidence in the literature on the effect of corporate tax rate is mixed. Several studies have found a negative effect of corporate tax rate on R&D location decisions (e.g. Mudambi and Mudambi 2005, Belderbos et al. 2016), some studies have also documented that this effect is negligible (e.g. Cantwell and Mudambi 2000, Siedschlag et al. 2013). The strictness of employment protection and the restrictiveness of business regulation have a negative impact in line with the findings of Ciriaci et al. (2016) on location choices of top R&D investors, but the associated effects are not significant in some models.

The results point to focus on the models that adopt the augmented specification on the reduced sample (the last three columns of Table 4), as the reduction of countries has a limited influence on results while the inclusion of institutional variables appears to improve the model fit. The finding suggests that the same drivers similarly affect effects different European countries.

[18] Similar effects to those estimated for the population and the number of people with tertiary education or employed in S&T are also observed in specifications with alternative measures of skills abundance such as the number of people with tertiary education, the number of scientists and engineers and the number of PhD student (which is available for a reduced set of regions, see footnote 10 for further details).

Various statistical tests indicate, moreover, that models including total labor costs for employee - i.e. specification (2) and (3) - are to be preferred to the one including per-capita GDP - i.e. specification (1). In fact, the effect associated with labor costs for employee is consistently found significant (at the 1% confidence level) and negative in all specifications where it is included, while per-capita GDP is often found not significant - including in specification (3) in the reduced sample. The Akaike's information criteria of the models estimated on the reduced sample using the augmented specification are equal to 7,434, 7,419 and 7,421 in specifications (1), (2) and (3) respectively, suggesting a strong preference of specification (2) to specification (1) and, to smaller extent, of specification (2) to specification (3).[19]

Based on the presented evidence we opt to use the augmented specification (2) in the reduced sample as the benchmark model to assess the relative importance of the different potential determinants and test for the presence of heterogeneous effects.[20]

We therefore use point-estimates of the benchmark model to derive elasticities and other relevant measures shown in Table 5 in order to examine to what extent the various determinants attract FDI. The elasticity of attraction of a determinant is defined as the percentage change in the probability of a region to attract a FDI in R&D due to a 1% increase in its sample mean. The largest elasticities are observed for the size (associated with the abundance of qualified labor force, elasticity equal to 1.1) and corporate tax rate (-1.0) of destination regions. It means that a 1% increase in the number of people with tertiary education and/or employed in S&T or a 1% fall in the corporate tax rate of a region would determine on average respectively a 1.1% or 1.0% increase in the probability of such a region to attract a FDI in R&D. Other determinants with relative high estimated elasticities are the regional total labor costs per employee (-0.6), technological strength (0.5) and R&D expenditure performed by the higher education sector (0.4), as well as the distance between origin cities and destination regions (-0.4). Belderbos et al. (2016) study on patterns of global investments in R&D and innovation report the elasticities of a somewhat larger group of investments (including also Design Development and Testing activities in addition to R&D ones) to be equal to 0.9 for R&D tax incentives, -0.8 for the corporate tax rate and -0.6 for wage levels.

It is moreover of interest to consider how the probability of a region to attract a FDI is affected by changes in some specific determinants other than the 1% change embedded in the computation of elasticities. In particular, a 0.1 percentage point increase in the share of GDP devoted to R&D fiscal incentives would imply an increase in the attraction probability by almost 25%. An analogous increase in the share of GDP devoted to R&D expenditure performed by the higher education and business sectors would imply smaller yet sizeable increases, namely by 8.6% and 2.3% respectively. This contrasts with the finding by Siedschlag et al. (2013) that the effect of business R&D expenditure intensity was stronger compared to the effect of government R&D expenditure intensity. We also assess the change of an increase in the two revealed advantages indices from 0.95 to 1.05 so that they cross the critical value equal to 1 meaning that the regional share in the industry of the investment equals its share in the other industries (no advantage) and move from a situation of slight disadvantage to one slight advantage. Such a change would increase the probability of a region to attract an investment by 5.6% in the case of technological strength and by 1.6% in the case of academic strength. We finally notice that the – hypothetical – change of a region from not sharing the same language with the origin region to doing so would almost double the probability of such a region to receive the FDI.

[19] The Akaike's information criteria of the models estimated on the reduced sample using the augmented specification are equal to 7,402, 7,397 7,413, and 7,369 in specifications (1), (2) (3) and (4) respectively.

[20] The results of the analysis - available upon request by the authors - indicate that all findings of the study are also confirmed using the augmented specification (3) in the reduced sample as the model benchmark, so that our choice of specification (2) is also justified on the ground of parsimony.

Table 5 Determinants of the location choice of FDI in R&D: mixed logit models

	Sample mean	Measure of impact: Definition	Measure of impact: Estimate
GOVRD	0.19	Elasticity: % change in the probability of a region to attract a FDI in R&D due to a 1% increase in the sample mean	0.00
HERD	0.42		0.38
BERD	1.03		0.21
Geographic distance	5,174.6		-0.39
Unemployment rate	8.00		-0.18
People with tertiary education and/or employed in S&T	388.62		1.09
Total labour costs per employee	4,7524.1		-0.59
Technology strength	1.04		0.54
Technology concentration	0.15		-0.13
Academic strength	0.89		0.13
R&D tax incentives	0.06		0.12
Corporate tax rate	29.79		-0.97
Strictness of EPL	2.61		-0.32
FDI RRI	0.05		-0.12
HERD	0.42	% change in the probability of a region to attract a FDI in R&D due to a 0.1 increase in the sample mean	8.62
BERD	1.03		2.29
R&D tax incentives	0.06		24.88
Technology strength	1.04	% change in the probability of a region to attract a FDI in R&D due to a change from 0.95 to 1.05 in the revealed technological advantage indexes	5.57
Academic strength	0.89		1.61
Common language	0.12	% change in the probability of a region to attract a FDI in R&D due to a change from not to do use the same language in the origin country	186.10

Notes: measures of impact are derived using the point-estimates from the baseline model, whose results are shown in Table B5 in Appendix B.

5.2 Different impacts across investment's timing, country of origin and industry

We finally test for the presence of heterogeneous location choice determinants according to the timing, the country of the MNE headquarters and the industry of the investment. We therefore estimate mixed logit models applying the benchmark specification on different subsamples of FDI projects. In particular, the overall sample of FDI is split in subsamples according to the European or non-European location of the headquarters of the sending company (60% of the project originated from non-European countries). Furthermore, whether the timing of announcement happening before or after the economic crisis (2008), and whether the industry is one of the top 3 sectors accounting for about two-thirds of the total investments, namely, pharmaceutical or computer, electronic and optical manufacturing or ICT services.

The results reported in Table 6 show that determinants typically vary according to the considered breakdown. One noticeable exception is the positive effect of the size of the destination region (associated with the abundance of skilled labor), which is a statistically significant attracting effect for all considered breakdowns.

Location choices that occurred before the financial crisis were particularly influenced by the unemployment rate, labor costs, the academic strength of the industry of the investment and the generosity of R&D tax incentives, while those occurring after the crisis are more sensitive to the strictness of employment protection and the market regulatory restrictiveness. Differently than in the baseline model and for FDI occurred after 2007, the positive effect of sharing a common language with the destination region was significant only at the 90% level before the crisis. By contrast, R&D expenditure, technology strength and concentration of the industry of the investment and corporate taxation had similar influences across time. An explanation for the reduction of the importance of the unemployment rate and labor costs could be the excess supply of skilled labor in the aftermath of the crisis. As for the reduction of the importance of R&D tax incentives, it could be attribute to the diffusion and convergence of such a policy across regions as a way to compete to attract FDI in R&D.[21] Moreover, the findings on the increasing importance of labor and product market rigidities as deterring factors point to the need of relaxing rigidities to allow companies to cope with low demand in the aftermath of the crisis.

In comparison to MNEs with headquarters in Europe, those headquarted outside Europe are particularly responsive to unemployment rate, the degree of restrictiveness of business regulation and sharing a common language with the destination region. By contrast, MNEs with European headquarters are comparatively more sensitive to the academic strength of the industry of the investment. Patents-based measures of technology strength and concentration, geographic distance, corporate tax rate and strictness of employment protection legislation similarly affect MNEs with headquarters in and outside Europe. Differently than in the baseline model and for MNEs with non-European headquarters, the positive effects of R&D expenditure performed by the higher education and business sectors are only significant at the 90% level for MNEs with headquarters in Europe. The evidence, partly different than the one by Siedschlag et al. (2013) on the importance of R&D expenditure intensity in the case of European MNEs and of patents intensity and proximity to centres of research excellence in the case of North American ones[22], indicates the importance for governments to reduce the regulatory and communication barriers in order to globally compete in the attraction of this highly valued form of FDI. Given the a relatively high degree of similarity of the legal framework, especially intellectual property rights (IPR) across European regions, we may speculate that the importance of institutional variables would increase by widening the coverage of investment destinations, including for instance emerging economies of Asia and Latin America, which we leave for future research.

As for differences across industries, the results show that attracting and deterring factors change substantially. MNEs operating in the pharmaceutical industry are particularly responsive to R&D private expenditures, the unemployment rate and the degree of market concentration in the destination region, the strictness of employment protection legislation and the degree of restrictiveness of business regulation. MNEs operating in the computer, electronic and optical manufacturing and ICT services industries are particularly interested in sharing a common language with the destination region. MNEs operating in the computer, electronic and optical manufacturing one are strikingly unaffected by institutional variables. MNEs operating in the ICT services are particularly attracted by R&D expenditure performed by the government sector (but not in the higher education one), the academic strength in ICT of the destination region (but not by its technological strength) and R&D tax incentives. These findings suggest that, in order to maximize the potential of attraction, governments need to focus on industry-tailored elements of the innovation system.

[21] R&D tax incentives as percentage of GDP increased by 0.04 percentage points on average between 2006 and 2013 in the European countries considered in this study, while the corporate tax rate declined by 4.8 percentage points. Belderbos et al. (2016) report consistent temporal patterns for OECD and non-OECD countries.

[22] As shown in Table A3, North-American MNEs account for about 75% of FDI made by MNEs headquarted outside Europe in our sample.

Table 6 Estimation results of mixed logit models on determinants of the location choice of FDI in R&D: heterogeneous effects

		Country of origin		Timing		Industry		
	Baseline	**European**	**Non-European**	**Before crisis**	**After crisis**	**Pharmaceutical**	**Computer, electronic and optical manufacture**	**ICT services**
Regional variables								
GOVRD	ns	ns	ns	ns	ns	ns	-	++
HERD	+++	+	+++	+++	+++	++	+++	ns
BERD	+++	+	+++	+++	+++	+	ns	ns
Geographic distance	--	---	--	-	-	-	--	++
Common language	+++	ns	+++	+	+++	ns	+++	+++
Unemployment rate	-	ns	--	--	ns	---	ns	ns
People with tertiary education and/or employed in S&T	+++	+++	+++	+++	+++	+++	+++	+++
Total labour costs per employee	---	---	--	---	ns	--	-	ns
Industry-specific regional variables								
Technology strength	+++	+++	+++	+++	+++	+++	+++	ns
Technology concentration	ns	ns	ns	ns	ns	--	ns	ns
Academic strength	+	+	ns	++	ns	ns	ns	++
National variables								
R&D tax incentives	+++	+	+++	+++	ns	ns	ns	++
Corporate tax rate	---	--	--	ns	ns	--	ns	---
Strictness of EPL	ns	ns	ns	ns	--	---	ns	ns
FDI RRI	ns	ns	---	ns	--	--	ns	-
Destination NUTS2 regions (countries)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)
FDI (companies)	801 (527)	311 (211)	490 (316)	423 (307)	378 (283)	275 (170)	118 (77)	121 (74)
Observations	186,272	68,182	118,090	97,962	88,310	63,946	27,553	28,205
Log-likelihood	7,418.73	-1,415.32	-2,241.14	-1,974.80	-1,678.19	-1,188.49	-527.08	-515.91

Notes: all variables but the dummy on common language in origin and destination regions have undergone inverse sine transformation. Robust standard errors are clustered by company. Point-estimates and standard errors of the fixed and random components are shown in Table B5 in Appendix B.

6 Conclusions

Overall, the results of the analysis confirm the findings of previous studies in that key regional determinants in attracting FDI in R&D are the level of public and private R&D expenditures, the availability and cost of skilled labor, the technological and academic strength and the degree of concentration of the industry of the investment, the geographic and linguistic proximity between the sending and receiving areas, as well as institutional factors such as fiscal policy, the strictness of labor market regulation and restrictiveness of market regulation. Our findings indicate that out of those, the fiscal regime and the size of destination regions and the sharing of a common language in the sending and receiving regions are the most important determinants. Labor costs, the technological strength and R&D higher education expenditure are also important, yet to a lower extent.

These findings highlight the relevance of national and European-level policies aimed at boosting scientific and technological strength and R&D expenditure. It is particularly interesting that for FDIs in R&D, in general, the crucial attracting factor is public R&D performed in universities rather than in public research organizations, although we observe differences for certain industries.

The high correlation observed between the size of skilled labor force and population size as well GDP does not allow us to precisely attribute the observed size effect. Our estimates can capture the effect of the abundance of a potential input for companies (i.e., accumulation of talents) as well as the demand for their output (i.e., market size). Using alternative ways to measure the abundance of skills and market potential does not help resolve this issue. Neither can previous literature, which typically report smaller size effects in comparison to ours, provide answers to the measurement and interpretation puzzle: no previous study on Europe jointly controlled for market potential and human capital abundance. Resolving this puzzle therefore remains for further investigation.

Furthermore, the finding that the reduction of countries has a limited influence on results suggests that, for what concerns attractiveness, effects are similar across Member States. At the same time, it is possible that the impact of investments differs across regions, but this remains to be investigated in a future study.

Breaking down the FDI projects by timing with respect to the financial crisis (before vs. after), by country of headquarters (European vs. overseas), and focusing on the three largest industries (pharmaceuticals, computer electronic-and-optical and ICT services) offers further insights. The strength of determinants typically varies across the various breakdowns, with the noticeable exceptions of the positive effect for the size of the destination region that is statistically significant for all breakdowns.

With regards to the timing, after the occurrence of the financial crisis, labor costs and unemployment rates cease to be significant deterring factors, R&D tax incentives no longer act as attracting factors, while the strictness of labor market regulation and the restrictiveness of market regulation start being significant deterring factors. While an explanation for these results could be the excess supply of skilled labor after the crisis and the gradual diffusion of R&D tax incentives as an active policy measure, the findings point to the need of relaxing labor and product market rigidities to allow companies to cope with reduced demand in the aftermath of the crisis.

As for differences across the country of headquarters, the unemployment rate, a common language and a simplified business environment influence overseas FDI only, while MNEs with European headquarters are more sensitive to the academic strength of the industry of the investment. The evidence indicates the importance for governments to reduce the regulatory and communication barriers in order to globally compete in the attraction of this highly valued form of FDI.

As for differences across industries, the results show that location choices respond to substantially differently factors. MNEs operating in the pharmaceutical industry are particularly responsive to R&D private expenditures, the unemployment rate and the degree of market concentration in the destination region, as well as to institutional variables. On the contrary, MNEs operating in the computer, electronic and optical manufacturing are strikingly unaffected by institutional variables. MNEs operating in the ICT services are particularly attracted by R&D expenditure performed by the government sector (but not in the higher education one), the academic strength in ICT of the destination region (but not by its technological strength) and R&D tax incentives. These findings reveal the importance of industry-tailored elements of the innovation system governments need to focus on in order to maximize the potential of attractiveness of FDI in R&D.

In conclusion, our findings indicate that regional governments have some room to create favorable conditions for FDI in R&D in the medium term. Apart from fostering R&D in the higher education sector as well as technological strength, they also need to take into consideration the specificities of FDI in relation to regional characteristics, as the determinants of MNEs location choices vary over time and space as well as across industries.

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List of abbreviations and definitions

BERD	R&D expenditure performed by the business sector
EFTA	European Free Trade Association
EPL	Employment Protection Legislation
EPO	European Patent Office
EU28	European Union of 28 Member States
FDI	Foreign direct investment
GDP	Gross domestic product
GOVRD	R&D expenditure performed by the government sector
HERD	R&D expenditure performed by the higher education sector
HHI	Herfindahl-Hirschman index
ICT	Information and communication technology
IPC	International Patent Classification
IPR	intellectual property rights
MNE	multinational enterprises
NACE	Statistical classification of economic activities in the European Community
NAICS	North-American Industry Classification System
ns	not significant
NUTS	Nomenclature of territorial units for statistics
OECD	Organisation for Economic Co-operation and Development
RAI	revealed advantage indices
R&D	research and development
RRI	Regulatory Restrictiveness Index
S&T	Science and technology
UNCTAD	United Nations Conference on Trade and Development
VIF	variance inflation factors

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Annex A Additional descriptive statistics on FDI in R&D in Europe

Table A1 The 20 European regions (NUTS2) that attract the most FDI in R&D, 2003-2014

Top-receiving NUTS2	Country code	Number of FDI	Share of FDI over	
			total number of FDI	2014 population (mln)
Southern and Eastern	IE	64	7.5%	19.0
Cataluña	ES	45	5.3%	6.1
Île-de-France	FR	28	3.3%	2.3
Border, Midland and Western	IE	22	2.6%	17.8
Eastern Scotland	UK	22	2.6%	10.7
Közép-Magyarország	HU	22	2.6%	7.4
East Anglia	UK	20	2.3%	8.2
Northern Ireland	UK	17	2.0%	9.3
Comunidad de Madrid	ES	17	2.0%	2.7
Rhône-Alpes	FR	17	2.0%	2.6
Berkshire, Buckinghamshire and Oxfordshire	UK	16	1.9%	6.9
South Western Scotland	UK	16	1.9%	6.9
Hovedstaden	DK	14	1.6%	8.0
Oberbayern	DE	13	1.5%	2.9
Provence-Alpes-Côte d'Azur	FR	12	1.4%	2.4
Inner London	UK	11	1.3%	3.3
Düsseldorf	DE	11	1.3%	2.2
Prov. Antwerpen	BE	10	1.2%	5.5
Darmstadt	DE	10	1.2%	2.6
Praha	CZ	9	1.1%	7.2

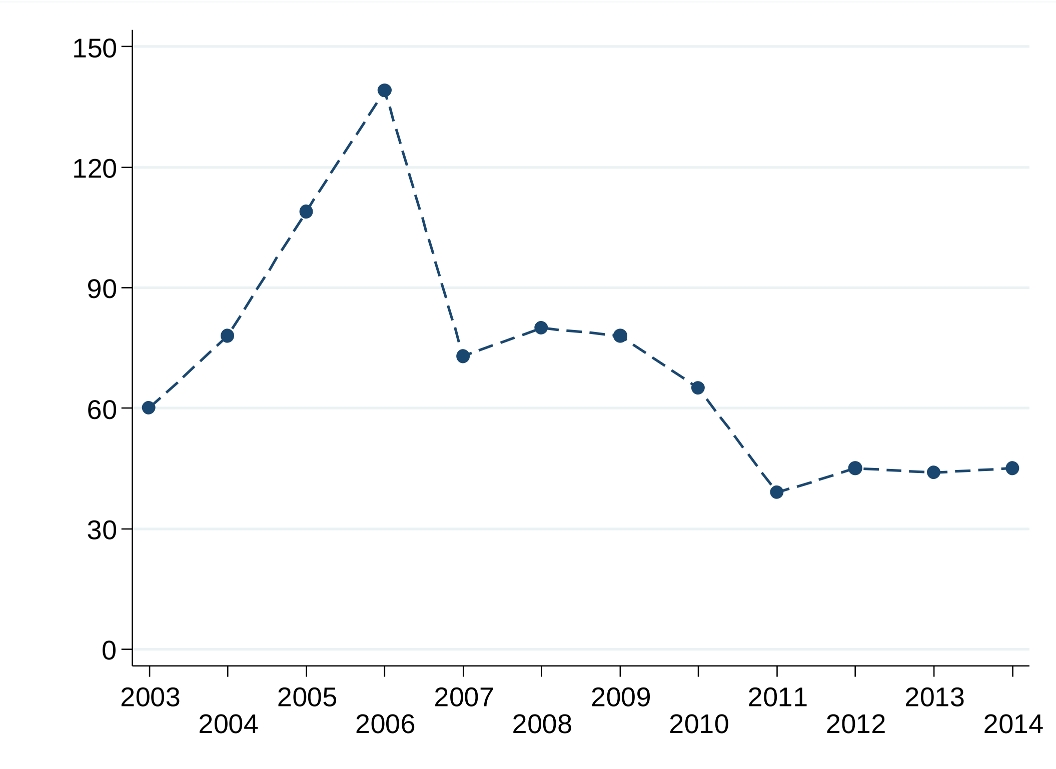
Source: Financial Times Ltd, fDi Markets database

Table A2 The European countries' attractiveness of FDI in R&D, 2003-2014

Country	Country code	Number of FDI	Share of FDI over total number of FDI	Share of FDI over 2014 population (mln)
United Kingdom	UK	174	20.4%	2.70
France	FR	110	12.9%	1.72
Germany	DE	88	10.3%	1.09
Ireland	IE	86	10.1%	18.67
Spain	ES	85	9.9%	1.83
Belgium	BE	37	4.3%	3.30
Hungary	HU	35	4.1%	3.54
Italy	IT	33	3.9%	0.54
Poland	PL	26	3.0%	0.68
Austria	AT	24	2.8%	1.43
The Netherlands	NL	24	2.8%	2.82
Denmark	DK	21	2.5%	2.18
Sweden	SE	21	2.5%	3.73
Switzerland	CH	16	1.9%	1.97
Czech Republic	CZ	16	1.9%	1.52
Finland	FI	15	1.8%	2.75
Romania	RO	13	1.5%	0.65
Portugal	PT	7	0.8%	0.71
Bulgaria	BG	5	0.6%	0.69
Lithuania	LT	4	0.5%	1.36
Norway	NO	4	0.1%	0.74
Slovakia	SK	4	0.1%	0.78
Croatia	HR	2	0.0%	0.47
Malta	MT	1	0.2%	2.35
Luxembourg	LU	1	0.2%	1.82
Estonia	EE	1	0.1%	0.76
Latvia	LV	1	0.0%	0.50
Greece	EL	1	0.0%	0.09
Cyprus	CY	0	0.0%	0.00
Iceland	IS	0	0.0%	0.00
Slovenia	SI	0	0.0%	0.00

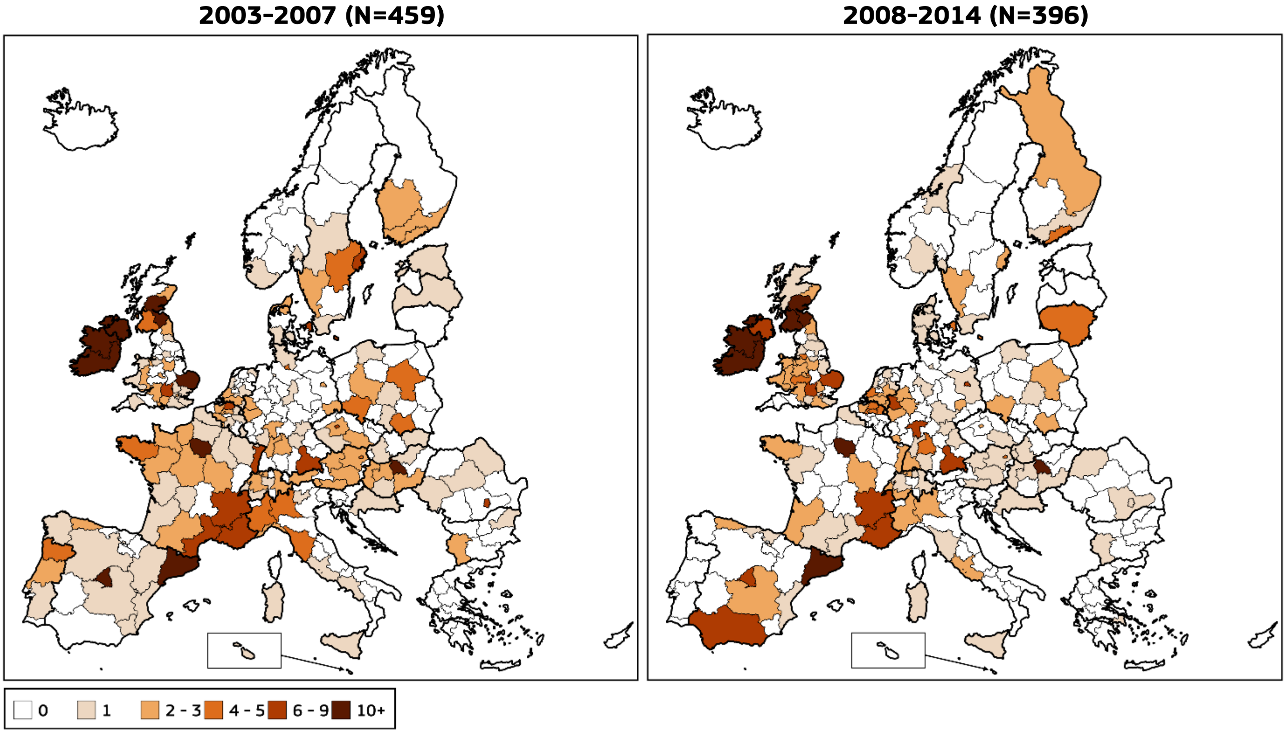
Source: Financial Times Ltd, fDi Markets database

Figure A1 The yearly number of FDI in R&D to Europe, 2003-2014



Source: Financial Times Ltd, fDi Markets database

Figure A2 The number of FDI in R&D across European regions (NUTS 2) before and after the economic crisis



Source: Financial Times Ltd, fDi Markets database

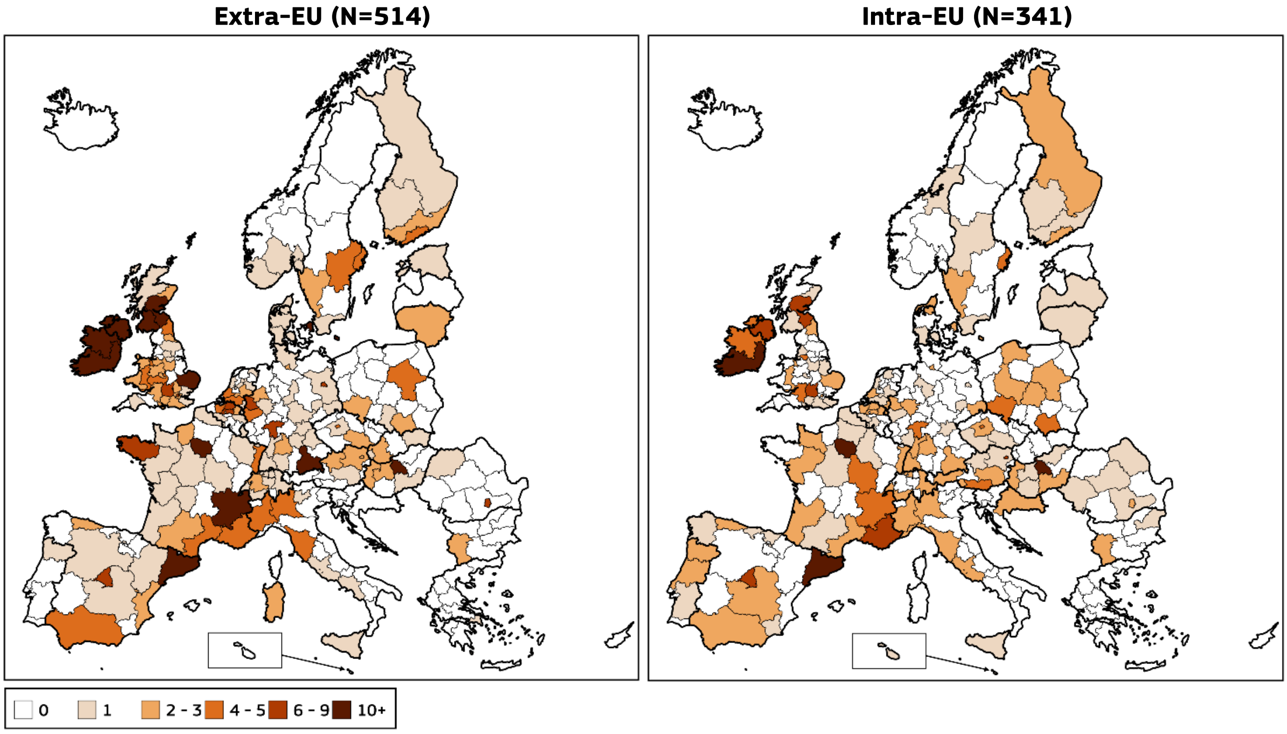
Table A3 FDI in R&D to Europe by source country, 2003-2014

Source country	Number of FDI	Share of FDI over total number of FDI
European countries	*341*	*39.9%*
Germany	80	9.4%
UK	58	6.8%
Switzerland	42	4.9%
France	40	4.7%
Netherlands	23	2.7%
Italy	19	2.2%
Ireland	13	1.5%
Sweden	13	1.5%
Belgium	10	1.2%
Norway	6	0.7%
Other European	37	4.3%
Non-European countries	*514*	*60.1%*
United States	362	42.3%
Japan	42	4.9%
China	34	4.0%
Canada	22	2.6%
India	15	1.8%
South Korea	11	1.3%
Emerging markets	20	2.3%
Other non-European	8	0.9%

Notes: Emerging markets include Brazil, Egypt, Iran, Israel, Malaysia, Mexico, Russia, South Africa, Taiwan and United Arab Emirates.

Source: Financial Times Ltd, fDi Markets database

Figure A3 The number of FDI in R&D across European regions by country of origin



Source: Financial Times Ltd, fDi Markets database

Table A4 The 16 companies (MNEs) with the highest number of FDI projects in R&D in Europe, 2003-14

Top-investing MNEs	Headquarter country	Industry	Number of FDI	Share of FDI over total number of FDI
Microsoft	United States	ICT Services	12	1.4%
Pfizer	United States	Pharmaceuticals	11	1.3%
IBM	United States	ICT Services	10	1.2%
Merck & Co	United States	Pharmaceuticals	8	0.9%
Siemens	Germany	Computer, Electronic & Optical	8	0.9%
AstraZeneca	UK	Pharmaceuticals	7	0.8%
GlaxoSmithKline (GSK)	UK	Pharmaceuticals	7	0.8%
Icon	Ireland	Pharmaceuticals	7	0.8%
Intel	United States	Computer, Electronic & Optical	7	0.8%
SAP	Germany	ICT Services	7	0.8%
Genzyme	United States	Pharmaceuticals	6	0.7%
Huawei Technologies	China	Computer, Electronic & Optical	6	0.7%
Johnson & Johnson	United States	Pharmaceuticals	6	0.7%
Les Laboratoires Servier	France	Pharmaceuticals	6	0.7%
Quintiles	United States	Pharmaceuticals	6	0.7%
Samsung	South Korea	Computer, Electronic & Optical	6	0.7%

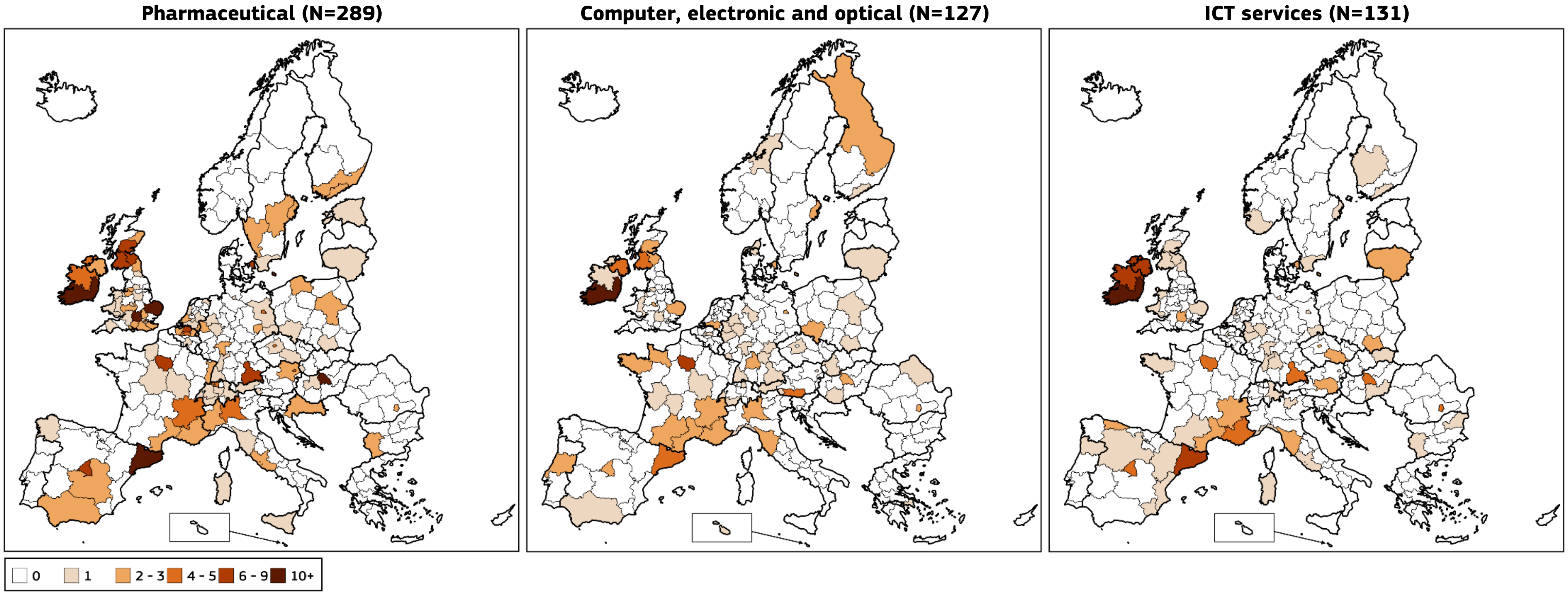
Source: Financial Times Ltd, fDi Markets database

Table A5 FDI in R&D to Europe by industry, 2003-2014

Industry	Number of FDI	Share of FDI over total number of FDI
Pharmaceuticals	289	33.8%
ICT Services	131	15.3%
Computer, Electronic & Optical Products	127	14.9%
Transport Equipment	63	7.4%
Chemicals	50	5.8%
Electrical & Machinery and Equipment	40	4.7%
Other Manufactures	39	4.6%
Food, Beverages & Tobacco	28	3.3%
Rubber, Plastics & Minerals	24	2.8%
Energy & Environmental Technologies	19	2.2%
Metals	13	1.5%
Wood & Paper	4	0.5%
Textiles	3	0.4%
Other Services	25	2.9%

Source: Financial Times Ltd, fDi Markets database

Figure A4 The number of FDI in R&D across European regions by industry



Source: Financial Times Ltd, fDi Markets database

Annex B Additional statistics

Table B1 Correspondence between industry categories used in the analysis and the Statistical Classification of Economic Activities in the European Community (NACE Rev 2.0)

Industry category	Two-digit NACE Rev 2.0 code
1 Food, Beverages & Tobacco	01-03; 10 to 12
2 Energy & Environmental Technologies	05 to 09; 19; 35 to 39
3 Textiles	13 to 15
4 Wood & Paper	16 to 18
5 Chemicals	20
6 Pharmaceuticals	21
7 Rubber, Plastics & Minerals	22 to 23
8 Metals	24 to 25
9 Computer, Electronic & Optical Products	26
10 Electrical Machinery & Equipment	27 to 28
11 Transport Equipment	29 to 30
12 Other Manufactures	31 to 33
13 ICT Services	58 to 63
14 Other Services	52; 64 to 66; 69 to 75; 85 to 86

Source: authors' construction based on fDi Markets correspondence table with North-American Industry Classification System (NAICS 2007) and US Census correspondence table between NAICS 2007 and ISIC Rev. 4 classes.

Table B2 Summary statistics of independent variables

	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
Regional variables						
GOVRD	0.18	0.21	0	1.24	2.17	8.39
HERD	0.42	0.28	0	1.78	1.27	6.16
BERD	1.02	0.90	0	5.55	1.62	6.34
Geographic distance	5,176	3,494	13	18,910	0.01	2.03
Common language	0.12	0.32	0	1	2.37	6.60
Population	1,774	1,536	26	11,872	2.62	13.06
Population density	370	913	3	10,119	6.65	57.02
Unemployment rate	8.02	4.41	2.54	29.46	1.56	5.88
Per-capita GDP	25,915	8,578	9,167	95,300	2.16	15.37
Persons with tertiary education and/or employed in S&T	38.03	8.40	14.84	68.64	0.12	3.38
Total labour costs per employee	47,316	18,504	10,524	118,633	1.07	6.83
Industry-specific regional variables						
Academic strength	1.04	1.07	0	33.49	8.02	164.12
Technology strength	0.15	0.22	0	1	2.74	10.55
Technology concentration	0.89	0.74	0	17.54	3.01	30.26
National variables						
R&D tax incentives	0.06	0.06	0	0.26	1.66	5.73
Corporate tax rate	29.72	5.65	12.50	39.16	-0.30	2.82
Strictness of EPL	2.61	0.48	1.68	4.00	-0.59	3.12
FDI RRI	0.05	0.03	0.01	0.17	1.43	5.46

Notes: see Table 2 for the definition and sources of variables. The descriptive statistics are estimated before having implemented the inverse sine transformation on the reduced sample that comprises 186,272 observations covering the subset of FDI and regions for which all independent variables are available.

Table B3 Correlations of regional independent variables over the extended sample

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	GOVRD	1											
(2)	HERD	0.353	1										
(3)	BERD	0.277	0.428	1									
(4)	Geographic distance	0.001	-0.023	-0.065	1								
(5)	Common language	-0.043	0.003	0.117	-0.050	1							
(6)	Unemployment rate	-0.034	-0.164	-0.405	0.065	-0.166	1						
(7)	People with tertiary education and/or employed in S&T	0.326	0.216	0.345	-0.028	0.044	0.028	1					
(8)	Per-capita GDP	0.288	0.457	0.564	-0.062	0.134	-0.480	0.221	1				
(9)	Total labour costs per employee	0.104	0.479	0.555	-0.066	0.166	-0.417	0.116	0.811	1			
(10)	Technology strength	0.096	0.078	0.018	-0.009	0.032	0.041	0.143	0.052	0.004	1		
(11)	Technology concentration	-0.132	-0.209	-0.251	0.027	-0.060	0.125	-0.266	-0.262	-0.270	0.164	1	
(12)	Academic strength	-0.040	0.062	0.021	-0.014	0.022	0.035	0.056	0.024	0.034	0.185	-0.018	1

Notes: the correlations are estimated on the extended sample that comprises 230,949 observations covering the whole of FDI and destination regions. All variables but the dummy on common language in origin and destination regions have undergone inverse sine transformation.

Table B4 Full results of mixed logit models, average impacts

	Extended sample and: all FDI and destination areas			Reduced sample: subset of FDI and destination areas					
	Baseline Specification			Baseline Specification			Augmented Specification		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
GOVRD	0.0422	-0.256	-0.331	-0.0407	-0.545**	-0.597**	0.238	-0.113	-0.0763
	(0.205)	(0.210)	(0.219)	(0.223)	(0.248)	(0.258)	(0.248)	(0.255)	(0.260)
HERD	0.649***	0.948***	0.873***	0.662***	1.010***	0.970***	0.785***	0.985***	1.027***
	(0.211)	(0.189)	(0.205)	(0.218)	(0.195)	(0.214)	(0.246)	(0.226)	(0.244)
BERD	0.243***	0.366***	0.395***	0.225**	0.368***	0.379***	0.314***	0.377***	0.367***
	(0.0826)	(0.0857)	(0.0854)	(0.0881)	(0.0883)	(0.0901)	(0.0958)	(0.0933)	(0.0949)
Geographic distance	-0.308**	-0.376***	-0.357***	-0.269*	-0.387***	-0.373***	-0.374**	-0.369**	-0.396***
	(0.127)	(0.129)	(0.125)	(0.141)	(0.130)	(0.134)	(0.164)	(0.164)	(0.142)
Common language	0.845***	0.877***	0.899***	0.813***	0.969***	0.881***	0.616***	0.584***	0.743***
	(0.163)	(0.172)	(0.162)	(0.192)	(0.171)	(0.190)	(0.202)	(0.192)	(0.159)
Unemployment rate	-0.210**	-0.231**	-0.188*	-0.303**	-0.336***	-0.310***	-0.154	-0.182*	-0.217*
	(0.106)	(0.104)	(0.106)	(0.121)	(0.107)	(0.118)	(0.111)	(0.111)	(0.115)
People with tertiary education and/or employed in S&T	1.131***	1.187***	1.141***	1.183***	1.268***	1.262***	1.233***	1.263***	1.277***
	(0.0685)	(0.0645)	(0.0711)	(0.0743)	(0.0719)	(0.0804)	(0.0867)	(0.0778)	(0.0894)
Per-capita GDP	-0.143		0.285*	-0.319*		0.113	-0.363**		-0.0972
	(0.149)		(0.154)	(0.184)		(0.162)	(0.184)		(0.182)
Total labour costs per employee		-0.483***	-0.599***		-0.866***	-0.911***		-0.580***	-0.566***
		(0.0972)	(0.109)		(0.144)	(0.142)		(0.193)	(0.165)
Technology strength	0.850***	0.829***	0.812***	0.928***	0.881***	0.862***	0.801***	0.785***	0.765***
	(0.0813)	(0.0808)	(0.0794)	(0.0919)	(0.0932)	(0.0893)	(0.102)	(0.101)	(0.0926)
Technology concentration	-1.086**	-1.216**	-1.267**	-1.436**	-1.472**	-1.441**	-1.108*	-1.220	-1.061*
	(0.500)	(0.494)	(0.525)	(0.604)	(0.718)	(0.655)	(0.599)	(0.839)	(0.549)
Academic strength	0.174*	0.186*	0.186*	0.196*	0.169	0.177	0.188	0.200*	0.196*
	(0.103)	(0.102)	(0.103)	(0.107)	(0.111)	(0.110)	(0.116)	(0.114)	(0.116)
R&D tax incentives							2.577***	2.229***	2.157***
							(0.692)	(0.756)	(0.717)
Corporate tax rate							-1.696***	-1.259***	-1.098***
							(0.272)	(0.392)	(0.323)
Strictness of EPL							-0.366	-0.539	-0.696*
							(0.437)	(0.420)	(0.405)

	Extended sample and: all FDI and destination areas			Reduced sample: subset of FDI and destination areas					
	Baseline Specification			**Baseline Specification**			**Augmented Specification**		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
FDI RRI							-4.464*	-2.962	-4.829**
							(2.352)	(2.495)	(2.451)
Random component's coefficients									
GOVRD	-0.0437	-0.315	-0.641	-0.512	0.970*	1.217***	-0.788	1.142***	0.864
	(0.480)	(0.744)	(0.537)	(0.709)	(0.553)	(0.452)	(0.751)	(0.423)	(0.576)
HERD	1.068***	0.962***	0.814*	1.068***	-0.861***	1.125***	1.330***	1.266***	1.303***
	(0.370)	(0.337)	(0.441)	(0.332)	(0.313)	(0.346)	(0.386)	(0.372)	(0.444)
BERD	0.307*	0.245	0.233	0.363*	0.264	0.108	0.502***	0.454*	0.399
	(0.167)	(0.183)	(0.159)	(0.209)	(0.172)	(0.234)	(0.187)	(0.251)	(0.304)
Geographic distance	0.976***	0.847***	0.881***	1.080***	0.991***	1.024***	0.977***	1.056***	1.068***
	(0.221)	(0.249)	(0.219)	(0.219)	(0.201)	(0.175)	(0.182)	(0.212)	(0.164)
Common language	1.704***	1.768***	1.706***	1.947***	-1.794***	1.861***	1.525***	1.701***	1.245***
	(0.259)	(0.245)	(0.255)	(0.451)	(0.327)	(0.333)	(0.406)	(0.289)	(0.440)
Unemployment rate	-0.455**	0.473*	-0.539***	-0.135	0.458**	0.155	-0.384*	-0.213	0.101
	(0.207)	(0.249)	(0.194)	(0.843)	(0.233)	(0.687)	(0.220)	(0.435)	(0.266)
People with tertiary education and/or employed in S&T	0.287**	0.349***	0.352***	0.293***	0.386***	0.393***	0.334***	0.383***	0.354***
	(0.122)	(0.117)	(0.104)	(0.112)	(0.107)	(0.102)	(0.105)	(0.0914)	(0.126)
Per-capita GDP	0.433*		0.139	0.453		0.228	-0.213		0.194
	(0.256)		(0.227)	(0.308)		(0.246)	(0.713)		(0.374)
Total labour costs per employee		0.158	0.0959		0.440**	0.379***		0.118	0.381***
		(0.152)	(0.165)		(0.195)	(0.138)		(0.692)	(0.136)
Technology strength	0.0959	0.0551	0.0324	0.305	0.335**	-0.261	0.245	0.284	-0.315
	(0.126)	(0.0911)	(0.222)	(0.222)	(0.158)	(0.184)	(0.286)	(0.204)	(0.297)
Technology concentration	1.115*	0.752	1.001	-1.973***	-1.391	1.539	-1.724**	-1.648	1.265**
	(0.665)	(0.940)	(0.824)	(0.698)	(1.122)	(0.979)	(0.700)	(1.760)	(0.597)
Academic strength	0.217	0.269	0.128	0.451**	-0.228	0.297	0.362	0.464**	0.263
	(0.209)	(0.195)	(0.284)	(0.191)	(0.242)	(0.307)	(0.326)	(0.225)	(0.291)
R&D tax incentives							0.795	0.255	-2.638*
							(1.835)	(1.617)	(1.562)
Corporate tax rate							1.334***	1.723***	2.081***
							(0.312)	(0.411)	(0.454)

	Extended sample and: all FDI and destination areas			Reduced sample: subset of FDI and destination areas					
	Baseline Specification			**Baseline Specification**			**Augmented Specification**		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
Strictness of EPL							2.117***	1.989***	1.854***
							(0.753)	(0.564)	(0.692)
FDI RRI							-5.674	-4.539	11.26***
							(9.504)	(8.700)	(3.808)
Destination NUTS2 regions (countries)	279 (31)	279 (31)	279 (31)	279 (21)	279 (21)	279 (21)	279 (21)	279 (21)	279 (21)
FDI (companies)	855 (555)	855 (555)	855 (555)	801 (527)	801 (527)	801 (527)	801 (527)	801 (527)	801 (527)
Observations	230,949	230,949	230,949	186,272	186,272	186,272	186,272	186,272	186,272
Log-likelihood	8,381.84	8,358.83	8,356.53	7,629.25	7,579.40	7,582.93	7,434.36	7,418.73	7,420.69

Notes: all variables but the dummy on common language in origin and destination regions have undergone inverse sine transformation. Robust standard errors clustered by investing companies are in parenthesis. MXL models have been estimated through the Stata mixlogit routine (Hole 2007) with 100 Halton draws.
Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

Table B5 Full results of mixed logit models, heterogeneous impacts

		Country of origin		Timing		Industry		
	Baseline	**European**	**non European**	**Before crisis**	**After crisis**	**Pharmaceutical**	**Computer, electronic and optical manufacture**	**ICT services**
GOVRD	-0.113	0.204	-0.262	-0.355	-0.232	0.156	-1.480*	1.183**
	(0.255)	(0.403)	(0.354)	(0.446)	(0.373)	(0.514)	(0.873)	(0.587)
HERD	0.985***	0.781*	1.072***	1.147***	0.964***	1.085**	1.566***	0.813
	(0.226)	(0.469)	(0.265)	(0.325)	(0.310)	(0.435)	(0.549)	(0.557)
BERD	0.377***	0.286*	0.448***	0.450***	0.373***	0.348*	0.329	0.201
	(0.0933)	(0.160)	(0.125)	(0.120)	(0.139)	(0.189)	(0.243)	(0.304)
Geographic distance	-0.369**	-0.498***	-1.631**	-0.358*	-0.433*	-0.392*	-0.671**	0.628**
	(0.164)	(0.144)	(0.764)	(0.190)	(0.235)	(0.237)	(0.341)	(0.320)
Common language	0.584***	0.516	0.900***	0.470*	1.059***	0.519	1.205***	1.498***
	(0.192)	(0.745)	(0.259)	(0.244)	(0.233)	(0.356)	(0.407)	(0.504)
Unemployment rate	-0.182*	0.00435	-0.292**	-0.389**	-0.162	-0.616***	-0.283	0.313
	(0.111)	(0.224)	(0.141)	(0.158)	(0.175)	(0.219)	(0.295)	(0.315)
People with tertiary education and/or employed in S&T	1.263***	1.354***	1.212***	1.143***	1.331***	1.389***	1.211***	1.508***
	(0.0778)	(0.142)	(0.0917)	(0.108)	(0.117)	(0.174)	(0.204)	(0.203)
Total labour costs per employee	-0.580***	-0.809***	-0.464**	-0.757***	-0.262	-0.644**	-0.623*	-0.486
	(0.193)	(0.283)	(0.204)	(0.217)	(0.257)	(0.295)	(0.371)	(0.412)
Technology strength	0.785***	0.684***	0.805***	0.685***	0.941***	0.917***	1.722***	0.0444
	(0.101)	(0.172)	(0.118)	(0.130)	(0.141)	(0.204)	(0.454)	(0.235)
Technology concentration	-1.220	-0.907	-1.230	-1.148	-1.555	-3.318**	-2.746	-0.0203
	(0.839)	(0.921)	(0.806)	(0.813)	(0.962)	(1.509)	(1.740)	(0.504)
Academic strength	0.200*	0.311*	0.133	0.336**	0.00951	-0.100	1.243	1.242**
	(0.114)	(0.188)	(0.142)	(0.150)	(0.173)	(0.197)	(0.919)	(0.602)
R&D tax incentives	2.229***	2.580*	2.964***	7.751***	0.464	1.274	2.856	5.233**
	(0.756)	(1.403)	(0.893)	(2.399)	(1.095)	(1.632)	(1.961)	(2.034)
Corporate tax rate	-1.259***	-1.457**	-0.889**	-0.768	-0.231	-1.112**	-0.600	-2.638***
	(0.392)	(0.600)	(0.400)	(0.496)	(0.793)	(0.507)	(0.607)	(0.607)
Strictness of EPL	-0.539	-0.585	-0.332	-0.190	-1.574**	-2.166***	0.783	0.421
	(0.420)	(0.697)	(0.575)	(0.511)	(0.648)	(0.694)	(0.899)	(1.623)
FDI RRI	-2.962	-0.0421	-8.000***	-1.316	-9.661**	-7.832**	-8.482	-10.34*
	(2.495)	(5.910)	(2.909)	(3.146)	(4.355)	(3.994)	(6.006)	(6.098)

	Baseline	Country of origin		Timing		Industry		
		European	non European	Before crisis	After crisis	Pharmaceutical	Computer, electronic and optical manufacture	ICT services
Random component's coefficients								
GOVRD	1.142***	-0.445	1.171**	1.732**	-1.181**	1.183*	1.402	0.0555
	(0.423)	(1.743)	(0.494)	(0.843)	(0.507)	(0.709)	(1.413)	(0.256)
HERD	1.266***	-1.605**	1.412***	-0.999*	1.706***	2.178***	-1.382**	0.774*
	(0.372)	(0.671)	(0.457)	(0.532)	(0.457)	(0.545)	(0.654)	(0.425)
BERD	0.454*	0.361	0.541***	0.328	0.291	0.679**	-0.367	0.778*
	(0.251)	(0.283)	(0.196)	(0.215)	(0.287)	(0.308)	(0.594)	(0.435)
Geographic distance	1.056***	0.866***	3.915**	1.016***	1.437***	0.785***	1.167***	0.148
	(0.212)	(0.222)	(1.534)	(0.275)	(0.281)	(0.153)	(0.279)	(0.480)
Common language	1.701***	1.553	1.232***	1.204**	0.886***	2.565***	0.986*	0.574**
	(0.289)	(1.524)	(0.337)	(0.506)	(0.341)	(0.726)	(0.536)	(0.243)
Unemployment rate	-0.213	0.398	-0.250	-0.136	0.623*	0.384	-0.220	0.412**
	(0.435)	(0.262)	(0.270)	(0.115)	(0.348)	(0.383)	(0.222)	(0.203)
People with tertiary education and/or employed in S&T	0.383***	0.518***	-0.0276	-0.219	0.390*	-0.409*	0.304	0.283*
	(0.0914)	(0.180)	(0.651)	(0.162)	(0.219)	(0.213)	(0.495)	(0.145)
Total labour costs per employee	0.118	0.0498	-0.192	-0.330*	0.456**	0.207	-0.00333	-0.572
	(0.692)	(0.371)	(0.151)	(0.173)	(0.216)	(0.259)	(0.136)	(0.416)
Technology strength	0.284	0.536**	-0.166	0.358	0.162	0.186	0.744	0.558
	(0.204)	(0.265)	(0.159)	(0.254)	(0.208)	(0.237)	(0.468)	(0.689)
Technology concentration	-1.648	1.565	1.610**	1.536*	2.113**	-0.845	1.317	-0.587
	(1.760)	(1.558)	(0.691)	(0.863)	(0.918)	(1.775)	(1.580)	(0.373)
Academic strength	0.464**	-0.580*	-0.432*	-0.331	-0.0642	0.704***	2.017***	1.409***
	(0.225)	(0.315)	(0.242)	(0.223)	(0.708)	(0.211)	(0.774)	(0.383)
R&D tax incentives	0.255	-4.901	2.116*	3.646	-0.809	4.483**	-2.124	-2.501
	(1.617)	(4.194)	(1.257)	(14.88)	(2.682)	(2.032)	(2.691)	(3.546)
Corporate tax rate	1.723***	0.649	1.980***	2.233***	2.963***	1.224*	1.437***	-0.966
	(0.411)	(1.559)	(0.487)	(0.490)	(0.831)	(0.628)	(0.323)	(1.297)
Strictness of EPL	1.989***	-3.153*	1.573	2.126***	1.973**	1.250	-0.844	-1.370
	(0.564)	(1.862)	(1.105)	(0.690)	(0.768)	(1.830)	(1.352)	(1.008)

		Country of origin		Timing		Industry		
	Baseline	European	non European	Before crisis	After crisis	Pharmaceutical	Computer, electronic and optical manufacture	ICT services
FDI RRI	-4.539	6.648	12.48***	7.119	-5.998	18.50***	8.000	17.33**
	(8.700)	(13.37)	(2.784)	(4.684)	(22.04)	(6.173)	(10.70)	(7.163)
Destination NUTS2 regions (countries)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)	241 (21)
FDI (companies)	801 (527)	311 (211)	490 (316)	423 (307)	378 (283)	275 (170)	118 (77)	121 (74)
Observations	186,272	68,182	118,090	97,962	88,310	63,946	27,553	28,205
Log-likelihood	7,418.73	-1,415.32	-2,241.14	-1,974.80	-1,678.19	-1,188.49	-527.08	-515.91

Notes: all variables but the dummy on common language in origin and destination regions have undergone inverse sine transformation. Robust standard errors clustered by investing companies are in parenthesis. MXL models have been estimated through the Stata mixlogit routine (Hole 2007) with 100 Halton draws.
Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

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