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"THE GRAVITY OF R&D FDIs"

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The Gravity of R&D FDIs

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Abstract

The gravity model predicts that international trade and FDI should fade with geographic distance. The negative effect of distance is justified by the existence of transport costs which hamper the international exchange of final and intermediate goods, and by higher uncertainty about local markets. We submit that distance plays a remarkably different role in the case of R&D FDIs since they mainly involve the international transfer, absorption and use of knowledge. Using data on bilateral investment projects in R&D, manufacturing and other business activities between 58 countries, we find that geographic distance does not hinder R&D FDIs as much as in the case of production and other investment activities. Furthermore, once we control for institutional and psychic distance, in particular language and religious differences, the negative effect of geographic distance vanishes.

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Introduction

Geographic distance is one key determinant of bilateral economic relations between countries. Given the size of transacting countries, the gravity model predicts that international trade should fade with geographic distance (Anderson and van Wincoop, 2004). This model has been widely applied to explaining bilateral trade flows between countries (see Brakman and van Bergeijk,2010, and De Benedictis and Taglioni, 2011, for recent reviews), and has been extended to bilateral FDI flows (Bergstrand and Egger, 2007) but has never been used to interpret investments in R&D. In the case of trade and vertical FDI the negative effect of distance is justified by the existence of transportation costs which hamper the international exchange of final and intermediate goods. Furthermore, remote locations may also be associated with higher uncertainty about foreign countries, thus discouraging trade and (horizontal and vertical) FDI.

We submit that distance plays a remarkably different role in the case of R&D FDIs because they mainly involve the international transfer, absorption and use of knowledge. The gravity framework needs be adapted to accommodate at least three basic characteristics of R&D FDIs.

First, transport costs have a much lower impact on the transmission of knowledge assets, especially in the case of codified information. This helps explain the increasing international dispersion of R&D location patterns (Prencipe et al. 2003) and the growing fragmentation of innovative activities on a global scale (ProInno 2007, Bartel et al. 2009).[D1]

Second, the international transfer and generation of knowledge do entail uncertainty about foreign contexts. However, this uncertainty has mainly to do with obstacles to communication between actors involved in the international generation and use of knowledge. We suggest that this specific type of uncertainty is affected by cultural and social diversity – i.e. factors that are usually subsumed in the concept of "psychic distance" – more than by geographic distance.

Third, knowledge agglomeration factors determine a high geographic concentration of R&D (Audretsch and Feldman 1996, Cantwell and Iammarino 2003).[D2] These forces play a distinctive role as economic attractors of R&D FDIs, and may by and large compensate the effects of distance.

This way of conceptualising the gravity of R&D FDIs is broadly consistent with the literature that has emphasised the role of proximity to centers of excellence in the transmission and absorption of knowledge (Jaffe et al. 1993). The idea is that while the exploitation of (tacit) knowledge requires proximity, firms need to source cut edge technology where it is concentrated and this implies that they may have no choice but setting up R&D labs in distant locations. In other words, to exploit the advantages of proximity in terms of knowledge generation and absorption it may be neither useful nor convenient to locate R&D close to the home-base.

Chart 1 provides some rough illustrative evidence of the lower impact of distance in the case of R&D FDIs. It is shown that FDIs originating from the US are much more directed towards close-by areas in the case of investments in manufacturing activities (continuous lines) than in the case of R&D investments (dotted lines). The share of total R&D FDIs is higher than the share of total manufacturing FDIs when we consider investment flows directed towards relatively distant locations like India and Europe, and it is just about the same in the case of investments directed towards China. The opposite can be observed in the case of nearby locations: US firms set up manufacturing activities in close by locations (Canada, Central and Latin America) much more than is the case when they locate R&D activities abroad.

We shall provide more detailed and rigorous evidence on the role of distance factors in the rest of this paper. Using data on bilateral FDIs of 58 countries in 2003-2008, we shall show that, in fact, geographic distance is less of an obstacle to the location of R&D activities than it does for other types of FDIs. Moreover, we shall provide evidence that psychic distance, as measured by differences in language and religion, and institutional proximity, as in the case of countries belonging to the same free trade area, are more important than geographic distance. Indeed, once accounted for psychic and institutional distance factors, it is equally likely to set up R&D activities in locations geographically near or far away from the home country.

The paper is organised as follows. Section 2 introduces some of the literature related to the present work and discusses how the gravity framework can be adapted to interpret R&D FDIs. Section 3 illustrates the data, while Section 4 presents the econometric specification and section 5 illustrates the results of the analysis. Section 5 concludes.

2. Related literature and interpretive framework

In this section we first review the basic gravity model and its applications to trade and FDIs (§ 2.1). We thereafter focus on the two building blocks of the model, namely "economic attractors" (§ 2.2) and "geographic distance" (§ 2.3), and then extend the analysis to the literature on "psychic distance" factors (§ 2.4). We finally derive implications for bilateral R&D FDIs (§ 2.5).

2.1 Gravity models of international trade and FDIs

In his pioneering work, Tinbergen (1962) identified two main sets of determinants of cross-border transactions: "Distance", which he expressed in terms of nautical miles separating two countries, and "Economic attractors", which he identified with the size of economic systems of origin and destination of trade flows. Using a cross country regression on 1958 trade flows for 18 countries, subsequently extended to 42 as a robustness check, he found a positive impact of attractors and a negative impact of geographic distance[1]. The model fitted extremely well in terms of statistic significance, thus representing a very successful application of Newton's universal law of gravity to social interactions[2].

Timbergen's book represents the beginning of an abundant theoretical and empirical literature on the gravity equation for trade (Anderson and van Wincoop, 2004, Brakman and van Bergeijk 2010). The model has been extended to explain also bilateral foreign direct investments (FDI) (Bergstrand and Egger, 2007). In general, studies using the gravity equation find that home and host country's market size have a positive effect on the volume of affiliate sales, while distance between the two countries has a negative effect on FDIs (Brainard, 1997; Kleinert and Toubal, 2010). Partially consistent with a gravity framework, Carr et al. (2001) and Blonigen et al. (2003) derive a empirical specification of the knowledge capital model, and show that even controlling difference in skills and market size, geographical distance still hamper U.S. outward FDI.

The successful empirical application of the gravity model to different contexts has long co-existed with an under-developed theoretical basis (Deardooff 1984, Evenett and Keller 2002, Harrigan 2001). In the 1990's economists have shown that the gravity equation could be derived from different theoretically founded models, and empirical specifications have been adapted and made more complex accordingly (see De Benedictis and Taglioni 2011 for a review). However the building blocks of both theoretical and empirical analysis remained largely the same as in the original model proposed by Timbergen. Let us focus on these building blocks more closely.

2.2 Economic attractors in gravity models

In the original gravity model, the propensity of countries to get involved in bilateral economic transactions basically depends on their size, commonly expressed in terms of GDP, GNP or population. In the case of the destination country the idea was to capture its actual and potential expenditure; in the case of the country of origin, size will proxy its capacity to supply export goods. Poyhonen (1963)[D3] claimed that the size of importing country plays a dual role. On the one hand, it indicates its demand, both internal and external. On the other hand it is associated with the country's diversification and richness of production. In principle the impact of this variable could

[1] Timbergen also included a dummy for adjacency of countries among the distance factors, assuming that economies sharing a border would have more intense trade than what distance would predict, and estimated non significant estimates for this variable's coefficient. Moreover he augmented the model with a policy variable to capture the impact of preferential agreements between countries, whose impact resulted barely significant.

[2] Several scholars independently developed similar approaches before and contemporaneously, although the use of gravity concepts was not as simple and straightforward, as in the case of Ravenstein (1885) and Zipf (1946) with reference to migration flows, and Poyhonen (1963) who emphasized some non linearities in the role of economic attractors.

be positive if demand pressures prevail, or negative if it mainly signals self-sufficiency on the production side. Consistent with this view, he found that countries trading less than normal (i.e. below the regression line) were the biggest and the richest. This idea has been explored in subsequent works both theoretically (Anderson 2007), and empirically (Alesina et al 2005, Rose 2007).

Also in the case of FDIs the size of countries plays a role as an economic attractor. The size of destination countries reflects the possibility for foreign investors to exploit plant level economies of scales (Brainard 1997), and learning opportunities (Caves 1996)[D4]; while the size of home countries is associated with stronger country specific ownership advantages (Dunning 1981), higher diversification opportunities for firms (Franko 1976), [D5]and more dynamic national innovation systems, favouring firms' accumulation of competencies to exploit in foreign markets (Cantwell 1989, Narula 2003).

Other economic attractors include: per capita GDP (Frankel 1997)[D6], measures of infrastructural development (Limao and Venables 2001), and colonial ties as well as changes in post-colonial relations determined by political processes leading to independence of colonised countries (Head et al. 2009). While the latter variable may have some dynamic flavour, most of the proxies used for attractors have a low variability in time. Thus, a viable empirical strategy widely pursued in the literature, as an alternative to a proliferation of controls for economic attractors, is the use of fixed country effects as catch all dummy variables[3].

2.3 Geographic distance factors in gravity models

The hampering effect of geographic distance over bilateral economic transactions has been widely acknowledged. In a very revealing meta-analysis of 103 papers on this subject, Disdier and Head (2008) demonstrate that the alleged negative impact of geographic distance rose around the middle of the 20th century and has remained persistently high since then.

As Tinbergen (1962) first posited, distance can be considered a rough measure of transportation costs and/or as an index of uncertainty and information costs that firms bear to enter foreign markets. While the transportation costs may affect trade and vertical FDIs (which in turn involve trade intermediate goods), information costs are generally significant in the case of (vertical and horizontal) FDIs. In fact, the latter are associated with some fixed, partially irreversible costs, as in the case of setting up a plant (as it may be the case of both vertical and horizontal FDI) or commercialisation facilities (horizontal FDI). More generally speaking, geographic distance may

[3] The use of country fixed effects has also become a popular practice to capture "multilateral resistance" factors, that is obstacles to the development of economic relationships of a given country *vis à vis* all other countries (Harrigan 1996, Feenstra 2005).

positively affect what Hymer (1960) called the “liability of foreignness”, i.e. the extra-costs, risks and uncertainty that internationalising firms will bear due to the higher diversity of markets, institutions and cultures that they will have to deal with.

Some works address only part of the story and focus on the links between distance and transportation costs. Hummels and Skiba (2004)[D7] examine differences in transport costs across goods and challenge Samuelson’s assumption that transport costs are linear in distance. Harrigan (2010) distinguishes transport costs according to the weight of goods, and tests the implication that the US should import heavier goods from close countries, and lighter goods from faraway.

Other authors do try and disentangle the impact of distance on different cost categories, which are in turn affecting trade and FDIs. Egger and Pfaffermayr (2004) suggest that exports and FDI may be substitutes with respect to distance, depending on the impact of set-up costs relative to transportation costs. Davies and Kristjánsdóttir (2010) examine the determinants of fixed costs and highlight the crucial role they play in aggregate patterns of inward FDI in Iceland. Head et al. (2009) find that even in the case of services, where shipping costs are relatively low, it is more likely that firms offshore their activities to relatively closer locations. The authors reach the conclusion that higher distance would imply greater complexities in the delivery of services to the advantage of local suppliers. In a similar vein, Blum and Goldfarb (2006) show that gravity holds even in the case of digital goods consumed over the Internet, which do not have trading costs. Portes and Rey (2005)[D8] show that a gravity model explains international transactions in financial assets at least as well as in the case of material good transactions. In their analysis, distance proxies for costs associated with information asymmetries between domestic and foreign investors. Guiso et al. (2009)[D9] go even further, finding that lower bilateral trust leads to less trade between two countries, less portfolio investment, and less FDI. The effect is stronger the more trust-intensive are the goods exchanged.

2.4. Psychic distance factors in gravity models

Associating all the cost categories identified above, ranging from transport to information costs, to a single “rough measure” like geographic distance might simplify the job to correlation hunters, but is hardly satisfactory from an analytical point of view. Several scholars have thus extended their attention from spatial distance to other dyadic measures of social, cultural and institutional diversities between countries. All of these cross-country differences can be labelled as “psychic distance factors”.

The term dates back to Beckerman (1956) who observed that, transportation costs being equal, entrepreneurs might have difficulties serving markets characterised by significant psychic distance.

As Johanson and Vahlne (1977 p.24) would later put it, psychic distance is "the sum of factors preventing the flow of information from and to the market".

Most empirical studies on psychic distance have used proxies based on Hofstede's (1980) dimensions of national culture, namely: masculinity, individualism, power distance and uncertainty avoidance (Kogut and Singh 1988, Arora and Fosfuri 2000). However, these measures capture only part of the much broader concept of psychic distance. Other scholars developed more complex indicators taking into account additional factors, such as religion, education, industrial development or political systems (Shenkar, 2001; Evans and Mavondo, 2002; Dow and Kuranaratna, 2006)[4].

Psychic distance factors have been employed to analyze a wide range of phenomena, including performance (O´Grady and Lanes, 1996; Dow and Ferencikova, 2010), export-import relationships (Prime, et al. 2009), online internationalisation (Yamin and Sinkovics, 2006), MNE entry behaviour in foreign markets (Hosseini, 2008), entry mode (Dow and Larimo, 2009; Dow and Ferencikova, 2010) or the internationalisation of knowledge-intensive small and medium enterprises (Ojala and Tyrvainen, 2009). These studies generally find strong negative and significant correlations between psychic distance and economic relations between countries, including bilateral FDIs. However, there is a gap in the literature about the impact of psychic distance in the location of different business activities, especially R&D, that we try to overcome with our study.

2.5 The gravity of R&D FDIs: an interpretive framework

Chart 2 summarises the discussion above on the building blocks of the gravity model. Standard determinants of bilateral economic relations – including FDIs - are identified as "Distance factors" and "Economic attractors". The former affect international investment decisions via transportation costs (vertical FDIs) and information costs (both vertical and horizontal FDIs) as discussed earlier. Economic attractors include country size and other characteristics of economic systems affecting the likelihood of their involvement in bilateral (vertical and horizontal) FDI flows.

The framework is augmented with "Psychic distance" which includes a set of factors, different from geographic distance, which are likely to have a remarkable impact on "information costs" associated to internationalisation. In other words, social, cultural and institutional factors affect the ease of communication between economic agents, and raise "barriers to learning about markets" (O'Grady and Lanes 1996). Geographic distance may affect psychic distance in some way. In fact,

[4] Some authors claim that psychic distance should be examined in terms of managers' perceptions rather than exogenous differences between countries. Cognitive maps have been used for this purpose (Evans and Mavondo, 2002; Sousa and Bradley, 2006; Ellis, 2008). However, this approach leads to a problem of causality (Dow and Kuranaratna, 2006; Dow and Ferencikova, 2010). Since it is unusual to be able to survey a decision-maker's perceptions immediately prior to a critical decision, most researchers rely on *ex-post* perception. Unfortunately, it is very difficult to distinguish whether *ex-ante* perceptions lead to the decision or the *ex-post* experience influences the perception itself.

cultural and social similarities historically emerge by contamination between peoples, and the latter is obviously favoured by spatial proximity. However, differences in languages, religions, and institutions are also the result of largely autonomous processes occurring at different levels (national, sub-national and supra-national), which are thus independent of cross-country borders and distance. In other words, psychic distance may well influence trade and FDI decisions even in the absence of geographic distance[5].

We submit that some of the factors discussed earlier in this section, and illustrated in Chart 2, play a remarkably different role in the case of R&D FDIs because they mainly involve the international transfer, absorption and use of knowledge.

First, transport costs have a much lower impact on R&D offshoring than in the case of other activities, especially when codified knowledge is involved. This helps explain the increasing geographic dispersion of R&D activities, which is stimulated by the development and diffusion of new communication technologies and by advances in codification methods (Patel and Pavitt, 1991; [D10]Arora and Gambardella 1994[D11], Prencipe et al. 2003). Low and decreasing costs of knowledge transmission also favour the fragmentation of innovative activities on a global scale (ProInno 2007, Bartel et al 2009).

Second, the international transfer and generation of knowledge do entail uncertainty about foreign contexts. However, one may argue that this is a specific type of uncertainty. In fact, R&D FDI decisions are not so much affected by the costs of gathering information on the characteristics and evolution of local markets. What is even more important is the cost of communication between actors involved in the international generation and use of knowledge. We suggest that this specific type of uncertainty is affected by cultural and social diversity – i.e. factors that are usually subsumed in the concept of "psychic distance" – more than by geographic distance.

Third, along with standard economic attractors – country size, infrastructure, industrial development levels and colonial ties – knowledge agglomeration factors play a key role in the case of R&D FDIs. On the one hand, the "co-location" of complementary activities leads to cumulative processes of agglomeration, particularly in the case of R&D and production (Defever, 2006). On the other hand, there is also evidence of a growing number of asset seeking and asset augmenting FDIs (Narula and Zanfei 2005) accruing to top level national innovation systems, where high quality scientific institutions and centers of excellence are located, and where the protection of intellectual property rights is effective (von Zedtwitz and Gassmann 2002; Reddy 2000, UNCTAD 2005, Arundel and Geuna, 2004).

[5] "While the transportation costs paid by an Italian entrepreneur on a raw material supplied by Turkey may be no greater than the same material supplied by Switzerland, he is more likely to have contacts with Swiss suppliers, since Switzerland will be 'nearer' to him in a psychic evaluation (fewer language difficulties and so on)" (Beckerman, 1956).

Co-location processes within and across sectors are thus leading to a high geographic concentration of R&D (Audretsch and Feldman 1996, Cantwell and Iammarino 2003) and to the creation of clusters where investors can benefit from agglomeration economies and knowledge spillovers (Verspagen and Schoenmakers, 2004;[D12] Cantwell and Piscitello, 2005; Giarratana et al. 2005; Defever, 2006). These forces play a distinctive role as economic attractors of R&D FDIs, and may by and large compensate the effects of distance.

3. Data

Our empirical analysis is based on data on over 60,000 bilateral investment projects between 58 countries over the period 2003-2008. Information on bilateral investments is drawn from *fDi Markets,* an online database maintained by *fDi Intelligence* - a specialist division of the Financial Times Ltd - which monitors crossborder investments covering all sectors and countries worldwide. Relying on media sources and company data, *fDi Markets* collects detailed information on crossborder greenfield investments (available since 2003). Data are based on the announcement of the investment and provide daily updated data[6]. For each of the recorded projects, *fDi Markets* reports information on the investment, such as the industry and main business activity involved in the project, the location where the investment takes place (host country, regions and cities), as well as the name and location of the investing company (home country, region and city). The database is used as the source for FDI project information in UNCTAD's World Investment Report and in publications by the Economist Intelligence Unit.

Our sample includes all OECD countries, including those labelled as candidates (Russia) or enhanced engagement countries (Brazil, China, India, Indonesia and South Africa). We also included nineteen additional emerging economies which either attract or originate at least the same number of FDI projects as OECD countries which have the lowest involvement in bilateral investments according to our data source[D13]. This set of countries covers around 90% of all investment projects included in the selected source of bilateral FDI data and, more specifically, 97.5% of all *R&D* projects. The list of countries is available in Table A.1.

For the purpose of this paper, we exploit the information on home and host countries, as well as the main business activity involved in each project. In particular the latter information allow us to

[6] A team of in-house analysts search daily for investment projects from various publicly available information sources, including, Financial Times newswires, nearly 9,000 media, over 1,000 industry organizations and investment agencies, data purchased from market research and publication companies. Each project identified is cross-referenced against multiple sources, and over 90% of projects are validated with company sources. More information at http://www.fdimarkets.com/

classify each investment into one of three different types: investments in *R&D*[7], investments in *manufacturing* activities and a residual category, which includes a mix of *other types of investments*, spanning from sales/marketing (the largest category), to business services, logistics, testing and extraction. Consistent with conventional wisdom, R&D FDI projects appear to be more geographically concentrated than those in manufacturing activities, by both area of origin and destination. The US and EU15 countries originate over 75% of total R&D projects, as opposed to 56% of manufacturing FDIs originating from these two areas. The top 3 destination areas (India, China and the EU) account for about 70% of US R&D projects. EU 15 investments are more dispersed. It remains that the top 5 destination areas attract 74% of EU15 R&D FDIs (as opposed to 70% of manufacturing FDIs). See tables 1 and 2 for details

4. Econometric specification

4.1. Dependent variable

We estimate a gravity model for the number of bilateral investments projects in our sample of 58 countries over the 2003-2008 period. We ran several regressions for the total number of projects and for subsets aggregated by business activity into investments in *R&D*, in *Manufacturing* and in *Other activities*.

As most of our key explanatory variables are varying very slowly over time (see the discussion on explanatory variables below) there is not much to gain from a panel estimation, so we choose to estimate a cross-section regression where the dependent variable is the cumulative number of investment projects over 2003-2008 and the independent variables are measured before 2003. Since the dependent variable results from the count of the number of projects is non-negative and integer-valued with a very left-skewed distribution[8], then Poisson or negative binomial econometric models are more appropriate than OLS in our context. Due to the presence of overdispersion[9], negative binomial is to be preferred over Poisson, which assumes that the conditional variance equals the conditional mean. It is worth mentioning that the use of poisson and negative binomial methods has been recently indicated as one of the most appropriate methods to estimate gravity models, also in

[7] To clarify what is intended for R&D investments, here are two examples that fDi Markets reports with specific reference to IBM as an investor. Example 1: a nanotech research centre in Egypt is intended to be a world-class facility for both local engineers and scientists, and IBM's own researchers, to develop nanotechnology programs. The centre will work in co-ordination with other IBM Research efforts in the field in Switzerland and the US. Example 2: a business solution center to promote new technologies that help save energy used to run computer equipment and reduce hardware management costs. Teaming up with automakers and electronics manufacturers, the center will study how to make the best use of advanced technologies. IBM Japan intends to use the results of these efforts to win system development projects

[8] Indeed, 91.1% of country-pairs registered zero investments in R&D, and 87.7% have no investments in Design, Development and Testing. Investments in manufacturing are a less rare event, but still 64% of observations are zeros.

[9] Which can be easily detected in our data, for example, by testing for the significance of the parameter α in the negative binomial regressions reported below.

the case non count data, as a solution to the problems of zero trade flows (Santos Silva and Tenreyro, 2006).

4.2. Independent variables

As usual in gravity models, we control for geographical distance, defined as the number of kilometres separating the largest cities in the home and host countries weighted by their share in national population.

We also include a number of variables facilitating trade and investments between two countries, which are usually referred to as the bilateral resistance factors, such as sharing a common frontier, a colonial relationship, a common language[10], and being part of the same Free Trade Area[11]. To account for some specific factors facilitating bilateral investments, we add a dummy for countries sharing a bilateral investment treaty (BIT) in 2000[12]. Each regression includes both home and host country dummy variables, which control for standard "economic attractors" or, in more fashionable terms, for "multilateral resistance" factors (Anderson and van Wincoop, 2003, Subramanian and Wei, 2003). These dummies will capture the effect of market size, as well as any other country characteristic which may increase the propensity to invest abroad, and the attractiveness to foreign investors – including agglomeration economies which play a crucial role in attracting FDIs. This will allow us to focus on the determinants of bilateral investments[13]. We then augment our standard gravity equation, controlling for the psychic distance between home and host countries. We choose to rely on indicators of psychic distance from Dow and Karunaratna (2006), who propose five different constructs for differences in language, religion, level of democracy, industrialisation and education[14]. In accordance with the arguments of the authors, we use the difference in absolute value in the indicators of democracy, education and industrialisation. In fact, in these cases we have a value of the indicator for the home country and one for the host, so we can then compute the distance between the two countries. A value close to zero denotes two countries with very similar level of democracy, education or industrialisation. Thus we do not give any weight to the circumstance that the home country has higher values than host countries: what matters is that

[10] Data on geographic distance, adjacency, common language and colonial ties are from the CEPII (http://www.cepii.fr)

[11] Distinguishing between Asean, EU27, Mercosur and Nafta

[12] Data on Bilateral Investment Treaties have been compiled by the authors from information on UNCTAD's website (http://www.unctad.org)

[13] As a robustness check, we have included the difference and the sum of the home and host country's GDP, as suggested by Carr et al. (2001) and Blonigen et al. (2003), but our main results would not change. With home and host country dummies, introducing these additional terms created convergence problems in the less parsimounious models of R&D FDI, so we decided not to include them in our final specification.

[14] Data are available on line at: http://www.mbs.edu/home/dow/research/public/psydist.html

countries are similar or different (i.e. distant).[15] On the contrary, the language and religion factors are truly bilateral measures. For example, the distance between two countries in terms of religious attitude is based on a classification of religions according to the family, divisions and sects they belong to. The highest distance is recorded when a pair of countries is characterized by two "major" religions belonging to different families (e.g. monotheistic vs. reincarnation based); the lowest distance is observed when religions belonging to the same family (e.g. monotheistic based), also belong to the same religion group (e.g. Christianity), the same division (e.g. Anglican), and the same denomination/sect (e.g. Baptist). A major religion is defined as any religion to which more than 20% of the population claims an affiliation. The variable used is a factor resulting from a principal component analysis and takes values from -1.551 (religions of the home and host countries are very similar, as in the case of Ireland and Spain or Algeria and Morocco) to 1.528 (maximum difference, e.g. Israeel and India or Vietnam and Saudi Arabia). Then it is clear that taking the absolute value of this factor would in this case be meaningless. In a similar vein, the indicator used to capture the distance in languages is based on differences between families of idioms (e.g. Altaic), branches (e.g. Germanic), sub branches (e.g. Transitional Scandinavian), specific languages within sub-branches (e.g. Norwegian). This index ranges from -3.868 (lowest distance, in the case of countries whose major language belongs to the same family, branch, sub-branch, and the language itself is basically the same e.g. UK and U.S. or Argentina and Spain) to 0.526 (highest distance, in the case of countries with different language, branch, sub-branch and family, e.g. Germany and China or Mexico and Turkey)..

There are several reasons to use the Dow and Karunaratna (2006) scales, instead of other exogenous psychic distance scales, such as Brewer´s (2007). While the two scale typologies overlap in several respects, such as culture, language and level of development, the Dow and Karunaratna scales cover a broader range of the factors most commonly associated with psychic distance and are available for a larger set of countries (Dow and Ferencikova, 2010).

Robustness checks will be carried out using other measures of cultural and psychic distance. In particular, we will use an indicator of difference in the level of trust towards a third party, built from data from the World Values Survey. We will also exploit information on Hofstede (1980)'s cultural distance dimensions (masculinity, individualism, power distance and uncertainty avoidance) relying on the updated scores made available by Taras and Steel (2006)[16]. Differences in IPR regimes, which may reflect common business cultures and affect the level of bilateral trust, will be computed from Ginarte and Park index (2008) data for the year 2000.

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[15] On this aspect, see also the comment of Bloningen et al. (2008) on Carr et al. (2006)

[16] Results using the original Hofstede´s scores or those updated by Tang and Koveos (2008) remain with no significant changes.

The full list of variables, sources and descriptive statistics is available in Table A.2

5. Results

Table 3 presents the estimation of the basic and the augmented gravity equations for the overall number of bilateral investments as well as for the number of investments by business activity.

First, one may notice that the usual bilateral resistance terms used to explain trade, seem also to affect FDIs: countries are more likely to have bilateral investments if they share the same language, have a common border or past colonial ties, and are in the same Free Trade Area. In line with some previous research (e.g. Egger and Merlo, 2007) Bilateral Investment Treaties seem also to favour FDIs. However, the latter factors play a very different role according to the type of investments. BITs have a strong and significant impact in the case of investments in the residual group of activities, probably due to the fact that the lion's share is that of investments in sales and distribution investments, which are clearly complementary to export activities and are more affected by the quality of trade environment. These factors are instead quite irrelevant in the case of manufacturing and R&D FDIs.

As for the role of distance, results reveal that a 10% increase in distance, reduces bilateral investments by about 8%. This result is in line with what is generally found in the literature when the effects of geographic distance on trade are estimated.[17] However, again remarkable differences emerge when we compare different types of investments: in the case of R&D FDI the effect of geographic distance in the baseline gravity specification is as low 2.4%.

Once we control for Dow and Karunaratna's psychic distance measures, the effect of geographic distance on R&D FDI shrinks even more, becoming not statistically different from zero. In other words, once accounted for differences in psychic distance between countries, it is equally likely that firms from one country locate R&D in close as in distant locations.

This result is consistent with the interpretive line developed in section 2.5, where we suggested that the location of knowledge activities is less affected by transport cost considerations and more by communication costs, which in turn are influenced by psychic differences/proximity factors more than by geographic distance. Moreover, the choice of distant locations may be forced by knowledge agglomeration processes which have historically favoured a high geographic concentration of R&D in relatively few regions with higher quality human capital, infrastructures and institutions.

[17] The effect of distance on trade ranges from 8 to 13% (De Benedictis and Taglioni, 2011; Santos Silva and Tenreyro, 2006, Helpman et al. 2008) according to the estimation method used. We ran the same regression as the one illustrated in table 2 using export as a dependent variable and estimated an impact of 11% for this variable. Results are available from the authors upon request..

This interpretation of results is somewhat strengthened if we compare R&D FDIs to investments in Design, Development and Testing activities (one of the FDI typologies included in the residual "Other" category). These investments are likely to be closer to the commercialisation of technologies, and hence should be more sensitive to market pressures as compared to those that are more purely associated to the application of science or to the development of new technology. Hence, Design, Development and Testing (DDT) investments can be considered as a rough proxy of "market seeking"/ "asset exploiting" R&D FDIs, i.e. basically market driven and oriented to the commercial exploitation of existing knowledge. The dataset yields as many as 2100 FDI projects of the DDT type. The 392 which were classified as pure R&D FDI projects are likely to be more exploratory in nature and closer to the category of "knowledge sourcing"/ "asset seeking" FDIs which is being increasingly emphasised in the literature (Narula and Zanfei 2005, Griffith et al. 2006). Table A.3 shows that in the case of our proxy of asset exploiting investments in R&D, i.e. those in Design Development and Testing activities, the effect of distance is slightly larger at about 3.6%. This may signal that transport cost play some role here, due to the need of shipping intermediate inputs to be tested, or to the fact that these activities may be located relatively close to production and final markets. Furthermore, to the extent that these investments are not aimed at accessing cut-edge knowledge and technology, there may be more of a choice for a location, and this encourages locating these activities relatively closer to home.

In Table 4 we further investigate the key dimensions of psychic distance to explain bilateral R&D FDI. Column 1 shows that, if we do not account for the effect of sharing the same official language, bilateral R&D FDIs are more likely towards (former) colonies. However, this appears a figment of the fact that countries with colonial ties in many cases share the same official language. Once we control for language commonality (column 2) the colony dummy becomes insignificantly different from zero and the coefficient on distance falls from -.336 to -.242 (i.e. a substantial plunge in absolute magnitude). An even larger drop is obtained if we control for differences in religion between countries (column 3): the coefficient on geographic distance shrinks to -0.174 and becomes barely significantly different from zero. Controlling for both differences in religion and in the official language yields the final result: the effect of distance drops by 80% (from -0.336 to -0.069) and turns out to be not significant.[18] For comparison, consider that the coefficient of distance drops by 46% (from -0.453 to -0.243) in the case DDT investments and only by 14.6% (from -.902 to -.770) for manufacturing FDI (see table A.3, column 3).

[18] Adding further dimensions of psychic distance does not change much the overall picture. Only differences in democracy are barely significant, but the other coefficients are rather stable. Notice that it is not possible to compare the coefficients associated to `comlang` and `relig_f` since the former is a dummy variable, thus the coefficient can be interpreted as an elasticity, while the latter cannot.

It is worth mentioning that bilateral R&D investments are more likely between two countries which are part of a Free Trade Area (such as the EU, Nafta, Mercosur and Asean), and, more importantly, if we omit to control for this variable, geographic distance remains significant.

In sum, *coeteris paribus*, firms are equally likely to set up an R&D plant in the immediate geographic proximity or in a distant location, if their countries of origin and of destination share the same language and have a similar religion and belong to the same Free Trade Area.

The estimated impact of these factors thus confirms that R&D FDIs are largely driven by cultural and institutional proximity which facilitate communication between actors involved in international transmission, adoption and creation of knowledge. In the absence of more direct measures, international similarities in religious attitudes and belonging to the same trade area might also be considered as rough and indirect proxies of bilateral trust between countries. In fact Relig_f and FTA broadly capture a commonality of cultural values, beliefs, norms and codes of conduct, facilitating mutual understanding and reducing the likelihood of opportunistic behaviour.

In Table 5, we introduce, as robustness checks, further (imperfect) measures intended to capture differences in trust, culture and institutions. First, we include a measure of difference in the extent to which countries trust other people, built from the World Values Survey[19]. This measure is used as a determinant of bilateral R&D FDI in Column 1 of Table 5 and its effect turns out to be not significantly different from zero. However, upon inclusion of this variable the effect of differences in religion becomes also insignificant. This could be seen as confirming the fact that religion actually captures differences in trust, so that the two variables become collinear. However, a closer inspection of our results reveals that it is rather the effect of missing values that changes the result on the effect of `relig_f`. In fact, data from the World Values Survey are not available for all countries in our sample, so that the number of observations used for estimation in column 1 drops to 2970 (from 3306 of our baseline specification). Once we estimate our baseline specification on this reduced sample, even without introducing `ks_trust`, we notice that `relig_f` remains not significant. In other words, the drop in the effect of differences in religion reflects the sample selection induced by missing values in the measures of trust.

We further check for the robustness of our results by controlling for two sets of variables: one related to Hofstede's measures of cultural distance, and the other related to differences in Intellectual Property Rights (IPR) protection. As for cultural distance, we refer to the four classic dimensions introduced by Hofstede (1980): masculinity, individualism, power distance and

[19] The variable is constructed applying the following transformation (Kogut and Singh, 1988): $(X_s - X_d)^2 / Var(X)$, where X_s and X_d denote the value of the normalized variable in the source (home) or in the destination (host) country. The squared difference is then normalized by the variance of the variable.

uncertainty avoidance. We compute the Kogut and Sing's (1988) transformation (see footnote 19 for details) for each dimension, using the recently updated source of information made available by Taras and Steel (2006) for a larger sample of countries. Results, presented in column 3 of Table 5, reveal that only a similarity in uncertainty avoidance appears to foster bilateral R&D FDI, but this does not seem to change the effect of either geographic distance, nor `comlang` nor `relig_f`. Interestingly enough, since Taras and Steel data have missing values, the number of observations drop (more than in the case of columns 1 and 2) without affecting the general results.

Finally, we test whether small diversities in IPR, computed as the Kogut-Singh difference in Ginarte and Park's IPR indicators, may be conducive to more trust and thus to more bilateral R&D FDI, but results do not support this hypothesis. It is comforting, though, that even in this case missing values (equal in number but referred to different countries than those in the culture measures) do not affect the baseline results.

6. Conclusion

The key finding of this paper is that geographic distance does not hamper R&D FDIs as much as in the case of other FDIs. We have argued that this has to do with the fact that this FDI typology involves the development, transfer and use of knowledge. On the one hand this implies that usual trade costs are less relevant, thus reducing the role of distance as a bilateral resistance factor. On the other hand, geographic distance only partially captures the impact of information and communication costs that are crucial for the international transmission, exploitation and generation of knowledge. We have shown that other social, cultural and institutional factors help explain bilateral R&D FDIs. These include the commonality of language, and imperfect measures of bilateral trust, as belonging to the same trade area or sharing similar religious attitudes.

R&D FDIs may thus be directed towards faraway locations, especially when the extra-costs of geographic distance – which are generally lower in the case of knowledge transactions – are more than compensated by the advantages of social, cultural and institutional proximity.

Moreover, we have argued that the choice of distant locations may also be driven by agglomeration forces which are particularly significant in knowledge intensive activities and have favoured a high geographic concentration of R&D. Firms may thus need to cover long distances to get as close as possible to the key centres of generation and application of knowledge.

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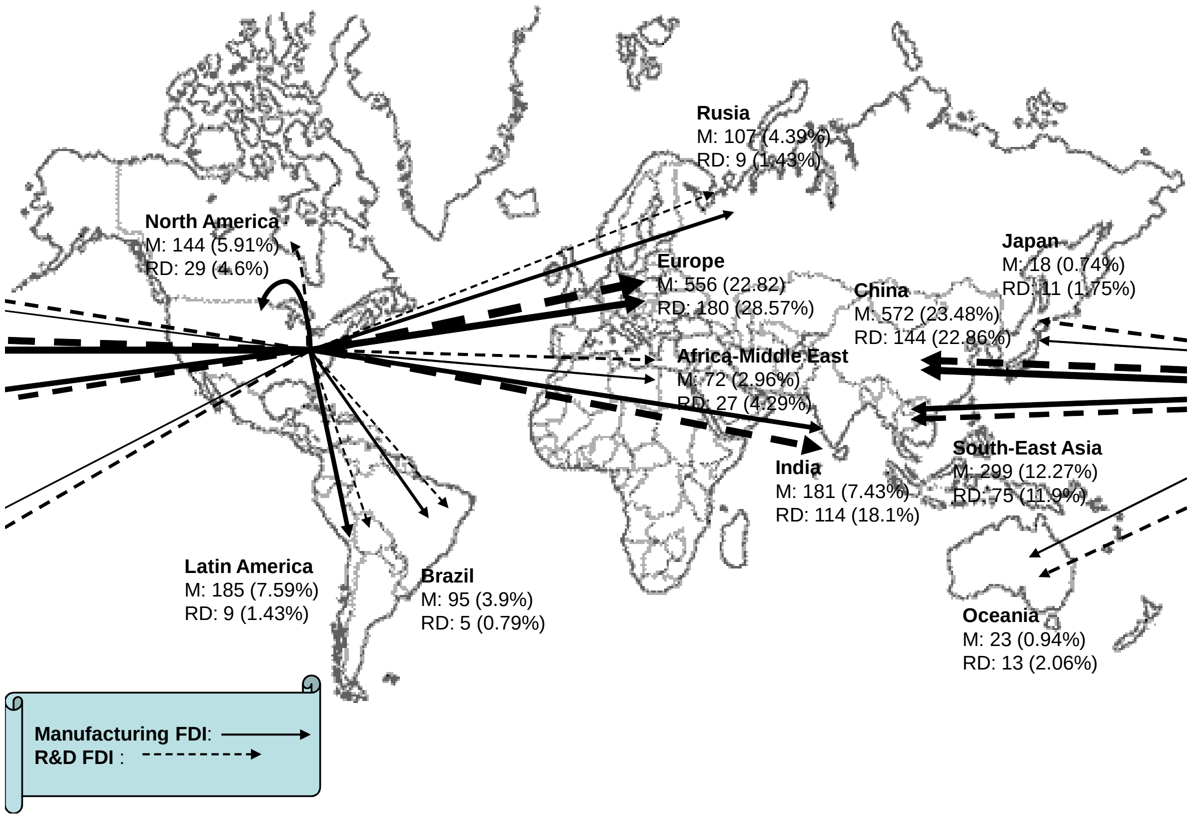
Chart 1 – Geographical distribution of US FDIs in manufacturing and R&D



Source: Authors' elaborations on fDi Markets

Chart 2 – A gravity like framework for the analysis of bilateral FDIs

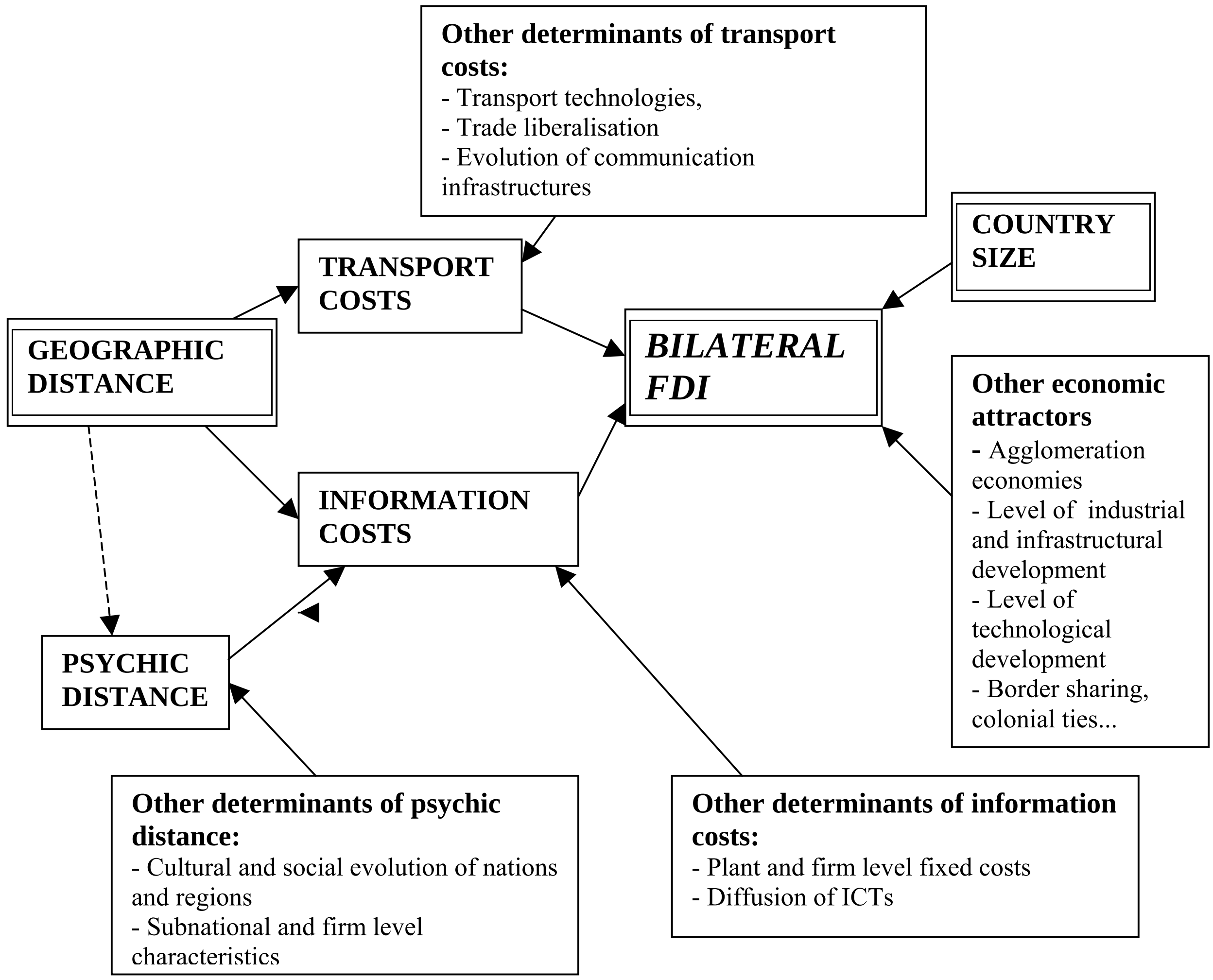


Table 1 – Geographical distribution of FDI, by area of origin and type of investment

Area of origin	Total	R&D	Manufacturing
EU-15	**43.41**	**28.1**	**41.91**
US	**25.57**	**47.81**	**16.63**
Japan	7.54	7.98	14.95
Other developed	4.67	2.96	3.9
BRIC	6.99	6.06	8.73
EU-12	1.65	0.33	1.15
Other-EU	3.85	3.34	4.15
Rest of the world	1.99	0.5	1.59
S. East Asia	4.34	2.93	6.99
Total	100	100	100

Source: Authors' elaborations on fDi Markets

Table 2 – Geographical distribution of FDI, by area of origin/destination pairs and type of investment

Origin / Destination	US		EU-15	
	man	**rd**	**man**	**rd**
EU12	10.1	4.7	**26.1**	**9.2**
EU15	**13.8**	**19.0**	**12.9**	**23.5**
Other Europe	1.0	1.2	2.0	1.8
Other advanced				
USA	0.0	0.0	7.3	**10.4**
Canada	2.8	2.4	1.0	1.7
Japan	0.9	2.0	0.4	1.9
Oceania	0.9	1.7	0.5	1.0
BRIC				
Brazil	4.7	1.4	3.3	2.4
China	26.6	20.8	16.2	17.0
India	**8.5**	**29.1**	**7.5**	**13.4**
Russia	4.7	1.9	7.8	1.2
Other developing				
Africa-M.East	3.8	4.0	5.1	4.7
Latin America	8.2	2.0	3.3	1.8
South-East-Asia	14.2	10.0	6.5	10.2
	100.0	100.0	100.0	100.0

Source: Authors' elaborations on fDi Markets

Table 3 – Geographic and psychic distance as determinants of foreign investment projects, all business activities, 2003-2008, negative binomial regressions, baseline results

	Total	Total	R&D	R&D	Manuf.	Manuf.	Other	Other
ln_distw	-0.814***	-0.761***	-0.242***	-0.074	-0.864***	-0.784***	-0.793***	-0.759***
	(0.036)	(0.036)	(0.084)	(0.099)	(0.047)	(0.048)	(0.038)	(0.039)
frontier	0.650***	0.418***	-0.350*	-0.296	0.205*	0.089	0.705***	0.464***
	(0.092)	(0.089)	(0.188)	(0.191)	(0.107)	(0.105)	(0.096)	(0.093)
colony	0.630***	0.537***	0.094	-0.080	0.648***	0.492***	0.613***	0.531***
	(0.098)	(0.095)	(0.173)	(0.172)	(0.116)	(0.114)	(0.102)	(0.100)
fta	0.192**	0.158*	0.306	0.467**	-0.072	-0.121	0.259***	0.218**
	(0.083)	(0.082)	(0.210)	(0.213)	(0.107)	(0.106)	(0.089)	(0.088)
bit_entr2000	0.299***	0.327***	0.083	0.088	0.099	0.130**	0.331***	0.354***
	(0.046)	(0.045)	(0.117)	(0.116)	(0.060)	(0.060)	(0.049)	(0.048)
offlang	0.717***	-0.332***	0.702***	0.830***	0.453***	-0.502***	0.716***	-0.290***
	(0.073)	(0.105)	(0.140)	(0.250)	(0.092)	(0.141)	(0.076)	(0.110)
relig_f		-0.108***		-0.333***		-0.095**		-0.087**
		(0.037)		(0.103)		(0.047)		(0.040)
lang_f		-0.399***		0.042		-0.382***		-0.392***
		(0.036)		(0.094)		(0.049)		(0.038)
dem_f_a		-0.016		0.397*		-0.131*		-0.005
		(0.053)		(0.230)		(0.071)		(0.057)
ind_f_a		-0.088**		-0.035		-0.099		-0.053
		(0.044)		(0.133)		(0.064)		(0.047)
edu_f_a		-0.047		-0.051		-0.102		-0.050
		(0.056)		(0.182)		(0.075)		(0.060)
_cons	9.583***	9.352***	-2.105*	-3.915***	6.694***	6.526***	9.524***	9.366***
	(0.350)	(0.354)	(1.078)	(1.198)	(0.474)	(0.492)	(0.369)	(0.374)
lnalpha	-0.659***	-0.773***	-2.083***	-2.335***	-0.841***	-0.958***	-0.620***	-0.714***
	(0.043)	(0.044)	(0.404)	(0.455)	(0.075)	(0.077)	(0.046)	(0.047)
LogLik	-7271.7	-7079.6	-963.5	-949.8	-3897.7	-3790.2	-6596.1	-6438.0
N. obs.	3422	3306	3422	3306	3422	3306	3422	3306

Table 4 – Geographic and psychic distance as determinants of foreign investment projects, R&D and manufacturing activities, 2003-2008, negative binomial regressions

	R&D				Manufacturing			
ln_distw	-0.336***	-0.242***	-0.174*	-0.069	-0.902***	-0.864***	-0.793***	-0.770***
	(0.087)	(0.084)	(0.101)	(0.098)	(0.046)	(0.047)	(0.049)	(0.049)
frontier	-0.181	-0.350*	-0.124	-0.297	0.257**	0.205*	0.284***	0.237**
	(0.196)	(0.188)	(0.195)	(0.185)	(0.107)	(0.107)	(0.106)	(0.106)
colony	0.346*	0.094	0.189	-0.055	0.826***	0.648***	0.743***	0.607***
	(0.184)	(0.173)	(0.182)	(0.170)	(0.111)	(0.116)	(0.112)	(0.116)
fta	0.192	0.306	0.332	0.457**	-0.109	-0.072	-0.083	-0.053
	(0.220)	(0.210)	(0.223)	(0.212)	(0.107)	(0.107)	(0.107)	(0.107)
bit_entr2000	0.081	0.083	0.076	0.073	0.106*	0.099	0.107*	0.100*
	(0.124)	(0.117)	(0.123)	(0.116)	(0.061)	(0.060)	(0.060)	(0.060)
offlang		0.702***		0.699***		0.453***		0.365***
		(0.140)		(0.137)		(0.092)		(0.092)
relig_f			-0.268***	-0.286***			-0.250***	-0.229***
			(0.098)	(0.092)			(0.045)	(0.045)
_cons	-1.426	-2.105*	-2.464**	-3.214***	7.014***	6.694***	6.319***	6.103***
	(1.101)	(1.078)	(1.143)	(1.119)	(0.473)	(0.474)	(0.483)	(0.483)
lnalpha	-1.669***	-2.083***	-1.767***	-2.269***	-0.818***	-0.841***	-0.863***	-0.884***
	(0.301)	(0.404)	(0.306)	(0.442)	(0.074)	(0.075)	(0.075)	(0.076)
LogLik	-975.4	-963.5	-963.6	-951.7	-3909.9	-3897.7	-3840.2	-3832.4
N	3422	3422	3306	3306	3422	3422	3306	3306

Table 5 Geographic and psychic distance as determinants of R&D FDIs, 2003-2008, negative binomial regressions, robustness checks

	R&D FDI	R&D FDI	R&D FDI	R&D FDI
ln_distw	-.11	-.106	-.0808	.00287
	(.0962)	(.096)	(.102)	(.101)
frontier	-.291	-.269	-.216	-.237
	(.184)	(.184)	(.203)	(.192)
colony	-.122	-.117	-.131	-.0979
	(.155)	(.155)	(.173)	(.173)
fta	.401**	.399**	.504**	.585***
	(.202)	(.202)	(.222)	(.217)
bit_entr2000	.198*	.209*	.228*	.114
	(.111)	(.111)	(.123)	(.117)
offlang	.789***	.785***	.971***	.835***
	(.249)	(.25)	(.254)	(.256)
relig_f	-.127	-.133	-.322***	-.359***
	(.11)	(.11)	(.113)	(.104)
lang_f	.0287	.0267	.201**	.0385
	(.0902)	(.0903)	(.0992)	(.0956)
dem_f_a	.303	.319	.471*	.345
	(.238)	(.24)	(.261)	(.243)
ind_f_a	-.0579	-.0576	.0767	-.0123
	(.139)	(.139)	(.142)	(.163)
edu_f_a	.00213	.00739	-.136	.0921
	(.189)	(.188)	(.198)	(.204)
ks_trust	-.0428			
	(.0314)			
ks_pdi_ts			.0117	
			(.0335)	
ks_ind_ts			-.0633	
			(.0415)	
ks_mas_ts			-.0283	
			(.0231)	
ks_uai_ts			-.0631***	
			(.0215)	
ks_gp				-.0268
				(.0453)
_cons	-18.9	-19.1	-4.09***	-19.7
	(911)	(844)	(1.23)	(600)
lnalpha	-3.54***	-3.54***	-2.43***	-2.38***
	(.995)	(.98)	(.475)	(.463)
LogLik	-837.4	-838.4	-860.0	-902.7
N	2970	2970	2756	2756

Table A.1 – Country list

Country code	Country name	Country code	Country name
ARE	UAE	JPN	Japan
ARG	Argentina	KOR	South Korea
AUS	Australia	LTU	Lithuania
AUT	Austria	LUX	Luxembourg
BEL	Belgium	LVA	Latvia
BGR	Bulgaria	MAR	Morocco
BRA	Brazil	MEX	Mexico
CAN	Canada	MYS	Malaysia
CHE	Switzerland	NGA	Nigeria
CHL	Chile	NLD	Netherlands
CHN	China	NOR	Norway
CZE	Czech Republic	NZL	New Zealand
DEU	Germany	PHL	Philippines
DNK	Denmark	POL	Poland
DZA	Algeria	PRT	Portugal
EGY	Egypt	ROM	Romania
ESP	Spain	RUS	Russia
EST	Estonia	SAU	Saudi Arabia
FIN	Finland	SGP	Singapore
FRA	France	SVK	Slovakia
GBR	UK	SVN	Slovenia
GRC	Greece	SWE	Sweden
HKG	Hong Kong	THA	Thailand
HUN	Hungary	TUN	Tunisia
IDN	Indonesia	TUR	Turkey
IND	India	TWN	Taiwan
IRL	Ireland	USA	USA
ISL	Iceland	VNM	Vietnam
ISR	Israel	ZAF	South Africa
ITA	Italy		

Table A.2 – Variable source and description

Variable	Description	% non-zero obs.	mean	std. dev.	p1	p10	p25	p50	p75
fdi_ddt	N. projects in Design, Development & Testing	12.3%	0.60	7.11	0	0	0	0	0
fdi_man	N. projects in Manufacturing	36.0%	3.50	18.38	0	0	0	0	1
fdi_rd	N. projects in Research & Development	9.9%	0.39	3.26	0	0	0	0	0
fdi_ret	N. projects in Other activities								
ln_distw	Log of distance between the n major cities of *s* and *d* (weighted) (CEPII)		8.44	0.98	5.96	7.02	7.67	8.84	9.19
frontier	frontier shared		0.04	0.19	0	0	0	0	0
colony	=1 if colonial ties existed between *s* and *d* (CEPII)		0.03	0.16	0	0	0	0	0
fta	=1 if *s* and *d* belong to a Free Trade Area (Asean, EU27, Mercosur, Nafta)		0.19	0.39	0	0	0	0	0
bit_entr2000	=1 if between *s* and *d* a Bilateral Investment Treaty has initiated before 2000 (UNCTAD)		0.33	0.47	0	0	0	0	1
offlang	=1 if *s* and *d* share the same official language (CEPII)		0.08	0.28	0	0	0	0	0
lang_f	Difference in language factor (Dow-Karunaratna)		0.09	0.84	-3.868	-0.258	0.048	0.265	0.526
relig_f	Difference in religion factor (Dow-Karunaratna)		-0.02	0.99	-1.551	-1.292	-1.032	-0.271	1.009
dem_f_a	Difference in degree of democracy factor (absolute value) (Dow-Karunaratna)		0.66	0.63	0.003	0.051	0.152	0.390	1.130
ind_f_a	Difference in degree of industrial development factor (absolute value) (Dow-Karunaratna)		0.77	0.54	0.014	0.111	0.306	0.708	1.103
edu_f_a	Difference in levels of education factor (absolute value) (Dow-Karunaratna)		0.69	0.50	0.013	0.104	0.27	0.595	1.027
ks_trust	Kogut and Sing's estimation of the difference in the extent to which countries trust other people (World Values Survey)		2.04	2.67	0	0.02	0.20	0.93	2.83
ks_pdi_ts	Kogut and Sing's estimation of the difference in the power distance index (Taras-Steel)		2.04	2.37	0	0.03	0.19	1.02	3.16
ks_ind_ts	Kogut and Sing's estimation of the difference in the individualism index (Taras-Steel)		2.04	2.55	0	0.04	0.21	0.97	2.95
ks_mas_ts	Kogut and Sing's estimation of the difference in the masculinity index (Taras-Steel)		2.04	3.31	0	0.01	0.18	0.93	2.48
ks_uai_ts	Kogut and Sing's estimation of the difference in the uncertainty avoidance index (Taras-Steel)		2.04	2.57	0	0.04	0.26	1.02	2.87
ks_gp	Kogut and Sing's estimation of the difference in intellectual property rights indicator (Ginarte-Parks)		2.04	2.80	0	0.03	0.18	0.75	2.71

Table A.3 – Geographic and psychic distance as determinants of foreign investment projects in Design, Development and Testing, 2003-2008, negative binomial regressions

	Design, Development and Testing		
ln_distw	-0.362***	-0.344***	-0.243***
	(0.072)	(0.087)	(0.084)
frontier	-0.027	0.153	0.006
	(0.148)	(0.160)	(0.149)
colony	0.174	0.340**	0.087
	(0.138)	(0.149)	(0.140)
fta	0.002	0.005	0.114
	(0.176)	(0.191)	(0.181)
bit_entr2000	0.175*	0.171	0.168*
	(0.098)	(0.105)	(0.098)
offlang	0.684***		0.696***
	(0.116)		(0.117)
relig_f		-0.178**	-0.193***
		(0.078)	(0.074)
_cons	0.395	0.298	-0.357
	(0.752)	(0.827)	(0.803)
lnalpha	-2.567***	-2.014***	-2.576***
	(0.386)	(0.257)	(0.369)
LogLik	-1159.5	-1165.0	-1149.1
N	3422	3306	3306