Determinants of Greenfield Foreign Direct Investment in R&D and Related Activities[1]

Martin Falk (Austrian Institute of Economic Research, WIFO)

this version 2013, may 3

Abstract:

This article investigates the determinants of bilateral greenfield FDI projects/flows in R&D, design, and testing activities from 24 OECD/BRIC countries to 40 industrialised and emerging countries for the period 2003-2010. The empirical results using the random-effects negative binomial regression model show that greenfield investments in R&D and related innovation activities depend on geographical distance, common language, hourly wage costs, skills measured as tertiary education, entry regulations, ICT infrastructure, and co-location with manufacturing FDI. Furthermore, the results show that the impact of FDI determinants differs between EU host countries and the total sample including all major industrialised and emerging countries as host countries. For the EU countries, the share of tertiary education is the most important determinant of greenfield FDI in R&D and related activities, while for the total sample, share of tertiary education, entry regulation costs, and internet infrastructure are significant and important factors.

JEL: F23, F14, C35

Keywords: greenfield foreign direct investment, R&D, gravity equation, panel count data models, FDI determinants

---

* Martin Falk, WIFO, Arsenal Objekt 20, A-1030 Vienna, Austria; phone: + 43-1-798 26 01 – 226, fax: + 43-1-798 93 86, e-mail: Martin.Falk@wifo.ac.at. Financial support from the European Commission within the framework of the Competitiveness Report is gratefully acknowledged. I thank Davide Castellani, Peter Egger, Heinz Hollenstein, Antonello Zanfei for helpful suggestions on a previous draft.

1 Introduction

Multinational corporations in industrialised countries are increasingly offshoring higher value-added, knowledge-intensive activities – often to low-wage countries (see also: Lewin et al., 2009). In particular, the offshoring of R&D activities has increased significantly in recent years (Hall, 2011). Advances in information and communication technologies are seen as the main factor in the rise of FDI in R&D and related innovation activities.

Historically, the EU member states have attracted a large share of cross-border investment in R&D and knowledge-intensive activities. Evidence based on the FDI markets database (fDi Markets) shows that this also holds true for greenfield investments in research and development, testing, and design activities. Furthermore, the EU economy is not only a major destination, but also a major source of greenfield investment in R&D and related innovation activities. However, the EU's attractiveness for FDI in R&D and related innovative activities decreased significantly after the recent financial and economic crises. Based on fDi Markets data, the EU 27's (intra and extra) share in the total number of greenfield FDI projects in R&D, design, development, and testing declined from 36 per cent in 2007 to 30 per cent in 2011. In contrast, the corresponding share of greenfield FDI projects in the United States increased from 9 per cent in 2009 to 13 per cent in 2011, and from 15 per cent to 17 per cent in emerging countries in the same period.

The simultaneous increase in the offshoring of knowledge-intensive activities to emerging economies and the decrease in greenfield FDI activities in knowledge-intensive activities in the EU countries have raised widespread concerns about declining

international competitiveness with regard to new investment in higher value-added activities. R&D and innovation activities are among the most targeted industries in industrialised countries. One reason for targeting knowledge-intensive activities is the potential for indirect spillover effects for local companies and local universities. The direct effects, meanwhile, include an increase in demand for highly skilled workers.

The aim of this paper is to investigate the main factors determining the choice of international locations for R&D and related activities in developed and emerging countries. The empirical model is based on a gravity model augmented by a large number of policy and non-policy factors (e.g. corporate taxes and labour costs, FDI regulation, entry regulation costs, and labour-market flexibility indicators), as well as factor endowments (e.g. skills, R&D, quality of universities, and broadband penetration). Since greenfield FDI projects are measured as the number of FDI projects, we use panel count data models.

This paper investigates the following research questions:

- How attractive is the EU for greenfield FDI in knowledge-intensive activities such as R&D, design, and testing?
- What are the main policy and non-policy determinants of inward and outward greenfield FDI in R&D and other innovation activities in the EU countries, the United States, the BRICS, and other emerging countries?
- Particularly, how do multinationals assess skills, entry regulation, broadband penetration, the scientific strength of universities, and the protection of intellectual property rights?
- Are there differences in the determinants of FDI across world regions (EU countries versus all industrialised and emerging countries)?

The main contribution of this paper is that it provides one of the first empirical investigations of the location factors in R&D, testing, and design activities. It focuses on the internationalisation of R&D activities and specific innovation activities as measured

by greenfield investments. Please note that while cross-border M&As and innovation cooperations are also important aspects of the internationalisation process, the determinants of these activities are not considered here due to a lack of available data. Knowledge of the determinants of greenfield FDI in knowledge-intensive activities is particularly important to policy makers because greenfield investment often leads to new jobs in the host country, whereas the effects of FDI through mergers and acquisitions are less straightforward. In fact, Wang and Wong (2009) find that while greenfield FDI is significantly and positively related to economic growth, FDI through M&As is insignificant. The study draws on a large database containing more than 110,000 FDI projects, including some 5,590 cross-border projects in R&D, design, and testing and a subset of greenfield FDI projects related to environmental technologies. In addition, there are 3,153 FDI projects in environmental technologies.

Despite the growing interest in the determinants of internationalisation of R&D and other innovation activities, few studies have investigated the location factors in greenfield investment related to these activities (see Castellani et al., 2011 and 2012 for exceptions). Concerning FDI in R&D and innovation activities, the literature agrees that the knowledge base is more important than cost-based factors (chapter 3 in this report, as well as OECD, 2011 and Cincera et al., 2010).

2 Empirical model and hypotheses

While cost-based considerations may play an important role in FDI in manufacturing, FDI in knowledge-intensive activities is unlikely to be driven by low labour costs; instead, it depends on the availability of a knowledge base in the host country, such as skilled workers and quality universities (Hall, 2011; Narula and Bellak, 2009; Rilla and

Squicciarini, 2011). Lewin et al. (2009) suggest that a shortage of skilled labour in a multinational corporation's home country relative to its host country is the main motivation for offshoring R&D activities.

Historically, higher value-added service activities such as R&D and design have been less likely to be offshored than production facilities. The conventional wisdom suggests that the home country remains the most important single location for R&D (Patel and Pavitt, 1991). Lewin et al. (2009) indicate that innovation activities should be kept under the tight control of the parent company. However, advances in ICT increase the likelihood that such activities will be relocated.

A firm's need to augment its knowledge base represents a major motivation for FDI in R&D and related knowledge activities. This is often referred to as asset-augmenting R&D. The previous empirical literature agrees that the available knowledge base – such as scientific infrastructure and educational qualifications of the workforce – are the main factors in attracting FDI in R&D and related activities (Rilla and Squicciarini, 2011). Hall (2011), meanwhile, suggests that the quality and specialisation of local universities and research institutions and the availability of scientists and engineers are the most important location factors in R&D. Another important determinant of the international location of R&D is the potential for knowledge spillovers from competitors, universities, and research institutes (Lewin et al., 2009). In addition, firms may also be sensitive to public subsidies for R&D (Cincera et al., 2010).

Furthermore, it is often argued that the strength of intellectual property rights protection (IPR) leads to an increase in FDI inflows in knowledge-intensive activities. However, the relationship between IPR protection and FDI is not clear-cut. On the one hand,

strong IPR protection may lead to other forms of internationalisation, such as licensing. On the other, a weak IPR regime increases the probability that innovations and products will be imitated, which makes a host country less attractive for cross-border investments in knowledge-intensive activities (Javorcik, 2004).

Innovation activities are typically highly agglomerated. The reason for this geographical concentration lies in the potential for knowledge spillovers from competitors and universities. Therefore, greenfield investment in R&D activities may exhibit a high degree of path dependence. It is often stated that there are tendencies to follow the location decisions of other multinational firms. These strategies are commonly referred to as "herd behaviour" or "follow the leader" strategies (Rilla and Squicciarini, 2011). Another important location factor is the amount of value added by foreign affiliates in medium- and high-technology industries, as these types of activities often require substantial R&D expenditures (Kuemmerle, 1999). Market size is historically regarded as another location factor (Doh, 2005).

Another factor in R&D location is the possible co-location with production activities. Several scholars argue that decisions on the location of new R&D facilities are highly correlated with those of manufacturing activities (Kenney and Florida, 1994). Based on data on German industrial firms, for instance, Ambos (2005) finds that 79 per cent of research laboratories were co-located with production.

An increasing number of studies have investigated the location factors in knowledge-intensive activities (see OECD, 2011 for a summary of the literature). Most studies use commercial FDI data to investigate the determinants of FDI in knowledge-intensive services. The literature tends to agree that skills, corporate taxes, and cultural factors are

the main factors in attracting FDI in knowledge-intensive services (Liu et al., 2011; Doh et al., 2009). In addition, cost-saving considerations due to taxes, wages, and energy prices also play a role. Among the cost factors, corporate taxes and labour costs are regarded as the main determinants of attracting FDI in knowledge-intensive services (Doh et al., 2009; Bunyaratavej et al., 2008; Farrell, 2005). The findings regarding the impact of ICT infrastructure, on the other hand, are mixed. Besides host country factors, home country conditions may also play an important role in determining outward FDI. Witt and Levin (2007) suggest that increases in outward FDI represent a strategic escape response caused by the home country's institutional environment. Kinkel and Som (2012), meanwhile, find that international relocation of R&D increases with firm size and the R&D intensity of the parent company. Based on the FDI market's database, Castellani et al. (2011) suggest that distance is less important in determining bilateral FDI activity in R&D than are cultural factors and regional trade agreements, which are significant and positive. Based on 1,722 R&D projects offshored between 2002 and 2005, Demirbag and Glaister (2010) find that the knowledge infrastructure (R&D, level of education) in the host country is a major determinant of R&D offshoring. Observing recent EU survey data on business trends in R&D investment, Cincera et al. (2010) find that access to public support for R&D is the most important factor influencing locations' attractiveness for R&D.

Firms' rankings of the importance of location factors for R&D have also provided important new insights. Based on a survey of 246 multinationals in the US and EU, Thursby and Thursby (2006) find that access to scientists and engineers (both as employees and at universities), intellectual property rights protection, and ownership are

the main factors in locating corporate R&D in developed countries, whereas tax breaks and subsidies are ranked as least important.

In summary, the sign and magnitude of the determinants of FDI are likely to be different between FDI in innovation related activities and FDI in general.

The empirical specification of the FDI gravity equation takes into consideration a wide range of potentially relevant determinants of FDI (see Zwinkels and Beugelsdijk, 2010; Chakrabarti, 2001). Recent studies by Carr et al. (2001) and Bergstrand and Egger (2007) emphasise the role of differences in skill endowments and capital intensity between the host and home country in determining bilateral FDI flows. In addition, a wide range of characteristics of the host and home markets play an important role in greenfield investment in R&D and related activities. As outlined above, these variables include market size, cost-based factors (such as labour costs and corporate taxes), skills, ICT infrastructure, and FDI restrictions.

The FDI gravity equation is specified as follows:

$$FDIRD_{ijt} = \exp\left(X_{ijt}\beta + \varepsilon_{ijt}\right),$$

where β represents the parameters and X_{ijt} contains the vector of independent variables:

$$X_{ijt} = \begin{pmatrix} \ln GDPHOME_{it-1}, \ln GDPHOST_{jt-1}, \ln DIST_{ij}, CTAXHOME_{it-1}, CTAXHOST_{jt-1}, \ln WHOME_{it-1}, \ln WHOST_{jt-1}, \\ TERTHOME_{it-1}, TERTHOST_{jt-1}, DFDIMAN_{ijt}, Z_{1it-1}, Z_{2jt-1}, Z_{3ij}, \text{host}_j, \text{home}_i, \lambda_t \end{pmatrix}$$

where *i* is the home country, *j* is the host country, *t* refers to the year, and *ln* is the natural logarithm. The variables are defined as follows:

$FDIRD_{ijt}$ is the number of bilateral greenfield FDI projects in R&D, design, and testing activities (alternatively, the number of bilateral greenfield FDI projects

for the subset related to environmental technologies and the total number of bilateral greenfield FDI projects involving environment technologies);

$GDPHOME_{it-1}$ and $GDPHOST_{jt-1}$ represent home country and host country GDP in constant PPP prices;

$DIST_{ij}$ is the distance between the capital cities of the investing and host countries;

$CTAXHOME_{it-1}$ and $CTAXHOST_{jt-1}$ are the statutory tax rates of the home and host countries, respectively (alternatively, the total tax rate of businesses is used);

$WHOME_{it-1}$ and $WHOST_{jt-1}$ are the wage costs of the home and host countries, respectively (alternatively, unit labour costs);

$TERTHOME_{it-1}$ and $TERTHOST_{jt-1}$ are the shares of the labour force between ages 15 and 74 with tertiary education (levels 5 and 6) in the home and host countries, respectively;

$DFDIMAN_{ijt}$: is a dummy variable equal to 1 if there is greenfield investment in manufacturing activities, and 0 otherwise (only used for the FDIRD equation);

Z_{1it-1} and Z_{2jt-1} represent a set of time-varying factor variables for the home country and host country, respectively (R&D/GDP ratio; FDI regulatory restrictiveness index; strength of legal rights index (degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders); strength of investor protection index; cost of starting a business as a percentage of income per capita; employment protection legislation; top marginal tax rate; protection of intellectual property; hiring and firing practices; labour force share with wages set by centralised collective bargaining; fixed broadband internet subscribers; internet users per 100 people; total tax rate of businesses as a percentage of commercial profits; measures of sectoral specialisation of innovation activities; such as the share of high-tech patents or high-tech R&D activities; and quality of investment promotion agencies; see table A1 in the appendix for the source of the data);

Z_{3ij} represents time-invariant control variables (contiguity, sharing the same language, and sharing an historical colonial link).

The main hypothesis is that skill endowment and high-quality universities are major factors determining the location of greenfield investment in knowledge-intensive services. ICT infrastructure, measured as broadband internet penetration, is also expected to have a positive and significant impact on greenfield investment in R&D. In addition, greenfield investment outflows may be higher for countries characterised by a highly skilled labour force and/or a high R&D/GDP ratio. Host and home country

regulations on product markets and labour markets can also affect greenfield investment. Among the regulation indicators, FDI restrictions are considered to be the most important. Although FDI restrictions in the EU countries have declined significantly in the last decade, they still hamper FDI in some service sectors.

The dependent variable is a count variable. The most common estimators used for count variables are the Poisson regression and the negative binomial model, which is an extension of the Poisson model (Cameron and Trivedi, 1986). The negative binomial model is used because it is less restrictive than the Poisson model. In order to account for unobserved heterogeneity, both the fixed and random-effects specifications are employed. The random effects specification makes it possible to include time-invariant variables such as distance and sharing a common language. The gravity equation estimated by the random-effects specification also includes common time effects and host- and home-country effects.

3 Data and descriptive statistics

Greenfield investment data is derived from the fDi Markets database, which contains a register of some 110,000 greenfield investment projects around the world for the period 2003-2011. The fDi Markets database is used by UNCTAD in its World Investment Report and also widely cited in the related academic literature (Hahn et al., 2011; Di Minin and Zhang, 2010). In particular, the fDi Markets database includes data on all new foreign establishments and expansions in existing foreign investments. The greenfield FDI project information is derived from media sources and can be interpreted as investment commitments. The fDi Markets database contains information on the types of greenfield FDI projects categorised by function, cluster, name and national

origin of parent company, destination country, number of jobs generated by greenfield investment, and amount of capital flow. Note that the FDI flows and the corresponding number of jobs they generate are based on estimated data, which may not be completely accurate. Therefore, this study focuses on the number of greenfield FDI projects rather than the amount of investment. The availability of FDI project data by function makes it possible to analyse greenfield FDI activities in knowledge-intensive activities. These are often characterised by low capital intensity and likely to be underrepresented in the Balance of Payment Statistics. The advantage of data on greenfield FDI is that it is less affected by measurement issues and also less affected by "round-tripping" activities via various EU countries. It is well known that FDI activity in some EU countries is exaggerated by the phenomenon of round-tripping FDI. A simple form of round tripping is when domestic investment is masked as FDI through a foreign affiliate in a tax haven country (OECD, 2008).

The data covers greenfield FDI projects and investment flows in three types of services for 26 major home countries (Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Finland, France, Germany, Hong Kong, India, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Russia, South Korea, Spain, Sweden, Switzerland, the United Kingdom, and the United States); 40 host countries, namely the EU-27 member states (excluding Malta and Cyprus); and 15 OECD and emerging countries, including Australia, Brazil, Canada, China, Hong Kong, India, Israel, Japan, New Zealand, Norway, Russia, Singapore, South Korea, Switzerland, and the United States. The data refers to the period 2003-2011 for the descriptive statistics and the

period 2003-2010 for the regression model. The FDI projects are aggregated across source destination pairs.

Table 1 shows the evolution of the number of greenfield investment projects in R&D, design, and testing by destination country and world region based on 5,885 investment projects. In addition, the number of jobs generated by greenfield investment is provided. One can see that the EU countries received a substantial global share of cross-border greenfield investment in R&D and other innovation-related activities. The EU's share of greenfield FDI projects in research, development, design, and testing activities was 30 per cent for the year 2011, of which 9 per cent refers to the intra-EU share and 21 per cent to the extra-EU share. It is interesting to note that the EU's share of greenfield FDI projects in these activities decreased significantly after the economic and financial crises of 2009. Distinguishing between intra- and extra-EU activities shows that the decline in the EU-27's share was mainly due to the decline in the share of intra-EU FDI projects, while the extra-EU FDI projects share was relatively stable. In 2011, however, the share outside of the EU-27 declined for the first year since the collection of greenfield FDI data began.

Table 1: Number of greenfield FDI projects and jobs in R&D, design, and testing by destination

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2003-2011
	Number of Greenfield FDI projects									
EU-27 (intra)	41	51	55	85	89	82	81	77	64	69
EU-27 (extra)	83	98	142	166	144	162	148	149	157	139
USA	41	24	33	37	55	68	57	62	94	52
Other OECD	53	54	58	73	64	87	69	68	73	67
India	112	198	146	199	121	106	89	84	113	130
China	94	119	126	113	91	118	87	99	109	106
Other emerging countries	81	85	77	82	81	98	95	93	125	91
Total	505	629	637	755	645	721	626	632	735	654
	Percentage shares of total									
EU-27 (intra)	8	8	9	11	14	11	13	12	9	11
EU-27 (extra)	16	16	22	22	22	22	24	24	21	21
USA	8	4	5	5	9	9	9	10	13	8
Other OECD	10	9	9	10	10	12	11	11	10	10
India	22	31	23	26	19	15	14	13	15	20
China	19	19	20	15	14	16	14	16	15	16
Other emerging countries	16	14	12	11	13	14	15	15	17	14
Total	100	100	100	100	100	100	100	100	100	100
EU-27 (intra+extra)	25	24	31	33	36	34	37	36	30	32
	Number of jobs generated by Greenfield FDI projects									
EU-27 (intra)	3,537	3,684	3,637	10,233	7,091	7,217	5,404	4,854	4,192	5,539
EU-27 (extra)	6,655	8,935	13,390	14,785	11,720	11,322	9,033	11,749	14,241	11,314
USA	5,176	2,407	4,970	2,887	4,124	6,915	8,969	5,706	8,984	5,571
Other OECD	10,047	7,097	7,565	11,032	10,127	8,670	10,324	7,065	8,423	8,928
India	32,286	45,725	33,180	68,772	29,412	34,111	23,467	24,835	30,387	35,797
China	16,538	17,126	28,412	18,806	23,209	25,568	15,583	15,389	19,212	19,983
Other emerging countries	12,930	9,445	16,413	15,549	11,504	14,564	15,961	11,084	19,876	14,147
Total	87,169	94,419	107,567	142,064	97,187	108,367	88,741	80,682	105,315	101,279
EU-27 (intra+extra)	10,192	12,619	17,027	25,018	18,811	18,539	14,437	16,603	18,433	16,853
	Percentage shares of total									
EU-27 (intra)	5	5	4	9	10	9	9	9	6	7
EU-27 (extra)	9	11	16	13	16	14	15	21	19	15
USA	4	1	3	2	3	4	8	4	6	4
Other OECD	12	7	7	8	11	10	10	8	9	9
India	40	48	37	50	34	34	27	36	31	37
China	21	22	25	15	24	27	23	16	18	21
Other emerging countries	14	10	11	12	11	12	16	16	17	13
Total	100	100	100	100	100	100	100	100	100	100
EU-27 (intra+extra)	14	16	20	22	26	23	24	30	25	22

Source: fDi Markets database.

Expressed as the number of jobs generated by these investments, the EU-27's (intra and extra) share was remarkably lower – about 25 per cent – in 2011. This may indicate that FDI projects are much smaller in the EU-27 countries than in other world regions.

However, this should be interpreted with caution since the employment numbers in question are rough estimates.

The total number of jobs generated through greenfield investments in R&D and design amounts to 16,850 in the EU-27 and 5,571 in the US on average between 2003 and 2011. However, FDI projects are much larger in China, India, and other emerging countries than in the US and the EU-27 countries, as indicated by the number of jobs per investment project. In particular, unreported results indicate that the average number of jobs for each investment project ranges from 80 in the EU-27 countries and 100 in the US to more than 150 in India and China.

Table 2 presents the descriptive statistics for the main explanatory variables in various world regions. One can see that the EU-15 and EU-10 countries are an attractive location for FDI thanks to their relatively highly educated workforces, low FDI regulations, moderate start-up regulation costs, extensive investor protection laws, moderate corporate tax burdens, and high levels of ICT endowment. However, the quality of their universities (as measured by the number of highly cited researchers) is clearly lower than that of the US or other OECD countries.

Table 2: Descriptive statistics on FDI determinants by host country

	EU-25	EU-15	EU-10	USA	Other OECD	India	China	Other emerging countries
Broadband penetration in %	16.0	19.7	10.5	20.1	22.1	0.3	4.7	8.1
Tertiary share in %	20.3	22.6	16.8	33.3	32.4	5.3	7.1	17.8
Costs of start-up regulations % of profits	8.2	7.7	8.9	0.7	5.0	64.9	11.2	10.2
Statutory tax rate in %	25.7	29.9	19.4	39.3	30.3	34.9	30.0	25.6
Number of highly cited researchers	5.8	9.0	0.9	20.2	11.2	11.3	0.0	4.8
Tax rate of businesses % profits	47.1	47.8	45.9	46.5	40.8	68.7	77.1	46.3
Strength of investor protection (index)	5.5	5.6	5.5	8.3	6.1	6.0	4.9	6.6
Employment protection (index)	2.1	2.3	1.9	0.2	1.6	2.8	2.7	2.8
FDI regulatory restrictiveness (index)	0.1	0.1	0.1	0.1	0.2	0.4	0.5	0.2
Hourly wage costs in euro	16.6	24.6	4.7	25.1	20.9	0.8	1.4	6.3
Protection of intellectual property (index)	6.8	7.8	5.3	8.2	7.8	5.4	5.1	5.9

Notes: Other OECD includes Australia, Canada, South Korea, Switzerland, Israel, and Japan.
Source: See table A1 in the appendix.

Table 3 shows the distribution of the number of FDI projects by source country ("outward FDI"). One can see that the US is by far the largest active investor in R&D and related activities, with a share of 39 per cent in 2011. The EU countries represent the second-largest investor (this includes intra-EU investment). Outward greenfield investments by emerging countries are still rather rare.

Table 3: Number and percentage shares of greenfield FDI projects in R&D, design, and testing by source country

	2003	2004	2005	2006	2007	2008	2009	2010	2011
	Number of Greenfield FDI projects in R&D, design, development and testing								
EU-14 (intra+extra)	134	159	169	216	235	260	229	229	258
USA	269	324	348	398	292	316	257	270	287
Other OECD	85	124	95	114	85	110	103	82	119
India	9	13	15	18	20	19	15	17	25
China	6	4	8	7	9	12	18	26	36
Other emerging countries	2	5	2	2	4	4	4	8	10
Total	505	629	637	755	645	721	626	632	735
	Percentage shares of total								
EU-14 (intra+extra)	27	25	27	29	36	36	37	36	35
USA	53	52	55	53	45	44	41	43	39
Other OECD	17	20	15	15	13	15	16	13	16
India	2	2	2	2	3	3	2	3	3
China	1	1	1	1	1	2	3	4	5
Other emerging countries	0	1	0	0	1	1	1	1	1
Total	100	100	100	100	100	100	100	100	100

Notes: The EU-14 includes Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

Source: fDi Markets database.

4 Empirical results

Table 4 shows the coefficients obtained from the random-effects negative binomial estimator of the determinants of bilateral greenfield FDI projects in R&D, design, and testing activities, where the random effects are home-host country pairs. All specifications control for host- and home-country fixed effects, as well as for time

effects. The lower panel of table 4 shows the estimates for the subgroup of EU-25 host countries (i.e. the EU-27 countries excluding Cyprus and Malta). Table A2 in the appendix shows the corresponding marginal effects for the predicted number of greenfield FDI projects, assuming that the random effect is zero. Table A4 in the appendix shows the results of the conditional fixed-effects negative binomial estimator for the total sample and the sample of EU countries.

The interpretation of the results is mainly based on the estimates obtained from the random-effects negative binomial model because most policy variables show little variation over time. For the total sample of 40 host countries, the results show that greenfield investments in R&D, design, and testing activities depend significantly on geographical distance, sharing a common language, entry regulation costs, broadband penetration, skills, and hourly wage costs all measured at the host-country level (see table 5, specifications (i)-(ii)). Among the parent-country factors, hourly wage costs and share of tertiary education have a significant and positive impact. This indicates that greenfield investment in R&D and related innovation activities comes from skill-rich and high-wage countries. Furthermore, gravity factors (i.e. host- and home-country size) are less relevant. In particular, source-country GDP exhibits the expected sign, but host-country GDP is either insignificant or shows a negative sign. This indicates that market size is not relevant as a factor determining the location of greenfield FDI in R&D and related innovation activities. The coefficient of the logarithm of source-country GDP in constant ppp is also not significant.

Table 5: Estimates obtained from the random-effects negative binomial model of the determinants of bilateral greenfield FDI projects in R&D, design, and testing

	(i)		(ii)		(iii)	
	ß	z	ß	z	ß	z
	All industrialised and emerging countries					
log GDP in EUR, host country, t-1	-0.85 ***	-2.92	-0.22	-0.46	0.30	0.79
log GDP in EUR, parent country, t-1	0.45	0.70	0.83	0.80	0.39	0.60
log distance	-0.08 *	-1.86	-0.07	-1.49	-0.07 *	-1.69
Shared border	0.08	0.61	-0.04	-0.29	0.08	0.65
Common language	0.63 ***	5.93	0.70 ***	6.37	0.63 ***	5.91
Former colony	-0.04	-0.31	-0.06	-0.51	-0.04	-0.35
Host statutory corporate tax rate, t-1	-2.19 **	-2.10	-1.83	-1.51	-1.05	-0.98
Parent statutory corporate tax rate, t-1	-2.28 *	-1.87	-2.57 *	-1.92	-2.26 *	-1.86
log hourly wages costs, host t-1	-0.33 *	-1.74	-0.80 ***	-2.84	-0.28	-1.47
log hourly wages costs, parent t-1	0.88 ***	3.15	0.81 *	1.89	0.83 ***	2.98
Share of tertiary education, host t-1	10.08 ***	4.56	1.84	0.65	6.02 **	2.56
Share of tertiary education, parent t-1	4.51 *	1.70	7.63 **	2.07	4.29	1.62
Greenfield FDI in manufacturing t			0.01 ***	3.39	0.01 ***	5.73
Cost of starting a business t-1			-1.99 ***	-5.14		
Broadband penetration rate t-1					3.86 ***	4.65
Number of observations	7,259		5,457		7,164	
Number of host-parent pairs	937		937		937	
	EU-25 countries					
log GDP in EUR, host country, t-1	0.44	0.37	0.38	0.25	0.59	0.49
log GDP in EUR, parent country, t-1	1.98 *	1.99	0.14	0.09	1.98 **	1.99
log distance	0.10	0.72	0.16	1.10	0.10	0.76
Shared border	0.19	1.02	0.05	0.24	0.19	0.98
Common language	0.78 *	4.18	0.95 ***	4.70	0.78 ***	4.18
Former colony	-0.29	-1.45	-0.30	-1.35	-0.29	-1.41
Host statutory corporate tax rate, t-1	-1.76	-1.14	-3.11 *	-1.65	-1.91	-1.22
Parent statutory corporate tax rate, t-1	-3.91 *	-1.96	-5.85 ***	-2.58	-4.05 **	-2.02
log hourly wages costs, host t-1	-0.51	-1.30	-0.31	-0.60	-0.30	-0.69
log hourly wages costs, parent t-1	0.06	0.12	0.68	0.96	0.01	0.03
Share of tertiary education, host t-1	13.77 ***	3.22	15.91 ***	2.81	14.21 ***	3.30
Share of tertiary education, parent t-1	4.77	1.10	12.30 **	1.97	4.28	0.99
Greenfield FDI in manufacturing t	0.02 ***	4.42	0.03 ***	3.88	0.03 ***	4.56
Cost of starting a business t-1			-1.50	-0.99		
Broadband penetration rate t-1					2.09	1.27
Number of observations	4,613		3,441		4,541	
Number of host-parent pairs	586		586		586	

Notes: The dependent variable is the number of greenfield FDI projects involving R&D, design, and testing activities of country *i* in country *j*. ***, **, and * indicate statistical significance at the 1-, 5-, and 10 per cent level, respectively. All specifications include time effects and parent- and host-country fixed effects. The sample is based on greenfield FDI projects conducted between 24 home countries in 40 host countries in the period 2003-2010.

Source: fDi Markets database; see table A1 in the appendix

Geographical distance between investor and recipient countries shows the expected negative sign, but is only significant at the 10 per cent level. This indicates that multinational companies still prefer offshore locations that are not too far away from

their home countries. However, the impact of distance is quite small, as indicated by the marginal effects. In addition, countries sharing a border do not exhibit increased greenfield investments. Overall, this is consistent with Castellani et al. (2011, 2012), who find that geographical distance is of minor importance compared to the influence of other cultural factors.

Cultural factors are also relevant in influencing bilateral greenfield FDI in R&D and related activities. The estimates show that having a common language significantly increases the number of bilateral FDI activities between two countries. The marginal effects range between 0.06 and 0.08, indicating that a host country that shares a common language with a corresponding home country receives less than a tenth more greenfield FDI projects on average – a relatively small effect. Overall, the findings indicate that both common language and geographical distance significantly matter for Greenfield investment in R&D and related innovation activities but the magnitude of the two factors is relatively small.

Furthermore, the estimates show that the costs associated with starting a business are a significant factor influencing greenfield FDI inflows into R&D, design, and testing (see table 5, specification (ii)). The higher the costs of start-up regulations are in a given host country, the lower the amount of greenfield investment into that country will be. In the EU economies, the cost of starting a business ranged from an average of zero per cent of income per capita in Denmark to 25 per cent in Greece for the period 2003-2010. Decreasing entry regulation costs by five percentage points will increase the number of greenfield FDI projects by one unit (project; 0.29 x 5).

Broadband penetration also has a significant and positive influence on greenfield investments in R&D (see specification (iii)). This clearly shows that a high level of broadband penetration is a prerequisite of knowledge interactions, such as the transfer of codified knowledge between a parent company and its affiliates.

Another important finding concerns the significance of greenfield investment in manufacturing in the same period. This clearly indicates that the location of new manufacturing plants is a strong determinant of where to conduct R&D. In other words, both activities tend to cluster together. From the home country perspective, this means that offshoring of manufacturing induces a relocation of R&D activities. However, although highly significant, the overall magnitude of the co-location effect is close to zero, as can be seen in the marginal effects. In particular, the effect of co-location of manufacturing is lower compared to that of sharing a common language.

The random-effects negative binomial estimator shows that cost factors play a significant role in the location of greenfield investments in R&D. The impact of hourly wages in the host country is negative and significant (based on specifications (i) and (ii)). The effect of statutory tax rates is negative and significant, but loses significance when broadband penetration is included in the regression (specification (iii)). Furthermore, both cost factors are no longer significant when based on the conditional fixed-effects count data model (see table A4 in the appendix). This indicates that changes in cost-based factors – due to reductions in corporate taxes or decreasing hourly wages, for example – will not lead to an increase in greenfield investment in high value-added activities such as R&D, design, and testing.

Other factors such as university quality (measured by the number of highly cited researchers or the Shanghai University ranking index) are not significant when host- and home-country fixed effects are introduced into the gravity equation. This stands in contrast with the previous empirical literature on the determinants of FDI in R&D activities, which find that the quality of local universities are one of the main factors driving international investment in R&D and related activities (Hall, 2011). Similarly, neither the impact of the strength of investor protection nor that of intellectual property protection in the host country is robust.

Unreported results show that the remaining policy factors are not significant at conventional significance levels; therefore, they are not included in the final specification. This group includes indicators of labour market flexibility, quality of investment promotion agencies, sectoral and patent specialisation, and regulatory restrictiveness on FDI. Furthermore, greenfield investments in R&D and related activities are not significantly influenced by past investments as measured by the cumulative number of past FDI projects (aggregated across all source countries); these investments are therefore also not included in the final specification.

When the sample is restricted to the EU host countries, we find level of skills – measured as the share of tertiary education in the host country – to be positive and highly significant (see table 4.5, lower panel). This also holds true for the fixed-effects count data model (see table A4 in the appendix). These findings are consistent with the previous empirical literature, which finds that the available knowledge base – indicated by the educational qualifications of the workforce, for instance – is a main factor in attracting FDI in R&D and related activities (Rilla and Squicciarini, 2011). It is

interesting to note that the impact of tertiary education is higher in the EU-27 countries than in the total sample, as indicated by the marginal effects. However, broadband penetration and entry regulation costs are no longer significant for the subsample of EU countries. In addition, based on the random- and fixed-effects specifications, FDI in manufacturing, R&D, design, and testing are significantly co-located, but the size of the effect is very low. Based on the fixed-effects specification, cost factors are also no longer a significant determinant of greenfield investment in R&D and related innovation activities in the EU-27 countries. This indicates that changes in wage costs and corporate taxes do not lead to an increase in the number of greenfield FDI projects in R&D and related activities in the following year.

5 Conclusions and policy implications

This paper has investigated the determinants of bilateral greenfield investments in R&D, design, and testing activities. It also documents trends and patterns in greenfield investment in these activities over time and across host and home countries. The data involved covers greenfield investments between the 24 most important parent countries and 40 host countries. Descriptive statistics show that the EU-27 remains one of the most important locations for international greenfield investment in research, development, design, and testing activities, with a world market share of 30 per cent in terms of the number of projects and 19 per cent in terms of jobs generated by these investments. However, the size of FDI projects is considerably lower in the EU-27 than in other world regions. In addition, there was a decline in the EU-27's share of such projects after the recent financial and economic crisis. A detailed investigation reveals that the reduction in the EU-27's share since 2008 was mainly due to the decrease in

intra-EU greenfield FDI activities. That said, we observe a strong decline in extra-EU greenfield FDI flows in research, development, design, and testing activities for the first time between 2010 and 2011. This decrease in the extra-EU-27 share of greenfield FDI in knowledge-intensive activities is critical and deserves further attention. Measures to increase the attractiveness of FDI in innovation-related activities should be a major concern of policymakers.

The empirical results using the random-effects negative binomial regression model show that greenfield investment in R&D and related innovation activities depends on geographical distance, sharing a common language, hourly wage costs, skills (measured as tertiary education), entry regulations, ICT infrastructure, and co-location with manufacturing FDI. Furthermore, the results show that the impact of FDI determinants differs between EU host countries and the total sample (which includes all major industrialised and emerging countries as host countries). For the EU countries, the share of tertiary education is the most important determinant of greenfield FDI in R&D and related activities, while for the total sample, the presence of skilled workers, entry regulation costs, and internet infrastructure are significant factors. Since a knowledge base is more important than cost factor considerations, one can conclude that the investments of multinational enterprises in the EU-27 are driven by asset-seeking rather than asset-exploiting. In contrast, cost factors such as entry regulations are also important for the total sample.

Another major finding of this paper is that the location of new manufacturing plants is a significant determinant of where R&D is conducted, indicating that these activities tend to cluster together. This holds true for both the EU-27 countries and the total sample.

From the home-country perspective, this means that the offshoring of manufacturing induces a relocation of R&D activities. However, although highly significant, the overall size of the co-location effect is rather modest. Another important finding is that corporate taxes and wage costs are no longer significant when measures of broadband penetration and/or fixed effects are introduced. This suggests that cutting taxes or decreasing wages will not stimulate greenfield investment in knowledge-intensive activities.

The results of this study have important policy implications, and not only in direct relation to FDI; they also affect policies related to investments in education, product and labour market regulation, and intellectual property rights systems. First, wage costs and corporate taxation are not as important with regard to the location of R&D and other innovation-related activities as the media and political organisations suggest. Therefore, a decrease in corporate taxes will not lead to higher greenfield investment in such activities. Note also that corporate taxes are already very low in the new EU member states and lower than the global average in the EU-15 countries.

Second, entry regulation costs play a significant role in attracting innovation-related greenfield investment. Therefore, reducing the regulatory burden on new businesses should be a key goal of policy makers. This holds particularly true for the southern European countries that are characterised by a high degree of product and labour market regulation. Third, the presence of a skilled labour force and a high level of broadband penetration are substantial drivers of innovation-related FDI. Additional investments in tertiary education and internet infrastructure should thus be the main objective of policy makers. Fourth, while cultural factors such as sharing a common language are important

in attracting international innovation-related investment, this is the result of an historical process; in other words, it is set in time and unchangeable. Finally, a large number of product- and labour-market regulation indicators and FDI regulations are not significant at conventional levels. However, with respect to the latter, all of the EU member states (except two) are more open to FDI than the OECD average. This holds particularly true for manufacturing. Given the generally very low degree of FDI regulations in the EU, the observed cross-country variations are of little importance.

References

Ambos, B. (2005), "Foreign direct investment in industrial research and development: A study of German MNCs", Research Policy, 34(4), pp. 395-410.

Bergstrand, J.H. and P. Egger (2007), "A knowledge-and-physical-capital model of international trade flows, foreign direct investment, and multinational enterprises", Journal of International Economics, 73(2), pp. 278-308.

Beugelsdijk, S., Hennart, J.F., Slangen, A. and R. Smeets (2010), "Why and how FDI stocks are a biased measure of MNE affiliate activity", Journal of International Business Studies, 42(1), pp. 1-16.

Bunyaratavej, K., Hahn, E.D. and J.P. Doh (2008), "Multinational investment and host country development: Location efficiencies for services offshoring", Journal of World Business, 43(2), pp. 227-242.

Cameron, A.C. and P.K. Trivedi (1998); Regression Analysis of Count Data, Cambridge University Press, Cambridge.

Carr, D.L., Markusen, J.R. and K.E. Maskus (2001), "Estimating the Knowledge-Capital Model of the Multinational Enterprise", American Economic Review, 91(3), pp. 693-708.

Castellani, D., Jimenez Palmero, A. and A. Zanfei (2011), The Gravity of R&D FDIs, University of Burgos, Spain, University of Urbino, Italy.

Castellani, D., Jimenez Palmero, A. and A. Zanfei (2012), How remote are R&D labs? Distance factors and international innovative activities, University of Perugia mimeo.

Chakrabarti, A. (2001), "The determinants of foreign direct investments: sensitivity analyses of cross-country regressions", Kyklos, 54(1), pp. 89-114.

Cincera, M., Cozza, C. and A. Tübke (2010), "Drivers and policies for increasing and internationalising R&D activities of EU MNEs, IPTS working paper on corporate and innovation N°2.

Demirbag, M. and K.W. Glaister (2010), "Factors determining offshore location choice for R&D projects: A comparative study of developed and emerging regions", Journal of Management Studies, 47(8), pp. 1534-1560.

Devereux, M.P. and R. Griffith (1999), "The Taxation of Discrete Investment Choices. Revision 2", IFS Working Paper N°W98/16.

Devereux, M.P. and R. Griffith (2003), "Evaluating Tax Policy for Location Decisions", International Tax and Public Finance, 10(2), pp. 107-126.

Di Minin, A. and J. Zhang (2010), "An Exploratory Study on International R&D Strategies of Chinese Companies in Europe", Review of Policy Research, 27(4), pp. 433-455.

Doh, J.P. (2005), "Offshore Outsourcing: Implications for International Business and Strategic Management Theory and Practice", Journal of Management Studies, 42(3), pp. 695-704.

Doh, J.P., Bunyaratavej, K. and E.D. Hahn (2009), "Separable but not equal: The location determinants of discrete services offshoring activities", Journal of International Business Studies, 40(6), pp. 926-943.

European Commission (2012), "A European strategy for Key Enabling Technologies - A bridge to growth and jobs", COM(2012)341.

Eurostat (2009), Foreign Affiliate Statistics (FATS). Recommendations Manual, Luxembourg.

Farrell, D. (2005), "Offshoring: Value creation through economic change", Journal of Management Studies, 42(3), pp. 675-683

Hahn, E.D., Bunyaratavej, K. and J.P. Doh (2011), "Impacts of risk and service type on nearshore and offshore investment location decisions: An empirical approach", Management International Review, 51(3), pp. 357-380.

Hall, B.H. (2011), "The internationalisation of R&D", UNU-MERIT Working Paper Series N°049, United Nations University.

Javorcik, S.B. (2004), "The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies", European Economic Review, 48(1), pp. 39-62.

Kalinova, B., Palerm, A. and S. Thomsen (2010), "OECD's FDI Restrictiveness Index: 2010 Update", OECD Working Papers on International Investment N°2010/3.

Kenney, M. and R. Florida (1994), "The organization and geography of Japanese R&D: results from a survey of Japanese electronics and biotechnology firms", Research Policy, 23(3), pp. 305-323

Kinkel, S. and O. Som (2012), Changing patterns of R&D relocation activities in the course of the global economic crisis, Paper presented at the DRUID summer conference.

Kuemmerle, W. (1999), "The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation", Journal of International Business Studies, 30(1), pp. 1-24.

Lewin, A.Y., Massini, S. and C. Peeters (2009), "Why are companies offshoring innovation? The emerging global race for talent", Journal of International Business Studies, 40(8), pp. 901-925.

Liu, R., Feils, D.J. and B. Scholnick (2011), "Why are different services outsourced to different countries?", Journal of International Business Studies, 42(4), pp. 558-571.

Mayer, T. and S. Zignago (2006), "Notes on CEPII's distances measures", MPRA Paper N°26469.

Narula, R. and C. Bellak (2009), "EU enlargement and consequences for FDI assisted industrial development", Transnational Corporations, 18(2), pp. 69-90.

OECD (2008), Benchmark definition of foreign direct investment. Fourth Edition, Paris.

OECD (2011), Attractiveness for Innovation: Location factors for international investment, OECD, Paris.

Patel, P. and K. Pavitt (1991), "Large Firms in the Production of the World's Technology: An Important Case of Non-Globalisation", Journal of International Business Studies, 22(1), pp. 1-21.

Rilla, N. and M. Squicciarini (2011), "R&D (Re)location and Offshore Outsourcing: A Management Perspective", International Journal of Management Reviews, 13(4), pp. 393-413.

Thursby, J. and M. Thursby (2006), Here or There? A Survey on the Factors in Multinational R&D Location, National Academies Press, Washington, D.C.

Wang, M. and M.C. Wong (2009), "What Drives Economic Growth? The Case of Cross-Border M&A and Greenfield FDI Activities", Kyklos, 62(2), pp. 316-330.

Witt, M.A. and A.Y. Lewin (2007), "Outward Foreign Direct Investment as Escape Response to Home Country Institutional Constraints", Journal of International Business Studies, 38(4), pp. 579-594.

Zwinkels, R.C.J. and S. Beugelsdijk (2010), "Gravity Equations: Workhorse or Trojan Horse In Explaining Trade and FDI Patterns Across Time and Space?", International Business Review, 19(1), pp. 482-497.

Appendix

Table A1: Source of explanatory variables

Variable	Measure	Source
Level of GDP	Euro current prices	New Cronos, OECD, national statistics
Geographical distance	Distance between the principal cities weighted by population size in km	Mayer and Zignago (2006)
Sharing the same language	Dummy variable	Mayer and Zignago (2006)
(Former) colonial link	Dummy variable	Mayer and Zignago (2006)
Shared border	Dummy variable	Mayer and Zignago (2006)
Educational attainment of the people aged between 15-64	Share in total population aged 15-64 in percent	New Cronos, OECD, national statistics
Ratio of R&D expenditures to GDP	Percent	New Cronos, OECD, Eurostat, World Bank
Hourly labour costs in the business sector	Euro in current prices	New Cronos, U.S. Bureau of labor office for some non EU countries
Effective average tax rate	Percent	European Commission, "Taxation trends in the European Union" based on ZEW, based on Devereux and Griffith (1999, 2003)
Strength of investor protection	Index (0-10); (10=highest protection)	World Bank
Protection of intellectual property	Index (0-10); (10=highest protection)	World Bank
Getting credit - strength of legal rights	Index (0-10); (10=best)	World Bank
Ratio of costs of starting a business to income per capita	Percent	World Bank
Fixed broadband internet subscribers	Per 100 people	World Bank
Internet users	Per 100 people	World Bank
Ratio total tax rate to commercial profit	Percent	World Bank
Top marginal tax rate	Percent	Economic Freedom
Hiring and firing practices	Index (1-10); (1=least,10=most regulated)	Economic Freedom
Labour force share with wages set by centralised collective bargaining	Index (1-10); (1=highly centralized, 10=least centralised, i.e. best)	Economic Freedom
Protection of intellectual property	Index (1-10); (10=highest)	Economic Freedom
The number of highly cited researchers in 21 subject categories	Score	Shanghai ranking
Employment protection legislation	Index (0-4); (0=best)	OECD
FDI regulatory restrictiveness	Index (0 and 1); (0=open, 1=closed)	OECD, Kalinova et al. (2010)

Table A2: Marginal effects based on the random-effects negative binomial model of the determinants of bilateral Greenfield FDI projects in R&D, design, development and testing

	(i)			(ii)			(iii)		
	dy/dx		z	dy/dx		z	dy/dx		z
	40 industrialised and emerging countries								
log GDP in EUR, host country, t-1	-0.06	***	-2.87	-0.02		-0.46	0.02		0.79
log GDP in EUR, parent country, t-1	0.03		0.70	0.07		0.79	0.03		0.60
log distance	-0.01	*	-1.85	-0.01		-1.48	-0.01	*	-1.68
Shared border	0.01		0.59	0.00		-0.30	0.01		0.63
Common language	0.06	***	4.46	0.08	***	4.61	0.06	***	4.44
Former colony	0.00		-0.32	-0.01		-0.52	0.00		-0.35
Host statutory corporate tax rate, t-1	-0.17	**	-2.09	-0.16		-1.50	-0.08		-0.98
Parent statutory corporate tax rate, t-1	-0.17	*	-1.86	-0.22	*	-1.91	-0.17	*	-1.85
log hourly wages costs, host t-1	-0.03	*	-1.73	-0.07	***	-2.79	-0.02		-1.47
log hourly wages costs, parent t-1	0.07	***	3.12	0.07	*	1.88	0.06	***	2.96
Share of tertiary education, host t-1	0.76	***	4.41	0.16		0.64	0.46	**	2.53
Share of tertiary education, parent t-1	0.34	*	1.70	0.65	**	2.06	0.33		1.61
Greenfield FDI in manufacturing t	0.00	***	4.60	0.00	***	3.19	0.00	***	5.19
Cost of starting a business t-1				-0.17	***	-4.79			
Broadband penetration rate t-1							0.29	***	4.45
Number of observations	7,259			5,457			7,164		
Number of host-parent pairs	937			937			937		
	EU-25 host countries								
log GDP in EUR, host country, t-1	0.02		0.37	0.02		0.25	0.03		0.49
log GDP in EUR, parent country, t-1	0.11	*	1.97	0.01		0.09	0.11	**	1.96
log distance	0.01		0.72	0.01		1.10	0.01		0.76
Shared border	0.01		0.94	0.00		0.24	0.01		0.91
Common language	0.06	***	2.95	0.09	***	3.07	0.06	***	2.94
Former colony	-0.01		-1.66	-0.02		-1.55	-0.01		-1.61
Host statutory corporate tax rate, t-1	-0.10		-1.14	-0.19		-1.63	-0.11		-1.22
Parent statutory corporate tax rate, t-1	-0.22	*	-1.94	-0.36	**	-2.51	-0.23	**	-1.99
log hourly wages costs, host t-1	-0.03		-1.30	-0.02		-0.60	-0.02		-0.69
log hourly wages costs, parent t-1	0.00		0.12	0.04		0.96	0.00		0.03
Share of tertiary education, host t-1	0.76	***	3.12	0.98	***	2.73	0.80	***	3.20
Share of tertiary education, parent t-1	0.26		1.10	0.76	*	1.94	0.24		0.99
Greenfield FDI in manufacturing t	0.00	***	3.94	0.00	***	3.45	0.00	***	4.04
Cost of starting a business t-1				-0.09		-0.99			
Broadband penetration rate t-1							0.12		1.26
Number of observations	4,613			3,441			4,541		
Number of host-parent pairs	586			586			586		

Notes: The dependent variable is the number of Greenfield FDI projects in R&D, design and testing activities from country *i* to country *j*. ***, **, and * indicates statistical significance at the 1-, 5-, 10-percent level, respectively. All specifications include time effects, parent and host country fixed effects.

Source: fDi Markets database, see Table A1 in the Appendix, WIFO calculations.

Table A3: Estimates obtained from the fixed-effects negative binomial model of the determinants of bilateral Greenfield FDI projects in R&D, design, development and testing

	(i)			(ii)			(iii)		
	ß		z	ß		z	ß		z
	40 industrialised and emerging countries								
log GDP in EUR, host country, t-1	-0.38	*	-1.69	-0.22		-0.72	0.16		0.95
log GDP in EUR, parent country, t-1	0.45	**	2.42	0.56	**	2.10	0.63	***	3.85
Host statutory corporate tax rate, t-1	-1.94	*	-1.77	-0.93		-0.69	-0.80		-0.64
Parent statutory corporate tax rate, t-1	-1.87		-1.59	-2.45	*	-1.92	-2.19	*	-1.84
log hourly wages costs, host t-1	-0.38	***	-2.96	-0.46	***	-2.69	-0.14		-0.62
log hourly wages costs, parent t-1	0.38	**	2.00	0.30		1.31	0.36	*	1.92
Share of tertiary education, host t-1	7.41	***	4.07	4.20	*	1.81	1.07		0.25
Share of tertiary education, parent t-1	-1.93		-1.12	0.94		0.40	-1.31		-0.73
Greenfield FDI in manufacturing t	0.01	***	4.65	0.01	**	2.34	0.01	***	4.67
Cost of starting a business t-1				-1.38	***	-2.68			
Broadband penetration rate t-1							3.35	***	3.30
Number of observations	3,437			2,346			3,437		
Number of host-parent pairs	443			403			443		
	EU-25 host countries								
log GDP in EUR, host country, t-1	0.53		1.15	0.80		1.10	0.49		1.00
log GDP in EUR, parent country, t-1	1.70	***	3.48	1.70	***	3.19	1.63	***	3.36
Host statutory corporate tax rate, t-1	-1.05		-0.72	-2.29		-1.30	-1.42		-0.98
Parent statutory corporate tax rate, t-1	-4.19	**	-2.20	-4.42	**	-2.04	-4.53	**	-2.35
log hourly wages costs, host t-1	-0.36		-1.18	-0.37		-1.03	-0.12		-0.38
log hourly wages costs, parent t-1	0.09		0.23	0.20		0.38	0.09		0.24
Share of tertiary education, host t-1	11.53	***	3.27	11.52	***	2.57	11.71	***	3.24
Share of tertiary education, parent t-1	1.47		0.35	2.97		0.53	1.39		0.33
Greenfield FDI in manufacturing t	0.02	***	3.58	0.02	***	3.03	0.02	***	3.68
Cost of starting a business t-1				-1.48		-1.05			
Broadband penetration rate t-1							2.63	*	1.71
Number of observations	2,008			1,332			1,992		
Number of host-parent pairs	255			227			255		

Notes: The underlying dependent variable is the number of Greenfield FDI projects in R&D, design and testing from country i to country j. ***, **, and * indicates statistical significance at the 1-, 5-, 10-percent level, respectively. All specifications include time effects.

Source: fDi Markets database.