New empirical findings for international investment in intangible assets

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Author: Martin Falk (WIFO)

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Author: Martin Falk (WIFO)

Reviewed by: Werner Bönte (University of Wuppertal), Heinz Hollenstein (WIFO)

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New empirical findings for international investment in intangible assets

Martin Falk (WIFO)

Contribution to the Project

The planned work will contribute to the question how can social and technological innovations be supported to achieve the socio-ecological transition. It will focus on intangible assets (i.e. software, R&D, organizational capital). Intangible assets are non-monetary assets without physical substance and with low energy consumption and low carbon emission. Knowledge of the main determinants of intangible assets are helpful to develop the formulation of effective policies to enhance investment in these areas.

Keywords: Innovation, innovation policy, intangible assets

Jel codes: O3

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Executive Summary

This study empirically analyses the determinants of greenfield investment in intangible assets in emerging and industrialized countries. Data consists of host parent country pairs of greenfield FDI projects in (i) advertising, public relations and related activities, (ii) design, development & testing, (iii) headquarters, (iv) research & development and (v) software (except video games). With a world market share of 33 per cent in 2011 in terms of the number of projects, descriptive statistics show that the EU 27 is one of the most important locations for international greenfield investment in intangible assets. However, there was a decline in the EU 27s share of such projects after the recent financial and economic crisis, which is mainly due to the decrease in intra-EU greenfield FDI activities. In contrast, FDI inflows in intangible assets increased in the United States, in other non EU OECD countries and in emerging countries. Among the EU countries United Kingdom, Germany, France, Spain and Ireland are the most attractive locations for investment in intangible assets, whereas the Southern and Eastern EU member states are least successful in attracting FDI projects in intangible assets. For investors from Non EU countries the ranking is quite similar with United Kingdom receiving the largest number of FDI projects followed by Germany, France, Ireland and the Netherlands.

The results using fixed and random effects negative binomial regression models for 40 host and 26 parent countries during the period 2003–2010 show that FDI in intangible assets depends significantly positively on quantity of human capital, quality of human capital measured as the PISA score in maths and reading, broadband penetration, strength of investor protection, R&D endowment and direct R&D subsidies. Wage costs (or unit labour costs) and costs of starting a business have a significant negative impact on FDI inflows in intangible assets. Other policy factors, such as labour market regulations, product, or FDI regulations, do not have a significant impact. Separate estimates for the EU-27 countries show that corporate taxes matter for the international location decision for intangible assets. The empirical results presented may help to develop a proactive action plan to attract international investments in intangible assets in Europe.

1. Introduction

In advanced economies, knowledge is the main factor influencing growth and competitiveness. Intangible assets (or intangible capital) can be characterized as "knowledge capital." In the last decades, investment has shifted from tangible to intangibles. This development is often described as the evolution of the knowledge economy.

Intangible assets can be defined in various ways. In economic literature, investment in intangible assets comprises computerized information (i.e. software), innovative property (scientific and non scientific R&D) and economic competencies, such as organizational capital and firm specific human capital (Corrado, Hulten and Sichel [CHS], 2005). In the accounting literature, intangible assets include computer software, patents, copyrights, motion picture films, licenses, franchises, models, design, prototypes, etc., but exclude firm specific human capital (see Eckstein, 2004).

In recent years, investment in intangible assets increased considerably, while investment in tangible assets has been quite stable over time. According to CHS data, in the EU countries, the ratio of intangible investment to GDP has doubled since 1995 and now stands between five and ten per cent. When intangibles are measured based on balance sheet data, Marrocu et al. (2012) find similar tendencies for six EU countries, namely France, Italy, the Netherlands, Spain, Sweden and the United Kingdom.

Many firms and organizations recognize the importance of intangible assets as a principal driver of firm performance and competitive advantage (Kaplan and Norton, 2004). It is so often stated that the performance of companies no longer depends upon investment in physical capital (investment in tangibles), but more and more upon immaterial values, known as intangible assets and intellectual property. The primary advantage of intangible assets and other knowledge intensive assets is that they are difficult for competitors to imitate, unlike physical capital.

Previous studies using the growth accounting framework find that intangible assets are an important determinant of productivity growth (see Corrado et al., 2012 for selected OECD countries; Dal Borgo et al. 2012 for the UK, Edquist, 2011 for Sweden; Jalava et al., 2007 for Finland; Marrano, Haskel and Wallis 2009 for the UK; Van Ark et al., 2009 for the EU countries). The contribution of intangible capital to labour productivity ranges between 15 per cent in the Czech Republic to 64 per cent in Spain. For some countries, the contribution of intangibles to productivity growth is larger or only slightly lower than that of tangibles (Corrado et al., 2012; Van Ark et al., 2009). Econometric studies based on country level data (Roth and Thum, 2013) and regional data (Melachroinos and Spence, 2012) find similar results. In particular, using panel data models, Roth and Thum (2013) show that intangible assets, defined as investment computerized information, innovative property and economic competences, explain 50 per cent of labour productivity growth. The data consists of macroeconomic data for 13 EU countries for the period of 1998-2005.

At the firm level, few studies have investigated the impact of intangibles on firm performance and productivity (Marrocu et al., 2012; Bontempi and Mairesse, 2008). Because it is difficult to measure intangible capital, most empirical studies have used innovation input variables, such

as R&D expenditure, advertising expenditure and/or training expenditures. For some subcategories of intangibles, namely R&D expenditures, investment in software, advertising expenditures and training expenditures, there is ample evidence that these factors are important drivers of growth and productivity at the firm level. For total intangibles, there are only a few studies available. One exception is the study of Marrocu et al. (2012) who find that the accounting based measure of intangible assets has a significant impact on both total productivity and labour productivity growth. The underlying data consists of a large firm level panel data set of six European countries (France, Italy, the Netherlands, Spain, Sweden, and United Kingdom) extracted from the AMADEUS database for the period 2002-2006. An interesting finding is that in three service sectors, the marginal impact of intangible capital is higher than that of the tangible one. Bontempi and Mairesse (2008), based on Italian firm level data, also find a positive effect of intangibles on productivity. However, there is little empirical evidence on the productivity effects of the most important subgroup of intangible assets, namely organizational capital. Note that it is important to understand that intangible assets affect performance indirectly through complex chains via human capital, skills and information capital (Brynjolfsson, Hitt and Yang, 2002; Arvanitis and Loukis, 2009). There are few studies investigating the indirect productivity effects of intangible assets via complementary production factors, such as firm specific human capital and information capital. Other studies find that intangible assets have a significant impact on the market value of firms (Greenhalgh and Rogers, 2006; Sandner and Block, 2011). Braunerhjelm (1996) finds that intangible assets have a significant impact on exporting.

However, unlike for the contribution of intangible assets to growth and productivity at the macroeconomic level, little is known about the drivers of international investment in intangible assets. Despite the growing interest in the determinants of internationalisation of R&D and other innovation activities, few studies have investigated the international location factors in greenfield investment related to intangible assets. For instance, Castellani, Jimenz and Zanfei (2011, 2013) have investigated the determinants of greenfield FDI in R&D and development, design and testing activities which represents a subgroup of intangible investments. This study will contribute to the emerging literature on the drivers and impacts of intangible assets by investigating the determinants of international investment in intangibles. The main contribution of this study is that it provides one of the first empirical investigations of the location factors in intangible assets. It focuses on the internationalisation of intangible assets as measured by greenfield investments. Please note that while cross-border M&As and innovation cooperations are also important aspects of the internationalisation process (Berger and Hollenstein, 2012), the determinants of these activities are not considered here due to a lack of available data. Knowledge of the determinants of greenfield FDI in intangible assets is particularly important to policy makers because greenfield investment often leads to higher economic growth in the host country, whereas the effects of FDI through mergers and acquisitions are less straightforward (see Wang and Wong, 2009). The study draws on a large database, namely the FDI markets database containing more than 110,000 FDI projects, including some 15,000 cross-border FDI projects in intangible assets.

In particular, we investigate the main factors determining the choice of international locations for intangible assets in developed (including the EU countries) and emerging countries (including the BRICs). Intangible assets are defined as software, except video games, (ii) advertising, public relations and related activities (iii) headquarters, (iv) research & development and (v) design and development & testing. The empirical model is based on a FDI gravity model augmented by a large number of 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. quantity and quality of skills, R&D expenditures, R&D subsidies, 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 study investigates the four following research questions:

(i) How attractive is the EU for greenfield FDI in intangible assets as compared to other world regions?

(ii) What are the main policy and non-policy determinants of inward and outward greenfield FDI in intangible assets in the EU countries, the United States, the BRICS, and other emerging countries?

(iii) Particularly, how do multinationals assess quantity and quality of skills, entry regulation, broadband penetration, the scientific strength of universities, and the protection of intellectual property rights?

(iv) Are there differences in the determinants of FDI intangible assets across world regions (EU countries versus all industrialised and emerging countries)?

The outline of the study is as follows. Section 2 provides an overview of definitions and the database. Section 3 provides descriptive statistics while section 4 provides the theoretical background. Section 5 provides the empirical results. Section 6 concludes the study.

2. Definition and database

Intangible assets are difficult to observe and to measure (Hunter, Webster and Wyatt, 2012). Intangible assets, intellectual capital and knowledge capital are often used interchangeably. Definitions and measures of intangible assets are available at the microeconomic (firm) level and the macroeconomic level. Zambon (2003), in a study prepared on behalf of the European Commission, defines intangible assets as non-physical sources of expected future benefits.

At the firm level, statements of financial accounting standards are the main data sources. The international accounting standard (IAS 38) defines an intangible asset as an “identifiable non-monetary asset without physical substance held for use in the production or supply of goods or services” (International Accounting Standards Committee, 1998). Intangible assets can be classified as the acquisition, development in the areas of scientific or technical knowledge, design, and implementation of new processes or systems, licences, intellectual property market knowledge and trademarks (Brennan and Connel, 2000). Computer software, patents, copyrights, customer rights and marketing rights are typical examples of intangible assets.

According to the international accounting standard, intangible assets do not include human resources, customer loyalty or company reputation (Brennan and Connel, 2000).

Existing procedures to determine the value of intangible assets within the accounting framework have several problems (Wilson and Stenson, 2008; Zéghal and Maaloul, 2011). The main reason for the difficulties in measuring investment in intangible assets is that there is a lack of consensus as to what they exactly constitute. Often only proxies are available. This holds particularly true for organizational capital, which represents the most important subgroup of intangible assets and is an important value driving asset of the firm (Prescott and Visscher, 1980). Furthermore, in the accounting framework, valuation is based on transactions reflecting historical costs. This may be valid for the acquisition of intangible assets from other firms, but not for internally created intangible assets (Wilson and Stenson, 2008). Therefore, many internally created intangible assets are not recognized in the balance sheets (Wilson and Stenson, 2008). Based on a survey of 600 firms, Hunter et al. (2012) find that managers use rules of thumb to estimate the amount and type of intangible assets. In spite of such problems, Hulten and Hao (2012) suggest that accounting book values based on replacement costs on intangible assets can be viewed as useful, although imperfect, measures of the market value of intangible assets. Some subcategories of intangible assets, such as R&D, advertising, software, and intellectual property (e.g. trademarks, patents and licenses) and training expenditures, can be measured quite easily. Based on balance sheet information drawn from the AMADEUS database, Marrocu et al. (2012) find that the share of intangible assets increased for all countries for which data is available and reliable.

A related concept is intellectual capital introduced by Edvinsson and Malone (1997). Intellectual capital is broader than intangible assets, as it includes not only intellectual property, but also all aspects of infrastructure assets (e.g. management philosophy, information systems), customer capital (e.g. licensing agreements) and human capital (e.g. know-how, education, vocational qualification, entrepreneurial spirit) (see Brennan and Connel, 2000).

In the economic literature, Corrado et al. (2005, 2006, 2009, 2012) have introduced a broad measure of intangible assets consisting of computerized information (including software), innovative property and economic competences (see Table 1 for an overview of definitions).

The authors construct measures of investment in intangible assets for all EU countries. Note that the subcategories of software, mineral exploration and evaluation, entertainment, and literary and artistic originals are already included in the National accounts definition. According to the estimates by Corrado et al. (2012), the most important subcategory of investment in intangible assets is organizational capital ranging between 12 and 36 per cent across the EU countries with an unweighted mean of 24 per cent, followed by software and R&D each having a share of 16 per cent (unweighted across EU countries) (see Table 2). New architectural and engineering designs, advertising and training are also important with each constituting about 10 per cent of total investment in intangibles assets, whereas the remaining subcategories, such as entertainment, literary and artistic originals, mineral explorations, new financial products and market research only represent a tiny proportion.

Table 1 **Definition of intangibles assets**

	National accounts	OECD (1998)	CHS (2012)	our definition
computerized information	software	software	software & computerized database	software publishers (except video games)
Innovative property		R&D expenditure patents	scientific R&D	R&D
			new architectural & engineering designs new product development costs in the financial industry	design, development & testing
	entertainment, literary or artistic orginals		entertainment, artistic & literary originals	
	mineral exploration & evaluation		mineral explorations	
economic competencies		economic competencies		
			market research, advertising expenditure	advertising, PR, & related
		employee training	training	
			organisational capital	headquarters

Table 2 **Distribution of intangible assets by subgroup, 2009 in %**

	soft-ware	R&D	new archi-tectural and eng-ineering designs	Entertain-ment, literary and artistic originals + mineral explorations	New Financial Products	Adver-tising	Market re-search	Train-ing	Organi-sational capital
Austria	12	26	11	1	1	10	1	12	25
Belgium	12	14	11	2	1	7	13	7	33
Czech Republic	11	12	20	3	1	14	9	9	22
Denmark	27	20	11	2	1	7	2	17	12
Finland	17	31	11	2	1	8	2	7	21
France	19	16	14	2	2	5	3	13	26
Germany	11	27	12	3	1	7	2	15	21
Greece	18	7	6	7	5	39	1	5	12
Ireland	8	13	7	6	4	17	5	13	27
Italy	14	14	17	0	2	8	9	13	23
Luxembourg	18	18	6	1	7	8	10	14	18
Netherlands	16	10	11	1	2	6	7	12	35
Portugal	15	13	12	4	3	8	4	9	32
Slovenia	10	15	18	3	2	14	2	10	26
Spain	20	14	18	3	3	13	5	9	16
Sweden	22	26	13	1	1	5	2	8	22
United Kingdom	19	10	11	3	2	5	3	12	36
EU unweighted	16	17	12	3	2	11	5	11	24
United States	15	19	7	9	2	12	1	11	23

Source: CHS 2012.

Corrado et al. (2012) suggest that only employer funded training rather than employee's own training should be regarded as intangible assets. However, for the subcategory of entertainment, literary and artistic originals and mineral explorations, there is no distinction for each subgroup available. Evidence for the US suggests that the artistic originals, entertainment, literary and artistic originals are much more important than investment in mineral explorations. All together intangible investment accounts for a sizable proportion of GDP ranging from eight per cent and more in the advanced countries and between two and four per cent in the Southern EU countries (see Table 3). It is interesting to note that in some advanced EU countries and the US, the GDP share of investment in intangible assets exceeds that of tangible assets. Furthermore, investment in intangible assets as a percentage of GDP increased much faster than that of tangible fixed investment. Between 2003 and 2009 the share of investment in intangible assets increased in 16 out 17 EU countries for which data is available (see Table 3). In contrast, the share of investment in tangible assets as a percentage of GDP decreased in 14 out of 17 EU countries for which data is available.

Table 3 **Investment in intangible and tangible assets as a percentage of GDP**

	investment in intangible assets as a percentage of GDP			investment in tangible assets as a percentage of GDP		
	2003	2009	change	2003	2009	
Austria	6.4	6.6	0.2	16.4	14.1	-2.4
Belgium	7.3	8.4	1.1	11.6	12.4	0.8
Czech Republic	6.8	6.7	-0.1	20.0	17.9	-2.1
Denmark	7.2	8.3	1.1	12.1	9.7	-2.3
Finland	6.9	8.0	1.1	12.0	11.7	-0.3
France	7.3	7.8	0.5	11.0	11.7	0.7
Germany	6.8	6.8	0.0	11.0	10.4	-0.6
Greece	2.1	2.2	0.1	21.2	17.7	-3.5
Ireland	4.8	6.0	1.2	17.7	9.8	-7.8
Italy	4.3	4.4	0.2	16.3	15.0	-1.3
Luxembourg	6.5	6.5	0.1	15.7	12.5	-3.1
Netherlands	7.5	8.2	0.6	11.9	10.8	-1.1
Portugal	4.2	5.0	0.8	19.4	15.6	-3.8
Slovenia	6.9	7.7	0.8	17.2	15.4	-1.8
Spain	4.2	4.7	0.6	23.1	18.9	-4.2
Sweden	8.8	9.2	0.4	8.1	8.8	0.7
United Kingdom	8.9	9.6	0.7	7.5	5.3	-2.2
United States	11.1	11.1	0.1	7.5	4.7	-2.8

Source: CHS 2012, own calculations.

Our measure of investment in intangible assets consists of greenfield investment in intangible assets. These data are 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 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 the 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 generated jobs is 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.

Note that the data on greenfield investments are an imperfect measure of the true amount of new investments in intangible assets by foreign investors. This may particularly be the case for industrialized countries, where greenfield FDI only represents a small proportion of total FDI flows (with an average of about 20 per cent). However, total FDI flows or stocks (including both cross border M&As and greenfield investment) also adequately measure the investment activity of foreign affiliates in a host country since they consist of the net financial capital flows or stocks from multinational firms to their affiliates (Beugelsdijk et al., 2010). The main drawback of both measures, namely greenfield FDI based on media sources and FDI based on the balance of payment concept, is that they do not include locally raised external funds. However, these funds can be used to finance invest in intangible assets and may therefore lead to a bias. Another problem is that information on activity of the greenfield investment refers to the year of investment. However, it is not unlikely that greenfield investment projects in production activities change their character after some time. It may be possible that foreign affiliates extend their activities by doing research activities or other types of intangibles.

Foreign affiliate sales by activity with information on different types of intangible assets would be a perfect measure. However, the official FATS statistics only include data on the R&D activities of foreign affiliates and also suffer from incomplete country coverage. In contrast, FDI markets include worldwide information on different types of intangible assets and do not suffer from missing data due to confidentiality. Furthermore, international investments in intangible assets are often characterised by low capital intensity and are likely to be underrepresented in the Balance of Payment Statistics. The advantage of data on greenfield FDI is that it is 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). Although there are limitations to the data, they can nonetheless be very useful in analysing the international attractiveness for intangible assets if these limitations are kept in mind.

The availability of FDI project data by function makes it possible to analyse greenfield FDI activities in intangible assets defined as FDI projects in (i) software (except video games), (ii) advertising, public relations and related activities, (iii) headquarters, (iv) research & development and (v) design, development & testing. There is also information on mineral explorations and entertainment. However, the number of FDI projects in these areas is very small. Table 4 shows the structure of intangible assets by subgroups. Software accounts for the major bulk with more than one third of all projects followed by headquarter services and design, and development & testing.

Table 4 **Structure of greenfield FDI projects in intangible assets by subgroup**

	EU-27	40 host countries
software except video games	40	36
advertising, public relations and related activities	9	7
headquarter services	24	22
research & development	10	12
design, development & testing	17	22

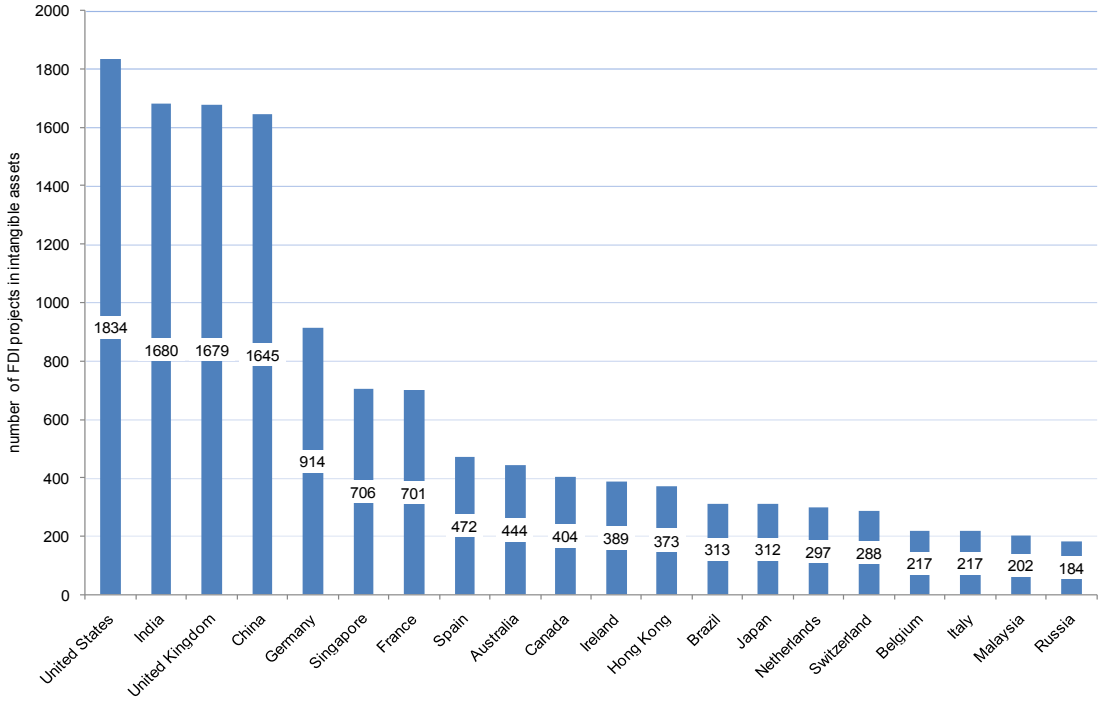
Source: FDI markets database, own calculations.

3. Descriptive statistics

The data covers greenfield FDI projects and investment flows in intangible assets 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.

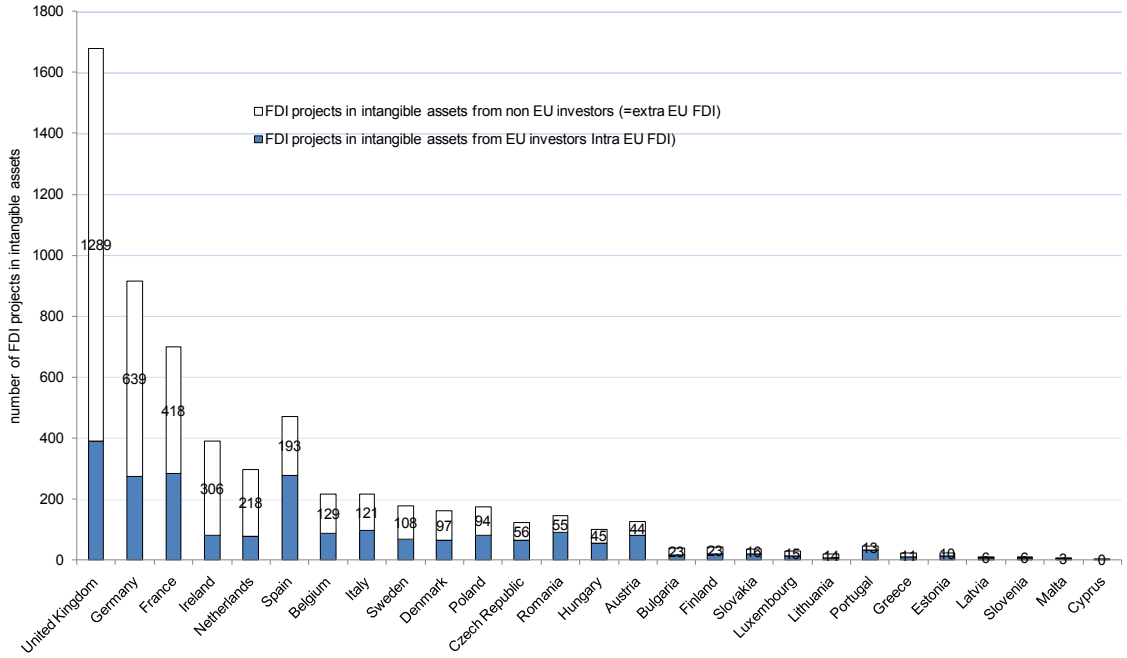
Figure 1 shows the distribution of the number of greenfield investment projects in intangible assets by country for the Top 20 destinations based on the estimation sample with about 15,000 greenfield investment projects in intangible assets.

Figure 1 **Number of greenfield FDI projects in intangible assets by host country (cumulated 2003-2011)**



Notes: descriptive statistics is based on 40 host countries and 26 parent countries representing 90 per cent of total FDI projects in intangible assets. Source: FDImarkets data.

Figure 2 **Number of greenfield FDI projects in intangible assets in the EU countries disaggregated by intra and Extra EU-FDI projects (cumulated 2003-2011)**



Notes: descriptive statistics is based on 40 host countries and 26 parent countries representing 90 per cent of total FDI projects in intangible assets. Source: FDImarkets data.

One can see that United States, India, the United Kingdom and China are the top locations for international investment in intangible assets, receiving almost one half of the investment projects worldwide. It is interesting to note that smaller countries, such as Singapore, Hong Kong and Ireland and Switzerland, receive a high share of investments in intangible assets given their country size. This already indicates that market size is not a major determinant of the location decision for international investment in intangible assets. Among the EU countries, Germany is second after the United Kingdom and then followed by France, Spain and Ireland. When distinguishing between investors from EU and non EU countries, we find that for non EU investors, United Kingdom, Germany, France, Ireland and the Netherlands are the most attractive locations (see Figure 2).

Table 5 shows the number of greenfield FDI projects in intangible assets by host region and year based on the estimation sample. One can see that the number of greenfield FDI projects in the EU-27 decreased by 10 per cent between 2008 and 2011. In contrast, Brazil, Russia and the United States experienced an increase in the number of greenfield FDI projects in intangible assets during the same period. However, the decline in the number of FDI greenfield FDI in the EU-27 has been highly uneven across EU member states. In the EU-15 countries, the decrease is about nine per cent, whereas in the EU-12 countries (CEE countries) a decrease of 24 per cent is shown. In addition, the southern EU-15 countries suffer most from the decrease in FDI inflows in knowledge intensive assets with a decrease of almost 50 per cent. A detailed breakdown in intra and extra EU FDI activity show that the drop has been concentrated on intra-EU FDI activities rather than extra EU FDI activities.

Table 6 shows the distribution of greenfield FDI projects in intangible assets by host region based on data for the estimation sample. The EU-27 accounts for 40 percent of total greenfield FDI projects. Unreported results show based on the total sample of the fdi markets data, the EU-27 countries have world share of 35 per cent cumulated over the period 2003-2011, of which 13 per cent refers to the intra-EU share and 22 per cent to the extra-EU share.

The United States and China (including Hong Kong SAR) account for 12 and 13 per cent of total greenfield FDI projects in intangible assets. The other emerging countries (other than the BRICs) account also for 9 per cent. India alone accounts for 11 nine er cent of total greenfield FDI projects in intangible assets. It is interesting to note that the EUs share of greenfield FDI projects in these activities decreased after the economic and financial crises of 2009 (from 43 to 37 per cent). Distinguishing between intra- and extra-EU activities shows that the decline in the EU-27s share was mainly due to the decline in the share of intra-EU FDI projects, while the extra-EU FDI projects share is relatively stable. In 2011, however, the extra-EU share declined for the first year since the data has been available.

Table 5 **Number of greenfield FDI projects in intangible assets by host country**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	total 2003-11	change 2008-11 in %
EU-27	413	506	644	708	808	848	749	759	759	6194	-10
Intra EU-27	142	162	217	249	345	340	282	287	262	2286	-23
Extra EU-27	271	344	427	459	463	508	467	472	497	3908	-2
EU-15	370	441	572	587	724	755	684	672	688	5493	-9
Southern EU-15	51	66	57	80	129	135	78	93	69	758	-49
Extra EU-15	245	315	398	400	443	478	440	432	473	3624	-1
EU-12	43	65	72	121	84	93	65	87	71	701	-24
United States	109	100	112	168	227	214	264	291	349	1834	63
Japan	23	34	34	36	48	30	42	40	25	312	-17
China + Hong Kong	176	232	222	222	229	264	224	222	227	2018	-14
India	158	251	188	255	189	179	144	138	178	1680	-1
Brazil	20	19	12	26	38	31	45	46	76	313	145
Russia	11	24	35	16	20	21	15	14	28	184	33
other emerging co.	125	135	111	136	150	207	189	194	205	1452	-1
other countries	121	141	141	151	162	190	178	189	223	1496	17
total	1156	1442	1499	1718	1871	1984	1850	1893	2070	15483	4

Source: FDImarkets data.

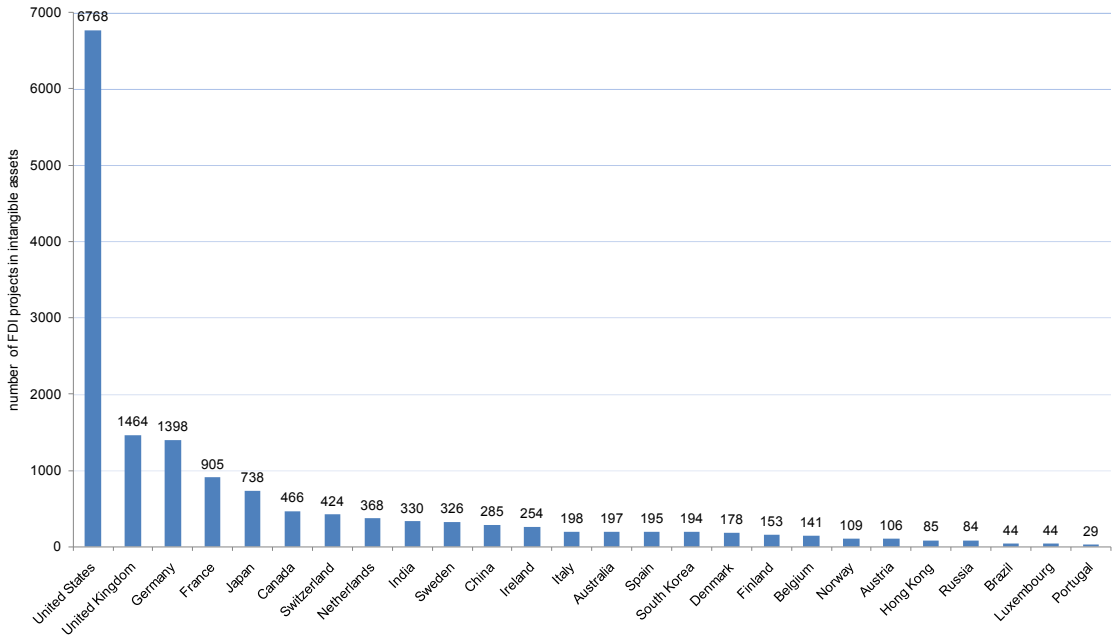
Table 6 **Percentages of greenfield FDI projects in intangible assets by host country**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	total 2003-2011	change 2008-2011 in %
EU-27	36	35	43	41	43	43	40	40	37	40	-6
Intra EU-27	12	11	14	14	18	17	15	15	13	15	-4
Extra EU-27	23	24	28	27	25	26	25	25	24	25	-2
EU-15	32	31	38	34	39	38	37	35	33	35	-5
Southern EU-15	4	5	4	5	7	7	4	5	3	5	-3
Extra EU-15	21	22	27	23	24	24	24	23	23	23	-1
EU-12	4	5	5	7	4	5	4	5	3	5	-1
United States	9	7	7	10	12	11	14	15	17	12	6
Japan	2	2	2	2	3	2	2	2	1	2	0
China + Hong Kong	15	16	15	13	12	13	12	12	11	13	-2
India	14	17	13	15	10	9	8	7	9	11	0
Brazil	2	1	1	2	2	2	2	2	4	2	2
Russia	1	2	2	1	1	1	1	1	1	1	0
other emerging countries	11	9	7	8	8	10	10	10	10	9	-1
other countries	10	10	9	9	9	10	10	10	11	10	1
total	100	100	100	100	100	100	100	100	100	100	0

Source: FDImarkets data.

Turning to the source countries, one can see that the United States is the largest investor with about 40 per cent of all FDI projects in intangible assets (see Figure 3). United Kingdom and Germany are on the second and third position with a considerable difference to the United States It is interesting to note that small countries are important investors (e.g. Switzerland, Netherlands, Sweden). This is not surprising because these countries host a sizable number of large MNEs.

Figure 3 **Number of greenfield FDI projects in intangible assets by source country (cumulated 2003-2011)**



Source: FDImarkets data.

4. Determinants of FDI in intangibles

4.1 Previous literature

The OLI *paradigm* serves as the theoretical background for understanding the motivations and determinants for the international investment decision. The OLI theory states that a firm decides to invest abroad because of ownership specific advantages, location specific advantages and internationalisation advantages (Dunning, 2000). Ownership specific advantages arise from firm-specific knowledge based assets, such as human capital, R&D expenditures and intangible assets. Firms with a high level of investment in knowledge-based assets are more likely to invest in intangible assets abroad. Hence, countries that are relatively abundant with highly educated workers and with a high level of R&D expenditures relative to GDP show higher levels of FDI outflows. Location-specific advantages refer to the conditions in the host country. These

factors can be classified into four groups: (i) demand side factors, (ii) knowledge-based factors, (iii) factor costs and (iv) product market regulations and institutional characteristics.

Previous studies on the determinants of cross-border activities in knowledge-based activities primarily deal with foreign investment in R&D and/or software. Studies on international R&D activities by multinational firms have identified two main motivations for cross-border investments in R&D: (i) “asset-exploiting” strategy and (ii) “asset-augmenting” attitude (von Zedtwitz and Gassmann, 2002; Narula and Zanfei, 2005). Dunning and Lundan (2008, 2009) distinguish between three main motivations for international investment in R&D (see also Hollenstein, 2013; OECD, 2011):

- market seeking strategy (e.g. market size, market growth, proximity to suppliers) (“asset exploiting strategy”)
- knowledge and resource seeking strategies (e.g. presence of good universities, availability of skilled workers) (“asset augmenting strategy”)
- efficiency seeking strategy (low wage costs, tax advantages).

The so-called asset-exploiting strategy means that multinational firms undertake foreign R&D in order to adapt their products to local market conditions. Thus, size of the market, market growth and proximity to potential suppliers are the main factor for this type of motivation. The larger the size of the market and the better its market growth prospects, the more likely foreign affiliates are willing to undertake R&D activities and other knowledge based activities. Empirical evidence confirms that market demand is an important determinant of FDI in R&D in general (Ito and Wakasugi, 2007) and for development activities in particular (Shimizutani and Todo, 2008). However, it is unclear whether this also holds for international investments in intangible assets. Unreported results based on FDI market data suggest that small countries, such as Singapore, Dubai, Ireland and Switzerland, given their respective size, are disproportionally successful in attracting international investment in intangible assets.

The second major motivation for cross-border investments in R&D and related knowledge based activities is to obtain access to local scientific and technological resources and skilled labour. This is referred to as the “asset- or knowledge-seeking/augmenting” attitude (Narula and Zanfei, 2005; Dunning and Lundan, 2009). 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; Narula and Bellak, 2009 for surveys of the literature). For instance, Kumar (2001) finds that a higher ratio of scientists and engineers has a positive effect on the R&D expenditure of MNCs’ affiliates. More recently, 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 cross-border investments in R&D. Belderbos et al. (2009) find that the scientific strength of local universities is an important factor for the international location choice of R&D. Similarly, Liu et al. (2011) and Doh et al. (2009) find that skills in the host country are the main factors in attracting FDI in knowledge-intensive services.

In summarizing the literature on the determinants of FDI in knowledge intensive industries Hollenstein (2013) suggests that asset-exploiting is more important than asset-seeking as a motive of FDI in these activities although the relevance of asset-seeking motivation strongly increased in the last years.

Firms' rankings of the importance of location factors for knowledge intensive activities, such as R&D, are consistent with the view that the knowledge-base in the host country is an important determinant of cross-border investment in these activities. Based on a survey of EU multinational firms conducting R&D activities, Moncada-Paterno-Castello, Vivarelli and Voigt (2011) find that the access to specialized knowledge, the availability of researchers, and the legal framework are the most important factors for international R&D outsourcing. Access to the market, cheap labor cost of researchers and the proximity to suppliers appear to play a secondary role as drivers of R&D locations abroad. Therefore, one can conclude that the importance of "asset exploiting" motives seems to be decreasing over time. 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 R&D tax breaks and subsidies are ranked as least important. However, in emerging countries, demand is more important than supply factors according to these authors. In contrast, using 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 a location's attractiveness for R&D. However, this is stands in contrast to the previous literature.

The choice of investing abroad in knowledge-based activities is also likely to be influenced by institutional factors. These factors include the strength of protection for IPR in the host country and FDI regulatory regime. Branstetter et al. (2006) find empirical evidence that a strong IPR regime in the host country has a positive impact on local R&D expenditure of US foreign affiliates. However, the relationship between IPR protection and FDI in knowledge-based activities is not clear-cut. On the one hand, strong IPR protection may lead to other forms of internationalisation, such as licensing. On the other hand, 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).

To sum up, the literature confirms that countries that are relatively abundant in skilled labour, with a high level of R&D expenditures and with excellent universities, tend to be an attractive location for cross-border investments in R&D. This relationship may hold true not only for cross border investments in R&D, but also for international investments in other types of intangible assets, such as software that shares many common characteristics with research and development activities. However, intangible assets not only include R&D and software, but also activities, such as advertising and market research, which relies less heavily on the availability of knowledge-based assets in the host country but more on demand-side factors.

Factor costs are commonly regarded as less important in influencing FDI activities in knowledge based factors. However, Kumar (2001) finds that wages of R&D personnel has a negative effect on the R&D expenditure for affiliates of MNCs. Similarly, a number of other studies find that

corporate taxes and labour costs are significant determinants of FDI in knowledge-intensive services (Doh et al., 2009; Bunyaratavej et al., 2008; Farrell, 2005).

Furthermore, knowledge intensive 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 intangible assets 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 factor for the international investment in knowledge-based activities is geographical distance. FDI flows in intangible assets are expected to decrease with the distance between host and home country. Empirical evidence is mixed. Based on the FDi Markets database, Castellani et al. (2011) suggest that distance is less important in determining bilateral FDI activity in R&D than cultural factors and regional trade agreements, which are significant and positive.

4.2 Specification of the model and estimation method

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). In addition, a wide range of characteristics of the host and home markets play an important role in greenfield investment in intangible assets. As outlined above, these variables include market size, skills, R&D endowment, ICT infrastructure, cost-based factors (such as labour costs and corporate taxes), and FDI restrictions.

The origins of the gravity model come from the gravity theory in physics. Newton's law of universal gravitation states that the gravitational attraction between two objects is proportional to the product of their masses and inversely proportional to the square of the (geographical) distance between them. In other words, the larger the economies, the larger FDI activities and the greater the geographical distance, the lower the FDI activities.

The FDI gravity equation with random effects 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:

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

where *i* is the home country, *j* is the host country, *t* refers to the year, and *ln* is the natural logarithm. α_{ij} denotes the random bilateral host parent country effects, $\text{host}_j, \text{home}_i, \lambda_t$ are host and home country dummy variables and time dummy variables, respectively.

The variables are defined as follows:

$FDIRD_{ijt}$ is the number of bilateral greenfield FDI projects in intangible assets;

$GDPHOME_{it-1}$ and $GDPHOST_{jt-1}$ represent home country and host country GDP in constant purchasing power parities,

$DIST_{ij}$ is the geographical 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 and effect average corporate tax rate (EATR) 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; alternatively, the PISA scores in maths, science and reading are used;

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; public and private sector R&D, R&D tax subsidies (1-B-index), direct R&D funding for the business sector; number of highly cited papers based on the Shanghai index, 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 (see table A1 in the appendix for the data sources and table A2 for descriptive statistics 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 quantity and quality of skills, R&D endowment and high-quality universities are major factors determining the location of greenfield investment in intangible assets. ICT infrastructure, measured as broadband Internet penetration, is also expected to have a positive and significant impact on greenfield investment in intangible assets. In addition, greenfield investment outflows may also be affected by parent country characteristics, such as 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 in intangible assets. Among the regulation indicators, costs of starting a business and FDI restrictions are considered to be the most important. Although FDI restrictions in EU countries have declined significantly in the last decade, they still hamper FDI in some knowledge intensive business services.

The dependent variable, namely the number of FDI projects in intangible assets, is a count variable. The distribution of the number of FDI projects is strongly skewed to the right with an accumulation of observations at zero and a display of significant overdispersion with the variance being greater than the mean. The most common estimators used for count variables are the Poisson regression and the negative binomial model, where the latter is an extension of the Poisson model (Cameron and Trivedi,1998). The negative binomial model is commonly

suggested as the preferred estimator because it is less restrictive than the Poisson model. This particularly holds true when the data exhibits a high degree of overdispersion, i.e. variance exceeding the mean. In our case, out of 7000 observations, about 66 per cent are zero observations. 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 FDI gravity equation estimated by the random-effects specification also includes common time effects and host- and home-country effects while the fixed effects specification only includes time effects. We also use the conditional fixed effect Negative Binomial for panel data as used in most of the patent literature for over-dispersed count data (Hausman, Hall & Griliches, 1984).

As an alternative to the fixed effects negative binomial regression model, we also employ the quasi-maximum likelihood (QML) Poisson regression with parent-host country fixed effects. This regression technique is preferred against the standard poisson model since it allows the variance-to-mean ratio to take any value (Wooldridge, 1999). Therefore, the results are robust to any overdispersion in the estimation sample. Note that overdispersion represents a problem in our data set because of the large proportion of zero investments (about two thirds). Furthermore, QML Poisson models also overcome the drawbacks of conditional fixed effect negative binomial models developed by Hausman, Hall and Griliches (1984). Allison and Waterman (2002) have shown that fixed effect negative binomial models is not a true fixed effects estimator since it does not necessarily control for all of its unit-specific covariates as does the standard linear fixed effects model. We use Simcoe's xtpqml STATA code for robust standard errors in the Fixed Effects Poisson Model based on Wooldridge (1999).

5. Econometrics results

Table 7 shows the estimates of the baseline specification of the determinants of bilateral greenfield FDI projects in intangible assets. The table includes coefficients obtained from the random-effects and fixed-effects negative binomial estimator, where the random and fixed effects are parent-host country pairs.[1] The table also includes the marginal effects assuming that the random or fixed effect is zero. The random effects specification controls for host- and home-country fixed effects as well as for time effects, whereas the fixed effects specification only include time effects. Table 8 shows the corresponding estimates for the subgroup of EU-25 host countries (i.e. the EU-27 countries excluding Cyprus and Malta). Since information of the explanatory variables is not available for all years or countries, the number of observations depends on the choice of explanatory variables. Unreported results show that the results are robust when using the quasi-maximum likelihood (QML) Poisson regression model with fixed

[1] We use the xtnbreg command in STATA with the fe and re option to fit our data to the conditional fixed and random effects negative binomial model.

effects.[2] However, the standard errors of the FDI determinants are somewhat larger in most cases.

The interpretation of the results for the time invariant or almost time invariant variables is mainly based on the estimates obtained from the random-effects negative binomial model. For the time varying variables, the fixed effects specification is preferred. Note that a number of policy related host country factors are excluded from the final specification because they are not significant at conventional significance levels.

Table 7 **Determinants of greenfield FDI projects in intangible assets (baseline specification total sample)**

	Fixed-effects negative binomial regression model (40 countries)										
	(i)						(ii)				
	coef.		z	marg eff		z	coef.		z	marg eff		z
log GDP in const. ppp, host, t-1	-0.06		-0.70	-0.47		-0.63	0.10		0.53	0.86		0.59
log GDP in const ppp., parent, t-1	0.36	***	3.42	2.70	***	3.71	0.17		0.87	1.44		1.08
host statutory corporate tax rate, t-1	0.00		-0.59	-0.03		-0.56	0.00		-0.01	0.00		-0.01
parent stat. corporate tax rate, t-1	-0.01	*	-1.73	-0.10		-1.64	0.00		0.34	0.04		0.34
log hourly wages costs, host t-1	-0.27	***	-3.01	-1.98	**	-2.29	-0.58	***	-2.63	-4.99		-1.61
log hourly wages costs, parent t-1	0.46	***	4.40	3.46	***	3.17	0.59	***	2.62	5.01	*	1.81
share of tertiary education, host t-1	0.05	***	4.11	0.35	***	2.83						
share of tertiary educat, parent t-1	0.00		-0.31	-0.02		-0.31						
log PISA score, host t-1							4.43	**	2.25	37.91	*	1.66
year dummies	yes						yes					
constant	-1.17		-0.93				-27.4	**	-2.16			
number of observations	4912						1230					
number of host-parent country pairs	633						436					
	Random-effects negative binomial regression model (40 host countries)										
	(i)						(ii)				
	coef.		z	marg eff		z	coef.		z	marg eff		z
log distance	-0.17	***	-4.95	-0.05	***	-4.89	-0.11	**	-2.35	-0.03	**	-2.33
shared border	0.20	**	2.05	0.06	*	1.87	0.24	*	1.80	0.08		1.63
common language	0.45	***	5.26	0.15	***	4.38	0.48	***	4.47	0.17	***	3.65
former colony	0.37	***	3.68	0.13	***	3.08	0.24	**	2.01	0.08	*	1.78
log GDP in const. ppp, host, t-1	-0.84	***	-4.37	-0.24	***	-4.34	-0.75		-1.10	-0.22		-1.10
log GDP in const ppp., parent, t-1	0.26		0.60	0.07		0.60	-0.13		-0.13	-0.04		-0.13
host statutory corporate tax rate, t-1	-0.01		-1.61	0.00		-1.61	0.00		0.20	0.00		0.20
parent stat. corporate tax rate, t-1	-0.01	*	-1.72	0.00	*	-1.72	0.01		0.51	0.00		0.51
log hourly wages costs, host t-1	-0.34	***	-2.91	-0.10	***	-2.88	-0.63	***	-2.81	-0.19	***	-2.78
log hourly wages costs, parent t-1	1.05	***	6.13	0.30	***	6.09	0.62	**	1.97	0.19	**	1.97
share of tertiary education, host t-1	0.03	**	2.32	0.01	**	2.32						
share of tertiary educat., parent t-1	0.09	***	5.32	0.03	***	5.30						
log PISA score, host t-1							4.78	**	2.34	1.42	**	2.32
parent, host and year, dummies	yes						yes					
constant	6.03		1.34				-14.2		-0.88			
number of observations	7259						2448					
number of host-parent country pairs	937						935					

[2] The STATA procedure xtpqml is used to estimate the equation.

Notes: The dependent variable is the number of Greenfield FDI projects in intangible assets from country *i* to country *j*. ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

In particular, the FDI regulatory restrictiveness, share of scientists and engineers, protection of intellectual property, number of highly cited researchers as a proxy of the scientific strength of academic sector, employment protection legislation, ratio of total tax rate to commercial profits and strength of legal rights for obtaining credit are either not significant or show the wrong sign when source and host country fixed effects and common time effects are taken into account (see Table A3 in the Appendix). In particular, a striking result is that the two labour market regulation indicators, namely hiring and firing practices and employment protection legislation shows the wrong sign. This indicates that many policy relevant factors are not relevant for the attractiveness of Greenfield FDI in intangible assets.

For the total sample of 40 host countries, the results show that greenfield investments in intangible assets depend significantly on geographical distance, sharing a common language and a former colony status. In particular, geographical distance between investor and recipient countries shows the expected negative sign and is significant at the one 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.

Estimates based on the random-effects negative binomial model shows that both quantity of education measured as the tertiary graduates share and quality of education measured as the PISA index are highly significant at the five per cent level. Hourly wage costs have a significant and negative impact on greenfield investment in intangible assets. Furthermore, the corporate tax rate does not have a significant impact. The results for the fixed-effects negative binomial regression model largely confirm the findings obtained from the random effects specification. Again, the coefficient on the tertiary graduates share and the PISA score are positive and significant at the five per cent level. Wages are also a significant location factor for international investment in intangible assets while corporate taxes do not play a significant role.

The results for the remaining gravity factors, namely the logarithm of host country and home country GDP, are not clear-cut. Based on the fixed and random effects specification, we find that host country GDP is either insignificant or shows a negative sign. This indicates that market seeking considerations are not relevant for FDI in intangible assets. This is consistent with Nachum and Zaheer (2005) who find that FDI in ICT-intensive industries is unlikely to be driven by market seeking considerations.

Overall, the findings are consistent with the previous empirical literature, which finds that the available knowledge base – indicated by the educational qualifications of the workforce and the quality of educational system – is a main factor in attracting FDI in knowledge intensive activities, while cost-based factors only play a minor role (Rilla and Squicciarini, 2011). However, the insignificance of host country GDP stands in contrast to the literature.

Among the parent-country factors, hourly wage costs and share of tertiary education have a significant and positive impact indicating that the number of greenfield investment projects in intangible assets are higher in skill-rich and high wage home countries.

When the sample is restricted to the EU host countries, we find significant differences in the FDI determinants (see Table 8) between the total sample of 40 industrialized and emerging countries and the subsample of EU countries. In particular, corporate taxes in the host country are now significantly negative, while the coefficient of wages is much lower in absolute terms than for the total sample including 40 emerging and industrialized countries. These findings are robust to both the random and fixed effects specification. In addition, corporate taxes remain negative and highly significant when based on the quasi-maximum likelihood (QML) poisson regression with parent host country fixed effects (results are available upon request).

Table 8 **Determinants of greenfield FDI projects in intangible assets (baseline specification EU-25 countries)**

	Fixed-effects negative binomial regression model (25 EU host countries)									
	(i)					(ii)				
	coef.		z	marg eff		z	coef.		z	marg eff		z
log GDP in const. ppp, host country, t-1	0.63	***	3.88	2.60	***	3.34	0.16		0.45	0.96		0.50
log GDP in const ppp., parent, t-1	0.55	***	3.55	2.27	***	3.59	0.49	**	2.11	2.94		1.53
host statutory corporate tax rate, t-1	-0.03	***	-2.80	-0.11	**	-2.23	0.00		-0.04	0.00		-0.03
parent statutory corporate tax rate, t-1	-0.03	**	-2.31	-0.10	**	-2.05	0.00		-0.21	-0.02		-0.20
log hourly wages costs, host t-1	-0.33	*	-1.69	-1.36		-1.45	-0.34		-0.73	-2.06		-0.61
log hourly wages costs, parent t-1	0.54	***	3.32	2.22	***	2.66	0.83	***	2.58	5.00		1.50
share of tertiary education, host t-1	0.07	***	3.61	0.30	***	2.77						
share of tertiary education, parent t-1	0.00		0.01	0.00		0.01						
log PISA score, host t-1							0.67		0.20	4.05		0.20
year dummies	yes						yes					
constant	-6.98	***	-4.14				-8.17		-0.38			
number of observations	2878						749					
number of host-parent country pairs	364						268					
	Random-effects negative binomial regression model (25 EU host countries)									
	(i)					(ii)				
	coef.		z	marg eff		z	coef.		z	marg eff		z
log distance	-0.33	***	-3.36	-0.07	***	-3.34	-0.12		-0.86	-0.03		-0.86
shared border	0.20		1.34	0.04		1.23	0.25		1.50	0.07		1.35
common language	0.51	***	3.45	0.13	***	2.77	0.56	***	3.28	0.16	***	2.58
former colony	0.31	*	1.78	0.07		1.53	-0.10		-0.58	-0.02		-0.61
log GDP in const. ppp, host country, t-1	-0.15		-0.20	-0.03		-0.20	-1.12		-0.96	-0.26		-0.95
log GDP in const ppp., parent, t-1	0.59		0.96	0.12		0.96	2.27		1.51	0.52		1.51
host statutory corporate tax rate, t-1	-0.03	***	-3.96	-0.01	***	-3.91	-0.01		-0.91	0.00		-0.91
parent statutory corporate tax rate, t-1	-0.03	***	-2.61	-0.01	***	-2.60	0.00		0.03	0.00		0.03
log hourly wages costs, host t-1	-0.45	*	-1.95	-0.09	*	-1.94	-0.19		-0.47	-0.04		-0.47
log hourly wages costs, parent t-1	1.04	***	4.02	0.21		4.00	1.00	*	1.89	0.23	*	1.90
share of tertiary education, host t-1	0.07	***	2.86	0.01	***	2.84						
share of tertiary education, parent t-1	0.07	***	2.85	0.01	***	2.84						
log PISA score, host t-1							-1.88		-0.62	-0.43		-0.62
parent, host and year, dummies	yes						yes					
constant	-1.31		-0.17				3.41		0.14			
number of observations	3887						1565					
number of host-parent country pairs	511						585					

Notes: The dependent variable is the number of Greenfield FDI projects in intangible assets from country *i* to country *j*. ***, **, and * denote statistical significance at the one per cent, five per cent and ten per cent levels, respectively.

This indicates that a decrease in corporate taxes leads to an increase in the number of greenfield FDI projects in intangible assets in the following year. However, the marginal effects are quite small. A decrease in the corporate tax rate by 10 percentage points leads to an increase in the expected number of FDI projects by one additional FDI project based on the fixed effects specification. A striking finding is that quality of education measured as the PISA score is no longer significant. Furthermore, we again find that the level of skills – measured as the share of tertiary education in the host country – to be positive and highly significant. This also holds true for both the fixed-effects and random effects negative binomial regression model. In addition, the impact of wages is much lower in absolute terms and less significant than for the total sample. Furthermore, host country GDP shows the expected positive sign indicating that market size of EU countries is a relevant factor for the location of greenfield investments in intangible assets.

Table 9 shows the results for the FDI gravity equation where the human capital variables are replaced by the R&D to GDP ratio of the host and parent country (see specification [i]) and the public and private sector R&D to GDP (see specification [ii]). The estimates show that the R&D endowment of the host country is a significant factor influencing greenfield FDI inflows into intangible assets. This indicates that the higher the R&D to GDP ratio in a given host country, the higher the number of greenfield investment in intangible assets in that country. When R&D is divided into public sector and private sector, we find that public sector R&D is more important than private sector R&D in determining FDI inflows in intangible assets. However, when the sample is restricted to the sample of the EU-25 host countries, we find that the ratio of R&D to GDP is only significant at 10 per cent (results are available upon request). Overall, the results are consistent with the previous literature showing that the available knowledge base in the host country is an important and significant factor influencing new international investment in intangible assets.

Table 10 shows an alternative specification using entry regulation costs and strength of investor protection. The results based on the random effects specification show that that the costs associated with starting a business and strength of investor protection are significant factors influencing greenfield FDI inflows into intangible assets. The higher the costs of start-up regulations in a given host country, the lower the amount of greenfield investment into that country. In the EU economies, the cost of starting a business ranges from an average of zero per cent of income per capita in Denmark to 25 per cent in Greece for the period 2003-2010. Based on the fixed effects, specification strength of investor protection remains weakly significant while entry regulation costs are no longer significant. The latter finding is not surprising given that entry regulation costs hardly change over time.

Broadband penetration also has a significant and positive influence on greenfield investments in intangible assets (see Table 11). 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. Unreported results show that both entry regulation costs and broadband penetration are no longer significant when the sample is restricted to the sample of EU countries. In contrast, strength of investor protection remains significant for the smaller sample, including the EU-25 host countries.

We conducted a number of robustness checks. As already suggested, intangible assets consists of a number of diverse activities ranging from R&D to advertising, software and headquarter services. It is likely that the determinants of greenfield investments in the different types of intangible assets differ across the different subcategories. However, a detailed discussion of these differences is beyond the scope of the present paper. Preliminary estimates show that market-seeking factors are more important for the subgroup of design, development & testing and advertising. Corporate taxes matter for investment in headquarter services.

Table 9 **Impact of R&D endowment on the number of greenfield FDI projects in intangible assets (40 host countries)**

	Fixed-effects negative binomial regression model											
	(i)						(ii)					
	coef.		z	marg eff		z	coef.		z	marg eff		z
log GDP in const. ppp, host country, t-1	-0.06		-0.77	-0.44		-0.69	-0.05		-0.56	-0.33		-0.52
log GDP in const ppp., parent, t-1	0.36	***	4.46	2.44	***	4.78	0.38	***	4.36	2.44	***	4.64
host statutory corporate tax rate, t-1	0.00		0.66	0.03		0.67	0.00		0.18	0.01		0.18
parent statutory corporate tax rate, t-1	-0.02	**	-2.12	-0.11	*	-1.95	-0.02	**	-1.97	-0.10	*	-1.85
log hourly wages costs, host t-1	-0.08		-1.19	-0.57		-1.13	-0.12		-1.55	-0.76		-1.42
log hourly wages costs, parent t-1	0.54	***	5.44	3.63	***	3.56	0.47	***	5.20	3.02	***	3.44
R&D to GDP ratio, host t-1	0.33	***	3.13	2.22	**	2.52						
R&D to GDP ratio, parent t-1	0.00	**	-2.46	-0.02	**	-2.11						
business R&D to GDP ratio, host t-1							0.14		1.07	0.90		1.00
public R&D to GDP ratio, host t-1							0.96	***	2.86	6.22	**	2.54
year dummies	yes						yes					
constant	-1.01		-0.90				-1.80		-1.51			
number of observations	4877						4728					
number of host-parent country pairs	641						612					
	Random-effects negative binomial regression model											
	(i)						(ii)					
	coef.		z	marg eff		z	coef.		z	marg eff		z
log GDP in const ppp., parent, t-1	0.25		0.56	0.08		0.56	0.15		0.34	0.05		0.34
log GDP in const. ppp, host country, t-1	-1.08	***	-5.62	-0.33	***	-5.58	-0.57	**	-2.51	-0.18	**	-2.50
log distance	-0.19	***	-5.27	-0.06	***	-5.21	-0.18	***	-4.96	-0.06	***	-4.91
shared border	0.21	**	2.03	0.07	*	1.85	0.23	**	2.19	0.08	**	1.99
common language	0.46	***	5.27	0.17	***	4.37	0.45	***	5.14	0.17	***	4.29
former colony	0.42	***	4.01	0.16	***	3.28	0.38	***	3.63	0.14	***	3.03
host statutory corporate tax rate, t-1	-0.01		-0.92	0.00		-0.92	-0.01		-1.49	0.00		-1.49
parent statutory corporate tax rate, t-1	-0.01		-1.17	0.00		-1.17	-0.01		-0.84	0.00		-0.84
log hourly wages costs, host t-1	-0.27	**	-2.31	-0.08	**	-2.29	-0.50	***	-3.96	-0.16	***	-3.91
log hourly wages costs, parent t-1	1.19	***	6.98	0.37	***	6.94	1.23	***	7.12	0.39	***	7.08
R&D to GDP ratio, host t-1	0.37	***	3.26	0.11	***	3.25						
R&D to GDP ratio, parent t-1	0.00	*	-1.76	0.00	*	-1.75						
business R&D to GDP ratio, host t-1							0.12		0.90	0.04		0.90
public R&D to GDP ratio, host t-1							1.35	***	4.16	0.43	***	4.14
parent, host and year, dummies	yes						yes					
constant	12.76	***	2.92				8.43	*	1.86			
number of observations	7213						6861					
number of host-parent country pairs	961						890					

Notes: The dependent variable is the number of Greenfield FDI projects in intangible assets from country *i* to country *j*. ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Table 10 **Impact of entry regulations and strength of investor protection on the number of greenfield FDI projects in intangible assets (40 host countries)**

	Fixed effects specification (40 countries)											
			(i)						(ii)			
	coef.		z	marg eff		z	coef.		z	marg eff		z
log GDP in const ppp., parent, t-1	0.31	**	2.14	1.71	**	2.36	0.39	***	3.71	1.78	***	3.94
log GDP in const. ppp, host country, t-1	0.34	***	2.59	1.86	***	2.70	0.21	**	2.41	0.98	***	2.79
host statutory corporate tax rate, t-1	0.01		0.77	0.04		0.77	0.00		0.05	0.00		0.05
parent statutory corporate tax rate, t-1	-0.01		-0.63	-0.04		-0.62	-0.01		-1.37	-0.06		-1.34
log hourly wages costs, host t-1	-0.23		-1.60	-1.25		-1.47	-0.25	**	-2.27	-1.16		-2.00
log hourly wages costs, parent t-1	0.22		1.15	1.20		1.17	0.30	**	2.36	1.38	**	2.28
share of tertiary education, host t-1	0.06	***	3.33	0.34	**	2.46	0.04		3.00	0.20	**	2.46
share of tertiary education, parent t-1	0.04	**	2.24	0.20	*	1.91	0.01		0.94	0.05		0.92
strength of investor protection, host t-1	0.98	**	2.03	5.39	*	1.82						
costs of starting a business in %, host t-1							-0.01		-1.43	-0.02		-1.41
year dummies	yes						yes					
constant	-11.56	***	-4.56				-3.71	***	-3.21			
number of observations	1152						3420					
number of host-parent country pairs	296						586					
	Random effects specification (40 countries)											
			(i)						(ii)			
	coef.		z	marg eff		z	coef.		z	marg eff		z
log GDP in const ppp., parent, t-1	1.05		1.04	0.37		1.04	0.98		1.48	0.32		1.48
log GDP in const. ppp, host country, t-1	0.35		0.67	0.13		0.67	-0.12		-0.38	-0.04		-0.38
log distance	-0.15	***	-3.96	-0.05	***	-3.92	-0.16	***	-4.52	-0.05	***	-4.47
shared border	0.10		0.88	0.04		0.84	0.09		0.89	0.03		0.86
common language	0.49	***	5.42	0.21	***	4.41	0.52	***	6.15	0.21	***	4.95
former colony	0.26	**	2.43	0.10	**	2.14	0.31	***	3.08	0.12	***	2.65
host statutory corporate tax rate, t-1	0.00		-0.52	0.00		-0.52	-0.01		-0.88	0.00		-0.88
parent statutory corporate tax rate, t-1	-0.01		-1.23	0.00		-1.23	-0.02	*	-1.95	-0.01	*	-1.95
log hourly wages costs, host t-1	-0.84	***	-3.38	-0.30	***	-3.36	-0.67	***	-3.99	-0.22	***	-3.94
log hourly wages costs, parent t-1	0.51	*	1.73	0.18	*	1.72	0.75	***	2.94	0.25	***	2.93
share of tertiary education, host t-1	0.00		0.02	0.00		0.02	-0.01		-0.64	0.00		-0.64
share of tertiary education, parent t-1	0.10	***	3.51	0.04	***	3.50	0.11	***	4.92	0.04	***	4.90
strength of investor protection, host t-1	1.22	*	1.79	0.44	*	1.79						
costs of starting a business in %, host t-1							-0.01	***	-4.99	-0.00	***	-4.93
parent, host and year, dummies	yes						yes					
constant	-11.82		-1.14				-5.49		-0.84			
number of observations	3607						5457					
number of host-parent pairs	937						937					

Notes: The dependent variable is the number of Greenfield FDI projects in intangible assets from country *i* to country *j*. ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Table 11 **Impact of broadband penetration on the number of greenfield FDI projects in intangible assets (40 host countries)**

	RE negative binomial regression model					FE negative binomial regression model				
	coef.		z	marg eff	z	coef.		z	marg eff	z
log GDP in const ppp., parent, t-1	0.26		0.61	0.08	0.61	0.49	***	5.47	1.79	*** 5.30
log GDP in const. ppp, host, t-1	-0.59	**	-2.32	-0.17	** -2.32	0.21	***	2.79	0.79	*** 3.24
log distance	-0.17	***	-4.93	-0.05	*** -4.87					
shared border	0.20	**	2.03	0.07	* 1.86					
common language	0.45	***	5.27	0.16	*** 4.39					
former colony	0.37	***	3.69	0.13	*** 3.08					
corporate tax rate, host t-1	-0.01		-1.05	0.00	-1.05	0.00		0.07	0.00	0.07
corporate tax rate, parent t-1	-0.01	*	-1.74	0.00	* -1.74	-0.02	**	-1.99	-0.06	* -1.94
log hourly wages costs, host t-1	-0.31	***	-2.67	-0.09	*** -2.65	-0.11		-1.16	-0.40	-1.11
log hourly wages costs, parent t-1	1.03	***	6.03	0.30	*** 5.98	0.43	***	4.26	1.61	*** 3.68
share of tertiary education, host t-1	0.02	*	1.67	0.01	* 1.67	0.02	*	1.66	0.09	1.51
sh. of tertiary education, parent t-1	0.09	***	5.36	0.03	*** 5.34	0.01		0.68	0.02	0.67
broadband infrastructure host t-1	0.01		1.64	0.00	1.64	0.02	***	3.92	0.07	*** 3.97
parent, host and year, dummies	yes					yes				
constant	3.40		0.71			-5.05	***	-5.33		
number of observations	7164					4677				
number of host-parent pairs	937					608				

Notes: The dependent variable is the number of Greenfield FDI projects in intangible assets from country *i* to country *j*. ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

6. Conclusion and policy implications

Higher investments in knowledge intensive activities, such as intangible assets, are essential for making progress in the implementation of Europe's 2020 strategy for smart, sustainable and inclusive growth. The new growth strategy is broader than previous growth strategies, such as the Lisbon Strategy, since it focuses on higher investments in knowledge intensive assets rather than on higher investments in narrow segments, such as R&D and ICT. Hence, knowledge about the factors influencing the level of international investments in intangible assets is important for policy makers.

This study has investigated the policy and non-policy determinants of bilateral greenfield investments in intangible assets. It also documents trends and patterns in greenfield investment in these activities over time and across host and home countries. The data covers greenfield investments between the 26 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 intangible assets, with a world market share of more than 30 per cent in terms of the number of FDI projects in this field. However, there was a decline in the EU 27s share of such projects after the recent financial and economic crisis. A detailed investigation reveals that the reduction in the EU 27s share since 2008 was mainly due to the decrease in intra-EU greenfield FDI activities (in particular in Southern Europe and the EU-12 countries). Policies to increase the attractiveness of FDI in intangible assets should be a major concern of policymakers.

The empirical results using the random-effects negative binomial regression model show that greenfield investment in intangible assets depends on geographical distance, sharing a common language, hourly wage costs, skills (measured as tertiary education), quality of skills measured as the PISA scores, entry regulations, and ICT infrastructure. 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, R&D intensity, market size, strength of investor protection and corporate taxes are significant determinants of greenfield FDI in intangible assets, while for the total sample, the presence of skilled workers, quality of education, direct R&D subsidies, entry regulation costs, broadband penetration and strength of investor protection and Internet infrastructure are significant factors. Labour market regulations are not relevant as a determinant of greenfield FDI in intangible assets. Since the 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 the asset-seeking rather than asset exploiting strategies.

Some limitations of the study are worth mentioning. In particular, the estimation results cannot be interpreted as causal effects because of potential endogeneity of some right hand variables. Future works should use instrumental variable methods to account for the possible endogeneity problems.

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 market regulation, and intellectual property rights systems. First, 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 market regulation. Second, the presence of a skilled labour force and a high level of broadband penetration are substantial drivers of FDI in intangible assets. Additional investments in tertiary education and Internet infrastructure should thus be the main objective of policy makers. Third, wage costs and corporate taxation play some role in determining FDI inflows in intangible assets. However, cutting corporate taxes is not a policy option because corporate taxes are already very low in the new EU member states and lower than in other world regions. Fourth, while cultural factors, such as sharing a common language, are important in attracting international investment in intangible assets, this is the result of a 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, meaning that with respect to FDI these regulations may be not very important. However, with respect to FDI regulations, all EU member states (except two) are more open to FDI than the OECD average. This holds particularly true for manufacturing.

The empirical results on the determinants of international investment in intangible assets may help to develop a proactive action plan to increase the attractiveness of the EU countries for future international investments in intangible assets. Improving the quality and quantity of skilled

labour, decreasing entry regulation costs, further investment in broadband infrastructure and better investment protection systems should be the main elements of such an action plan.

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Annex

Table A1: Source of explanatory variables

variable	measure	source
level of GDP	EURO constant ppp	New Cronos, OECD, national statistics
geographical distance	distance between the principal cities weighted by population size in kilometers	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 per cent	New Cronos, OECD, national statistics
PISA score in maths, science and reading, 2004, 2007, 2010	score	OECD
share of scientists and engineers in % of total population from 15-74 yrs	in percent	New Cronos
ratio of R&D expenditures to GDP	per cent	New Cronos OECD and EUROSTAT, World Bank
direct R&D subsidies	per cent	OECD
Tax incentives for R&D	1-B-index	OECD
hourly labour costs in the business sector	EURO in current prices	New Cronos, U.S. Bureau of labor office for some non EU countries.
statutory corporate tax rate	in percent	KPMG
effective average tax rate	per cent	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
getting credit - strength of legal rights	index (0-10) (10=best)	World Bank
ratio of costs of starting a business to income per capita	per cent	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	per cent	World Bank
top marginal tax rate	per cent	Economic Freedom
hiring and firing practices	index 1-10, 1=most,10=least regulated	Economic Freedom
labor force share with wages set by centralized collective bargaining	index 1-10, 1= highly centralized, 10=least centralized, 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, 4=least	OECD
FDI regulatory restrictiveness	index 0 and 1, 0=open and 1=closed	OECD, Kalinova, Palerm and Thomsen (2010)

Table A2: Descriptive statistics of the main explanatory variables

	40 host countries			EU-25		
	# of obs	mean	std. dev	# of obs	mean	std. dev
# of FDI projects in intangible assets	7259	1.9	8.7	4613	1.3	6.3
level of GDP parent	7259	1740.0	2700.0	4613	1750.0	
level of GDP host	7259	1190.0	2260.0	4613	533.0	
geographical distance	7259	5391.8	4816.8	4613	3829.0	4053.9
shared border	7259	0.1		4613	0.1	
sharing the same language	7259	0.1		4613	0.1	
(former) colonial link	7259	0.0		4613	0.0	
statutory corporate tax rate in %, host	7259	27.6	7.6	4613	26.3	7.7
statutory corporate tax rate n %, parent	7259	31.0	6.1	4613	31.0	6.1
hourly wages in euro, host	7259	16.6	11.7	4613	17.5	11.8
hourly wages in euro, parent	7180	23.8	10.1	4563	23.7	10.1
PISA score, host	2441	496.4	33.4	1590	492.6	25.0
educational attainment people aged 15-64, host	7259	22.0	10.2	4613	19.4	6.4
educational attainment people aged 15-64, parent	7259	23.2	10.2	4613	23.3	10.2
Fixed broadband Internet subscribers host	7164	13.8	10.2	4541	13.3	9.7
ratio of costs of starting a business to income per capita host in %, host	5457	9.1	11.5	3441	8.7	7.7
strength of investor protection, host	4544	5.9	1.5	2855	5.5	1.1
The number of highly cited researchers in 21 subject categories host	5457	7.5	6.6	3441	5.8	5.8
R&D to GDP ratio in %, host	7167	1.7	1.0	4521	1.5	0.9
R&D to GDP ratio in %,, parent	7145	2.1	0.8	4539	2.1	0.8
ratio of business R&D to GDP in % host	6700	1.1	0.8	4235	1.0	0.7
ratio of public sector R&D to GDP in % host	6700	0.6	0.2	4235	0.6	0.3
Tax incentives for R&D	6862	0.1	0.1	4613	0.1	0.1
direct R&D subsidies in % of total business R&D	6509	9.0	10.0	4235	8.8	7.4

Table A3: Additional estimates of the random effects negative binomial model

	controls (gravity factors, wages, skills and taxes)	coeff		t	# of obs	# of groups
log FDI regulatory restrictiveness, host	yes	0.47	***	3.51	6756	864
share of scientists and engineers in %, host	yes	-5.64		-0.46	4903	632
log protection of intellectual property, host	yes	0.17		1.48	7259	937
log number of highly cited researchers in 21 subject categories, host	yes	-0.04		-0.71	5457	937
log employment protection legislation, host	yes	0.83	*	1.85	4740	743
log hiring and firing practices, host	yes	-0.40	***	-5.26	7259	937
ratio total tax rate to commercial profit, host	yes	-0.25		-0.28	3584	937
log getting credit - strength of legal rights, host	yes	-0.84		-5.10	4498	937

Notes: The dependent variable is the number of Greenfield FDI projects in intangible assets from country *i* to country *j*. ***, **, and * denote statistical significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Project Information

Welfare, Wealth and Work for Europe

A European research consortium is working on the analytical foundations for a socio-ecological transition

Abstract

Europe needs a change: The financial crisis has exposed long neglected deficiencies in the present growth path, most visibly in unemployment and public debt. At the same time Europe has to cope with new challenges ranging from globalisation and demographic shifts to new technologies and ecological challenges. Under the title of Welfare, Wealth and Work for Europe – WWWforEurope – a European research consortium is laying the analytical foundations for a new development strategy that enables a socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. The four year research project within the 7th Framework Programme funded by the European Commission started in April 2012. The consortium brings together researchers from 33 scientific institutions in 12 European countries and is coordinated by the Austrian Institute of Economic Research (WIFO). Project coordinator is Karl Aiginger, director of WIFO.

For details on WWWforEurope see: www.foreurope.eu

Contact for information

Kristin Smeral

WWWforEurope – Project Management Office

WIFO – Austrian Institute of Economic Research

Arsenal, Objekt 20

1030 Vienna

wwwforeurope-office@wifo.ac.at

T: +43 1 7982601 332

Domenico Rossetti di Valdalbero

DG Research and Innovation

European Commission

Domenico.Rossetti-di-Valdalbero@ec.europa.eu

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