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The main drivers for the internationalization of R&D activities by EU MNEs

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CORPORATE R&D: AN ENGINE FOR GROWTH, A CHALLENGE FOR EUROPEAN POLICY

Globalising economies & internationalisation of corporate R&D

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Abstract

Based on an original and recent sample representative of the largest R&D corporations in the EU, this paper aims at investigating in a quantitative way the main factors explaining: (i) the decision of firms to increase their R&D investment effort in the near future; (ii) the main drivers explaining the favorite location choice for R&D; and (iii) the impact of direct and indirect policies to support R&D activities in the EU. Main findings suggest that competitive pressures from the US are the main determinants for increasing R&D investments. Public support to R&D and proximity to other activities of the company explain the decision to locate R&D in the home country while considerations on the cost of employing researchers appear also to matter for firms preferring a location outside their home country, in particular in China and India.

Key words: R&D internationalisation; drivers; R&D policies; EU large R&D corporations

JEL classification: O33

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1 - Introduction

In the last decade, theoretical (Dunning and Narula, 1995; Kuemmerle, 1997) and empirical studies (among the others: Kuemmerle, 1999; Kumar, 2001; Von Zedwitz and Gassmann, 2002) on the internationalization of R&D have highlighted a shift from the so-called home-base exploiting to the home-base augmenting R&D strategies. Within such framework, MNEs set R&D laboratories abroad not only for adapting technologies and products developed at home to local market conditions; but even with the aim of tapping into knowledge and technological sources in centres of scientific excellence located worldwide.

Such location strategies refer to multiple dimensions, comprising the technological strengths of the countries with respect to those of the company (Patel and Vega, 1999; Le Bas and Sierra, 2002), institutional factors – such as public support to R&D, IPR systems, quality of technological infrastructures – and lowering costs of qualified research, especially in emerging countries (UNCTAD, 2005).

In the light of the current discussion about R&D relocation trends, this paper aims at investigating in a quantitative way the main factors explaining R&D investment effort and location in the world by the largest EU R&D spenders together with the main determinants from both the supply and the demand side for increasing these activities.

The empirical analysis is based on an original dataset of the top EU R&D spending firms in 2007, which represents about one fourth of the total R&D amount invested by EU companies worldwide. Such data come from the last edition of the IRMA survey on trends in business R&D investment (European Commission JRC-IPTS, 2009).

According to the dataset, roughly half of EU MNEs consider their home country as the most attractive location for R&D. For the other ones, Germany, the US and India are the most often cited as being the most attractive economies for expanding R&D investment. The availability of researchers and the access to specialized R&D knowledge emerge as the main drivers of firms' R&D location decisions. Though of less importance, considerations on the cost of employing researchers appear also to matter for firms preferring a location outside their home country. Then, in line with the findings in the literature, market pull and exploiting technological opportunities appear to be the most important drivers for increasing the overall R&D investment.

The structure of the paper is as follows. In section 2 we present the theoretical background for R&D internationalization; in section 3 we report data specificities and descriptive statistics; in section 4 we present the results of the econometric analysis and in section 5 the main conclusions.

2 - Theoretical background

Research and Development (R&D) investments by private companies have since long attracted considerable attention due to their role for growth, productivity, employment and competitiveness. Ever since Solow (1957), R&D has been perceived as a fundamental engine for productivity growth, both at the macro and microeconomic level (for an overview of the findings as to the original approach by Griliches, 1979, see e.g. Mairesse and Mohnen, 2001, and for more recent additions: Baumol, 2002; Jones, 2002; Rogers, 2006; Lööf and Heshmati, 2003) and has therefore been widely analyzed. Many studies have found a significant contribution of R&D to firm productivity, in the range of estimated overall average elasticity between 0.0 and 0.25, depending on the methods of measurement and the data used. Recent findings from Ortega-Argilés, Potters and Vivarelli (2009) confirmed R&D as a fundamental determinant of possible competitive advantage and revealed that companies in high-tech sectors not only invest more in R&D, but also achieve more in terms of efficiency gains connected with research activities.

Attracting and retaining companies with significant R&D investment thus has the potential of considerable economic benefit. As a consequence, governments have increasingly seen R&D policies as an instrument for achieving their wider objectives related to growth, productivity and competitiveness. One effect of this is that many governments, as well as the EU as a whole, have established R&D intensity targets[1].

The Lisbon strategy – aiming at making the EU 'the most competitive knowledge-based economy' – includes the commitment to higher levels of R&D intensity as well as to changes in organizational R&D and framework conditions. The objectives rest partly on proposals to increase publicly-funded R&D, but also emphasize the need for significant increases in business-funded R&D. The EU aim is to approach and possibly surpass the effort made by competing economies, especially the US. In fact, Europe has kept up with the US in investing public resources in knowledge, both in higher education and research, but the EU has dramatically failed to convince the private sector and its citizens to invest in

knowledge, the key to its own long term future (Soete, 2006). Building on the Lisbon objective, the 2002 Barcelona European Council set a target for EU R&D of 3% of EU GDP, of which 2/3 should be financed by the private sector (European Commission, 2003). These targets are appealing and enticingly easy to grasp. However, they are even more easily misunderstood because aggregate R&D numbers for countries or regions are not simply an effect of R&D 'effort': they are a combined outcome of firm strategies, company demographics, industrial structures, and macroeconomic dynamics (Soete, 2005).

Jaumotte and Pain (2005) and Falk (2004) addressed a range of top-down determinants of R&D expenditure, e.g. in the form of shares of government BERD, high-tech export shares, or patenting activity, from a country level point of view. This kind of determinants constitutes an important background for R&D investment location. While R&D internationalization has been observed as a trend since decades (for a first comprehensive review, see Granstrand et al., 1992), there are very few studies addressing location decisions from a bottom-up company viewpoint. Among them, von Zedtwitz and Gassmann (2002) showed the concentration of R&D sites in the US, Europe, Japan and Asia, often around major regional centres in South Korea, Singapore, and other emerging economies along the Pacific Rim. Furthermore, a trend of the past years – and often a matter of concern for policy-makers – is the increasing attractiveness of China and India as R&D locations with these countries being the two biggest "net-importers" of R&D (Jaruzelski and Dehoff, 2008).

From the company point of view, R&D location decisions are however complex and subject to a number of underlying factors. Thursby and Thursby (2006) found four outstanding factors: output market potential, quality of R&D personnel, University collaboration and intellectual property protection. Further, for companies locating in emerging economies, the growth potential in the market and the quality of R&D personnel were the most important factors. For companies locating in developed countries (at home or in another country), the quality of R&D personnel and intellectual property protection were the most important factors. In addition, for more than 75 percent of the respondents, the R&D location decision was part of an expansion and in less than 30 percent a relocation.

[1] For a comprehensive overview, see Sheehan and Wyckoff (2003).

As regards the more specific topic of the drivers for the internationalisation of MNEs R&D activities, a well established literature (Dunning and Narula, 1995, and Kuemmerle, 1997) has led to the distinction between two sets of forces:

- Demand-pull forces: Home based exploiting (HBE). Foreign R&D laboratories adapt technologies and products developed at home to local market conditions (regulations, standards, consumer tastes) and/or provide technological support to local subsidiaries.
- Technology-push forces: Home based augmenting (HBA). Foreign R&D laboratories are needed in order to tap into knowledge and technology sources in centres of scientific excellence located worldwide.

Besides them, other institutional factors have been individuated, such as for instance the public support of R&D activities; the strength and scope of the IPR system; the quality of the technological infrastructure; the macro economic and political stability and other framework conditions. Furthermore, some studies have tried to disentangle the concept of the Research vs. the Development component in R&D (see table 1) or the typology of R&D units (see table 2).

Table 1: Location drivers for research vs. development

Reasons to locate 'Research' in a particular location	Reasons to locate 'Development' in a particular location
Proximity to local universities and research parks	Local market requirements
Tapping informal networks	Global customers request local support
Proximity to centres-of-innovation	Customer proximity and lead users
Limited domestic science base	Cooperation with local partners
Access to local specialists/recruiting	Market access

Source: von Zedtwitz and Gassman (2002)

Table 2: Determinants for the location of R&D by type of R&D unit

	Scientific and technological supply	Demand
Production support unit	Quality of formation (engineers, technicians)	Important local market (size, purchasing power)
Global unit	Centres of excellence Quality of science-industry relations	Lead market
Rationalisation unit	Cost/efficiency of R&D activities	

Source: Sachwald (2004)

Following this brief state of the art of the literature dealing with the determinants of R&D investments and localization decisions of the largest European MNEs, we are interested in this paper in investigating three main questions. (i) What are the main factors both on the demand and supply sides explaining the decisions of companies to increase the budget they allocate to R&D activities on the three coming years; (ii) What are the main reasons explaining why a given country is considered by a firm as the most favourite destination for performing R&D; and (iii) among the different policies implemented by Member States as well as at EU level, which ones are considered by MNEs as the most important ones for continuing ton invest in research in the EU. These questions are investigated quantitatively in Section 4. The next section discusses the dataset constructed from the survey as well as presents main trends and descriptive statistics based on these data.

3 - Data: the IRMA surveys on trends in business R&D investment

In order to shed light from a company perspective, the IRMA Surveys of R&D Investment Business Trends[2] have gathered information from across Europe on the factors and issues which influence R&D investment by companies. The survey is part of the Industrial Research Investment Monitoring (IRIM) initiative and accompanies the EU Industrial R&D Investment Scoreboard[3]. These activities are jointly carried out by the European Commission's Joint Research Centre (JRC) – Institute for Prospective Technological Studies (IPTS) and the Directorate General Research - Directorate C, European Research Area: Knowledge-based economy. Their aim is to improve the understanding of industrial R&D and Innovation in the EU and to identify medium and long-term policy implications[4]. The survey explicitly avoids duplication with other R&D investment related surveys and data collection exercises (e.g. Innobarometer[5], the Trend Chart on Innovation[6], the results from the Knowledge Economy Indicators project[7], EUROSTAT data collection of structural indicators or other ongoing surveys).

[2] See: http://iri.jrc.ec.europa.eu/research/survey.htm.
[3] The EU Industrial R&D Investment Scoreboard is published annually since 2004. It provides data and analysis on companies (1000 with headquarters in the EU and 1000 outside the EU) with the highest global investment in R&D. The 2009 edition is the sixth one (see: http://iri.jrc.ec.europa.eu/research/scoreboard.htm).
[4] More information, including activities and publications, is available at: http://iri.jrc.es.
[5] http://cordis.europa.eu/innovation/en/policy/innobarometer.htm
[6] www.proinno-europe.eu
[7] http://kei.publicstatistics.net

Each year between 2005 and 2008, one edition of the survey was undertaken by sending a questionnaire (see appendix B for the 2008 edition) to the European companies which had appeared in the EU Industrial R&D Investment Scoreboard of the previous year. These companies received the questionnaire together with a printed Scoreboard and the printed analysis of the previous survey. Where possible, the survey was addressed to the compilers of previous surveys, otherwise to the company CEO or equivalent. This procedure is followed-up by two rounds of printed reminders and email and phone contacts. The 2005 edition was the pilot for the survey testing different approaches of many subsamples in order to examine the responsiveness of companies. Following the experience with the 2005 pilot phase of the survey and the analysis of the different subsamples, for subsequent editions it was decided to focus on the European companies in the Scoreboard. Table 3 provides an overview of the basic populations and response rates to the pilot survey and the subsequent regular editions.

The table shows a constantly high responsiveness of the European Scoreboard companies over the years: between 13 % and 19 % in terms of numbers of questionnaires and 23.1 % and 30.4 % in terms of R&D investment amount compared to the Scoreboard. The latter amounts correspond to a similar share of the R&D spent and performed by the business sector (the so-called BERD) in the EU. Despite the fact that Scoreboard and BERD data address industrial R&D in the EU through different concepts and are therefore not directly comparable, their latest figures were of similar magnitude[8]. In particular, R&D investment in the surveys refers to the total amount of R&D financed by the company, regardless of where or by whom that R&D is performed. This excludes R&D financed by governments or other companies as well as the companies' share of any associated company or joint venture R&D investment. The survey therefore reports what each responding company states as its particular financial commitment to R&D. This is different from the official BERD concept, which takes a geographic perspective and thus refers to all R&D performed by businesses within a particular territory, regardless of the home location of the business, and regardless of the sources of finance[9].

[8] According to 2006 data for EU-27: Scoreboard €121bn (European Commission, 2008) and BERD €116 bn (EUROSTAT, 2008).

[9] BERD includes R&D financed by the company itself as well as R&D performed by a company but funded from other sources. Official BERD figures comprise R&D performed in a given country or region and carried out by the companies (including foreign-owned subsidiaries) that are physically located in the country, regardless of the source of funding.

Table 3: Overview of the basic populations and response rates of the 2005-2008 surveys

	Pilot Survey 2005	Survey 2006	Survey 2007	Survey 2008
Basic populations addressed				
Scoreboard	500 EU companies of the 2004 Scoreboard	700 EU companies of the 2005 Scoreboard	1000 EU companies of the 2006 Scoreboard	1000 EU companies of the 2007 Scoreboard
Industrial associations / Technology Platforms	• European Industrial Research Management Association (EIRMA) • European Council for Automotive R&D (EUCAR) • European Association of Automotive Suppliers (CLEPA) • European Association for Bioindustries (EuropaBio) • European Federation of Pharmaceutical Industries and Associations (EFPIA)	not addressed	not addressed	Presentation of the survey activity to the Techology Platform leaders
From other sources	• 3092 companies in pharmaceuticals & biotechnology • 1499 companies in chemicals • 1509 companies in engineering & machinery	not addressed	not addressed	not addressed
Response rates				
Total responses	593 in total (95 from Scoreboard companies)	110	118	130
Response rate in terms of number	9.4% overall (19% Scoreboard)	15.7%	11.8%	13.0%
Response rate in terms of R&D investment	n.a.overall (27% Scoreboard)	24.3%	23.1%	30.4%

Source: European Commission JRC-IPTS (2009)

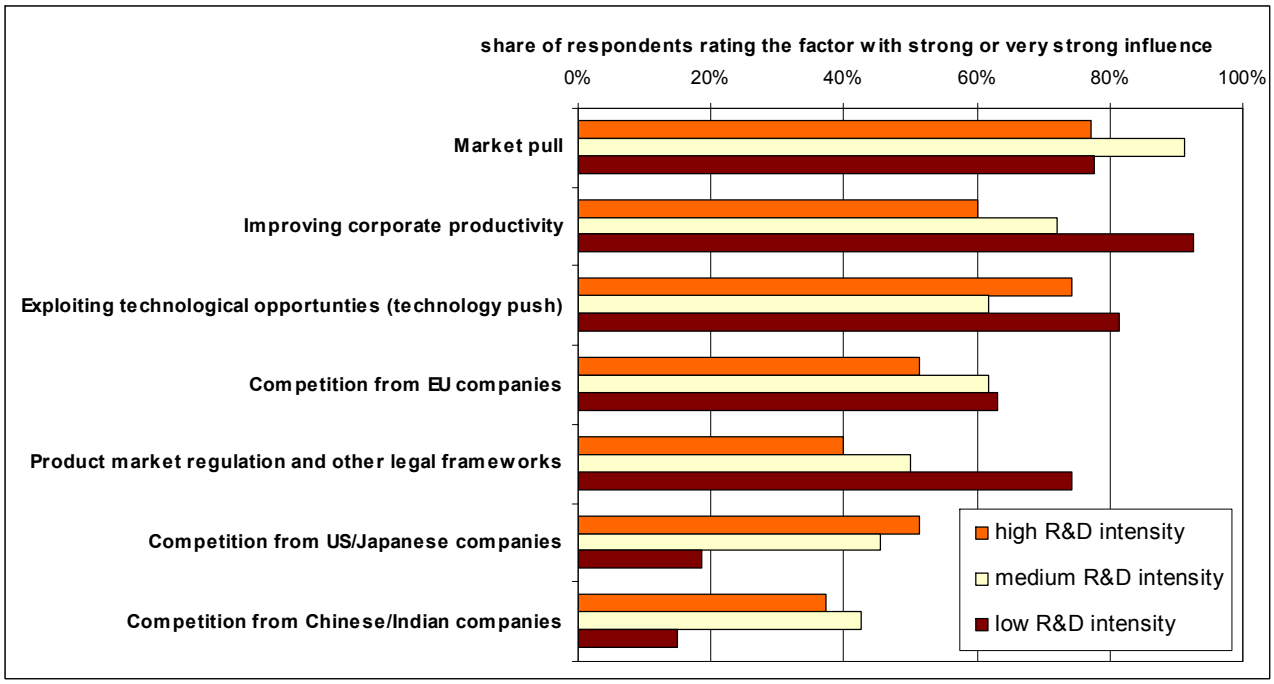
For the purposes of the current paper, data from the last survey have been used. As highlighted in the published report (European Commission JRC-IPTS, 2009), some major trends are clearly evident through a descriptive overview. Before discussing in the following section the findings of the econometric regressions, we recall the main ones in what follows.

3.1 Motivations for increasing R&D investment

More than two thirds of respondents still consider market pull, improving corporate productivity and technological push as the main incentives for increasing the overall level of R&D investment. As shown in figure 1, anyway, even among these factors there are differences according to high, medium and low R&D intensive sector groups[10].

[10] In the 2008 IRMA survey, sectors are combined into three groups accoding to their average R&D intensities in the 2007 Scoreboard: **High (more than 5%) R&D intensity**: biotechnology, health care equipment & services, leisure goods, pharmaceuticals, software, support services, technology hardware & equipment; **Medium (between 2 and 5%) R&D intensity**: aerospace & defence, automobiles & parts, chemicals, commercial vehicles & trucks, computer services, electrical components & equipment, electronic equipment, food producers, general industrials, industrial machinery, personal goods; **Low (less than 2%) R&D intensity**: banks, construction & materials, electricity, fixed-line telecommunications, food & drug retailers, food producers, forestry & paper, gas, water & multiutilities, general retailers, industrial metals, industrial transportation, oil & gas producers, oil equipment, services & distribution.

Figure 1: Importance of factors for increasing R&D investment, by sector group



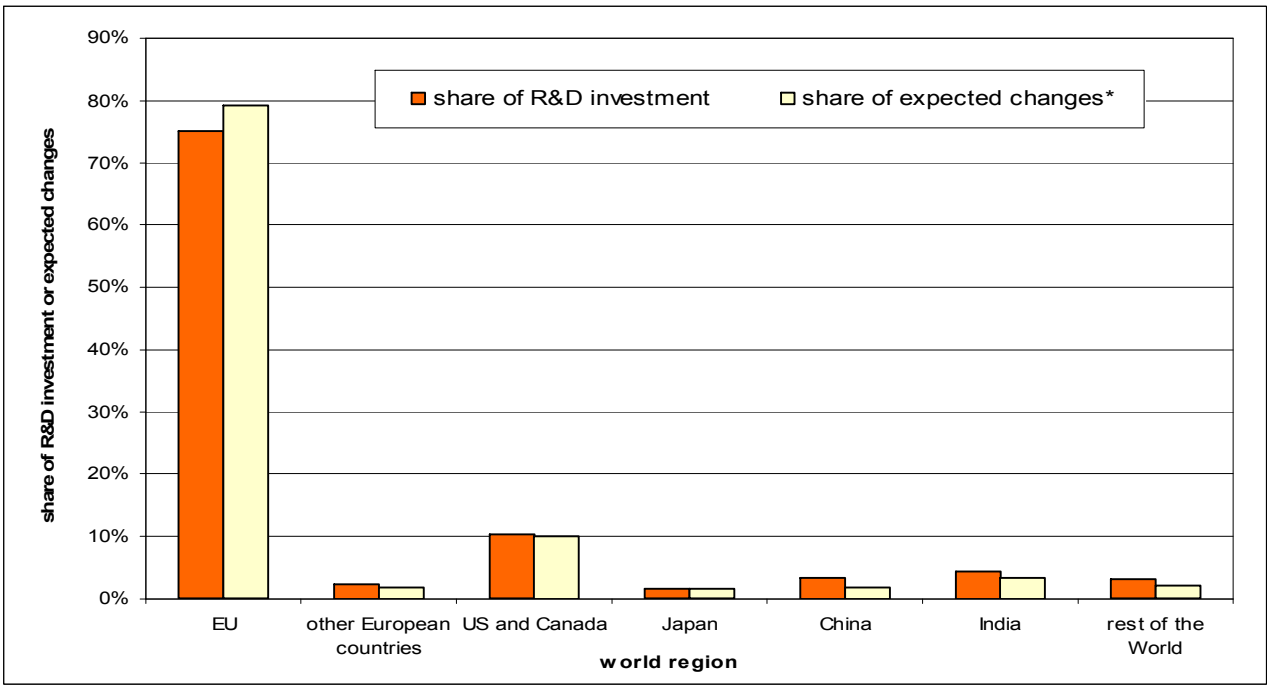
Source: European Commission JRC-IPTS (2009)

While market pull is generically rated as the most important driver, low tech companies seem to be more interested in expanding R&D activities for productivity and technological reasons. They consider regulation as an important motivation, too. Competition appears to be more relevant towards EU companies, although for high tech companies the US/Japanese competitors are relevant as well. In general, it seems that the classical motivations for technological development remain the most important. Such conclusion is consistent with the findings of previous editions of the survey.

3.2 Country factors for R&D investment

On average, the EU-based companies in the sample carry out just over 20% of their R&D outside the EU. On one side, such result is consistent with the literature, especially with contributions stating that a shift of R&D outside the home country is increasing only slowly. Furthermore, Northern America is still the main recipient for R&D carried out by EU companies outside EU (see figure 2). Emerging countries such as China and India are increasing their attractiveness but without a clear trend. Apparently, EU is going to be even more relevant in terms of expected changes.

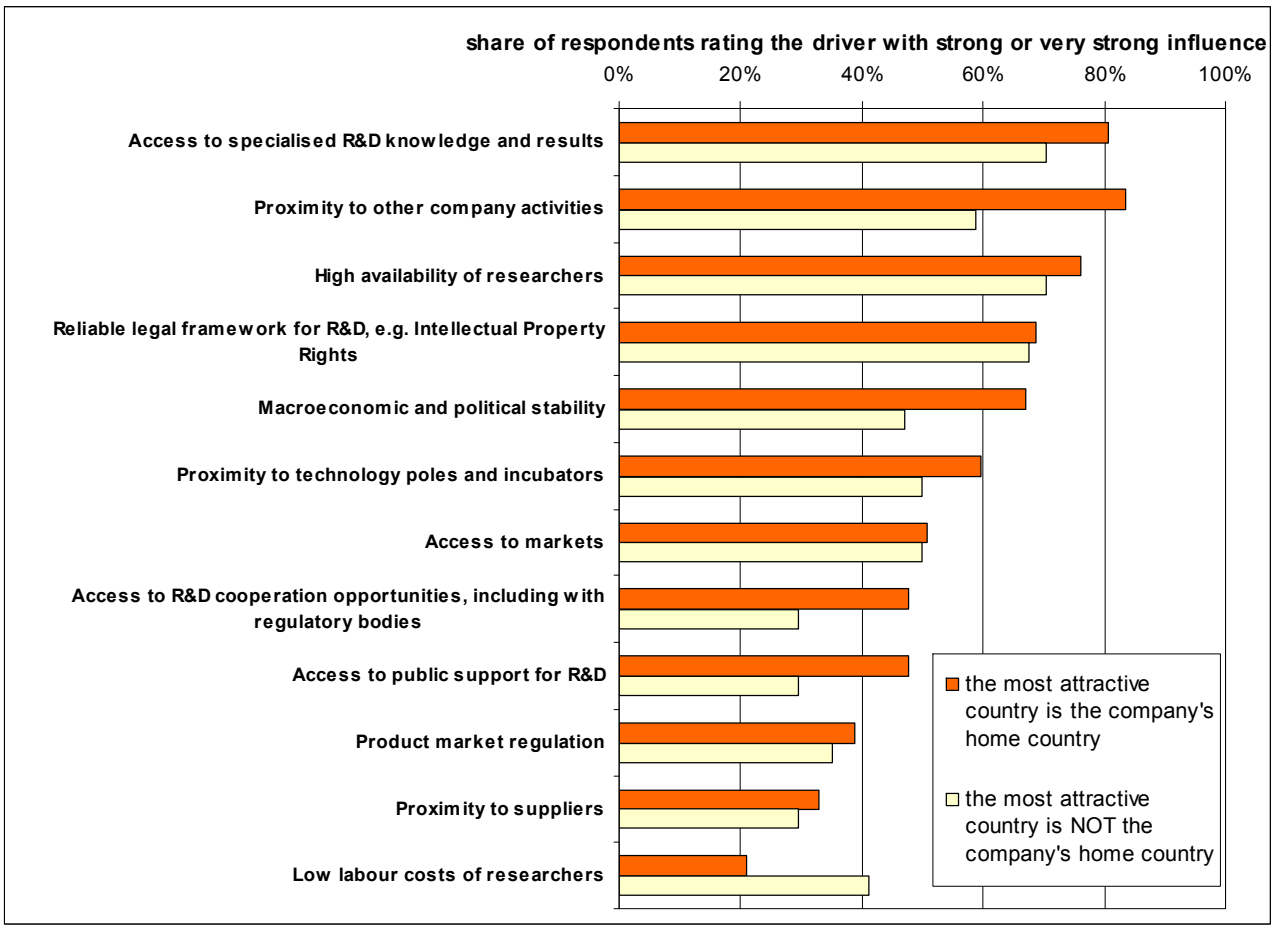
Figure 2: Shares of R&D investment and expected changes by world region



Note: * The share of expected (on 3 years) changes in R&D investment is the amount accounted for by the world region as a share of the total expected changes for all world regions.

Anyway, considering the EU recipient as a whole might be a misleading concept, since it comprises 27 different countries. In order to verify the most important factors for the R&D location, the dichotomy within/outside the home country is still a useful tool, at least as a proxy. One of the main results of the survey is that for all but one location drivers (ranked in figure 3), the home country is still generically considered as the most attractive country. The only factor for which that is not true, is the "low labour costs of researchers". Then, another factor for which the home and the outside percentage are almost the same is "access to markets". Therefore, it is interesting to verify econometrically if these factors are associated with different patterns of delocalization of R&D activities (e.g. low labour costs for emerging countries and access to markets for developed countries).

Figure 3: Location factors for companies according to whether or not they choose their home country as the most attractive place for R&D

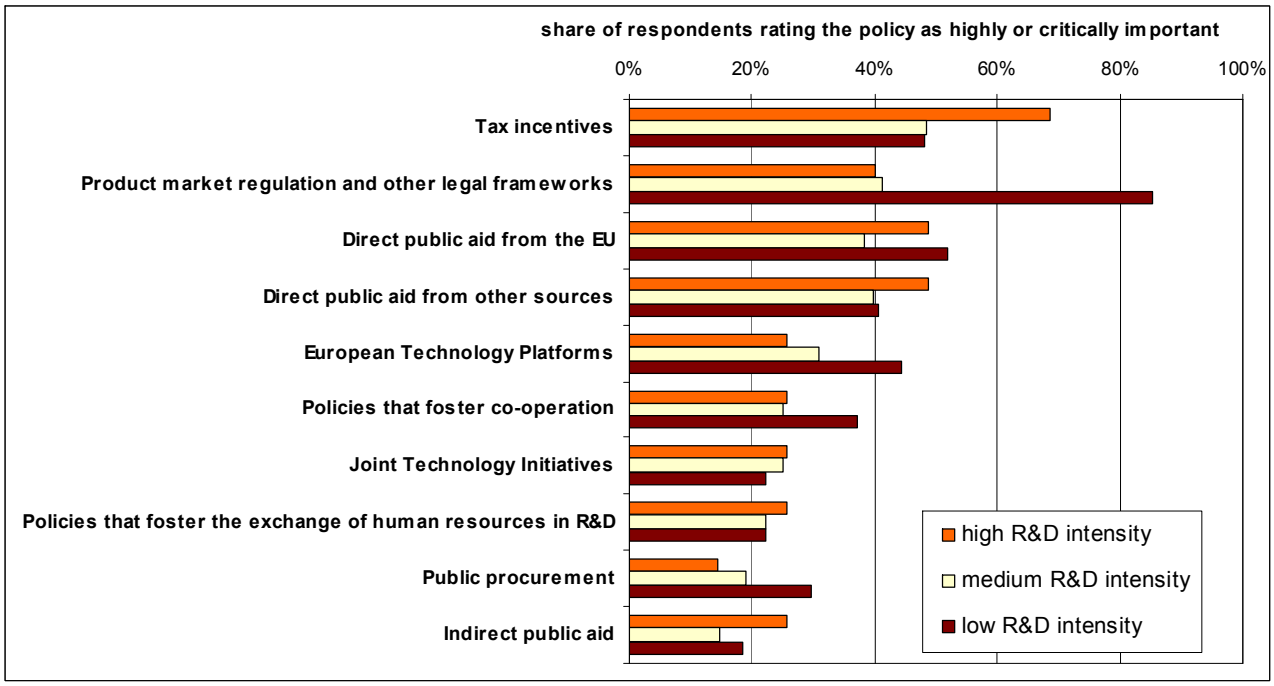


Note: The factors are sorted by average importance. The figure refers to 101 out of the 130 companies in the sample.
Source: European Commission JRC-IPTS (2009)

3.3 Public policies supporting R&D activities

Finally, companies responding to the survey were also asked to rate the importance of some public policies for supporting their R&D activities (see figure 4). Among them, the most notable figure refers to the polarization of sector groups: companies in high R&D intensity sectors consider tax incentives as the most important policy; companies in low R&D intensity sectors report as first, almost unanimously, the product market regulation and other legal frameworks.

Figure 4: Importance of public policies for supporting R&D activities inside the EU



Note: The factors are sorted by average importance. The figure refers to 124 out of the 130 companies in the sample.
Source: European Commission JRC-IPTS (2009)

4 - Empirical findings

The descriptive evidence has helped in individuating the main aspects of R&D behaviour by companies in the sample. In this section, we report the empirical findings of the econometric analysis with a particular attention to the three subthemes individuated: the motivations for increasing the overall R&D engagement, the geographical preferences and the evaluation of EU public policies supporting R&D.

The econometric analysis is especially needed in order to test the significance of companies' answers. Given the structure of the survey, in fact, companies are asked to evaluate the importance of each driver/policy (on an increasing scale from 1 to 5, see Appendix B). The average values of the previous section catch the overall importance of the variables but not their critical significance with respect to R&D behaviour (i.e. R&D growth or country location). That is, some variables might be important for all companies in any case, thus implying that they are not crucial in determining a *specific R&D behaviour*. Through the empirical analysis we try to check the effective importance of variables emerged in the descriptive part.

4.1. Drivers for increasing R&D investment

The first research question addressed in the empirical analysis regards the drivers for increasing the overall R&D investment. The dependent variable, according to the survey, is the increase of overall R&D investment over the next three years. Table 4 shows the main factors explaining such decision by EU firms.

Table 4: Most relevant drivers for increasing the company's overall R&D investment

	OLS		Heckman selection model			
Constant	10.862	(9.178)	9.475	(8.983)	0.490	(0.576)
Market pull	0.320	(0.964)	0.212	(0.740)		
Technology push, i.e. exploiting technological opportunities	-0.058	(0.676)	-0.100	(0.531)		
Competition from firms located in:						
European Union	-0.190	(0.737)	-0.233	(0.573)		
Other developed countries, e.g. US or Japan	1.218*	(0.692)	1.266**	(0.555)		
Emerging countries, e.g. China or India	-.901	(0.645)	-0.997*	(0.495)		
Meeting product market regulation and other legal frameworks	-0.254	(0.711)	-0.311	(0.577)		
Improving the company's productivity	-0.421	(0.689)	-	-		
Other drivers	-0.717	(0.474)	-0.755*	(0.397)		
Rank					-0.001*	0.000
Quoted					-0.249	0.176
R^2	0.414					
Log likelihood			-678.234			
Number of observations	125		125		999	
Rho			0.123		(0.536)	
Wald test of independent equations (rho = 0): $\chi^2(1)$			0.050		[0.8201]	

Notes: Robust standard errors in brackets; P-value in square brackets; * (**, ***) statistically significant at the 1% (5%, 10%) level; country and industry sector dummies included.

The left hand side of the table reports the results of an Ordinary Least Square (OLS) regression while the right hand side reports the results of a Heckman Maximum Likelihood regression model with sample selection. The equations also include country and industry and services sector dummies which are not reported here for the sake of space. The Wald test for the independence between the selection equation, i.e. the fact that the EU firms from the R&D scoreboard answered to the survey, and the drivers one, i.e. the factors explaining the decision to increase R&D, is not statistically different from zero. Thus we can conclude that there is no sample selection bias in the estimates. In other terms, the firms that responded to the survey can be considered as a representative sample of the full EU 1000 ones from the R&D Scoreboard. As regards the characteristics of the firms that responded to the survey, it follows that the largest ones in terms of size are more likely to respond.

Only one factor appears to be statistically significant at the 1% and 5% levels in both regression models and to positively affect this decision. This factor is the competition arising from companies located in other developed countries such as for instance the US or Japan. For the Heckman selection model, two other explanatory variables turn out to be significant, namely the competition arising form emerging countries such as China or India and a second variable 'other drivers'. These two variables negatively affect the firm's decision to augment its R&D activities in the near future.

The main explanation for the difference between such result and the descriptive statistics (where competition with non-EU countries were the least important drivers in the ranking) resides in the different standard deviations associated with the explanatory variables[11]. For instance, for the "classical drivers" such as market pull, improving productivity and technology push, the standard deviations are by far the lowest. In other words, these drivers are considered in the same way by all companies, in this case all firms consider them as very important. This lack of variability in the answers to the questions corresponding to these factors explains why these variables are not statistically significant in explaining the variations in the level of R&D.

As far as competition with firms resident in advanced countries (namely the US) is concerned, this factor is more likely to be considered as a critical driver. This is consistent with the literature on the EU-US technology gap (O' Sullivan, 2007). Competition with China and India is, instead, still perceived as a driver with a lower degree of relevance, thus implying the significant negative value in the regression.

4.2. Determinants for R&D localisation

A second research question we are interested in, concerns the most important factors determining the "most attractive" country for the company's R&D. To explore econometrically such factors, we first distinguish whether this favourite country is or not the company's home country. It should be noted that more than 50% of survey respondents reported their home country as the most favourite location for investing in R&D. Table 5 summarizes the main findings as regards this question.

[11] This information is reported in Table A1 in the Appendix A together with other basic descriptive statistics of main variables.

Again, in order to control for possible sample selection biases arising from the firms that did not respond to the survey, Heckman models with sample selection are estimated. The left hand side of Table 5 presents the results of a Heckman Maximum Likelihood probit model while the right hand side the results of a Heckman Maximum Likelihood regression model. The reason for implementing a probit Heckman model rests in the binary nature of the dependent variable, i.e. the most favourite location for doing R&D, in this case the firms' home country. Hence the dependent variable takes the value one when a firm reports its home country as its most favourite location for doing R&D.

Table 5: Most important factors explaining the most attractive location for R&D – Home country

	Heckman ML probit model with sample selection				Heckman ML regression model with sample selection			
Constant	4.346	(10,128)	0.489	0.598	0.349	(0.370)	0.496	0.596
Access to markets	-0.094	(0.159)			-0.021	(0.037)		
Access to public support for R&D	0.469**	(0.227)			0.105*	(0.041)		
Proximity to other activities of your company	0.494**	(0.212)			0.118*	(0.035)		
Proximity to suppliers	-0.107	(0.210)			-0.026	(0.044)		
Proximity to technology poles and incubators	0.109	(0.174)			0.028	(0.040)		
Access to specialised R&D knowledge and results	0.257	(0.242)			0.037	(0.042)		
High availability of researchers	-0.078	(0.233)			-0.023	(0.045)		
Low labour costs of researchers	-0.303***	(0.173)			-0.075**	(0.032)		
Access to R&D cooperation opportunities, including with regulatory bodies	-0.534	(0.328)			-0.088***	(0.053)		
Reliable framework for R&D, e.g. IPR	0.076	(0.247)			0.017	(0.051)		
Regulation of your product markets	0.239	(0.191)			0.058	(0.038)		
Macroeconomic and political stability	-0.212	(0.236)			-0.052	(0.044)		
Rank			-0.001*	(0.000)			-0.001*	(0.000)
Quoted			-0.244	(0.169)			-0.245	(0.163)
Log likelihood	-343.059				-345.988			
Number of observations	125		999		125		999	
Rho	0.242		(0.799)		0.177		(0.288)	
Wald test of independent equations (rho = 0): $\chi^2(1)$	0.100		[0.7542]		0.690		[0.5348]	

Notes: ML = Maximum Likelihood; robust standard errors in brackets; P-value in square brackets; * (**, ***) statistically significant at the 1% (5%, 10%) level; country and industry sector dummies included.

As it can be seen in Table 5, the results do not differ a lot from one regression model to the other. The estimated coefficients seem to be less precise, i.e. their associated standard errors are somewhat higher, as compared to the corresponding results in the second model. Finally, we can notice that in terms of selection bias, the Wald tests reject the null hypothesis of no independence between the equation of interest and the selection one.

Three factors that explain the firms' home country as the favourite destination for carrying out R&D appear to be statistically significant in both models. The access to public support for R&D and the proximity to other activities of the company positively influence this choice while low labour costs of the R&D workforce negatively affect this choice. These results confirm the ranking in the descriptive statistics as well as those reported in the literature. For Instance Kuemmerle (1999) found that HBE sites (as compared to HBA ones) are more likely to be located in proximity to an existing factory. Davies and Meyer (2004) found that government support has a positive effect on the incidence of subsidiary R&D, but not its level.

In order to verify the importance of such factors for all companies in the sample, in Table 6 we report the results concerning the main factors determining the overall favourite location of firms R&D investments. Two other destinations, i.e. the US and the Rest of the world[12] are considered as well besides the home country whose results are reported once again.

It should be noted that these results are based on a Heckman maximum likelihood regression model. Indeed, with the Heckman Maximum Likelihood probit model no convergence could be achieved after more than 2000 iterations due to the non concavity of the log-likelihood function.

For the US, the coefficient on the choice of this destination for performing R&D is negative for two factors: low labour costs of R&D personnel as well as macroeconomic and political stability. Taking into account the formulation of this question and its scale categories (see the questionnaire in the Annex), this suggests that these factors do not matter for the location decision, i.e. they are considered in a way as boundary conditions.

For those respondents that prefer another country (Rest of the World), the results obtained for the factors 'low labour costs of R&D personnel' and 'macroeconomic and political stability' is the opposite to that described above for the US: low labour costs of R&D personnel and macroeconomic and political stability do play an important role in the location decision of EU R&D MNEs. Gassman and Han (2004) found that the low wage structure in China is an important factor for attracting R&D foreign MNEs[13] while Reddy (2000) and von Zedtwitz and Gassmann (2002) emphasise the role of adequate systems of IPR protection among other determinants as an important driver to attract foreign R&D

[12] The countries concerned are China (2 responses); India (5 responses) and Korea; Philippines; Russia and Tunisia (one response).

in host developing countries. On the other hand, the access to public support for R&D and the proximity to other activities of the company have a negative impact. In terms of selection bias, the Wald tests once again reject the null hypothesis of no independence between the equation of interest and the selection one.

Table 6: Most important factors explaining the most attractive location for the company's R&D – Home country vs. US and Rest of the world

Favourite location Factors	Home country		US		Rest of the World	
Constant	0.349	(0.372)	-0.095	(0.178)	-0.097	(0.204)
Access to markets	-0.021	(0.034)	0.019	(0.016)	-0.002	(0.019)
Access to public support for R&D	0.105*	(0.038)	-0.004	(0.018)	-0.053**	(0.021)
Proximity to other activities of your company	0.118*	(0.035)	0.014	(0.016)	-0.065*	(0.020)
Proximity to suppliers	-0.026	(0.041)	0.016	(0.019)	0.016	(0.023)
Proximity to technology poles and incubators	0.028	(0.037)	0.003	(0.017)	-0.014	(0.021)
to specialised R&D knowledge and results	0.037	(0.044)	-0.016	(0.021)	0.026	(0.025)
High availability of researchers	-0.023	(0.046)	0.012	(0.021)	-0.024	(0.026)
Low labour costs of researchers	-0.075**	(0.034)	-0.038**	(0.016)	0.114*	(0.019)
Access to R&D cooperation opportunities, including with regulatory bodies	-0.088***	(0.052)	0.003	(0.024)	-0.032	(0.029)
Reliable framework for R&D, e.g. IPR	0.017	(0.049)	0.007	(0.022)	-0.025	(0.027)
Regulation of your product markets	0.058	(0.037)	0.027	(0.017)	0.007	(0.021)
Macroeconomic and political stability	-0.052	(0.044)	-0.036***	(0.020)	0.067*	(0.025)
Log likelihood	-345.988		-248.893		-273.122	
Number of observations	125		125		125	
Rho	0.177	(0.288)	0.179	(0.482)	-0.217	(0.281)
Wald test of independent equations (rho = 0): $\chi^2(1)$	0.690	[0.5348]	0.000	[0.9698]	0.530	[0.4648]

Notes: Heckman Maximum Likelihood regression models with sample selection, robust standard errors in brackets; P-value in square brackets; * (**, ***) statistically significant at the 1% (5%, 10%) level; country and industry sector dummies included.

4.3. Public policies supporting R&D investment in the EU

Finally, we are interested in quantifying the most important EU public policies for keeping the R&D activities of European MNEs within the EU itself. Table 7 reports the main findings about this question. The dependent variable considered is the growth rate between 2006 and 2009 of the R&D investment carried out in the EU.

Two public policies turn out to positively affect the increase of R&D activities inside the EU: indirect public aid, e.g. publicly supported loan and guarantee schemes and meetings product market regulation and other legal framework. This last policy measure was also reported as among the most important ones in the descriptive analysis (cfr. Figure 4).

[13] As pointed out by the authors, "Although the wages of highly qualified Chinese R&D staff is higher compared to Chinese domestic level, it is still 25% or 20% of that of R&D staff salary in triad regions."

More surprisingly, the Joint Technology Initiative[14] appears to have a negative impact on R&D investments in the EU. One possible reason to explain this result rests in the fact that this initiative is very recent and therefore may be rated as not being a very important policy measure for supporting the firms R&D in the EU.

Table 7: Most important public policies for supporting R&D within the EU

	growth rate (2006 and 2009) of R&D carried out in the EU	
Constant	16.450	(17.286)
Direct public aid from the EU	-3.308	(6.689)
Direct public aid from other sources	-2.979	(6.367)
Indirect public aid	28.233**	(13.496)
Tax incentives	6.071	(5.847)
Public procurement	9.874	(7.615)
European technology platforms	7.683	(9.164)
Joint Technology Initiatives	-25.870**	(10.390)
Meeting products market regulation	12.983**	(5.311)
Policies that foster cooperation	-22.013	(16.001)
Policies that support the exchange of human resources in R&D	-5.896	(15.914)
Number of observations	125	
Rho	0.506	(0.310)
Mills ratio	0.9854	(7.327)

Notes: Heckman Maximum Likelihood regression models with sample selection, standard errors in brackets; P-value in square brackets; * (**, ***) statistically significant at the 1% (5%, 10%) level; country and industry sector dummies included.

5 - Conclusions

This paper showed interesting insights into company expectations about future R&D investment and companies' motivations for investing in research, as well as their location decisions. Based on an original and recent sample representative of the largest R&D corporations in the EU, the paper investigated in a quantitative way the main factors explaining the decision of firms to increase their R&D investment effort in the near future; the main drivers explaining the favourite location choice for R&D; as well as the impact of direct and indirect policies to support R&D activities in the EU.

Main findings suggest that competitive pressures from the US represent the main determinants for increasing R&D investments. Public support to R&D and proximity to other activities of the company explain the decision to locate R&D in the home country while considerations on the cost of employing researchers appear also to matter for firms preferring a location outside their home country, in particular in China and India.

[14] Joint Technology Initiatives are a major new element of the EU's 7th Research Framework Programme. They provide a way of creating new partnerships between publicly and privately-funded organisations involved in research, focussing on areas where research and technological development can contribute to European competitiveness and quality of life.

An integrated analysis of the three aspects might suggest that EU companies perceive the need of increasing their technological strength in order to compete with the global leaders (often companies resident in the US). The strategy of lowering research costs is only a part of the story and might be not enough: public support is needed to reinforce the overall home base (represented by the proximity to other company's activities). Among public policies, the indirect aid might be considered of higher importance as it leaves a higher degree of freedom and flexibility for strategic decisions, vis-à-vis direct aids.

In order to extend the analysis, a further step would be to compare the present results with those coming from previous editions of the survey. Moreover, an integrated analysis of a panel built on the four surveys, although unbalanced, might provide additional insights with regards to the trends in R&D internationalisation of EU MNEs.

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Annex 1

Table A1. Descriptive statistics of main variables

Variable	Mean	Standard deviation.	Min	Max
Growth rate (2006 and 2009) of total R&D	4.770	6.502	-10	30
Market pull	4.270	0.898	0	5
Technology push, i.e. exploiting technological opportunities	3.762	1.054	0	5
Competition from firms located in:				
European Union	3.619	1.144	0	5
Other developed countries, e.g. US or Japan	3.087	1.321	0	5
Emerging countries, e.g. China or India	2.754	1.395	0	5
Improving the company's productivity	3.889	1.090	0	5
Meeting product market regulation and other legal frameworks	3.484	1.270	0	5
Most favourite destination = home country	0.540	0.500	0	1
Most favourite destination = US	0.056	0.230	0	1
Most favourite destination = Rest of the World	0.087	0.283	0	1
Access to markets	3.286	1.469	0	5
Access to public support for R&D	3.056	1.405	0	5
Proximity to other activities of your company	3.802	1.302	0	5
Proximity to suppliers	2.794	1.347	0	5
Proximity to technology poles and incubators	3.230	1.404	0	5
to specialised R&D knowledge and results	3.802	1.380	0	5
High availability of researchers	3.810	1.238	0	5
Low labour costs of researchers	2.706	1.357	0	5
Access to R&D cooperation opportunities, including with regulatory bodies	3.159	1.341	0	5
Reliable framework for R&D, e.g. IPR	3.603	1.321	0	5
Regulation of your product markets	2.698	1.466	0	5
Macroeconomic and political stability	3.357	1.249	0	5
Growth rate (2006 and 2009) of R&D carried out in the EU	16.370	24.161	-27.1	119.7
Direct public aid from the EU	0.135	0.343	0	1
Direct public aid from other sources	0.175	0.381	0	1
Indirect public aid	0.032	0.176	0	1
Tax incentives	0.159	0.367	0	1
Public procurement	0.071	0.259	0	1
European technology platforms	0.103	0.305	0	1
Joint Technology Initiatives	0.063	0.245	0	1
Meeting products market regulation	0.222	0.417	0	1
Policies that foster cooperation	0.024	0.153	0	1
Policies that support the exchange of human resources in R&D	0.024	0.153	0	1

Annex 2

The 2008 Questionnaire on R&D Investment

We would appreciate your response by **deadline**, **preferably by using the questionnaire on our website** at: **http://iri-survey.jrc.es/2008/**. Alternatively, you may return this completed form by e-mail (Alexander.Tuebke@ec.europa.eu), fax (+34.95.448.83.26), or post[15].

Your response will be treated as **confidential**. The information will only be used within this study and aggregated for analysis. The European Commission is committed to data protection and privacy[16].

It will take about **20 minutes** to complete the questionnaire.

We will automatically inform you of the results of the survey when they are available (please ensure that you have provided your e-mail address below).

Thank you very much for your contribution!

Name of the company you are responding for: _____

Its primary sectors of activity: _____

Your name: _____

Job title: _____

E-mail: _____

Phone number: _____

The European Commission plans to clarify trends revealed in the analysis, which may involve short follow-up interviews. Please **tick here** ☐ if you *do not* wish to be approached for this purpose.

Definition of R&D investment

For the purposes of this questionnaire, **'R&D investment' is the total amount of R&D financed by your company** (as typically reported in its accounts, exclusive of R&D from public sources).

[15] European Commission, Institute for Prospective Technological Studies (IPTS), Attn.: Alexander Tübke, Edificio Expo, Calle Inca Garcilaso s/n, E-41092 Seville, Spain, Tel : +34.95.448.83.80

[16] see the Disclaimer on page 6

A. Corporate background

1. How many employees in total work in your company?

   About _____.

2. How many employees work on R&D in the company?

   About _____.

3. What was its turnover in the last financial year?

   About € _____ million for the financial year ending _____.

B. R&D investment levels and trends

4. What was your company's R&D investment in the last financial year?

   About € _____ million.

5. At what rate do you expect the company to increase its overall R&D investment over the next three years, in real terms?

   About _____ % per annum.

6. How much of your R&D investment is in research[17] and how much is in development[18]?

	research	development
(a) R&D carried out *inside the EU*	_____ %	_____ %
(b) R&D carried out *outside the EU*	_____ %	_____ %

7. How relevant are the following drivers for *increasing* the company's overall R&D investment? *Please rate on a scale from 1 (irrelevant) to 5 (highly relevant).*

	Irrelevant 1	2	3	4	Highly relevant 5
(a) Market pull	☐	☐	☐	☐	☐
(b) Exploiting technological opportunities (technology push)	☐	☐	☐	☐	☐
(c) Competition from companies located in:					
(c1) the European Union	☐	☐	☐	☐	☐
(c2) other developed countries, e.g. the US or Japan	☐	☐	☐	☐	☐
(c3) emerging countries, e.g. China or India	☐	☐	☐	☐	☐
(d) Improving the company's productivity	☐	☐	☐	☐	☐
(e) Meeting product market regulation and other legal frameworks	☐	☐	☐	☐	☐
(f) Other:	☐	☐	☐	☐	☐

[17] Research is undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and facts, with or without any particular application or use in view.

[18] Development draws on existing knowledge to produce new, or to improve substantially, products, processes and services.

C. R&D location strategy and management

8. Please estimate the distribution of your company's in-house R&D activity among the following world regions at present and in three years?

Present distribution	R&D carried out:	Expected distribution in three years
%	in the European Union	%
%	in other European countries	%
%	in the US and Canada	%
%	in Japan	%
%	in China	%
%	in India	%
%	in the Rest of the World	%

9. For supporting your R&D activities *inside the European Union*, how important are the following public policies? *Please rate on a scale from 1 (unimportant) to 5 (critically important).*

	Un-important 1	2	3	4	Critically important 5
(a) Direct public aid from the EU.e.g. the Framework Programme or the Structural Funds	☐	☐	☐	☐	☐
(b) Direct public aid from other sources, e.g. R&D grants	☐	☐	☐	☐	☐
(c) Indirect public aid, e.g. publicly supported loan and guarantee schemes	☐	☐	☐	☐	☐
(d) Tax incentives	☐	☐	☐	☐	☐
(e) Public procurement	☐	☐	☐	☐	☐
(f) European Technology Platforms[19]	☐	☐	☐	☐	☐
(g) Joint Technology Initiatives[20]	☐	☐	☐	☐	☐
(h) Meeting product market regulation and other legal frameworks	☐	☐	☐	☐	☐
(i) Policies that foster cooperation	☐	☐	☐	☐	☐
(j) Policies that support the exchange of human resources in R&D	☐	☐	☐	☐	☐
(k) Other:	☐	☐	☐	☐	☐

[19] European Technology Platforms are led by industry and provide a platform to define R&D priorities, timeframes and action plans on a number of strategically important issues where achieving Europe's future growth, competitiveness and sustainability objectives is dependent upon major research and technological advances in the medium to long term (see http://cordis.europa.eu/technology-platforms/home_en.html).

[20] Joint Technology Initiatives are a major new element of the EU's 7th Research Framework Programme. They provide a way of creating new partnerships between publicly and privately-funded organisations involved in research, focussing on areas where research and technological development can contribute to European competitiveness and quality of life (see http://cordis.europa.eu/fp7/jtis/).

10. Which country do you consider the *most attractive* location for the company's R&D?

⇨_____

How important are the following factors for this consideration? *Please rate on a scale from 1 (unimportant) to 5 (highly important).*

	Un-important 1	2	3	4	Highly important 5
(a) Access to markets	☐	☐	☐	☐	☐
(b) High availability of researchers	☐	☐	☐	☐	☐
(c) Low labour costs of researchers	☐	☐	☐	☐	☐
(d) Access to specialised R&D knowledge and results	☐	☐	☐	☐	☐
(e) Reliable legal framework for R&D, e.g. Intellectual Property Rights	☐	☐	☐	☐	☐
(f) Macroeconomic and political stability	☐	☐	☐	☐	☐
(g) Proximity to technology poles[21] and incubators[22]	☐	☐	☐	☐	☐
(h) Proximity to other activities of your company	☐	☐	☐	☐	☐
(i) Proximity to suppliers	☐	☐	☐	☐	☐
(j) Access to R&D cooperation opportunities, including with regulatory bodies	☐	☐	☐	☐	☐
(k) Access to public support for R&D	☐	☐	☐	☐	☐
(l) Regulation of your product markets	☐	☐	☐	☐	☐
(m) Other:	☐	☐	☐	☐	☐

D. Comments or suggestions

⇨_____
_____
_____
_____
_____

Thank you very much for your contribution!

[21] "Technology poles" are areas where R&D active companies, institutions and universitites are concentrated.
[22] "Incubators" are structures that support innovative startup companies in order to increase their survival rates.