

Drivers for International Research and Innovation Activities in Developed and Emerging Countries

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Abstract

Globalisation has enlarged the business environment of firms that can benefit from resources available globally. For innovative firms the availability of new knowledge is essential to remain competitive. By using international knowledge pools firms can overcome the constraint of national available knowledge. This paper aims to shed light on firm specific drivers that lead firms to internationalise their R&D and innovation activities. The paper draws a comprehensive picture of driving forces by including firm capabilities, characteristics of the firm's competitive environment and the influence of innovation barriers in the home country. The influence of the potential driving forces is tested on the likelihood to carry out different steps of the innovation process abroad (R&D, Design/Conception of new products, Manufacturing of innovative products, Implementation of new processes, Sales of innovations). In a second step these driving forces are used to observe their impact on the decision to locate R&D and innovation activities in various countries and regions (Asia, China, Western Europe, Eastern Europe, North America) as well as in groups of countries with similar levels of knowledge (country clubs). The analysis is based on the German CIS (Community Innovation Survey) data and additional information which is captured by the Mannheim Innovation Panel survey. We retrieve a sample of about 1200 observations. The results show that the decision to perform R&D and innovation activities abroad is mainly driven by organizational capabilities such as absorptive capacities, international experience and technological advantages. Innovation barriers such as lack of labour and high innovation costs foster only the decision to carry out less R&D intensive innovation activities abroad. The location decision is mainly influenced by the international experience of the firm. Firms innovating in developing countries seem to require a more extensive level of international experience. In addition, a firm's technological advantage is more relevant for firms performing innovation and R&D activities in Asian and Marginalized countries.

Keywords: Internationalisation of R&D, Innovation, Absorptive Capacities, Market Structure, China, Asia, Emerging countries

1 Introduction

Globalisation has been reshaping the business environment of firms. The corporate response to increased openness of economies is the internationalisation of business processes. The international expansion of firm's value chain meets with both huge opportunities. Foreign markets allow international firms to achieve scale advantages and to source international resources, including knowledge. As a consequence, firms can enlarge their market size on the one hand but also use internationally dispersed knowledge resources to enhance their competitiveness. However, firms might not take the risks of shifting business operations away from the centre if they would not be forced by their competitive environment and the need to enhance their innovativeness by absorbing new ideas and knowledge for innovative products and processes. Beside these pushing forces firms might possess capabilities and resources that enable to not only perform innovation activities abroad but also to benefit from these overseas investments. This paper aims to spot the factors that lead firms to the decision to perform innovation and research activities abroad. Internationalising innovation will allow firms to enlarge their knowledge base by sourcing knowledge, technology and skills from other locations than their home market, potentially contributing to more ambitious and more efficient innovation efforts. By sourcing knowledge from other places firms can overcome knowledge constraints in the home country. Furthermore, approaching new markets often requires innovation designs that are adjusted to the specific environment in these markets. Developing or adopting such innovations at the location of potential customers may be more effective. Moreover, market success of new products not only depends on technological superiority or customer-tailored solutions, but also on price-efficiency.

Most of the literature on internationalisation of innovation has not mentioned the different innovation activities carried out at foreign subsidiaries. This paper attempts to enrich the empirical literature by employing a large data set on the internationalisation decisions of German MNEs from various sectors and by considering different types of innovation activities at foreign locations: R&D, product development, new process

installation and sale of innovative products. The location decision for internationalisation of R&D has not been very detailed either. Especially developing regions are underrepresented in studies. This paper will contribute to identify the driving forces on the decision to locate research and innovation activities in countries with different levels of knowledge (country clubs) as well as specific country analysis for China, Asia, Eastern Europe, Western Europe and North America. Summing up, the paper explores three research questions:

- (1) What role do firm capabilities, the level of home market competition and local innovation disadvantages play for driving firm's decision to engage in international innovation activities?
- (2) Do these determinants differ by type of innovation activity (R&D, design, production of new products, implementation of new processes, sales of new products)?
- (3) How do these determinants differ by host country and countries with developed or developing knowledge level?

In the next section we provide the theoretical background of the topic. Section 3 describes the data and the measurement of model variables. Chapter 4 presents the results of empirical analyses of the drivers of internationalisation of innovation while the geographic destinations and the impact of the driving forces on the location decision of international R&D is shown in section 5. Section 6 summarises the main findings and concludes with management recommendations.

2 Conceptual Background

The topic of the paper is grounded on the literature of the internationalisation of R&D including drivers and barriers that affect internationalisation decisions, motives and determinants of internationalising innovation activities as well as the geographic scope of international R&D activities. In this section, the main findings of the

literature which are relevant to this study are presented. Based on that, a set of hypotheses is developed.

Internationalisation of Firms and Corporate R&D

The internationalisation of firms is an ongoing trend which is spurred by increased openness of economies, the rise of new world players and the firm's need for new sources of competitiveness. The underlying determinants of firm's decision to internationalise business processes are summarized in the OLI-model of Dunning (1981). The "eclectic paradigm" emphasizes the role of ownership-specific (O), location-specific (L) and internalising (I) advantages for a firm's decision to enter into economic activities outside its domestic market. The ownership advantage refers to competitive advantages that can be capitalised abroad. These can be the result of domestic rivalry which puts pressure on firms to constantly improve their business activities (Granstrand et al., 1992; Porter, 1990). Fierce home market competition may result in a high level of product or service quality which makes entering international markets easier. Besides rivalry, specific corporate capabilities such as international experience or organisational knowledge can form a competitive advantage, too. The location-specific advantage refers to specific factor endowments of potential host countries (such as knowledge or skill resources, raw materials, climate, factor costs) which are difficult or costly to acquire through market transaction. Localising their businesses in these host countries allows firms to utilise the country specific potentials. The internalising advantage of a firm refers to the added value that a firm gains when conducting business activities abroad in comparison to purchasing goods and services from local producers abroad. These three OLI-advantages should characterise the nature of the firm which aims to internationalise business operations and the potential host country in order to make the international expansion of the firm successful.

Internationalisation of firms' innovation activities has long been a major research topic (see OECD, 2007; UNCTAD, 2005; Veugelers et al., 2005; Brockhoff, 1998; Granstrand et al., 1993). One strand of literature relates to the drivers and motives for engaging in innovation activities abroad, in particular with regard to R&D. This work

almost entirely focuses on large multinational firms and the way they organise corporate research and technology development globally (see Dunning, 1994; Kuemmerle, 1999; Narula and Zanfei, 2005; Dunning and Narula, 1995; Pearce, 1999; Pearce and Papanastassiou, 1999; Patel and Vega, 1999; Le Bas and Sierra, 2002; Hakanson and Nobel, 1993; Chesnais, 1992). Related to this research are studies on the management of global R&D activities of multinationals (see Dodgson, 1993, 2000; Kuemmerle, 1997; Ghoshal and Bartlett, 1988; Gupta and Govindarajan, 2000; Boutellier et al., 2000). Another strand of literature emphasises the role of international co-operation in innovation, including research joint ventures, as a mechanism to exploit global opportunities for a firm's innovation activities (see Haagedoorn, 1996, 2002; Veugelers, 1997; Cassiman and Veugelers, 2002). Studies on international technology spillovers are a further direction of research that captures internationalisation issues in innovation (see Veugelers and Cassiman, 2004; MacGarvie, 2005; Guellec and van Pottelsberghe, 2001; Lichtenberg and van Pottelsberghe, 1998; Coe and Helpman, 1995). What most of the existing literature on internationalisation of innovation has in common is a focus on R&D and patenting as measures for innovative activity abroad.

A firm's decision to internationalise its innovation activities may be related to three motives (see Granstrand et al., 1993): knowledge seeking, market seeking and efficiency seeking. Knowledge seeking firms aim at exploiting a country's endowment with certain research capacities or technologies in order to augment its existing knowledge assets. Establishing innovation activities on site facilitates access to foreign knowledge and its integration into firm-internal processes (see Cantwell and Piscitello, 2005). Market seekers aim to access foreign markets for selling their innovations, i.e. to exploit their existing knowledge assets. This often requires adaptations of technologies to local environments and preferences, including user-producer interactions (see Pearce 1992, 1999; Pearce and Papanastassiou, 1999). Innovation activities in the foreign market certainly ease this "localisation" of product innovations. Efficiency seeking firms are primarily interested in reducing costs of innovation by performing activities in countries with a low price/productivity ratio for

innovation inputs, particularly human capital. It has been shown that firms often follow more than one motive.

Depending on the motives to internationalise innovation activities, a firm's R&D and innovation units abroad will serve different purposes. Ito and Wakasugi (2007) distinguish between support-oriented R&D and knowledge sourcing R&D. Also Kuemmerle (1997) differentiates between two categories of R&D sites abroad. The home-base exploiting laboratory has the task of transferring the existing knowledge of the home-base to the R&D unit abroad for local manufacturing and marketing (market and efficiency seeking). The key objective of the home-base augmenting laboratory is to use the knowledge of the host country and transfer it to the home base (resource seeking). Nobel and Birkinshaw (1998) further distinguish international R&D active firms into local and international adaptors as well as international creators. While the category "international creators" is linked to the home-base augmenting firm characteristics following Kuemmerle (1997), the local and international adaptors are both a counterpart to Kuemmerle's home-base exploiting theory. Local adaptors are basically local support units that have a rather limited role in R&D. Its mandate is mainly to facilitate technology transfer from the home base to the local manufacturing (Nobel and Birkinshaw, 1998).

A peculiar motive that combines knowledge and market seeking relates to innovation activities in foreign markets in order to leverage lead market advantages. Lead market advantages refer to the role of customers in demanding a specific innovation design which later becomes the globally preferred design, giving the innovator a lead advantage (see Beise, 2004; Beise-Zee and Rammer, 2006). In order to identify lead market characteristics of local economies and to receive innovation impulses from local demand, firms will have to establish some sort of innovation-related activity in countries with presumed lead market potential. This need not necessarily be R&D laboratories, rather conceptual, design and marketing stages of innovation activities may serve as more suitable access channels to this type of localised knowledge.

Internal Resources

The internationalisation of corporate R&D is associated with a number of challenges. While many MNEs have acquired experience of foreign markets and demands through exports, sales branches or production activities, managing international innovation processes is likely to be a different task which requires different capabilities (Le Bas and Sierra, 2002; Patel and Vega, 1999; Ito and Wagasuki, 2007). When it comes to establishing innovation activities abroad, the role of absorptive capacities, i.e. the ability to identify, value and integrate relevant knowledge sources (see Cohen and Levinthal, 1990) becomes particularly important. Entering markets in order to establish innovation activities may also reinforce the typical barriers to internationalisation such as financial constraints, lack of information, lack of management capabilities, liability of foreignness and lack of abilities to deal with unfamiliar market and regulatory environments (see Acs et al., 1997).

To be able to engage in international innovation activities innovative firms require certain capabilities to identify, absorb and use the knowledge available in host countries. Cohen and Levinthal (1989, 1990) argue that the capabilities are developed while performing R&D activities internally. Only then firms possess the competence to recognize and further use relevant knowledge outside their organisation. A high level of skilled employees will facilitate these organisational adaptations. It is thus assumed that:

Hypothesis 1: The Internationalisation of R&D and innovation activities is driven by the firm's absorptive capacities and technological strength.

When it comes to internationalisation and therefore to confrontation with foreign cultures and business practices then technological competence might not be sufficient to cope with foreign business environments at R&D sites abroad. International experience of organisations can minimize the uncertainty arising from the exposure to unfamiliar situations and the distance to the home-base (Harvey and Novicevic 2000). Companies could gain the ability to adapt and cope with local challenges by increasing the organisation's international contacts. This can be achieved by engaging joint innovation projects with international partners or by exporting. Therefore, it is anticipated that:

Hypothesis 2: Firms with international experience are more likely to decide to internationalise their R&D and innovation activities.

Competitive environment

The home market environment is supposed to drive internationalisation of innovation activities of firms in two ways: On the one hand, the quality and quantity of competition will force them to respond by leveraging the location advantages of the home and other countries. This will be particularly relevant in case firms experience increased competitive pressure in their home market, due to strong price competition or the entry of new competitors in their markets. Firms that are subject to fierce competitive pressure may be compelled to access additional international knowledge pools in order to sustain or build competitive advantages. Additionally, domestic firms, on account of the globalisation of competition, increasingly face new competitors from abroad in their home market. These new rivals might have access to resources that firms lack in their home country. Therefore it is expected:

Hypothesis 3: A high degree of competition in the home market propels the likelihood to undertake R&D and innovation activities abroad.

Attractiveness of domestic location for innovation

The earlier mentioned motives (knowledge, market and efficiency seeking) for international R&D are very likely to be the result from the deficits of the innovation environment at the firm's home base. The lack of specific resources and services lower the attractiveness of a domestic location for conducting innovation. With regard to factor markets, this refers on the one hand to the availability and costs of high qualified labour with skills that a firm requires for conducting a specific innovation project and to the availability of external financial resources and their costs on the other. A further "factor market" relates to technology. Trading technology is, however, rather restricted due to its immaterial and tacit character (Polanyi, 1966). Therefore, having access to technological information and appropriate partners for collaborating in innovation projects may be an important dimension of a location's attractiveness for innovation. Moreover, the willingness of customers to pay for innovations, or more

generally: their responsiveness to innovations may form another important element of location attractiveness.

We suppose that obstacles to innovation in the home market will therefore act as a pushing effect for the internationalisation of innovation activities. Location disadvantages especially for innovative firms is a shortage of qualified personnel, technological information, high costs, lack of potential cooperation partners and lack of markets for innovation. Legal innovation regulation can hinder innovation projects, too. Therefore we assume that:

Hypothesis 4: Firms that are suffering from innovation-related location disadvantages in their home country are more likely to internationalise their R&D and innovation activities to benefit from location advantages in host countries.

International R&D Location Decision

The decision where firms locate their overseas R&D units is closely related to the extent and nature of innovation disadvantages of the home country and firms' motives. Knowledge, as being one of the most valuable resource in today's business, is similarly to other resources not equally available everywhere. The different availability of resources leads to the creation of national systems of innovation and certain 'pockets of expertise' (Nelson, 1993; Porter 1990). The extraordinary and distinct capabilities in certain sectors shaped by the national innovation system supports the international competitiveness of certain industries worldwide (Porter, 1990) and therefore influence the attractiveness of nations in different fields of technology.

According to the international R&D strategy of the firm, to follow homebase-augmenting and/or homebase-exploiting objectives nations differ in their attractiveness (Kuemmerle, 1999). Firms that wish to perform R&D outside their home country generally look for countries that offer attractive market potentials, the availability of high qualified staff and potential cooperation partners (Thursby and Thursby, 2006). Firms normally locate their R&D in countries that are advanced in the same field

(Kumar, 1995). They prefer to set up R&D centres in nations with technological resources, a supply of low-cost staff and good communication infrastructure (Kumar, 1995). German companies that intend to perform less R&D intensive innovation activities abroad are mostly driven by cost-reducing aims (Kinkel, Lay, Maloca, 2007). Other in the literature mentioned moderating effects on the location choice include the cultural distance between two home and host country. Previous country studies show that firms tend to follow a national path in their innovation internationalization strategy. For Germany Ambos (2005) found, that German firms tend to cross borders initially only within Europe or to the USA and only later adopt R&D and innovation activities in Asian countries.

The rise of the emerging giant countries such as China and India has challenged the attractiveness of developed nations. The literature has been enriched by studies about the set up and management of foreign R&D labs in China (Zedtwitz, 2004, Zedtwitz et al., 2007) and the innovation potential of India (World Bank, 2007; EIU 2007). Based on the emergence of these not only new big markets but also increasingly large and valuable knowledge pools the motives and drivers for international R&D activities have been extended. Sachwald (2008) finds that new lead markets or centres of excellence abroad foster R&D internationalisation and that emerging countries offer a pool of high skilled scientists and engineers at lower costs. Other studies have already set their focus on the differences of doing R&D in developed versus undeveloped countries. It has been always argued that lower costs in developing countries are a major pull factor to locate R&D capacities in these countries. However, it has been also suggested to neglect short-term ROI-reasons for the decision to internationalize R&D and innovation activities (Zedtwitz and Gassmann, 1998). Based on the rationale that research and innovation activities abroad are carried out to access the foreign scientific pools and to adjust innovations with local knowledge to local market requirements the decision to the set up R&D capacities abroad should follow a rather long-term strategy. Therefore, it is anticipated that:

Hypothesis 4: High innovation costs and price competition in the home country are not predominant drivers to locate R&D and innovation activities in regions with developing knowledge levels.

As mentioned earlier, firms follow a nation-specific geographic internationalisation pattern. In the case of German MNEs, countries with developed economic status and advanced knowledge levels are the premier location choice and later followed by countries with a less developed economy. By that time firms have accumulated international experience by being exposed to unexpected and different business environment characteristics at their first international R&D locations. This international experience serves as a prerequisite to minimize uncertainties at the foreign R&D site. Knowing that developing countries often offer an even more challenging business environment it is therefore assumed that:

Hypothesis 5: The effects of firm's international experience that innovate in developing regions are stronger than for firms innovating in developed regions.

3 Database & Empirical Analysis

In this section, the database, variables and the methods which are used to test the hypothesis empirically are introduced. One set of explanatory variables is used to address the research questions and is applied to two sets of dependent variables: first on the MNE's decision to engage in research and different innovation activities abroad and second on the MNE's decision to engage in research and innovation activities in different regions and countries.

The German Innovation Survey

This paper employs data from the German Innovation Survey, which represents the German contribution to the EU's Community Innovation Survey (CIS). The German Innovation Survey follows the methodological recommendations for CIS surveys and adopts the standard CIS questions. The German Innovation Survey is conducted by the Centre for European Economic Research (ZEW) in Mannheim, Germany and called

the Mannheim Innovation Panel (MIP). In addition, the German Survey contains a significantly larger number of questions compared to the harmonised CIS questionnaire, which allows for a much more detailed analysis of relations between firms' innovation activities and their market and innovation environment. The database has a broader sector and size coverage than the CIS standard, including firms with 5 to 9 employees and covering a larger set of service sectors.

Explanatory variables

The paper employs information from two survey waves of the Mannheim Innovation Panel: 2005 and 2006. The 2005 survey contributes all the variables that will be used to characterize the firm's innovation environment, the competitive conditions as well as the firm's internal resources, capabilities and innovation activities. Basically all variables that are used to describe the driving forces for the different innovation activities carried out by firms abroad. The variables of the 2005 survey refer to the firm's conditions in 2004. Table 1 summarises the variables and the indicators that are used to measure the firm's capabilities and resources, the competitive environment as well as the location attractiveness for innovations of their home base. Almost all indicators are taken from the MIP surveys. Industry level data come from the German Federal Statistical Office and information of firm age is captured by the credit reform database.

Among the variables on internal resources for engaging in international innovation activities, experience in international activities is measured by two indicators: one indicator measures whether a firm has had any experience in collaborating with foreign partners in innovation projects in 2002-2004 while another one measures experience in selling products abroad. A firm is regarded as having accumulated experience in successfully protecting intellectual property (IP) when it was able to use at least one formal or strategic protection measure (out of patents, trade marks, utility patterns, industrial designs, copyrights, secrecy, complex innovation designs, lead time over competitors) in a way that it made a high contribution to IP protection. The availability of internal financial resources is measured by the profit margin. Firms reporting a significant positive profit margin in the years prior to the decision to expand innovation activities abroad are regarded as having sufficient internal funding

to engage in a high-risk activity such as establishing innovative activities in foreign locations.

The variables characterising the competitive environment, i.e. the significance of price competition and the degree of competition concentration (number of main competitors) were all measured by a firm's own assessment with reference to the firm's main product market. This measure of competition by firm's own perception has the advantage to capture the effect of firm-specific competition and can explain the difference why some firms undertake more innovation activities than others in the same product market (Tang, 2006). These variables thus directly capture the competitive situation from a firm's point of view and avoid the disadvantages of measuring the competitive environment on sector level based on industry classifications (see Heger and Kraft, 2008).

The existence of a technological advantage of the firm is measured by patent applications (in the absence of information on granted patents), for firms from the service sectors we also consider applications of trade marks since many service innovations, even if they are entirely new to the market, cannot be protected by a patent while trade marks tend to serve as an effective way to protect radically new service innovations (see Schmoch, 2003).

The attractiveness of Germany as a location for conducting innovation is measured by a firm's assessment on the relevance of various obstacles to innovation. We consider six such obstacles, each being measured on a 4-point Likert scale: lack of demand for a firm's innovations, lack of qualified personnel, lack of external sources of finance, very high innovation costs, lack of appropriate partners for innovation, and legal innovation barriers. Firms stating that one of these obstacles was medium or very important for impeding their innovation activities in 2002-2004 are considered to be facing difficulties with the innovation environment at their domestic location. Control variables for firm size, firm age and firm location within Germany are included in both models as well. As for the industry variables, a lower number of observations in the second model did not allow to include the same broad coverage of industry dummies as in model one. Therefore, an industry dummy variable for firms in the manufacturing sector is included.

Table 1: Explanatory Variables

Model variable	Indicator	Source
<i>Internal Resources</i>		
Continuous R&D	1 if a firm conducted in-house R&D continuously in 2002-2004; 0 otherwise	MIP05
High skilled employees	No. of graduated employees to total number of employees in 2004	MIP05
Experience in innovation cooperation with foreign partners	1 if a firm co-operated in innovation 2002-2004 with a partner located outside Germany which is at the same time not part of the same enterprise group the firm might belong to; 0 otherwise.	MIP05
Export experience	1 if a firm had any exports in 2002-2004; 0 otherwise	MIP05
Experience in successfully protecting intellectual property	1 if a firm had used at least one formal or strategic protection method for IPR (out of patents, trade marks, utility patterns, industrial designs, copyrights, secrecy, complex innovation designs, lead time over competitors) in 2002-2004 that was highly important for protecting its IP; 0 otherwise	MIP05
Financial resources	1 if a firm reported a profit margin $\geq 2\%$ in 2003 and 2004; 0 otherwise ¹⁾	MIP05
Technology advantage	1 if a firm has applied for at least one patent and/or (for service sector firms) registered trade mark in 2002-2004; 0 otherwise	MIP05
<i>Competitive Environment</i>		
Dominating price competition	1 if price competition is the most important factor of competition in a firm's main product market in 2004; 0 otherwise	MIP05
Competitive pressure due to market entries	1 if a firm stated that its product market environment (in 2004) is characterised by strong competitive pressure due to market entries; 0 otherwise	MIP05
Concentration	1 if a firm had less than 6 main competitors in 2004; 0 otherwise	MIP05
Low Number of Competitors	1 if a firm had less than 3 main competitors in 2004; 0 otherwise	MIP05
<i>Location Attractiveness</i>		
Lack of technological information	1 if a firm stated that the lack of technological information was an important obstacle to innovation 2002-2004 (answers 2 or 3 on a 0 to 3 Likert scale); 0 otherwise	MIP05
Lack of customer response/demand for innovation	1 if a firm stated that a lack of customer response or demand for innovation was an important obstacle to innovation 2002-2004 (answers 2 or 3 on a 0 to 3 Likert scale); 0 otherwise	MIP05
Lack of qualified labour	1 if a firm stated that a lack of qualified personnel was an important obstacle to innovation 2002-2004; 0 otherwise	MIP05
Lack of external sources of finance	1 if a firm stated that lack of appropriate external financing was an important obstacle to innovation 2002-2004; 0 otherwise	MIP05
High innovation costs	1 if a firm stated that too high innovation costs was an important obstacle to innovation 2002-2004; 0 otherwise	MIP05
Lack of appropriate partners	1 if a firm stated that a lack of appropriate partner for innovation was an important obstacle to innovation 2002-2004; 0 otherwise	MIP05
Regulation as barrier to innovation	1 if a firm stated that regulation and long administrative procedures were an important obstacle to innovation 2002-2004; 0 otherwise	MIP05
<i>Control Variables</i>		
Size	$\ln(\text{No. employees at FTE in 2004})$	MIP05
Age	$\ln(\text{Time between the year of market entry and 2005})$	MIP05
East German location	1 if a firm is located in East Germany in 2004; 0 otherwise	MIP05
Industry affiliation (model 1)	1 if a firm is affiliated to industry m ; 0 otherwise (m : six sector groups: consumer products (NACE 15-19, 22, 36), industrial intermediaries (10-14, 20, 21, 23, 26-28, 37, 40-41), medium-to-high and high-tech products (24, 29-35), knowledge-intensive services (64.3, 65-67, 72-73, 74.1-74.4, 92.1-92.2), transport and other business services (60-63, 64.1, 74.5-74.8), trade, construction and other services (45, 50-52, 70-71, 90))	MIP05
Manufacturing Industry dummy (model 2)	Restricted numbers of observations in model 2 for each country allow only industry differentiation between manufacturing and services	MIP05

FTE: Full time equivalents; NACE: EU industry classification, rev. 1.2; FSO: Federal Statistical Office of Germany.

1) Since about 20% of firms did not provide information on their profit margin, we set variable to zero for these firms and added a dummy variable for capturing likely effects of these non-responding firms.

Dependent Variables

The first model aims to describe the conditions of firms and firm environment that influence their likelihood to perform research or other innovation activities outside their home country. Therefore the dependent variables of Model 1 comprise the planned research and innovation activities (“R&D”, “Design/Conception of new products”, “Production of new products”, “Implementation of new processes”, “Sales of new products/services”) for the year 2006/2007 abroad. The 2006 survey has questioned firms about their innovation activities outside Germany. The questions targeted the type of innovation activity which is performed abroad, distinguishing into 5 steps of the innovation process: 1) Inhouse R&D 2) Design/Conception/Construction of new products 3) Manufacturing of new products 4) Implementation of new services 5) Sales of innovative products. The firms were asked whether they performed these innovation activities abroad in the year 2005 and in a second step whether they plan to take up or increase these activities in the years 2006 and 2007. Furthermore, the firms were asked to state in which countries (free text) they perform and planning to perform these activities predominantly. For activities in 2005, firms were also requested to estimate how significant international innovation activities of each type were in relation to the firm’s total activities of the respective type (distinguishing three categories: 1-10%, 11-50%, >50%). The sample has been restricted to innovative firms having their headquarters in Germany, meaning that the analysis focuses on German-based firms only.

The second model is constructed to measure how the abilities of firms and the firms’ business and innovation environment influence their likelihood to perform research and other innovation activities in a specific country or region. Based on the idea that firms look for developed knowledge pools, lead markets and efficiency advantages, the dependent variables are set up to group countries by their level of knowledge. Hereby, the countries are grouped by their ability to create and imitate advanced knowledge as proposed by Castellacci and Achibugi (2008) as technology clubs. In this vein 3 groups of technology clubs following the country definitions of Castellacci and Achibugi (2008) are defined: Advanced countries, Followers and Marginalized

(for a detailed list of countries and their respective category see Table 2). However, not only the knowledge and technology seeking motive but also the market and efficiency seeking motive has been mentioned before. China and India are e.g. in the same technology club (marginalized) as African countries, but due to their greater attractiveness for firms in terms of market size and the speed of the economic growth they might have a different priority than other countries for firms. Therefore, other country variables are generated to measure the influence of internationalisation drivers for certain countries of interest (China, India, China, Asia, North-America, Western Europe and Eastern Europe). The sample has been restricted to firms that carry out at least one of the international R&D and innovation activities (R&D, product development, new process installation in order to be able to compare the effects of the internationalisation drivers of different countries and regions.

Table 2: Definition of Dependent Variables

Model variable	Indicator	Source
<i>Model 1: Planned Research and Innovation Activities Abroad</i>		
Planned internationalisation of innovation activities of type k	1 if a firm plans to take up or expand type k innovation activity outside Germany in 2006 or 2007; 0 otherwise (k : R&D, design/preparation of innovations, production of new products, implementation of new processes, sales of new products)	MIP06
<i>Model 2: Planned Research and Innovation Activities in Different Countries and Regions</i>		
Planned internalisation of innovation activities of type i in countries c	1 if a firm has or plans to take up or expand type i innovation activity (i : R&D, design/preparation of innovations, production of new products, implementation of new processes) outside Germany in 2005, 2006 or 2007 in one of the c countries or technology clubs (c : Advanced, Followers, Marginalized, China, IndiaChina, Asia, North-America, Western Europe, Eastern Europe); 0 otherwise	MIP06
<i>Specification of Countries and Regions (as stated by firms in the survey)</i>		
Advanced countries	Europe, Northern Europe, Scandinavia, Switzerland, Netherlands, Norway, Denmark, UK, Sweden, Finland, Western Europe, Iceland, Japan, USA, Canada, Australia, Israel	
Follower countries	Eastern Europe, Middle and Eastern European countries (CEE, MEE, MOE), Southern European Countries, Austria, Belgium, Benelux, France, Luxembourg, Poland, Romania, Slovakia, Czech Republic, Hungary, Slovenia, Serbia/Kosovo, Croatia, Bulgaria, Bosnia, Spain, Italy, Turkey, Greece, Cyprus, Portugal, Ireland, Malta, Latvia, South Korea, South East Asia, Singapore, Malaysia, Hong Kong, Thailand, Philippines, South America, Brazil, Chile, Mexico, Argentina, Peru, Columbia, Russia, Ukraine, Georgia, Baltic, Belarus, Lithuania, Arabic States, Saudi Arabia, Lebanon, Libya, UAE, Middle East, Near East, Dubai, South Africa	
Marginalized countries	Asia, China, India, Pakistan, Vietnam, Taiwan, Sri Lanka, Indonesia, Mongolia, Egypt, Iran, Niger, Namibia, Morocco, Macao, Montserrat, Africa, Nigeria, Tanzania	
Asia	Asia, China, India, Vietnam, Taiwan, Sri Lanka, Indonesia, Macao, Southeast Asia, Singapore, Malaysia, Hong Kong, Thailand, Philippines, South Korea, Japan	
China	China	
IndiaChina	China, India	
North-America (NA)	USA, Canada	
Western Europe (WestEU)	Europe, Northern Europe, Scandinavia, Switzerland, Netherlands, Norway, Denmark, UK, Sweden, Finland, Western Europe, Iceland, Southern European Countries, Austria, Belgium, Benelux, France, Luxembourg, Spain, Italy, Portugal, Ireland, Malta	
Eastern Europe (EastEU)	Eastern Europe, Middle and Eastern European countries (CEE, MEE, MOE), Poland, Romania, Slovakia, Czech Republic, Hungary, Slovenia, Serbia/Kosovo, Croatia, Bulgaria, Bosnia, Russia, Ukraine, Georgia, Baltic, Belarus, Lithuania	

4 Drivers of Internationalising Innovation Activities

The planned sales of new products and services are the most frequent activity which is observed in the data. About 35% of the firms plant to sell their innovative products abroad followed by 20% of firms which plan to manufacture innovations outside Germany. In the sample about 9% of the firms plan to set up internal research capacities abroad which make it the less internationalised of the observed innovation

activities. Model 1 has been used to estimate the drivers of internationalising research and innovation activities by using separate probit models with marginal effects grounded on a number of about 1200 observations. The results in Table 3 clearly show that the most prominent forces to set up R&D capacities abroad are the firm's capabilities and resources. Hereby previous export experience is found to have the strongest influence, especially on the internationalisation of manufacturing innovative products abroad as well the sales of innovative products abroad. Export experience seems to provide the knowledge about market conditions and location advantages that also increase the likelihood to set up the manufacturing of innovative products and new processes abroad. Furthermore, export oriented firms are 9% more likely to design or construct their innovations abroad. Exports show also the third greatest effect for firms doing research abroad. Surprisingly international experience gathered by international research cooperation has got only a positive significant effect for the manufacturing and sales of innovative products. However the result that MNEs which aim to perform research on a continuous base at home are 4% more likely to carry out research activities outside national borders is in line with the results of previous studies. Firms that plan to source knowledge internationally ground their overseas R&D activities on a high level of well qualified employees at the home base and show their innovation success by having granted patents or trademarks.

A certain technological advantage of the firm as well as continuous R&D activities in the home country and export experience fosters the decision to design/construct new products and processes abroad. However firms that do not meet the preferred design of customers in the home country are less likely to set up innovation design and innovation manufacturing capacities overseas. It becomes obvious that the overseas innovation centres are not made to work out the lack of success of innovation activities in the home base but to complement their innovation

Firms with experience in intellectual property protection are more likely to manufacture new products and processes abroad as well as to sell their innovations internationally. It seems that the loss of knowledge is greatest when it is embodied in products and services. Firms with pronounced financial resources are 4% more likely to manufacture their products abroad. These firms also state that a moderate number of

competitors, the lack of labour and high innovation cost drive their decision to manufacture their products abroad. The lack of labour and high innovation costs, the often mentioned forces that are driving firms to relocate their R&D, are actually only effecting the decision to set up innovation manufacturing capacities abroad. In this vein price competition in the home market makes firms less likely to produce innovations abroad.

Firms that plan to develop innovative processes abroad can be characterised as export and IPR experienced firms that face a moderate number of competitors in their home market.

Firms that plan to sell their innovations abroad, the most common activity among the observed activities in this study, seem to be market leaders in the home market. They face a low number of competitors and the competition less likely to be based on pricing. Firms which plan to extend their market by selling their innovative products abroad are strongly driven by their knowledge resources (high skilled employees) and their sustainable innovation activity. In addition their previous international experience with exports and international cooperation partners propelled the decision to sell overseas. Technological advantage of firms also impacts on the decision to export innovations as well as the experience use methods (e.g. patents or trademarks) to appropriate the returns of their innovations.

Table 3: Drivers to Internationalise Innovation Activities of German MNEs (by Innovation Activity): Marginal Effects of Probit Models

Variables	Planned Research Abroad	Planned Design/Conception Abroad	Planned Manufacturing Abroad	Planned New Processes Abroad	Planned Innovation Sales Abroad
Continuous Inhouse R&D	0.044 ***	0.034	0.009	0.011	0.097 ***
High skilled employees	0.056 **	0.016	0.044	-0.028	0.217 ***
Innovation coop. with intl. Partners	0.015	0.006	0.058 *	0.023	0.15 ***
Export experience	0.044 ***	0.087 ***	0.102 ***	0.057 ***	0.239 ***
Experienced usage of IPR	0.011	0.015	0.049 **	0.027 *	0.104 ***
Financial Ressources	0.009	0.016	0.044 **	0.005	-0.019
Technological advantage	0.026 *	0.034 *	-0.002	0.015	0.061 *
Price competition	-0.001	-0.003	-0.038 **	-0.011	-0.087 ***
Competition from new competitors	-0.002	0.000	0.000	-0.004	-0.027
Moderate number of competitors	0.011	0.026	0.035 *	0.026 **	-0.014
Low number of competitors	0.014	-0.004	0.002	0.014	0.077 ***
Lack of technological information	0.017	0.001	-0.009	0.005	-0.105 **
Lack of customer response	-0.012	-0.054 ***	-0.040 *	-0.013	0.035
Lack of qualified labour	-0.013	0.023	0.064 *	-0.009	0.047
Lack of ext. sources of finance	0.001	-0.001	0.025	0.011	0.061
High innovation costs	0.004	0.029	0.086 ***	0.024	0.005
Lack of appropriate partners	0.028	0.044	0.018	0.001	-0.028
Regulation as barrier for innovation	0.015	0.021	-0.029	0.004	0.022
Firm size	0.005	0.006	0.024 ***	0.016 ***	0.012
Firm age	-0.004	-0.022 **	-0.017	-0.012 **	-0.013
Firm located in East Germany	-0.008	-0.044 ***	-0.067 ***	-0.033 ***	-0.086 ***
Medium-tech/high-tech manufacturing	0.032	0.002	-0.008	-0.001	-0.013
Manufact. of intermediary goods	0.021	0.010	0.022	-0.008	0.001
Trade, Construction, other services	0.009	-0.005	-0.013	-0.018	-0.135 **
Transport, other business services	0.017	0.010	0.016	0.016	-0.084
Knowledge-intensive services	0.026	0.035	-0.050 *	-0.014	-0.146 ***
No. of Observations	1196	1192	1194	1187	1199
Pseudo R-squared	0.21	0.12	0.19	0.29	0.25

5 Drivers for International Innovation Activities by Host Country and Region

For the regional analysis of international R&D drivers the data shows that the most popular region for German firms that plan to extend or to set up international R&D and innovation activities are nations with medium developed knowledge levels. Asian countries are second most cited (9%) as preferred and planned innovation locations (see also Rammer und Schmiele (2008)) Nations with advanced knowledge infrastructure count only for 6 % of the firms in the sample as their next preferred innovation location. Marginalized countries and India&China are for about 8% (Western Europe 5%, North America 3%) of the German firms the next R&D location abroad.

The main factors that lead firms to innovation activities in different countries and regions are again the firm capabilities and resources and only to a lesser extent innovation barriers in the home country. Competition rather hinders the relocation of innovation to one of the observed country and region. The results, provided in Table 4, show that firms with previous international experience and the technological advantage are more likely to set up research and innovation activities in Asian, Followers and Marginalized countries. Although international experience via international cooperation partners shows the largest effect in comparison with exports. The technological competence of a firm outweighs the driving effects of exports. Interestingly, the effect of firm's technological advantage that plan to innovate in North America is lower than for developing countries. These results support the assumptions made in Hypothesis 5.

The strongest location determinant for advanced knowledge nations including North America is the search for financial resources abroad to finance innovation projects. In this vein firms that argue they have to refrain from innovation projects due to high costs are less likely to carry out R&D projects in advanced knowledge economies. Other innovation location disadvantages also form a barrier to innovate in any

observed country or region. Especially the lack of appropriate innovation partners hinders firms to set up R&D sites in marginalized and Asian countries. The same effect can be observed for firms that are affected by legal innovation barriers. Summing up, innovation barriers in the home country demonstrate no location choice drivers (except for firms seeking external sources of finance in advanced knowledge countries). On the contrary, they serve as barriers to international R&D as well.

Similar results are found for the effect of the competitive environment as location choice driver. The number of competitors as well as the threat of new market entries doesn't have an effect the likelihood to carry out R&D in a specific region of the world. Only for China a negative significant effect is found for the quality of competition. Firms that face price competition in the home country are less likely to move their R&D to China. This result partly supports hypothesis 4.

Table 4: Drivers to Internationalise Innovation Activities of German MNEs (by Region): Marginal Effects of Probit Models

Variables	China	IndiaChina	Asia	EastEU	NA	WestEU	Advanced	Followers	Marginalized
<i>Internal Ressources & Capabilities</i>									
Continuous Inhouse R&D	-0.008	0.004	0.003	0.052 **	0.000	0.025	0.001	0.076 **	0.011
High skilled employees	-0.084 ***	-0.063 *	-0.048	-0.024	0.003	0.031	0.022	-0.059	-0.042
Innovation coop. with intl. Partners	0.045 *	0.056 *	0.068 *	-0.005	0.002	0.014	0.009	0.130 **	0.048
Export experience	0.018 *	0.032 **	0.037 **	0.020	0.009	-0.028	0.001	0.016	0.031 **
Experienced usage of IPR	-0.006	-0.011	-0.004	0.013	0.004	0.011	0.029 *	0.045	-0.008
Financial Ressources	0.007	0.008	0.001	-0.023	0.003	0.017	0.002	-0.004	0.019
Technological advantage	0.037 **	0.052 **	0.061 **	-0.031	0.032 **	0.001	0.029	0.046	0.045 **
<i>Competitive Environment</i>									
Price competition	-0.022 **	-0.017	-0.014	-0.012	-0.004	-0.006	-0.006	-0.051	-0.016
Competition from new competitors	-0.003	-0.006	-0.008	0.025	0.006	0.011	0.017	0.020	0.004
Moderate number of competitors	0.003	0.010	0.012	-0.006	0.000	0.011	0.003	0.001	0.017
Low number of competitors	0.006	0.004	-0.009	0.004	0.003	0.004	-0.005	-0.018	-0.009
<i>Innovation Location Advantages</i>									
Lack of technological information	0.021	0.014	0.014	0.044	-0.008	0.008	-0.006	0.030	0.020
Lack of customer response	0.015	0.054	0.061	-0.013	0.003	-0.003	0.010	0.034	0.038
Lack of qualified labour	-0.003	0.003	-0.001	0.025	-0.001	0.017	0.018	0.053	0.016
Lack of ext. sources of finance	0.005	0.032	0.024	-0.024	0.009	0.081 *	0.084 *	0.083	0.021
High innovation costs	0.006	-0.011	-0.018	0.031	-0.007	-0.036 ***	-0.037 **	-0.014	-0.015
Lack of appropriate partners	-0.024 ***	-0.042 ***	-0.054 ***	0.003	0.008	0.045	0.006	-0.035	-0.046 ***
Regulation as barrier for innovation	-0.029 ***	-0.039 ***	-0.051 ***	-0.022	0.004	-0.008	0.003	-0.076 *	-0.048 ***
<i>Control Variables</i>									
Firm size	0.005 *	0.005	0.004	0.004	0.003	-0.001	0.006	0.005	0.003
Firm age	-0.006	-0.007	-0.009	0.014	-0.001	0.005	0.002	0.009	-0.010
Firm located in East Germany	0.006	-0.007	-0.010	-0.018	0.002	-0.028 **	-0.003	-0.073 **	-0.018
Manufacturing Industry dummy	0.025	0.028	0.046	0.031	-0.003	0.012	-0.002	0.009	0.033
No. of observations	705	705	705	705	705	705	705	705	705
Pseudo R-squared	0.26	0.22	0.20	0.07	0.21	0.12	0.11	0.09	0.18

Source: ZEW: Mannheim Innovation Panel, 2005 and 2006 waves

6 Discussion

The paper aimed to shed light on the driving forces within the firm's local business and innovation environment as well as the influence of firm's capabilities and resources to perform R&D activities abroad. Moreover, this study sought to go beyond the term 'R&D abroad' and analysed the impact of the various driving forces for five different innovation activities abroad. Furthermore, the study not only distinguished the effects of the driving forces by the different types of R&D activities abroad but also analysed the effects of firm capabilities, firm's competitive environment and home country location disadvantages as drivers for the planned R&D and innovation activities in developed and developing countries as well as in technology clubs.

It could be shown that innovation disadvantages at the home location has weaker or even negative effects on the likelihood to carry out R&D and innovation activities abroad. The often mentioned high innovation costs and lack of labour propel only the manufacturing of innovative goods abroad. Therefore, it can be noticed that firms that have reduced innovativeness due to location disadvantages are not seeking to overcome these constraints by setting up R&D sites abroad. This indicates that these firms might lack certain capabilities and are generally weaker and therefore more concerned with lack of innovation factors. Firms rather use R&D activities abroad to further strengthen their existing innovation and business success. Firms that plan to innovate abroad have accumulated experience with foreign markets by exporting while for the location decision more elaborate international contacts via innovation collaborations are necessary. R&D in developing countries is still a very open field in the literature and the results achieved in this paper help to clarify the conditions that lead firms to innovate in countries with 'marginal' knowledge stocks. Again it becomes obvious that firms that underlay price competition are not pushed to developing countries to sell, manufacture innovative goods or to carry out other innovation activities in Asian and Marginalized countries.

As for the research intensive activities, it can be clearly shown that internal research activities abroad complement existing and continuous R&D activities in the home country. An existing technological advantage and a strong knowledge base at the firm headquarter are increasing the likelihood for international research and design abroad. While export experience is the major international experience driver for all types of innovation activities analysed in the first model, innovation cooperation with international partners show stronger effects for R&D activities in the different countries in the second model.

The results show that firms that wish to internationalise their R&D activities should have absorptive capacities and develop international experience. If the choice of location is a country belonging to the group of countries with developed knowledge levels or Asian countries then additional cultural competence should be gathered by engaging in partnerships with international innovation partners.

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