

Discussion Paper No. 09-064

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

Anja Schmiele

ZEW

Zentrum für Europäische
Wirtschaftsforschung GmbH

Centre for European
Economic Research

Discussion Paper No. 09-064

Drivers for International Innovation Activities in Developed and Emerging Countries

Anja Schmiele

Download this ZEW Discussion Paper from our ftp server:

<ftp://ftp.zew.de/pub/zew-docs/dp/dp09064.pdf>

Die Discussion Papers dienen einer möglichst schnellen Verbreitung von neueren Forschungsarbeiten des ZEW. Die Beiträge liegen in alleiniger Verantwortung der Autoren und stellen nicht notwendigerweise die Meinung des ZEW dar.

Discussion Papers are intended to make results of ZEW research promptly available to other economists in order to encourage discussion and suggestions for revisions. The authors are solely responsible for the contents which do not necessarily represent the opinion of the ZEW.

Non-technical Summary

The internationalisation of corporate R&D is an opportunity for firms to reach local knowledge and expertise which is distributed globally. Firms' innovation activities which are carried out abroad comprise either the localization of uniform products to local needs with locally available knowledge or the whole product development process including R&D.

The aim of the paper is to show how internal firm capabilities as well as external forces from the firm's business and national innovation environment impact on the firm's decision to carry out different innovation activities abroad. The analysis is based on around 1200 firms headquartered in Germany. A second step observes whether the effects of the potential internal and external driving factors vary by the host country.

The results show that especially firms with developed absorptive capacities and international experience are more likely to shift R&D intensive innovation activities abroad such as research and the conception/construction of new products. For the internationalisation of later stage innovation activities such as the manufacturing of new products or the implementation of new processes international experience as well as experience with intellectual property rights are required firm capabilities. The national innovation environment with high innovation costs and lack of labour contributes to the firm's decision to set up manufacturing capacities for new products abroad. The competition in the home market has a limited influence or even hinders firms to internationalise their innovation activities.

For the effect of the analysed internationalisation drivers per host country it could be shown that firms that innovate in countries with medium developed knowledge levels need pronounced export experience and in-house R&D activities than firms that innovate in advanced countries or nations with marginal knowledge levels. However, firms that plan to innovate in China should also engage in international R&D activities to further develop their international contacts. High innovation costs in the home country seem to motivate firms to innovate in medium knowledge countries while price competition fosters innovation activities in advanced knowledge economies but hinders firms to innovate in China. The overall conclusion emphasizes the capability driven decisions of firms to innovate abroad and not being forced predominantly by fierce competition or the lack of innovation resources in the home country.

Das Wichtigste in Kürze

In zahlreichen Studien hat sich gezeigt, dass Unternehmen den Trend ihre Innovationstätigkeiten zu internationalisieren weiter fortführen. Die Unternehmen verfolgen damit oft das Ziel ihre Produkte mit Hilfe lokalen Wissens an die Bedürfnisse der unterschiedlichen Märkte im Ausland anzupassen und damit eine höhere Zahl von Kunden zu gewinnen zu können. Durch die Dezentralisierung der Forschung und Entwicklung wird somit die internationale Produktion unterstützt. Daneben haben Unternehmen auch Forschungs- und Entwicklungszentren im Ausland angesiedelt um vor Ort innovative Produkte und Dienstleistungen zu entwickeln. Dabei können attraktive Innovationsbedingungen im Ausland, wie z.B. verfügbares Wissen, geringere rechtliche Hürden oder niedrigere Lohnkosten eine tragende Rolle spielen.

Diese Forschungsarbeit untersucht entscheidende treibende Kräfte, die Unternehmen zur Entscheidung motivieren, verschiedene Innovationstätigkeiten zu internationalisieren. In die Betrachtung werden neben den nationalen Innovationsbedingungen am Heimatstandort, die Firmencharakteristiken und die Wettbewerbssituation der Unternehmen als beeinflussende Faktoren einbezogen. Die Analyse stützt sich auf Informationen von ca. 1200 innovativen Unternehmen in Deutschland.

Dabei stellte sich heraus, dass weder intensiver Wettbewerb noch Standortnachteile im Heimatmarkt die treibenden Kräfte in der F&E Dezentralisierung sind. Die größte Rolle bei der Entscheidung interne Forschungstätigkeiten zu internationalisieren spielen vielmehr die absorptiven Fähigkeiten und die internationale Erfahrung der Unternehmen. Für Unternehmen, die planen weniger forschungsintensive Innovationstätigkeiten, wie die Herstellung von neuen Produkten, im Ausland durchzuführen, sind Erfahrungen im Export und im Umgang mit intellektuellen Eigentumsrechten signifikante Unternehmens-eigenschaften. Zudem sind diese Unternehmen durch hohe Innovationskosten und dem Mangel an Personal getrieben.

Ein zentrales Ergebnis bei der Analyse, wie sich die Einflussfaktoren in ihrem Effekt nach Zielländern unterscheiden ist, dass sich Unternehmen, die planen FuE in Entwicklungsländern zu betreiben, durch starke internationale Erfahrung, insbesondere durch bereits durchgeführte internationale Forschungs Kooperationen auszeichnen.

Drivers for International Innovation Activities in Developed and Emerging Countries

Anja Schmiele^{*,**}

^{*}ZEW–Centre for European Economic Research

^{**}WHU–Otto Beisheim School of Management

Abstract

This paper aims to shed light on firm specific drivers that lead firms to internationalise their 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 obstacles in the home country. In particular, the role of the potential driving forces is tested on the probability to carry out different innovative activities abroad (R&D, design/conception of new products, manufacturing of innovative products and implementation of new processes). In a second step these driving forces are used to observe their impact on the decision to locate innovation activities in various countries and regions (China, Eastern Europe, Western Europe and North America) as well as in groups of countries with similar levels of knowledge (country clubs). The analysis is based on the Mannheim Innovation Panel survey which represents the German CIS (Community Innovation Survey) contribution. Two survey waves are combined and result in a sample of about 1400 firms. The results show that the decision to perform innovation activities abroad is mainly driven by organisational capabilities such as absorptive capacities, international experience and existing technological competences of the respective firm. Innovation barriers at the German home base such as lack of labour and high innovation costs foster the set up of later-stage innovation activities abroad while the lack of demand demonstrates a barrier to the internationalisation decision for the development and manufacturing of new products. Location decisions receive the strongest influencing effects from the international experience of the firm. Firms which innovate in developing countries seem to require a more extensive level of international experience by international R&D cooperation.

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

JEL-Codes: F23, L22, L25, O31, O32, O47

1 Introduction

Globalisation has been reshaping the business environment of firms. The corporate response to the increased openness of economies is the ongoing trend to internationalise business processes. Foreign markets allow international firms to achieve scale advantages and to source international assets, including knowledge. As a consequence, firms can enlarge their market size and use internationally dispersed knowledge resources to enhance their competitiveness. Internationalising innovation will allow firms to enlarge their knowledge base by obtaining knowledge, technology and skills from other locations than their home market, potentially contributing to more ambitious and more efficient innovation efforts. By acquiring knowledge from other places firms can overcome knowledge constraints in the home country. Furthermore, approaching new markets often requires innovation designs which are adjusted to the specific environment in these markets. Developing or adapting such innovations at the location of potential customers may be more effective. Moreover, market success of new products depends not only on technological superiority or customer-tailored solutions but also on price-efficiency.

However, firms might not take the risks of shifting business operations away from the centre if their competitive environment and the need to overcome shortcomings in the national innovation environment forced them in some way. Beside these potential pushing forces firms might possess capabilities and resources that enable them to perform innovation activities abroad. This paper aims to spot both firm specific factors and characteristics of the home innovation environment in their influence to locate innovation activities abroad. Most of the literature on internationalisation of innovation neglects the competitive forces and R&D attractiveness of the home location and focuses on host country advantages. Furthermore, existing studies concentrate on R&D and neglect later-stage 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 firms from various sectors by considering different types of innovation activities: R&D, product design,

production of new products and services as well as investments in new processes. Closely related to the decision to carry out innovation activities abroad is the location decision since it also reflects firm intentions. The trend to set up corporate innovative capacities in developing countries, especially in the Asian region, has been witnessed in recent studies (UNCTAD, 2005). However, developing regions are underrepresented in most of the existing studies. This paper will assist in identifying country effects of the driving forces on the decision to locate research and innovation activities in countries with different levels of knowledge (country clubs as proposed by Castellacci and Achibugi, 2008) as well as a specific analysis for innovation investments in China, Eastern Europe, Western Europe and North America. Summing up, the paper explores three research questions: To which extent do firm capabilities, the level of home market competition and local innovation disadvantages drive a firm's decision to engage in international innovation activities? Do these determinants differ by type of innovation activity? Do these determinants differ with respect to the stage of economic development of the host country?

In the next section the theoretical background of the topic is presented while 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 whereas 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 Literature Review and Hypotheses

This paper is built on the stream of literature about internationalisation of R&D including motives, strategies and barriers that affect internationalisation decisions, determinants of internationalising innovation activities as well as the geographic scope of international R&D activities.

Internationalisation of corporate R&D

The internationalisation of firms is an ongoing trend which is encouraged by the increased openness of economies, the rise of new world players and the firm's need for new sources of competitiveness. It has been pointed out that the pace of internationalising R&D is accelerating and supported by advances in ICT and transport (UNCTAD, 2005).

Globalisation of firms' innovation activities has also been a major research topic for a long time (OECD, 2008; OECD, 2007; UNCTAD 2006; UNCTAD, 2005; Veugelers et al., 2005; Brockhoff, 1998; Granstrand et al., 1993; Pearce, 1989). One stream relates to the drivers and motives for engaging in innovation activities abroad, in particular with regard to R&D (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).

A firm's decision to internationalise its innovation activities may be related to three motives (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 the access to foreign knowledge and its integration into firm-internal processes (Cantwell and Piscitello, 2005). Market seekers aim to access foreign markets in order to sell 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 (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 activities by performing activities in countries with a lower price/productivity ratio for innovation inputs, particularly human capital. It has been shown that firms often follow more than one motive and recent studies illustrate the trend towards R&D intensive subsidiaries abroad (OECD, 2008; Alcáer and Chung, 2002; Kogut and Chang, 1991).

Depending on the motives to internationalise innovation activities, a firm's R&D and innovation units abroad will serve different purposes. There are a number of studies that aimed to differentiate between different types of R&D activities abroad. Ito and Wakasugi (2007) distinguish between support-oriented R&D and knowledge sourcing R&D, Dunning and Narula (1995) between asset-seeking and asset-exploiting purposes, whereas Kuemmerle (1997) differentiates between two international R&D strategy categories of R&D sites abroad. The home-base exploiting laboratory is in charge of the transfer of the existing knowledge of the home-base to the R&D unit abroad for local manufacturing and marketing (market and efficiency seeking). The home-base augmenting laboratory primarily aims 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 which have a rather limited role in R&D. Their mandate is mainly to facilitate technology transfer from the home base to the local manufacturing (Nobel and Birkinshaw, 1998). Ito and Wagasuki (2007) follow up on this international R&D strategy research with an analysis of the determinants of firms and host countries which foster one or the other strategy. Related to this research are studies on the management of global R&D activities of multinationals (Gerybadze and Reger, 1999; (von Zedtwitz and Gassmann 2002), 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 (Haagedoorn, 1996, 2002; Veugelers, 1997; Cassiman and Veugelers, 2002). Studies on international technology spillovers are another direction of research which captures internationalisation issues in innovation (Veugelers and Cassiman, 2004; MacGarvie, 2005; Guellec and van Pottelsberghe, 2001; Lichtenberg and van Pottelsberghe, 1998; Coe and Helpman, 1995).

Driving forces for international innovation activities

A number of studies have been dedicated to observe the question why some firms carry out innovation activities abroad and others do not. Viewing firms from their resource and knowledge base has been one perspective in the literature to explain firms' international R&D activities (Wernerfelt, 1984; Peteraf, 1993; Liebeskind, 1996; Grant, 1996).

Internationalising innovation is a specific type of foreign direct investment (FDI). Thus, the theory of the international firm and the determinants for FDI occurrence are also relevant for the investigation of a firm's decision to internationalise its innovation activities. The determinants of a firm's decision to internationalise business processes and their location choice for R&D facilities are combined in the OLI-model of Dunning (1981). The "eclectic paradigm" combines ownership-specific (O), location-specific (L) and internalising (I) advantages for a firm's decision to enter into economic activities beyond its domestic market. The ownership advantage refers to competitive advantages, resources and capabilities of a firm which can be capitalised abroad. They can be the result of domestic rivalry which pressures firms to constantly improve their business activities (Porter, 1990). Fierce home market competition may result in a high level of product or service quality which makes entering international markets easier. The location-specific advantages refer 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 and form a location advantage in comparison with home country conditions. 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 which firms can gain when conducting business activities abroad by themselves in comparison with outsourced business processes to local firms abroad. These three OLI-advantages capture the extent of company's and host countries' conditions and provide an instrument to evaluate the prerequisites for a successful internationalisation of business processes including R&D.

The design of the empirical analysis of the paper will follow the outline of the OLI-model and will therefore test the influence of internal resources, capabilities and

experience, business and innovation environment on a firm's likelihood to internationalise its R&D.

Internal Resources

The internationalisation of corporate R&D is associated with a number of challenges. While many multinational enterprises (MNEs) have acquired experience about foreign markets 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). Every firm has a different base of resources, including knowledge and level of experience, and therefore it develops a varying competence level. When it comes to establishing innovation activities abroad, the role of firm competitive advantages resulting from resources and capabilities becomes particularly important. 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 absorptive capabilities are developed while performing R&D activities internally. Only then firms possess the competence to recognize and to continue using the 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 a firm's absorptive capacities.

For the confrontation with foreign cultures and business practices, technological competences might not be sufficient to cope with foreign business environments. The costs resulting from being a "stranger" in "a strange land" are summarized in the literature about liabilities of foreignness (Zaheer, 1995; Zaheer and Mosakowski, 1997; Mezias, 2002). International experience of organisations can reduce the uncertainty arising from the exposure to unfamiliar situations and the distance to the home-base (Zaheer and Mosakowski, 1997); Harvey and Novicevic, 2000). Companies can gain the ability to adapt and cope with local challenges by increasing the organisation's international contacts through engaging in joint innovation projects

with international partners or by exporting. Exporters, in addition, require more sophisticated knowledge than domestic suppliers (Ito and Wagasaki, 2007). Therefore, it is anticipated that:

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

Competitive environment

The relationship between the competitive firm environment and corporate innovation activities is a field of contradictory research results. Starting from Schumpeter (1943) who finds a negative impact of competition on innovation more recent studies (Aghion et al., 2005) show an inverted U-shaped relationship between the level of competition and the innovative activities of firms which might try to escape competition by innovation. These findings confirm the earlier results of Scherer (1967) who also found an inverse U-shaped relationship between the intensity of competition and innovation. In the era of globalised competition the home market environment is supposed to drive the internationalisation of innovation activities of firms twofoldly: On the one hand, the type and quality of competition may force firms to respond by leveraging the location advantages of the home and other countries. This will be particularly relevant in the event that firms experience increased competitive pressure in their home market due to strong price competition or due to the entry of new competitors. Firms that are subject to fierce competitive pressure may be compelled to access additional international knowledge pools in order to sustain or re-develop competitive advantages. On the other hand, domestic firms, on account of the globalisation of competition, increasingly face foreign competitors in their home market. These new rivals might have access to resources that firms lack in their home country. Therefore it is expected that:

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

Attractiveness of domestic location for innovation

The different motives for international R&D (knowledge, market and efficiency seeking) are very likely to be the result of deficits of the innovation environment at the firm's home base. Entering foreign countries in order to establish innovation activities may also reinforce the importance of typical barriers 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 (Acs et al., 1997). Lack of innovation-specific resources and services lowers the attractiveness of a domestic location to conduct innovation. In regard to factor markets this refers on the one hand to the availability and costs of highly qualified labour with skills which a firm requires for conducting a specific innovation project and to the availability of external financial resources and their costs on the other. Kinkel, Lay and Maloca (2007) found that companies that intend to perform less R&D intensive innovation activities abroad are mostly driven by high costs at home and cost-reducing potentials abroad. 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.

Obstacles to innovation in the home market can therefore act as a pushing effect for firms which aim to compensate home country disadvantages by internationalising corporate innovation (Almeida, 1996). Location disadvantages, especially for innovative firms, are characterized by a shortage of qualified personnel, technological information, high costs, lack of potential cooperation partners, and lack of demand for innovation. Political issues such as legal innovation barriers can also hamper innovation projects (Lall, 1979). Therefore we assume that:

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

International R&D location decision - The case of developing countries

The geographic decision where to locate innovation activities abroad is closely related to the extent and nature of innovation disadvantages of the home country and firms' internationalisation motives. Empirical studies in this field have dedicated their work to regional R&D location analysis within the USA (Audretsch and Feldman, 1996; Alcáer and Chung, 2007) or concentrated on firm strategies between home and host country (Le Bas and Sierra, 2002). Other studies have analysed the location (domestic or abroad) of innovation by patent citation analysis (Jaffe, Trajtenberg and Henderson, 1993; Frost 2001). Cross-country studies, instead, would contribute to the literature by demonstrating the influence of location determinants and their different impact on various countries. In this vein, Odagiri and Yasuda (1996) have analysed the impact of firms' capabilities and resources on the probability to innovate in Asia, Europe and the USA.

Knowledge, as being one of the most valuable resource in today's business, is not equally available everywhere. The different allocation of resources in space creates certain 'pockets of expertise' (Nelson, 1993; Porter, 1990) globally. According to a firm's internationalisation strategy (home base-augmenting and/or home base-exploiting) potential host countries differ in their attractiveness for R&D activities. The importance of host countries' demand and supply factors such as R&D resources for overseas R&D location decision has been pointed out (Odagiri and Yasuda, 1996). Firms wishing to perform R&D outside their home country generally look for countries that offer attractive market potentials, the availability of highly 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, 1996). They prefer to set up R&D centres in nations with technological resources, a supply of low-cost staff, and good communication infrastructure (Kumar, 1996). However, it remains unclear whether host country's supply and demand factors can explain the whole motivation of firms' overseas R&D location decision and to what extent home country innovation barriers contribute to this decision. It has been argued that international R&D aims to offset home country disadvantages (Almeida, 1996; Erken and Gilsing,

2005) Therefore, it seems obvious that both the abundance of host and home country's demand and supply factors impact on the firms' location decision. In this paper we focus on the home country perspective of firms.

Other moderating effects on the location choice include the cultural and geographic distance between the home and the host country. The more distant the home country is from the host country the higher the propensity for unfamiliar hazards which drive the liabilities of foreignness (Eden and Miller, 2004). Firms are aware of these unexpected costs by own experience or by the experience of other firms and aim to reduce these negative effects. Previous country studies discussed that firms tend to follow a national path in their internationalisation innovation strategy (Granstrand, 1999). Ambos (2005) found that German firms tend to cross borders initially only within Europe or to the USA and only later adopt innovation activities in Asian countries.

In the case of German MNEs, countries with developed economic status and advanced knowledge levels are the premier location choice, 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 (developed) international R&D locations. The acquired international experience serves as a qualification to minimise uncertainties at the foreign R&D site. Knowing that developing countries often offer an even more challenging business environment it is expected that:

Hypothesis 5: The effects of firms' international experience on internationalising innovation are stronger when locating innovation activities in developing regions.

The rise of the emerging giant countries such as China and India has challenged the attractiveness of developed nations. A study by UNCTAD (2005) asked large MNEs about their preferred prospective international R&D location from 2005 until 2009. 62% of the respondents rank China as premier, the United States (41%) as second and India (29%) as their third most attractive R&D location. The literature has been enriched by studies about the setup 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; Agarwal, Gupta and Dayal, 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 talent at lower costs and the increasing supply of scientists and engineers in emerging countries foster the trend of international dispersion of corporate R&D. Other studies have already set their focus on the differences of doing R&D in developed versus less developed countries (Thursby and Thursby, 2006). Gassmann and Han (2004) analysed the motivations behind foreign R&D activities in China based on case studies and found that input-oriented factors (skilled HR, local knowledge) as well as performance factors (low overheads) drive these activities. It has always been 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 return on investment reasons for the decision to internationalise R&D and innovation activities (Zedtwitz and Gassmann, 1998). Based on the rationale that research and innovation activities abroad are carried out to access foreign knowledge pools and to adjust innovations to local market requirements the decision to set up R&D capacities abroad should follow a rather long-term strategy. Therefore, it is anticipated that:

Hypothesis 6: Efficiency seeking motives (e.g. high innovation costs and price competition in the home country) are not predominant drivers to locate innovation activities in regions with less developed knowledge levels.

3 Database & Empirical Analysis

In this section, the database, variables and methods used to test the hypothesis empirically are introduced. A set of explanatory variables is used to analyse two types of decisions on internationalising innovation: first, a firm's decision to engage in certain types of innovation activities abroad and, second, on a firm's decision to engage their innovation activities in different regions and countries.

Data - 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 annually by the Centre for European Economic Research (ZEW) in Mannheim, Germany and is called the Mannheim Innovation Panel (MIP). In addition to the standard CIS, the MIP contains a significantly larger number of questions which allows 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 variables which will be used to characterise a firm's innovation environment, its competitive conditions as well as its internal resources, capabilities and innovation activities, i.e. the supposed drivers of internationalising innovation activities. The variables of the 2005 survey refer to the situation in the financial year 2004. Table 1 summarises the indicators used.

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 the other one measures experience in selling products abroad. A firm is regarded as having accumulated experience in successfully protecting intellectual property (IP) when it has been 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 has made a high contribution to the 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 measured by a firm's own assessment with reference to the firm's main product market. This measure of competition by a firm's own perception has the advantage of capturing the effect of firm-specific competition and explaining why some firms undertake more innovation activities than others in the same product market (Tang, 2006).

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 (Schmoch, 2003).

Table 1: Explanatory Variables

Model variable	Indicator
<i>Internal Resources</i>	
Continuous R&D	1 if a firm conducted in-house R&D continuously in 2002-2004; 0 otherwise
High skilled employees	No. of graduated employees to total number of employees in 2004
Experience in innovation cooperation with foreign partners	1 if a firm co-operated in innovation between 2002 and 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.
Export experience	1 if a firm had any exports from 2002 to 2004; 0 otherwise
Experience in successfully protecting intellectual property	1 if 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) from 2002 to 2004 which was highly important for protecting its IP; 0 otherwise
Financial resources	Firm reported a profit margin in 2003 and 2004; ordered variable (7 values: 6 categories ranging between 0-15%; 1 for more than 15%)
Technology advantage	1 if a firm has applied for at least one patent and/or (for service sector firms) registered trade mark between 2002 and 2004; 0 otherwise
<i>Home 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
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
Unstable competitive environment	1 if a firm judges the behaviour of competitors as very difficult to foresee in 2004; 0 otherwise
High number of competitors	1 if a firm had more than 6 main competitors in 2004; 0 otherwise
<i>Home Location Attractiveness</i>	
Lack of technological information	1 if a firm stated that the lack of technological information was an important obstacle to innovation between 2002 and 2004 (answers 2 or 3 on a 0 to 3 Likert scale); 0 otherwise
Lack of customer response/demand for innovation	1 if a firm stated that the lack of customer response or demand for innovation was an important obstacle for innovation from 2002 to 2004 (answers 2 or 3 on a 0 to 3 Likert scale); 0 otherwise
Lack of qualified labour	1 if a firm stated that the lack of qualified personnel was an important obstacle to innovation between 2002 and 2004; 0 otherwise
Lack of external sources of finance	1 if a firm stated that the lack of appropriate external financing was an important obstacle to innovation between 2002 and 2004; 0 otherwise
High innovation costs	1 if a firm stated that too high innovation costs was an important obstacle to innovation between 2002 and 2004; 0 otherwise
Lack of appropriate partners	1 if a firm stated that the lack of appropriate partner for innovation was an important obstacle to innovation between 2002 and 2004; 0 otherwise
Regulation as barrier to innovation	1 if a firm stated that regulation and long administrative procedures were an important obstacle to innovation between 2002 and 2004; 0 otherwise
Size	ln(No. employees at FTE in 2004)
Age	ln(time between the year of market entry and 2005)
East German location	1 if a firm is located in East Germany in 2004; 0 otherwise
Manufacturing Industry	1 if a firm belongs to an industry whose NACE classification code is larger than 500

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

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 from 2002 to 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 the inclusion of the same broad coverage of industry dummies as in model one. Therefore, an industry dummy variable for firms in the manufacturing sector is included.

Dependent Variables

The first model aims to identify the drivers of a firm's decision to conduct innovation activities outside their home country. Five different types of innovation activities were observed. The variables comprise the *planned* R&D, design/conception of new products, production of new products and the implementation of new processes abroad of firms for the years 2006 and 2007. In order to avoid endogeneity, we do not consider the actual innovation activities abroad (which may refer to firm decisions long time ago) but to currently planned internationalisation of innovation activities in the respective year. The sample is restricted to firms with innovation activities at their German home location. Foreign-owned firms were dropped from the sample.

The 2006 survey also asked firms in which countries (free text) they currently perform and plan to perform the four different innovation activities predominantly. The second model makes use of this information by analysing how the abilities of firms and the firms' business and innovation environment influence their likelihood to perform 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 as proposed by Castellacci and Achibugi (2008) as technology clubs. In this vein three groups of technology clubs are defined: advanced followers and marginalised countries (for a detailed list of countries and their respective category see Table 2). China and India are in the same technology club (marginalised countries) as African countries, but due to their greater attractiveness for firms in terms of market size,

speed of the economic growth and absolute numbers of graduates they might have a different priority than other countries. Therefore, country and regional variables for China, North America, Western Europe and Eastern Europe are generated to measure the influence of internationalisation drivers for certain countries and regions of interest.

Empirical Analysis

In a first step the sample of model 2 has been restricted to firms that carry out at least one of their R&D and innovation activities abroad in order to be able to compare the effects of the internationalisation drivers for different countries and regions. However, for the reader, the usage of a uniform sample for both models seemed easier to follow and the results from the restricted sample and from the sample used in model 1 do not vary extensively. Therefore, the choice of the sample was done in favour of one uniform sample for the R&D abroad and R&D location decision.

Initially, separate probit models for each decision (by type of innovative activity abroad and location abroad) have been estimated with marginal effects for both estimation models. However, for the second model, the decision to carry out innovation activities in certain regions can be a simultaneous decision process. Therefore, the location-specific effects of international innovation drivers have been estimated with two multivariate probit models with marginal effects. One multivariate probit estimation was done for the advanced, follower and marginalised country classification and a second one for the regions Western Europe, Eastern Europe, North America and China.¹

¹ Due to fruitful remarks from Otto Toivanen at the Zvi Griliches Research Summer School in Barcelona, July 2009, a rare event logit model (King and Zeng, 2001) has been estimated to capture the effects of the observable driving forces for rare events such as planned innovation activities of German firms in North America (3 %). However, no varying results have been achieved by this analysis.

Table 2: Definition of Dependent Variables

Model variable	Indicator
<i>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)
<i>Planned Research and Innovation Activities in Different Countries and Regions</i>	
Planned internalisation of innovation activities of type k in country c	1 if a firm plans to take up or expand type k innovation activity outside Germany in 2006 or 2007 in one of the c countries or technology clubs (c : advanced, followers, marginalised, China, North America, Western Europe, Eastern Europe); 0 otherwise
Advanced countries	Northern Europe, Scandinavia, Switzerland, Netherlands, Norway, Denmark, UK, Sweden, Finland, Western Europe, Iceland, Japan, USA, Canada, Australia, Israel
Follower 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, Saudi Arabia, Lebanon, Libya, UAE, Middle East, Near East, Dubai, South Africa
Marginalised countries	China, India, Pakistan, Vietnam, Taiwan, Sri Lanka, Indonesia, Mongolia, Iran, Macao, Montserrat, Africa (except for South Africa)
China	China
North America (NA)	USA, Canada
Western Europe (WestEU)	Switzerland, Netherlands, Norway, Denmark, UK, Sweden, Finland, Iceland, Austria, Belgium, Benelux, France, Luxembourg, Spain, Italy, Portugal, Ireland, Malta
Eastern Europe (EastEU)	Middle and Eastern European countries (CEE, MEE, MOE)

4 Drivers of Internationalising Innovation Activities

In the retrieved sample of 1439 innovative firms which are headquartered in Germany about 24% of the companies plan to set up or to expand existing international innovation activities abroad. 16% thereof want to manufacture innovations outside Germany, 11% intend to develop new products and about 10% to implement new processes abroad. In the sample, 8% of the firms plan to set up internal research capacities abroad which makes it the less internationalised of the observed innovation activities (the detailed descriptive statistics is provided in Table 5 in the Annex). Analysing the drivers of internationalising decisions for innovation activities 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. The decision to internationalise any innovation activity shows the strongest influence from previous

international experience and the firm's absorptive capacity. The home innovation environment indicates also a positive stimulus; in particular, the lack of information and high innovation costs spur the internationalisation decision. For each single type of innovative activities previous export experience is found to have strong influence, especially on the internationalisation of manufacturing innovative products abroad as well as on the design of new products (Hypothesis 2 supported). Export experience seems to provide knowledge about market conditions, demand and location advantages which might increase the likelihood to set up the manufacturing of innovative products and new processes abroad. This is in line with findings from Ito and Wagasaki (2007) stating a positive relationship between export activities and overseas R&D. However, similar to previous studies, the causality between export and international R&D activities remains ambiguous. This study has tried to circumvent this causality problem by relating existing exporting activities in the year 2004 to the intention of firms to internationalise their R&D activities in 2006. Surprisingly, previous international experience gathered by international research cooperation has no significant effects on the decision to locate single innovation activities overseas but it increases the likelihood for the decision to internationalise any innovation activities by 9%. Firms which plan to internationalise their R&D activities show stronger effects on the continuously performed in-house R&D and a high share of skilled labour. These indicators reflecting the importance of absorptive capabilities for international research activities (Hypothesis 1 partly supported) and the design of very innovative firms are supported by the positive effect of technological advantages of these firms on their likelihood to decide for international Research and Design. Surprisingly, the share of highly skilled employees has a negative effect on the decision to implement new processes abroad. Other firm resources which promote the decision of later stage innovation activities such as the manufacturing of new products and the implementation of new processes abroad are the experience in intellectual property rights use. It seems that the potential loss of knowledge is greatest when it is embodied in products and services. Firms with pronounced financial resources are also more likely to manufacture their products abroad.

Regarding the influence of competition on the likelihood to perform innovation activities abroad, varying results are retrieved. While the quality of competition, namely price competition, in the home market has a negative effect on the manufacturing and export of innovative goods the quantity of competition shows positive effects. Firms that face price competition are very likely to operate not at the leading edge of technology, thus explaining the lesser likelihood of carrying out innovation activities abroad. As for the quantity of competition in the home market, the results show that firms which face competition from new market players are by 3% more likely to implement new processes abroad. Therefore, a more intense competition seems to work as a driver for the decision to carry out later stage innovation activities abroad (Hypothesis 3) and to escape competition by innovation. However, competition has no effect on the likelihood to carry out R&D intensive activities at foreign locations.

The influence of firms' home country innovation environment on their innovation performance abroad shows positive and negative effects. Hereby, it was argued before that firms which are hindered by home country-specific innovation barriers will be more motivated to change their R&D location (Hypothesis 4). For the general decision to internationalise innovation activities the lack of information and high innovation costs demonstrate significant positive incentives. For the decision to expand single innovative activities abroad the lack of labour and high innovation costs in the home country, the often mentioned forces which make firms locate their R&D abroad, actually effect only the decision to set up innovation manufacturing capacities abroad positively. However, the lack of customer response in the home country makes firms less likely to design and manufacture innovative products abroad, which indicates that firms do not try to take advantage of different demands worldwide.

The results for firm size show that larger firms tend to be more likely to decide in favour of the manufacturing and development of new products and processes abroad. Firm age and firm location (in Eastern Germany) are negatively associated with the decision to internationalise innovation activities.

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

	Any Innovation Activity Abroad	Planned Research Abroad	Planned Design/ Conception Abroad	Planned Manu- facturing Abroad	Planned New Processes Abroad
<i>Firm Capabilities and Ressources</i>					
Continuous Inhouse R&D	0.068 ***	0.046 ***	0.036 *	0.017	0.010
High skilled employees	0.061	0.059 ***	0.037	-0.011	-0.048 *
Innovation coop. with intl. Partners	0.086 **	0.010	-0.001	0.042	0.015
Export experience	0.131 ***	0.044 ***	0.083 ***	0.116 ***	0.059 ***
Experienced usage of IPR	0.032	0.010	0.013	0.048 **	0.027 *
Financial Ressources	0.007	0.002	0.003	0.011 **	0.001
Technological advantage	0.025	0.028 *	0.036 *	0.004	0.015
<i>Home Competitive Environment</i>					
Price competition	-0.022	-0.001	-0.004	-0.034 *	-0.008
Unstable competitive situation	-0.013	-0.003	-0.002	0.000	-0.006
Competition from new competitors	0.011	0.012	0.026	0.031	0.027 **
High number of competitors	-0.007	-0.014	0.007	-0.006	-0.015
<i>Home Innovation Environment</i>					
Lack of technological information	0.100 **	0.020	0.006	0.033	0.016
Lack of customer response	-0.044	-0.013	-0.055 ***	-0.048 **	-0.014
Lack of qualified labour	0.021	-0.011	0.026	0.057 *	-0.009
Lack of ext. sources of finance	0.002	0.001	-0.001	0.023	0.014
High innovation costs	0.063 **	0.003	0.027	0.089 ***	0.025
Lack of appropriate partners	0.007	0.027	0.042	0.002	-0.002
Regulation as barrier for innovation	-0.020	0.017	0.021	-0.028	0.006
<i>Control Variables</i>					
Firm size	0.017 ***	0.003	0.004	0.019 ***	0.015 ***
Firm age	-0.014	-0.005	-0.023 **	-0.017	-0.013 **
Firm located in East Germany	-0.069 ***	-0.008	-0.044 ***	-0.062 ***	-0.034 ***
Manufacturing Industry	0.025	0.041	0.041	0.171 **	0.100 *
Pseudo R-squared	0.14	0.21	0.12	0.20	0.30
No. of Observations	1439	1202	1198	1200	1193

***1% Significance; **5% Significance; *10% Significance

5 Drivers for International R&D and Innovation Activities by Host Country, Region and Technology Club

The regional analysis of international innovation activities aims to observe country-specific effects of driving forces to internationalise innovation. In this regard the host countries of a firm's (any type) innovation activities abroad are the central point of interest in this analysis. The descriptive results show that for innovative German firms planning to internationalise their R&D the most popular region (for 13% of the sample firms) are nations with medium developed knowledge levels (follower countries). Nations with both advanced and marginalised knowledge infrastructure account for 6% of the firms in the sample as their preferred prospect innovation location (for detailed descriptive statistics refer to Table 5 in the Annex section, see also Rammer and Schmiele, 2008).

The results for the regional analysis of innovation internationalisation drivers are shown in Table 4 stating that the main factors which lead firms to innovation activities in certain countries and regions are firm capabilities and resources and only to a lesser extent location disadvantages in the home country. Competition rather hinders the location of innovation to one of the observed countries and regions. The results illustrate that the effects of firms' international experience are more pronounced for firms planning to set up or expand innovation capacities in follower countries than in advanced and marginalized countries. International experience via international cooperation partners, demonstrates only a higher influence on the propensity to move innovation activities to China than exports. The direct comparison between the effects of international experience (exports) between advanced and marginalized host countries shows slightly stronger effects for the marginalized group of countries (Hypothesis 5). Furthermore, the effect of firm's technological advantage on firm's decision to innovate in North America is lower than for China.

The last hypothesis was directed towards the motives which make firms set up or expand their innovation activities into countries with developing knowledge levels.

The results show that the innovation-related location disadvantages of the home country, namely the lack of appropriate partners and regulation barriers show negative significant coefficients. It demonstrates that firms which are affected by these two innovation barriers are less likely to plan innovation activities in marginalised countries and, particularly in China. High innovation costs as the anticipated drivers for R&D in developing countries show negative significant results for countries with advanced knowledge levels and slightly positive significance for follower countries.

Similar results are found for the effect of the competitive environment as location choice driver. A high number of competitors as well as unforeseeable competitive behaviour do not have an effect on the likelihood of carrying out innovation activities in a specific region of the world. For China, a negative significant effect is found from the quality of competition. Firms which face price competition in the home country are less likely to move their innovative capacities to China. This result partly supports hypothesis 6.

Other results which describe the nature of firms with plans to build up innovation capacities overseas show that firm size turns out to be a relevant characteristic for firms planning to innovate in China and in the East European countries. The manufacturing industry indicates a slightly positive likelihood to innovate in follower countries while firms from Eastern Germany are less likely to innovate in marginalised and follower countries as well as in North America.

Table 4: Drivers to Internationalise Innovation Activities (by Region): Two Multivariate Probit Models with Marginal Effects

	1	2	3	4	I	II	III	
	China	EastEU	NA	WestEU	Advanced	Followers	Marginalized	
<i>Internal Ressources & Capabilities</i>								
Continuous Inhouse R&D	-0.000	0.027 *	0.024 **	0.000	0.009	0.039 **	0.010	
High skilled employees	-0.020	0.018	0.022	0.005	0.015	0.047	-0.007	
Innovation coop. with intl. Partners	0.028 *	-0.003	0.018	0.006	0.027	0.025	0.023	
Export experience	0.014 **	0.042 ***	0.015	0.005	0.024 ***	0.060 ***	0.028 ***	
Experienced usage of IPR	0.001	-0.003	0.021 *	0.005	0.029 ***	0.020	0.002	
Financial Ressources	0.003 ***	-0.002	0.003	0.001	0.001	0.001	0.004 **	
Technological advantage	0.018 *	-0.009	-0.009	0.013 *	0.004	-0.004	0.018	
<i>Home Competitive Environment</i>								
Price competition	-0.012 **	-0.005	-0.010	-0.002	-0.007	-0.008	-0.005	
Unstable competitive situation	0.000	-0.004	-0.003	0.001	-0.006	-0.010	0.006	
Competition from new competitors	-0.004	-0.001	0.011	0.003	0.019 **	-0.001	-0.003	
High number of competitors	-0.005	-0.002	0.010	-0.003	0.006	0.010	0.002	
<i>Home Innovation Environment</i>								
Lack of technological information	0.012	0.019	0.005	-0.003	0.007	0.027	0.023	Log likelihood of multivariate probit est. I-4: -812.919
Lack of customer response	0.015	-0.014	-0.005	-0.003	-0.004	-0.015	0.025	Correlation coeff. betw. Eq. 1-2 0.043
Lack of qualified labour	-0.005	0.011	0.016	0.001	0.011	0.001	0.003	Correlation coeff. betw. Eq. 1-3 0.022
Lack of ext. sources of finance	-0.005	-0.012	0.008	0.005	0.020	-0.012	-0.011	Correlation coeff. betw. Eq. 1-4 0.347 **
High innovation costs	0.010	0.031	-0.016	-0.005	-0.025 ***	0.044 *	0.013	Correlation coeff. betw. Eq. 2-3 0.066
Lack of appropriate partners	-0.006	-0.002	0.014	0.004	0.007	-0.023	-0.022 ***	Correlation coeff. betw. Eq. 2-4 0.302 **
Regulation barrier for innovation	-0.017 ***	-0.005	-0.001	0.009	0.009	-0.015	-0.024 ***	Correlation coeff. betw. Eq. 3-4 0.099
<i>Control Variables</i>								
Firm size	0.004 **	0.007 **	-0.002	0.001	0.003	0.006	0.003	Log likelihood of multivariate probit est. I-III: -868.860
Firm age	-0.002	0.007	-0.002	-0.001	-0.003	0.007	-0.003	Correlation. coeff. betw. Eq. I-II 0.246 **
Firm located in East Germany	-0.005	-0.005	-0.019 **	-0.002	-0.006	-0.040 **	-0.015 *	Correlation. coeff. betw. Eq. I-III 0.200
Manufacturing Industry	0.015	0.008	0.005	-0.000	-0.005	0.091 *	0.018	Correlation. coeff. betw. Eq. II-III 0.616 ***
No. of Observations	1439				1439			

***1% Significance; **5% Significance; *10% Significance

6 Discussion

The paper aimed to shed light on driving forces from firms' local business and innovation environment as well as the influence of firms' capabilities and resources to perform innovation activities abroad. Moreover, this study went beyond the term 'R&D abroad' which is the state of the art in the literature of internationalisation of R&D. The contribution is a detailed analysis of four different innovation activities which firms plan to carry out abroad. Furthermore, the study not only distinguished the effects of the driving forces by the different types of R&D activities abroad but it also analysed the effects of firm capabilities, firm's competitive environment and home country location disadvantages as drivers for the planned innovation activities in developed and developing countries as well as in country groups with different level of technology knowledge.

It could be shown that firm capabilities and resources, in particular absorptive capacities and international experience, are most important for the decision to internationalise innovation activities. High innovation costs and the lack of qualified labour propel only the later stage innovation activities abroad while firms which are confronted with innovation obstacles are not seeking to overcome these constraints by innovating abroad. Companies performing R&D abroad are not driven by high competition either. The overall retrieved picture from the analysis demonstrated that firms rather use R&D activities abroad to continue strengthening their existing capabilities and business success than to escape intensive competition.

Firms which plan to innovate abroad have accumulated experience with foreign markets by exporting. Firms with the decision to innovate in developing countries like China in the near future have shown that 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 leading firms to innovate in countries with 'marginal' knowledge stocks. Again, it becomes obvious that firms which underlay price competition are not pushed

to developing countries to manufacture innovative goods or to carry out other innovation activities in Asian and in marginalised countries.

The results indicate that firms wishing to internationalise their R&D activities should have developed absorptive capacities and international experience. If the choice of location is a country belonging to the group of countries with lower developed knowledge levels or Asian countries additional cultural competence should be gathered by engaging in partnerships with international innovation partners. Policy implications can be directed to foster international innovation projects for firms to make international innovation experience or generally to set incentives to perform R&D on a continuous base and overcome innovation disadvantages at the home location. Furthermore, it could be shown that the trend to move innovative capacities to emerging regions can be blocked by legal innovation regulation.

References

- Acs, Z.J., Morck, R., Shaver, M.J., Yeung, B. (1997), The Internationalization of Small and Medium-Sized Enterprises: A Policy Perspective, *Small Business Economics*, 9, 7-20.
- Agarwal, S.P., Gupta, A., Dayal, R. (2007), Technology transfer perspectives in globalising India (drugs and pharmaceutical and biotechnology), *Journal of Technology Transfer*, 32, 397-423
- Alcácer, J., Chung, W. (2007), Location Strategies and Knowledge Spillovers, *Management Science*, 53(5), 760-776.
- Alcácer, J., Chung, W. (2002), Knowledge Seeking and Location Choice of Foreign Direct Investment in the United States, *Management Science*, 48 (12), 1534-1554.
- Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P. (2005), Competition and innovation: an inverted-U relationship, *The Quarterly Journal of Economics*, 701-728.
- Almeida, P. (1996), Knowledge Sourcing by foreign multinationals: patent citation analysis in the U.S. semiconductor industry, *Strategic Management Journal*, 17, 155-165.
- Ambos, B. (2005), Foreign direct investment in industrial research and development: A study of German MNC, *Research Policy*, 34(4), 395-410.
- Audretsch, D.B., Feldman, M.P. (1996), R&D Spillovers and the Geography of Innovation and Production, *American Economic Review*, 86 (3), 630-640.
- Boutellier, R., Gassman, O., von Zedtwitz, M. (2000), *Managing Global Innovation: Uncovering the Secrets of Future Competitiveness*, Berlin.
- Brockhoff, K. (1998), *Internationalization of Research and Development*, Berlin, Heidelberg.
- Cantwell, J., Piscitello, L. (2005), Recent Location of Foreign-Owned Research and Development Activities by Large Multinational Corporations in the European Regions: The Role of Spillovers and Externalities, *Regional Studies*, 39, 1-16.
- Cassiman, B., Veugelers, R. (2002), R and D Cooperation and Spillovers: Some Empirical Evidence from Belgium, *American Economic Review*, 92, 1169-1184.
- Castellacci, F., Archibugi, D. (2008), The technology clubs: The distribution of knowledge across nations, *Research Policy*, 37(10), 1659-1673.
- Chesnais, F. (1992), National Systems of Innovation, Foreign Direct Investment and the Operations of Multinational Enterprises, in B.A. Lundvall (ed.), *National Systems of Innovation - Towards a Theory of Innovation and Interactive Learning*, London, 265-295.

- Coe, D.T., Helpman, E. (1995), International R&D Spillovers, *European Economic Review*, 39, 859-887.
- Cohen, W.M., Levinthal, D.A. (1989), Innovation and Learning: The Two Faces of R&D, *The Economic Journal*, 99, 569-596.
- Cohen, W.M., Levinthal, D.A. (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, 35, 128-152.
- Dodgson, M. (1993), *Technological Collaboration in Industry: Strategy, Policy and Internationalisation in Innovation*, London.
- Dodgson, M. (2000), *The Management of Technological Innovation: An International and Strategic Approach*, Oxford University Press, Oxford.
- Dunning, J.H. (1981), *International production and the multinational enterprise*, Allen & Unwin, London.
- Dunning, J.H. (1994), Multinational Enterprises and the Globalization of Innovatory Capacity, *Research Policy*, 23, 67-88.
- Dunning, J.H., Narula, R. (1995), The R&D Activities of Foreign Firms in the United States, *International Studies of Management & Organization*, 25, 39-74.
- Eden, L., Miller, S.T. (2004), Distance matters: Liabilities of foreignness, Institutional distance and ownership strategy, *Bush School working Paper 404*, Texas A&M University.
- EIU (2004), *Scattering the seeds of invention: The Globalisation of R&D*, The Economist Intelligence Unit.
- Erken, Gilsing (2005), Relocation of R&D—a Dutch perspective, *Technovation*, 25 (10), 1079-1092.
- Frost, T.S. (2001), The geographic sources of foreign subsidiaries' innovations, *Strategic Management Journal*, 22 (2), 101-124.
- Gassmann, O., Han, Z. (2004), Motivations and Barriers of foreign R&D activities in China, *R&D Management*, 34 (4), 423-437.
- Gerybadze, A., Reger, G. (1999), Globalization of R&D: recent changes in the management of innovation in transnational corporations, *Research Policy*, 28, 251-274.
- Ghoshal, S., Bartlett, C.A. (1988), Creation, Adoption, and Diffusion of Innovations by Subsidiaries of Multinational Corporations, *Journal of International Business Studies*, 19, 365-388.
- Granstrand, O., Hakanson, L., Sjölander, S. (1993), Internationalization of R&D - a Survey of Some Recent Research, *Research Policy*, 22, 413-430.
- Granstrand, O. (1999), Internationalization of corporate R&D: a study of Japanese and Swedish corporations. *Research Policy*, 28(2-3), 275-302.
- Grant, R.M. (1996), Toward a knowledge –based theory of the firm, *Strategic Management Journal*, 17, 109-122.

- Guellec, D., Van Pottelsberghe de la Potterie, B. (2001), The internationalisation of technology analysed with patent data, *Research Policy*, 30, 1253-1266.
- Gupta, A.K., Govindarajan, V. (2000), Knowledge flows within multinational corporations, *Strategic Management Journal*, 21, 473-496.
- Haagedoorn, J. (1996), Trends and patterns in strategic technology partnering since the early seventies, *Review of Industrial Organization*, 11, 601-616.
- Haagedoorn, J. (2002), Inter-firm R&D partnerships: an overview of major trends and patterns since 1960, *Research Policy*, 31, 477.
- Hakanson, L., Nobel, R. (1993), Foreign Research and Development in Swedish Multinationals, *Research Policy*, 22, 373.
- Harvey, M., Novicevic, M.M. (2000), Staffing Global Marketing Positions: What We Don't Know Can Make a Difference, *Journal of World Business*, 35, 80-94.
- Ito, B., Wakasugi, R. (2007), What Factors Determine the Mode of Overseas R&D by Multinationals? Empirical Evidence, *Research Policy*, 36, 1275-1287.
- Jaffe, A. B., Trajtenberg, M., Henderson, R. (1993), Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, *The Quarterly Journal of Economics*, 108(3), 577-598.
- King, G., Zeng, L. (2001), Explaining Rare Events in International Relations, *International Organization*, 55 (3), 693-715.
- Kinkel, S., Lay, G., Maloca S. (2007), Development, motives and employment effects of manufacturing offshoring of German SMEs, *International Journal of Entrepreneurship and Small Business*, 4(3), 256 - 276.
- Kogut, B., Chang, S.J. (1991), Technological capabilities and Japanese foreign direct investment in the United States, *Review of Economics & Statistics*, 73 (3), 401-414.
- Kuemmerle, W. (1997), Building Effective R&D Capabilities Abroad, *Harvard Business Review*, 75, 61-70.
- Kuemmerle, W. (1999), The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation, *Journal of International Business Studies*, 30 (1), 1-24.
- Kumar, N. (1996), Intellectual property protection, market orientation and location of overseas R&D activities by multinational enterprises, *World Development*, 24(4), 673-688.
- Lall, S. (1979), The International Allocation of Research Activity by US Multinationals, *Oxford Bulletin of Economics & Statistics*, 41(4), 313-331.
- Le Bas, C., Sierra, C. (2002), Location Versus Home Country Advantages in R&D Activities: Some Further Results on Multinationals' Locational Strategies, *Research Policy*, 31, 589-601.
- Liebeskind, J.P. (1996), Knowledge, Strategy, and the Theory of the Firm, *Strategic Management Journal*, 17, 93-107.

- Lichtenberg, F.R., van Pottelsberghe de la Potterie, B. (1998), International R & D Spillovers: A Comment, *European Economic Review*, 42, 1483-1491.
- Lundvall, B. (1992), *National Systems of Innovation: Towards a theory of Innovation and Learning*, Pinter, London and New York.
- MacGarvie, M. (2005), The Determinants of International Knowledge Diffusion as Measured by Patent Citations, *Economics Letters*, 87, 121-126.
- Mezias, J.M. (2002), Identifying Liabilities of Foreignness and Strategies to Minimize Their Effects: The Case of Labor Lawsuit Judgement in the United States, *Strategic Management Journal*, 23, 229-244.
- Narula, R., Zanfei, A. (2005), Globalization and Innovation. The Role of Multinational Enterprises, in Fagerberg, J., Mowery, D., Nelson, R.R. (eds.), *The Oxford Handbook of Innovation*, Oxford University Press, Oxford, 318-345.
- Nelson, R.R. (1993), *National Innovation Systems: A Comparative Analysis.*, Oxford University Press, Oxford.
- Nobel, R., Birkinshaw, J. (1998), Innovation in Multinational Corporations: Control and Communication Patterns in International R&D, *Strategic Management Journal*, 19, 479-496.
- Odagiri, H., Yasuda, H. (1996), The determinants of overseas R&D by Japanese firms: an empirical study at the industry and company levels, *Research Policy*, 25, 1059-1079.
- OECD (2007), *OECD Science, Technology and Industry Scoreboard 2007. Innovation and Performance in the Global Economy*, OECD, Paris.
- OECD (2008), *The Internationalisation of Business R&D. Evidence, Impacts and Implications*, OECD, Paris.
- Patel, P., Vega, M. (1999), Patterns of Internationalisation of Corporate Technology: Location vs. Home Country Advantages, *Research Policy*, 28, 145-155.
- Pearce, R.D. (1992), World Product Mandates and MNE Specialization, *Scandinavian International Business Review*, 1, 38-58.
- Pearce, R.D. (1999), Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs), *Research Policy*, 28, 157-178.
- Pearce, R., Papanastassiou, M. (1999), Overseas R&D and the Strategic Evolution of MNEs: Evidence from Laboratories in the UK, *Research Policy*, 28, 23-41.
- Peteraf, M.A.. (1993), The cornerstones of competitive advantage: A resourced based view, *Strategic Management Journal*, 14, 179-191.
- Polanyi, M. (1966), *The Tacit Dimension*, Routledge & Kegan, London.
- Porter, M.E. (1990), *The Competitive Advantage of Nations*, Free Press, New York.
- Rammer, C., Schmiele, A. (2008), *Schwerpunktbericht zur Innovationserhebung 2006.*, ZEW Dokumentation, Mannheim.

- Sachwald, F. (2008), Location choices within global innovation networks: the case of Europe., *The Journal of Technology Transfer*, 33(4), 364-378.
- Scherer, F. M. (1967), Market structure and the employment of scientists and engineers, *American Economic Review*, 56, 524-531.
- Schmoch, U. (2003), Service marks as novel innovation indicator, *Research Evaluation*, 12, 149-156.
- Schumpeter, J.A.. (1943), *Capitalism, Socialism and Democracy*, Allen and Unwin, London, (1976).
- Tang, J. (2006), Competition and innovation behaviour, *Research Policy*, 35(1), 68-82.
- Thursby, J., Thursby, M. (2006), *Here or There? A Survey of Factors in Multinational R&D Location - Report to the Government-University-Industry Research Roundtable.*, National Academies Press, Washington.
- UNCTAD ed. (2005), *World Investment Report 2005: Transnational Corporations and the Internationalisation of R&D*, New York and Geneva.
- UNCTAD ed. (2006), *World Investment Report 2006: FDI from Developing and Transition Economies: Implications for Development*, New York and Geneva.
- Veugelers, R. (1997), Internal R&D Expenditures and External Technology Sourcing, *Research Policy*, 26, 303-315.
- Veugelers, R., Cassiman, B. (2004), Foreign Subsidiaries as a Channel of International Technology Diffusion: Some Direct Firm Level Evidence from Belgium, *European Economic Review*, 48, 455-476.
- Veugelers, R., Dachs, B., Mahroum, S., Nones, B., Schibany, A., Falk, R. (2005), *Internationalisation of R&D: Trends, Issues and Implications for S&T Policies. A Review of the Literature. Proceedings of Background Report Presented at the Forum on the Internationalisation of R&D*, Brussels.
- Wernerfelt, B.(1984), A resource-based View of the Firm, *Strategic Management Journal*, 5, 171-180.
- World Bank (2007), *Unleashing India's innovation*, World Bank Publications, Washington.
- Zaheer, S. (1995), Overcoming the liability of foreignness, *Academy of Management Journal*, 38(2), 341.
- Zaheer, S., Mosakowski, E. (1997), The dynamics of the liability of foreignness: A global study of survival in financial services, *Strategic Management Journal*, 18(6), 439-463.
- Zedtwitz, von M., Gassmann, O. (1998), *Towards the Integrated R&D Network. International Conference on Management of Technology (IAMOT)*, Orlando.
- Zedtwitz, von M., Gassmann, O. (2002), Market versus technology drive in R&D internationalization: four different patterns of managing research and development, *Research Policy*, 31(4), 569-588.

Zedtwitz, von M. (2004), Managing Foreign R&D Labs in China, *R&D Management*, 34 (4), 439-452.

Zedtwitz, von M., Ikeda, T., Li, G., Carpenter, R., Hämäläinen (2007), Managing foreign R&D in China, *Research Technology Management*, 50 (3), 19-27.

Annex

Table 5: Descriptive results for dependent and explanatory variables

No.		Mean	SD	Min	Max
	China	0.049	0.215	0	1
	EastEU	0.068	0.252	0	1
	WestEU	0.052	0.222	0	1
	NA	0.027	0.162	0	1
	Advanced	0.058	0.234	0	1
	Followers	0.127	0.333	0	1
	Marginalized	0.060	0.237	0	1
	Planned Research Abroad	0.076	0.266	0	1
	Planned Design/ Conception Abroad	0.111	0.314	0	1
	Planned Manufacturing Abroad	0.159	0.366	0	1
	Planned New processes Abroad	0.096	0.294	0	1
	Planned Any innovation activity Abroad	0.239	0.426	0	1
1	Continuous Inhouse R&D	0.434	0.496	0	1
2	High skilled employees	0.239	0.253	0	1
3	Innovation coop. with intl. Partners	0.127	0.333	0	1
4	Export experience	0.581	0.494	0	1
5	Experienced usage of IPR	0.504	0.500	0	1
6	Financial Ressources	2.941	2.110	0	7
7	Technological advantage	0.346	0.476	0	1
8	Price competition	0.448	0.497	0	1
9	Unstable competitive environment	0.502	0.500	0	1
10	Competition from new competitors	0.444	0.497	0	1
11	High number of competitors	0.397	0.489	0	1
12	Lack of technological information	0.082	0.275	0	1
13	Lack of customer response	0.121	0.326	0	1
14	Lack of qualified labour	0.127	0.333	0	1
15	Lack of ext. sources of finance	0.170	0.376	0	1
16	High innovation costs	0.266	0.442	0	1
17	Lack of appropriate partners	0.078	0.269	0	1
18	Regulation as barrier for innovation	0.169	0.375	0	1
19	Firm size	4.187	2.002	-0.693	12.181
20	Firm age	2.679	0.863	-0.693	5.527
21	Firm located in East Germany	0.348	0.477	0	1
22	Manufacturing Industry dummy	0.041	0.199	0	1

Table 6: Correlation matrix of explanatory sample variables (by no., see table 5)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
1	1																						
2	0.201	1																					
3	0.354	0.193	1																				
4	0.324	-0.018	0.201	1																			
5	0.461	0.137	0.287	0.373	1																		
6	-0.028	-0.029	0.004	-0.037	-0.007	1																	
7	0.472	0.135	0.381	0.314	0.527	-0.036	1																
8	-0.150	-0.172	-0.115	-0.098	-0.145	-0.073	-0.087	1															
9	-0.064	-0.023	-0.080	0.045	-0.017	-0.010	-0.027	0.117	1														
10	-0.089	-0.092	-0.041	-0.057	-0.079	-0.006	-0.053	0.117	0.186	1													
11	-0.058	0.006	-0.005	-0.091	-0.058	0.058	-0.056	0.102	0.039	0.168	1												
12	0.053	0.043	0.042	0.050	0.059	-0.022	0.045	0.001	0.036	0.028	0.007	1											
13	0.086	0.063	0.068	0.002	0.043	0.023	0.050	-0.029	0.009	0.037	0.015	0.404	1										
14	0.069	-0.007	0.022	-0.004	0.025	0.048	0.025	-0.034	0.001	0.020	0.001	0.363	0.222	1									
15	0.101	0.112	0.056	0.026	0.072	-0.094	0.033	0.034	-0.037	0.011	-0.037	0.255	0.224	0.211	1								
16	0.084	0.081	0.034	0.029	0.033	-0.060	0.050	0.009	0.017	0.007	0.038	0.325	0.355	0.302	0.559	1							
17	0.049	0.051	0.049	0.000	0.026	-0.075	0.018	0.021	-0.010	0.005	-0.012	0.323	0.276	0.246	0.369	0.328	1						
18	0.076	0.046	0.078	-0.017	0.066	-0.029	0.073	0.004	0.023	0.031	0.006	0.281	0.335	0.286	0.370	0.460	0.295	1					
19	0.278	-0.221	0.295	0.200	0.246	0.043	0.355	0.033	-0.060	-0.069	0.010	-0.012	0.037	-0.008	-0.132	-0.051	-0.072	-0.006	1				
20	0.011	-0.153	-0.011	0.049	-0.044	-0.011	0.026	0.047	0.037	0.002	0.025	0.010	0.028	0.000	-0.070	-0.031	0.003	-0.049	0.268	1			
21	0.002	0.170	-0.072	-0.098	-0.084	-0.030	-0.105	0.066	0.026	0.019	0.010	-0.013	-0.022	-0.029	0.074	0.100	-0.002	0.062	-0.233	-0.271	1		
22	0.186	-0.005	0.353	0.133	0.189	0.074	0.240	-0.034	-0.022	-0.032	0.014	-0.031	0.014	-0.054	-0.071	-0.038	-0.013	-0.003	0.441	0.113	-0.143	1	