# Drivers and Effects of Internationalising Innovation by SMEs

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**Abstract**

This paper investigates the drivers and the effects of the internationalisation of innovation activities in SMEs based on a large data set of German firms covering the period 2002-2007. We look at different stages of the innovation process (R&D, design, production and sales of new products, and implementation of new processes) and explore the role of internal resources, home market competition and innovation-related location advantages for an SME's decision to engage in innovation activities abroad. By linking international innovation activities to firm growth in the home market we try to identify likely internationalisation effects at the firm level. The results show that export experience and experience in knowledge protection are highly important for international innovation activities of SMEs. Fierce home market competition turns out to be rather an obstacle than a driver. High innovation costs stimulate internationalisation of non-R&D innovation activities, and shortage of qualified labour expels production of new products. R&D activities abroad and exports of new products spur firm growth in the home market while there are no negative effects on home market growth from shifting production of new products abroad.

**Keywords:** Internationalisation of Innovation, Globalisation, SMEs, Effects of Innovation, Absorptive Capacities, Market Structure

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# 1 Introduction

Globalisation is radically reshaping the business environment for SMEs. First, globalisation tends to benefit large companies in particular. Scale advantages allow large companies to exploit new opportunities from globalisation earlier, faster and more comprehensively, expanding their access to new markets and resources, including knowledge. As a consequence, SMEs in industrialised countries are faced with increasing price and technology competition from large companies in their home markets. At the same time, enterprises from emerging economies start to enter these markets based on price advantages, and their expanding demand of resources increases input prices for many commodities, consequently increasing production costs in industrialised countries. Moreover global shifts in market dynamics tend to restrict growth opportunities of SMEs as long as they focus on their home market.

SMEs may respond to these challenges through various ways. One option is to use business opportunities outside their home markets more intensively and more broadly, i.e. to actively participate in the process of globalisation. Another option is to strengthen their innovative capabilities in order to avoid price competition and to differentiate their products from those of the new competitors from abroad. Combining both strategies, i.e. internationalisation of their innovation activities may be particularly beneficial to SMEs from industrialised countries. First, internationalising innovation will allow them 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. Secondly, 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. Thirdly, market success of new products not only depends on technological superiority or customer-tailored solutions, but also on price-efficiency. Utilising global locations for producing innovations, and upgrading existing production activities abroad by process innovation may both contribute to an improved innovation performance of SMEs.

Most of the empirical literature on internationalisation of innovation focuses on large companies (see Narula and Zanfei, 2005). Analyses of internationalising innovation in SMEs either rest on rather small samples (see Buckley, 1997; Weikl and Grotz, 1999) or focus on R&D (see Hollenstein, 2005). This paper attempts to enrich the empirical literature by employing a large data set on the internationalisation decisions of German SMEs from various sectors and by considering different types of innovation activities at foreign locations: R&D, product development, new process installation, sale of innovative products. Distinguishing different types of innovation activities is particularly important since internationalising innovation demands certain capabilities at the side of SMEs, including financial resources, organisational skills, capabilities to deal with unfamiliar business environments, absorbing external knowledge and

protecting own knowledge. The relevance of these capabilities will vary by type of activity.

A further novelty of this paper is to look at the consequences of internationalising innovation for an SME's home market activities. On the one hand, internationalisation may increase a firm's competitiveness and thus have positive impacts on home market activities. On the other hand, shifting innovative resources to foreign locations may undermine the innovative potential of home market activities and hurt home market performance, including a decrease in employment. The latter is often raised as a concern by innovation policy makers (see Rose 2006).

The paper explores three research questions:

(1) What is the role of home market competition and absorptive capacities for driving SMEs 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 innovation activities abroad affect growth of SMEs in their home country?

In the next section we provide the conceptual background of our analysis. Section 3 describes the data and the measurement of model variables. Section 4 presents our data base and discusses the measurement of model variables. The results of econometric analyses on the drivers of internationalisation of innovation in SMEs are presented in section 5 while the effects of innovation activities abroad on home market performance of SMEs will be discussed in section 6. Section 7 summarises the main findings and concludes with some policy implications.

## 2 Conceptual Background

Our research questions combine three strands of literature: drivers and barriers that affect internationalisation decisions of SMEs, determinants of internationalising innovation activities, and effects of innovation on firm performance. In this section, we summarise the main findings of these strands that are relevant to our analysis, derive a set of hypotheses and present the models to be tested econometrically.

### *Internationalisation of SMEs*

Internationalising innovation by SMEs is associated with a number of challenges. While many SMEs have acquired experience in internationalising 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). 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 in SMEs 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).

Empirical evidence reveals that SMEs are to a lesser degree internationalised than large firms, regardless of the mode of internationalisation (exports, foreign direct investment, alliances, equity in foreign firms etc.) that is considered (see Hollenstein, 2005; Coviello and McAuley, 1999; OECD, 1997). As a result, much research focussed on explaining the lower propensity of SMEs to engage in international activities. Several barriers to internationalisation specific to SMEs have been identified. The restricted access to financial resources is one of the most frequently mentioned constraints that SMEs face on their way to globalisation (Buckley, 1989). They are also faced with higher fixed costs of establishing foreign subsidiaries (Hymer, 1976), and the liability of foreignness is likely to be more pronounced for SMEs since they lack reputation. SMEs are particularly challenged by coping with an unfamiliar business environment in the host country such as political, cultural and economic differences as well as the distance the home base (Zaheer, 1995, Mezias, 2002).

In order to overcome these barriers, it has been proposed that SMEs follow a model of incremental internationalisation (Katsikeas and Lenidou, 1996; Pedersen and Petersen, 1998; Ellis and Pecotich, 2001). In this view, SMEs start with those internationalisation activities implying the lowest barriers (i.e. exporting goods) and accumulate experience used to develop other forms of international business such as alliances, sales branches, production, and R&D. This model has been challenged by the literature on so-called “born globals” (see Knight and Cavusgil; 2004, McDougall et al., 1994; Madsen et al., 2000; Fryges, 2004). In this view, SMEs follow an international business strategy and adopt a global focus from the very beginning, especially to take advantage of unique selling propositions they were able to obtain through innovation.

Research on internationalisation of SMEs is of course strongly influenced by theories on the multinational enterprise (MNE) and the determinants of foreign direct investment (FDI). A main approach is the “eclectic paradigm” or OLI model (Dunning and Lundan, 1998) which stresses 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.

### *Internationalisation of Innovation Activities*

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; Hollenstein, 2008). 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). Internationalisation of innovation is also a topic of research in regional science, emphasising the geographic pattern of R&D locations (see Florida, 1997; Frost, 2001; Cantwell and Piscitello, 2005; Verspagen and Schoenmakers, 2004). Another strand emphasis 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 large enterprises on the one hand, and on R&D and patenting as measures for innovative activity on the other.

A firm's decision to internationalise its innovation activities may be related to three motives (see Granstrand et al., 1993; Hollenstein, 2008): 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.

Depending on the motives for internationalising 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.

### *Effects of Innovation on Firm Performance*

The ultimate goal of innovative efforts is to improve firm performance, i.e. increase profitability and growth. Scope and size of performance enhancing effects of innovation at the level of the innovating firm depend on the type of innovative activity and the degree to which innovation outputs (new products, new processes) are successfully implemented and succeed the market (see Stoneman, 1983; Katsoulacos, 1984; Blechinger and Pfeiffer, 1999; Peters, 2008). In general, one would expect a positive effect of any successful innovation activity on firm performance. Distinguishing between product and process innovation is critical, however. Product innovations alter a firm's product portfolio and will typically lead to an upward shift of a firm's demand curve as a result of some new quality features of the innovative product that distinguishes it from the firm's old products. The effects of this shift on profitability and growth will depend on the degree of novelty compared to the products supplied to the market by other firms, the willingness to pay by potential customers (i.e. price elasticity of demand), and the reaction of a firm's competitors (see

Jaumandreu, 2003). In case product innovations are not new to the market and imitate new products of competitors, profitability effects are likely to be low while growth effects may be substantial if the imitation can successfully compete against the original innovation and gain market shares.

Process innovations typically allow for a more efficient production and reduce a firm's unit costs. Effects on profitability and growth will basically depend on two factors: First, a firm may either be the first in its market to achieve efficiency gains from this type of innovation or it may have adopted a new production technology which has been implemented by competitors before. Secondly, a firm may use productivity advantages to either lower the price and gain market shares (which will most likely spur growth) or increase its profit margin by accepting the current market price.

Whether improved competitiveness of innovations translates into higher profitability and/or higher growth (in terms of output and labour demand) largely depends on the market structure effects of innovations. In case innovators can successfully alter market structures towards a lower level of competition (i.e. push competitors out of the market) and gain a lower price elasticity for their innovative product, they may raise prises and decrease output, resulting in low or negative growth despite having gained market shares (see Peters, 2008; Smolny, 1998).

It is generally agreed in the literature that innovation activities associated with in-house R&D activities imply higher potentials for positive growth and profitability effects than innovation activities that focus on the adoption of ideas and technologies developed by others (see Brouwer et al., 1993). R&D by definition aims at generating new knowledge and new applications of technologies, which is likely to generate a certain degree of novelty. A particular driver for high performance effects are granted patents on innovations since these give innovators exclusive rights to commercialise a new technology for a certain period of time (see Griliches, 1995).

Firms with international innovation activities may experience different performance effects of innovations compared to firms with only domestic innovation activities. On the one hand, sourcing knowledge on a global scale, making use of comparative advantages of different locations and opening up world markets are likely to result in more effective innovation activities, a more efficient production and higher sales of new products. On the other hand, international innovation activities are likely to be associated with higher costs, higher uncertainty and higher failure rates since firms will have to deal with different environments they are often not familiar with, and carry higher transaction costs. What is more, obtaining market power through innovation will be much more difficult when acting in a larger number of national markets, especially when we look at SMEs. One may thus assume lower effects from international innovation activities on profitability but higher ones on growth since SMEs may be less able to transfer innovations in a situation of lower price elasticity and while pushing out competitors but may transfer higher competitiveness over to other firms allowing them to gain market shares and increasing the level of their economic activities.

# 3 Empirical Models

In this section, we summarise the hypotheses which will guide our empirical research and present the models to be tested empirically. For answering our research questions, we test two types of models: one on the determinants of an SME's decision to engage in innovation activities abroad, and one on the effects of international innovation activities on the home market performance of SMEs.

### *Internal and external drivers of internationalising innovation activities in SMEs*

For identifying the drivers of internationalisation of innovation in SMEs, we only consider firms that already undertake innovation activities in their home country. We assume that in order to engage in innovation activities abroad, an SME will have to gather experience in innovation in its home market. Through this assumption we prevent mixing up the decision to internationalise innovation activities with the one to start innovation activities at all.

We are particularly interested in three types of drivers of an SME's (*i*) decision to engage in international innovation activities (*II*): the internal resources a firm has developed in order to conduct innovation activities abroad (represented by a vector **IR**), the competitive environment a firm faces in its home market (represented by a vector **CE**), and the attractiveness of the domestic location for conducting innovation activities (**LA**). The internal resources variable is closely linked to the ownership and internalisation variables in traditional OLI models while the competitive environment and attractiveness variables capture some arguments of the location-specific variables. In addition, there will be some more variables influencing this decision, which are not the focus of our analysis and are comprised in a vector **CV** of control variables. Our basic model thus reads:

$$II_i = \alpha + \beta\, \mathbf{IR}_i + \chi\, \mathbf{CE}_i + \delta\, \mathbf{LA}_i + \phi\, \mathbf{CV}_i + \varepsilon_i \qquad (1)$$

with $\alpha$, $\beta$, $\chi$ and $\delta$ being parameter (vectors) to be estimated and $\varepsilon$ being a firm specific error term.

*Internal Resources*

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. An important stream of research has conceptualised these processes as a firm's absorptive capacity. Absorptive capacities are the "eyes and ears" of a company to reinforce, complement or refocus their knowledge base (Lane et al., 2006). Cohen and Levinthal (1989, 1990) argue that the capabilities to identify, evaluate and exploit external knowledge are developed while performing R&D activities internally. Internationalisation of innovation activities demands further in-house capabilities associated with organising complex processes, adapting to unfamiliar situations and establishing new organisational routines and practices in order to cope with differences

in culture and the distance to the firm's home base (Harvey and Novicevic 2000). A high skill level of employees will facilitate organisational adaptations. We thus assume that:

> *Internationalisation of innovation activities is facilitated by in-house R&D activities and a high level of skilled employees.*

When internationalising innovation, the protection of intellectual property (IP) becomes even more important than at domestic locations since firms may be faced with different perceptions of trust and IP ownership as well as less effective local institutions guaranteeing IP rights. Internationalising innovative firms particularly depend upon effective appropriability methods to protect their knowledge (Zaheer and Zaheer, 2006). Therefore we argue that:

> *SMEs that have developed effective protection methods for their IP are better prepared for international R&D and innovation activities and are therefore more likely to expand these activities abroad.*

Entering international business environments for innovation purposes is associated with a particularly high degree of uncertainty. Firms can reduce this uncertainty by first developing international experience in other business activities in order to get familiar with challenges of internationalisation. Selling products and services to foreign customers and entering into cooperation agreements with foreign partners may be two low-cost options to accumulate experience in internationalisation. By accessing partners in host countries through international cooperation, firms can advance their learning process and reduce mistakes (Lu and Beamish, 2001). We thus argue that:

> *International experience of SMEs via exports and international innovation cooperation enhances the decision to internationalise innovation activities.*

Investing in innovation activities abroad involves higher economic risk and will demand higher financial resources than other types of internationalisation. Liabilities of foreignness are likely to be reinforced when firms introduce innovative products onto foreign markets. While SMEs generally suffer from restricted access to external funding as a result of liabilities of smallness (Buckley, 1989), they often find it particularly difficult to fund innovative activities from external sources such as banks due to information asymmetries and a lack of collaterals (see Liesch and Knight, 1999). Sufficient internal financing sources will be a key for internationalising innovation. We hypothesise that:

> *SMEs with higher internal financial resources are more likely to internationalise innovation activities.*

*Competitive environment*

The home market environment is supposed to drive internationalisation of innovation activities of SMEs in two ways: On the one hand, increasing international competition will force SMEs to respond to globalisation by leveraging the location advantages of other countries ("market pressure response"). This will be particularly relevant in case SMEs experience increased competitive pressure in their home market, such as strong

price competition and entry of new competitors to 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 SMEs, 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 SMEs lack in their home country. Therefore we argue:

> *A high degree of competition propels the likelihood to undertake innovation activities abroad.*

On the other hand, SMEs may use access to foreign markets to exploit their competitive advantages outside their home market ("market opportunity strategy"). Having developed a strong home market position in terms of successfully serving a niche market or competing based on a technological advantage will clearly help to successfully enter other regional markets. Technological advantage here means to have an ownership advantage for new technologies which can further be capitalised abroad. Therefore we argue that:

> *SMEs with a niche market position or with a technological advantage are more likely to expand their innovation activities abroad.*

*Attractiveness of domestic location for innovation*

The attractiveness of the domestic location for conducting innovation relates to the working of those factor and product markets that are specifically relevant to innovation activities. 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 appropriate partners for collaborating in innovation projects may be an important dimension of a location's attractiveness for innovation. With respect to product markets, prices for a specific material input of innovation projects (such as specialised equipment of process technology) may play a role. What is more, 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 location advantages of other countries are higher, the greater the location disadvantages for innovation in an SME's home country. Obstacles to innovation in the home market will therefore act as a driving force for the internationalisation of innovation activities. Location disadvantages especially for innovative SMEs is a shortage of qualified personnel, high costs (Hollenstein, 2008), lack of potential cooperation partners and lack of markets for innovation. Therefore we assume that:

> *SMEs that are suffering from innovation-related location disadvantages in their home country are more likely to*

*internationalise their innovation activities to benefit from the location advantages of their host country.*

In section 4 we discuss how these home market characteristics are measured empirically.

A key feature of our research question is to separate between different types of innovative activities, assuming that the role of internal and external drivers will differ by these types. We distinguish five types:

(1) in-house research and development ("R&D")

(2) non-R&D based innovation activities such as design, conceptual, construction and other preparatory activities for innovation ("design/preparation")

(3) manufacture of new products or supply of new services ("new product implementation")

(4) implementing new process technology ("new process implementation")

(5) sale of new products or new services ("innovation sales")

We expect that high absorptive capacities and market pressure through strong price competition and new market entries will push SMEs to internationalise their innovation activities in R&D, the design/preparation and new process implementation, while a niche market position or technology monopoly may have stronger effects on new product implementation and innovation sales abroad. A high skill level and prior experience in international business activities is expected to spur internationalisation of all types of innovation activities.

Model (1) will be estimated for each of the five types of innovation activities abroad ($k$) separately:

$$II_{ik} = \alpha_k + \beta_k \mathbf{AC}_i + \chi_k \mathbf{CE}_i + \delta_k \mathbf{LA}_i + \phi_k \mathbf{CV}_i + \varepsilon_{ik} \qquad \text{for } k = \{1,...,5\} \qquad (1a)$$

When analysing internationalisation decisions of SMEs, one may either look at the actual pattern of a firm's international innovation activities, or at its most recent or currently planned decisions to newly establish or expand innovation activities abroad. While the actual innovation activities abroad can directly be observed by asking firms whether they have certain activities abroad at a particular point in time (or during a certain reference period), however the link between these activities and the internal and external drivers may be loose since the underlying decisions of the current internationalisation pattern may have taken place long time ago and may have referred to very different internal and external conditions than those observed today. Moreover, past innovation activity abroad may have reshaped the SME's internal resources as well as its home market position, resulting in an endogenous relationship between international innovation activities and internal and external drivers. Against this background we refrain from analysing the actual internationalisation pattern of SMEs but rather focus on currently planned innovation activities abroad (*$II$) which can both refer to newly established activities or to the expansion of already existing innovation

activities abroad. Model (1a) is thus transformed to the following version which serves as the base for empirical estimations:

$$*II_{ik} = \alpha_k + \beta_k \mathbf{AC}_i + \chi_k \mathbf{CE}_i + \delta_k \mathbf{CV}_i + \phi_k II_{ik} + \varepsilon_{ik} \qquad \text{for } k = \{1,...,5\} \qquad (1b)$$

### *Effects of international innovation activities on SMEs' home market growth*

The aim of the second model is to analyse whether firms with innovation activities abroad perform better (in terms of growth in economic activities) in their domestic location than firms with only domestic innovation activities or with no innovation activities. This analysis is strongly linked to the policy question whether internationalisation of SMEs is a sign of weakness - innovative resources are shifted abroad and undermine domestic activities, the latter may eventually be closed down on the whole - or a sign of strength insofar as internationalisation helping SMEs to gain access to new knowledge sources and sales potentials which positively impact their domestic activities.

For analysing this question, we use a simple version of an innovation-performance model. This model attempts to explain growth of domestic activities (*GR*) of an SME by three groups of variables: A firm's efficiency (**EF**) should capture growth effects that result from the particular organisation of business processes in a firm and the resulting (positive or negative) competitiveness effects. The magnitude of firm-specific efficiency effects on growth will depend on the market situation (**MS**) under which an SME operates. Innovation activities (**IA**) should finally represent the growth effects of introducing new products and new processes. Furthermore, we consider a set of control variables ($^{GR}\mathbf{CV}$).

What is important to note is that EF and IA enter as lagged variables (*t* indicating the time period) in order to separate likely retroactive effects of growth on efficiency and innovation activity. The basic performance model thus reads:

$$GR_{il,t} = \alpha_l + \beta_l \mathbf{EF}_{i,t-1} + \chi_l \mathbf{MS}_{i,t} + \delta_l \mathbf{IA}_{i,t-1} + \phi_l {}^{GR}\mathbf{CV}_{i,t} + \varepsilon_{il} \qquad \text{for } l = \{1,2\} \qquad (2a)$$

We consider two alternative dimensions of growth (*l*): employment and sales growth. Changes in the number of employees (at full time equivalent) are likely to cover more sustainable alterations in the level of a firm's economic activities since hiring and firing staff is - at least in the context of the country considered in our empirical analyses, Germany - associated with rather high fixed costs and is thus often done only in case of significant changes in the (expected) demand for a firm's product. The magnitude of a firm's labour demand will also depend on the firm's labour productivity, with highly efficient firms transferring growth in demand with a smaller increase in employment compared to less efficient firms. Changes in sales may reflect more short-term effects of demand changes on growth and may also be subject to some arbitrary effects, especially when looking at small firms, such as extraordinary large orders in a particular year or sudden decline in sales for example, because of the withdrawal of a key customer. We thus assume to derive more stable results from employment growth.

A firm's efficiency **EF** is measured by labour productivity related to the industry average. In case of uniform prices for inputs and outputs for all firms in a particular market, labour productivity differences ultimately reflect competitive advantages. Since input prices may vary among firms within the same market according to their specific production function, we control for the skill level of employees to capture demand for heterogeneous labour and capital intensity to capture differences in capital demand. Variables for capturing a firm's market position **MS** include change in demand for the products of firm *i*'s industry, the sales share of the most important product line as a proxy for growth effects of product diversity, the importance of customer-specific products to capture effects of monopolistic competition, and the length of the product cycle as a proxy for the dynamics of the market environment. Control variables **CV** include firm size, firm age as a proxy for market experience and likely higher growth effects of young firms due to suboptimal starting size (see Almus, 2002), and a set of industry dummies.

The key variable of interest is **IA**. Since growth effects of innovation are likely to differ by type of innovative activity, we decompose **IA** into the five types of innovation activities *k*. In order to identify whether firms with international innovation activities of type *k* perform better than those with only domestic ones, we split up each type of innovation activity in international (*II*) and domestic (*DI*). Firms with international innovation activities of type *k* may have only international activities or both domestic and international ones, though in practice almost all SMEs with a certain type of innovation activity abroad perform the same type of innovation activity at home. In order to capture internalisation effects on growth not related to innovation activities (*IN*), we add two further variables, one that measures non-innovation activities at a foreign location and another variable for export sales with old products. Model (2a) is thus specified in the following way:

$$GR_{il,t} = \alpha_l + \beta_l \mathbf{EF}_{i,t-1} + \chi_l \mathbf{MS}_{i,t} + \Sigma_k \delta_{kl} II_{ik} + \Sigma_k \gamma_{kl} DI_{ik,t-1} + \Sigma_m \eta_{ml} IN_{im,t-1} + \phi_l {}^{GR}\mathbf{CV}_{i,t} + \varepsilon_{il} \quad \text{for } l = \{1,2\} \tag{2b}$$

# 4 Data

### *The German Innovation Survey*

This study rests on data from the German Innovation Survey, which is the German contribution to the EU's Community Innovation Survey (CIS). While the German Innovation Survey fully complies with the methodological recommendations for CIS surveys and adopts the standard CIS questions, it goes beyond the CIS design in three important respects (see Janz et al., 2001, for a more detailed discussion). First, the German Innovation Survey is designed as a panel survey and is conducted every year. The panel was established in 1993 for conducting the first CIS. From this year on, the same gross sample of firms is surveyed. Every second year, the gross sample is

refreshed including firms that have entered to the market in order to compensate for panel mortality. The German Innovation Survey is conducted by the Centre for European Economic Research (ZEW) located in Mannheim, thus also known as Mannheim Innovation Panel (MIP). Secondly, the MIP contains a significantly larger number of questions compared to the harmonised CIS questionnaire, which allows for a much more in depth analysis of relations between firms' innovation activities, their market environment and their economic performance. Thirdly, the MIP has a somewhat broader sector and size coverage than the CIS standard, including firms with 5 to 9 employees and covering a larger set of service sectors.

This paper employs data from three survey waves of the MIP: 2005, 2006 and 2007. The 2005 wave contained, among others, a set of questions on the firms' market environment as well as several questions on items that relate to absorptive capacities and other internal resources of a firm which may be regarded relevant for engaging in innovation activities abroad. Variables of this wave refer to the year 2004 or to the period 2002-2004 (with respect to variables related to innovation activities). The 2006 wave included a detailed question on international innovation activities and represents the critical information for this study. Firms were asked to state whether they had performed, in the year 2005, innovation activities outside Germany for each of the five areas R&D, design/preparation, production of new products, implementation of new processes, sales of new products, and whether they were planning to take up or increase such activities in the years 2006 and 2007. For both the actual and the planned innovation activities abroad, the main countries of destination were given as free text. For activities in 2005, firms were also asked 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%). What is more, we also know whether firms had international business activities without any innovation-related activities, and we know whether they sold products abroad even old products, regardless of being innovative. By merging these two waves, we are able to link a firm's internal resources and its market environment in 2004 to its international innovation activities in 2005 and those planned for 2006 and 2007 (at the time of survey, which was in spring 2006).

The 2007 wave is used to analyse the likely growth effects of international innovation activities. The key variables from this survey are the change in the number of employees (corrected for part-time employees) and the change of sales between 2004 and 2006. Furthermore, we use information on a firm's market position in 2006 to control for growth effects emerging from market structure and the competitive position of the firm.

The gross sample of the MIP survey is a stratified random sample of enterprises with 5 or more employees in mining, manufacturing, energy and water supply and a large number of service sectors. The size of the gross sample varies between years of sample refreshment (these are the uneven years which are at the same time CIS surveys) and the other years. In CIS years, a larger sample size (33,110 in 2005, 29,985 in 2007; see table 1) is chosen in order to compensate for a lower response rate due to the much longer survey questionnaire (8 pages) compared to the other years (4 pages) and the

inclusion of new firms to the sample. The 2006 survey had a gross sample size of 20,752 firms. One should also note that the German Innovation Survey is voluntary, and there are a many other firm surveys in Germany beside the MIP that target the same firm population. As a result, firms are rather reluctant to participate in voluntary surveys, causing a low response rate for all of these surveys.

**Table 1: Survey Characteristics of MIP Waves 2005 to 2007**

| | 2005 | 2006 | 2007 |
|---|---|---|---|
| Gross sample (#) | 33,110 | 20,752 | 29,985 |
| Neutral losses (#) | 5,184 | 3,357 | 2,457 |
| Gross sample corrected (#) | 27,926 | 17,395 | 27,528 |
| Net sample (#) | 5,557 | 5,183 | 5,628 |
| Non-response survey (NRS) (#) | 4,237 | 4,244 | 4,631 |
| Response rate (% of corrected gross sample) | 19.9 | 29.8 | 20.4 |
| Response rate incl. non-response survey (%) | 35.1 | 54.2 | 37.3 |
| Net sample of SMEs (<500 employees) (#) | 4,667 | 4,223 | 4,697 |
| SME share in net sample (%) | 84.0 | 81.5 | 83.5 |
| Share of innovators in net sample (%) | 63.4 | 54.6 | 58.7 |
| Share of innovators in non-response survey (%) | 60.5 | 61.4 | 58.5 |
| Share of innovators in net sample + non-response survey (%) | 62.2 | 57.7 | 58.7 |

Source: ZEW

The net sample of valid answers was 5,557, 5,183 and 5,586 firms in 2005, 2006 and 2007, respectively. This equals a response rate of about 20% in 2005 and 2007 and 30% in 2006. Since a low response rate may cause a bias in the net sample with respect to key variables, a comprehensive non-response survey (NRS) is performed in each year. Out of non-responding firms, a stratified random sample is drawn and firms are contacted by telephone and questioned on a few key innovation variables (product and process innovations, R&D). The response rate of the NRS is between 85 and 90%, and the net size is well over 4,000. In most years, there are no significant differences in the key innovation variables between the net sample and the NRS. In 2005, the share of innovators was slightly higher in the net sample than in the NRS, while in 2006 the situation was the opposite. In 2007, both samples showed the same share of innovators. In order to correct for a potential bias in the net sample, weights are calculated for each firm which represent the firm's weight in the total population of innovating and non-innovation firms (see Rammer et al., 2005, for technical details on the weighting methods applied).

Most of the firms in the net sample belong to the group of SMEs, which are defined here - according to standard definition in German SME policy - as firms with less than 500 employees. In the 2005 wave, 84.0% of surveyed firms had less employees than the threshold, in 2006 their share was 81.5% and in 2007 83.5%.

Though the MIP is a panel survey, the group of firms surveyed each year is not identical since many firms refrain from participating in the survey each year. Still, the number of firms for which observations in two consecutive waves are available, is considerably large. Merging the 2005 and 2006 wave results in 3,357 firms (= 60.4%

of the net sample in 2005 and 64.8% of the net sample in 2006), the 2006 and 2007 merge produces 2,937 joint observations (= 56.7% of the sample in 2006 and 52.2 % of the net sample in 2007).

### *Measuring Model Variables*

The models (1b) and (2b) are measured for firms which have less than 500 employees and are not a subsidiary of a firm having its headquarters outside Germany, meaning that we analyse German-based SMEs only. Table 2 summarises the model variables and the indicators used to measure them. Almost all indicators are taken from the MIP surveys. Industry level data come from the German Federal Statistical Office.

The dependent variable of Model (1b) is measured as planned innovation activities abroad in the years 2006-2007 while all independent variables refer to 2004 or 2005 which ensures that the indicators for drivers of internationalisation are clearly exogenous. In addition to the five types of innovation activities abroad, we generate a further dependent variable for any type of innovation activity at a foreign location (i.e. either R&D, design/preparation, production of new products, implementing new process technology) which serves as a reference for interpreting the results of the individual types. In order to capture differences in the drivers for innovation-oriented and non-innovation-oriented internationalisation, we construct two variables on international activities outside the area of innovation: One variable captures planned uptake or expansion of production activities abroad which neither involve R&D, design of innovations, the production of new products nor the implementation of new process technology. Another variable measures planned uptake or increase in export activities based on only old products.

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 has 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. SMEs 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 concentration (number of main competitors) were all measured by a firm's own assessment with reference to the firm's main product market. 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).

## Table 2: Specification of Model Variables

| Model variable | | Indicator | Source |
|---|---|---|---|
| ***Dependent variables*** | | | |
| $*II_k$ | Planned international-isation 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 (R), design/preparation of innovations (D), production of new products (P), implementation of new processes (I), sales of new products (S); any of R, D, P or I (A)) | MIP06 |
| $*IN_j$ | Planned internalisation of only non-innovation activities of type *j* | 1 if a firm plans to take up or expand type *j* non-innovation activity outside Germany in 2006 or 2007 without planning to take up or expand innovation activities abroad; 0 otherwise (*j*: production of non-innovative products and without new process technology (P), sales of old products (S)) | MIP06 |
| $GR_l$ | Growth of a firm's economic activities of type *l* | Growth of economic activities between at locations in Germany between 2004 and 2006 (*l*: employment growth (E): ln(no. of FTE employees 2006) - ln(no. of FTE employees 2004); sales growth (S): ln(sales in 2006) - ln(sales in 2004)) | MIP07 |
| ***Explanatory variables of the model on drivers of internationalisation*** | | | |
| *IR* | *Internal Resources* | | |
| RDc | Continuous R&D | 1 if a firm conducted in-house R&D continuously in 2002-2004; 0 otherwise | MIP05 |
| RDo | Occasional R&D | 1 if a firm conducted in-house R&D occasionally in 2002-2004; 0 otherwise | MIP05 |
| $HSE_1$ | High skilled employees | No. of graduated employees to total number of employees in 2004 | MIP05 |
| COP | 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 |
| EXP | Export experience | 1 if a firm had any exports in 2002-2004; 0 otherwise | MIP05 |
| IPR | Experience in successfully protecting intellectual property | 1 of firm had used at least on 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 |
| FIN | Financial resources | 1 if a firm reported a profit margin ≥ 2% in 2003 and 2004; 0 otherwise[1)] | MIP05 |
| *CE* | *Competitive Environment* | | |
| PRC | 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 |
| ENT | 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 |
| CON | Concentration | 1 if a firm had less than 6 main competitors in 2004; 0 otherwise | MIP05 |
| TEC | 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 |
| $LA_1$ | *Location Attractiveness* | | |
| DEM | 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 |
| LAB | 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 |
| EXF | 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 |
| COS | High innovation costs | 1 if a firm stated that too high innovation costs was an important obstacle to innovation 2002-2004; 0 otherwise | MIP05 |

## Table 2: Specification of Model Variables

| | | | |
|---|---|---|---|
| PAR | 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 |
| REG | Regulation/red tape hampering innovation | 1 if a firm stated that regulation and long administrative procedures were an important obstacle to innovation 2002-2004; 0 otherwise | MIP05 |
| $CV_1$ | *Control Variables* | | |
| $SIZ_1$ | Size | ln(No. employees at FTE in 2004) | MIP05 |
| $AGE_1$ | Age | ln(Time between the year of market entry and 2005) | MIP05 |
| $EAS_1$ | East German location | 1 if a firm is located in East Germany in 2004; 0 otherwise | MIP05 |
| $IND_m$ | Industry affiliation | 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 |
| ***Explanatory variables of the model on effects of internationalisation*** | | | |
| *EF* | *Efficiency of the Firm* | | |
| RLP | Relative labour productivity | Total sales per employee (at FTE) in 2004 divided by the industry mean (3-digit NACE level) | MIP07, FSO |
| CLR | Capital-labour ratio | Total fixed assets per employee (at FTE) in 2005 | MIP07 |
| $HSE_2$ | High skilled employees | No. of graduated employees to number of employees in 2005 | MIP07 |
| *MS* | *Market Situation* | | |
| CDE | Change in demand in the home market | Change in total sales between 2004 and 2006 in the industry a firm belongs to (at NACE 3-digit level) | FSO |
| DIV | Product diversity | Sales share of most important product line in total sales in 2006 | MIP07 |
| CUS | Customer-specific products | 1 if a firms stated that supplying customer-specific products is an important feature in its main product market in 2006; 0 otherwise | MIP07 |
| PLC | Product life cycle | ln(length of product life cycle of most important product group in 2006) | MIP07 |
| *II* | *International Innovation Activities* | | |
| $II_k$ | Actual innovation activities of type *k* abroad | 1 if a firm had type *k* innovation activity outside Germany in 2005; 0 otherwise (*k*: R&D (R), design/preparation of innovations (D), production of new products (P), implementation of new processes (I), sales of new products (S)) | MIP06 |
| $DI_k$ | Only domestic innovation activities of type *k* | 1 if a firm conducted type *k* innovation activity only in Germany in 2005; 0 otherwise | MIP06 |
| $CV_2$ | *Control Variables* | | |
| $IN_j$ | Non-innovation related international activities | 1 if a firm had type *j* non-innovation activity outside Germany in 2005 but no innovation activity abroad; 0 otherwise (*j*: production of non-innovative products and without new process technology (P), sales of old products (S)) | MIP06 |
| $SIZ_2$ | Size | ln(No. employees at FTE in 2004) | MIP07 |
| $AGE_2$ | Age | ln(Time between the year of market entry and 2006) | MIP07 |
| $EAS_2$ | East German location | 1 if a firm is located in East Germany in 2005; 0 otherwise | MIP07 |
| $IND_n$ | Industry affiliation | 1 if a firm is affiliated to industry *n* (*n*: 25 sectors, aggregated 2-digit level of NACE classification); 0 otherwise | MIP07 |

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 FIN to zero for these firms and added a dummy variable for capturing likely effects of these non-responding firms.

The existence of a technology advantage is measured by patent applications (in the absence of information on granted patents), for SMEs 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 seven 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, and lack of appropriate partners for innovation, legal innovation barriers, and resistance of employees against innovation projects. 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.

The dependent variable in model (2b) is the average annual rate of change in the number of employees (corrected for part-time workers) between 2004 and 2006. We choose this short time period for the following reasons: First, employment data on both years can be taken from the same survey (MIP 2007 wave) which increases the accuracy of the data compared to merging employee data from different survey waves. Secondly, a short time period is less subject to extraordinary (and difficult to control for) effects on employment change due to mergers, acquisitions and sales of parts of the enterprises than is the case when longer time periods are considered. Thirdly, the period 2004-2006 is characterised by an economic upswing of the German domestic market after a long period of stagnation (2001-2003) and slow growth (2004-2005). This upswing was accompanied by an accelerated growth of the world economy. Since we are particularly interested in the likely effects of international innovation activities on domestic performance of SMEs, this time period seems well suited since it provides favourable opportunities to either transfer growth potentials developed at foreign locations to the home market or to use the prosperous business climate for an even more ambitious internationalisation strategy.

The variables on a firm's market situation include the change of demand in a firm's home market which is measured as the change in total sales between 2004 and 2006 by firms located in Germany in the industry to which a firm belongs to. This variable includes export sales since we are interested in capturing the growth effect on a firm's activities in Germany that originates from demand dynamics. Increasing demand from outside Germany is a major source of such demand dynamics that has to be taken into account. Other indicators for a firm's market situation include the sales share of the most important product line, the significance of customer-specific products as a characteristic of competition in a firm's product market (measured on a 5-point Likert scale, using the two highest values for constructing a dummy variable) and the typical length of the product life cycle of the most important product group (as assessed by the firm). All these variables refer to the situation in 2006. Table A1 in the Annex shows

the descriptive statistics for all variables of both models, tables A2 and A3 report the correlation matrix for the variables of the two models.

# 5 International innovation activities in German SMEs

Before turning to our model estimation results, we present information on some main characteristics of the internationalisation of innovation activities in German SMEs based on weighted data (see table 3). First, one has to bear in mind that international business activities are rather rare among innovative SMEs. Out of all German firms (with 5 to 499 employees in manufacturing, mining, energy and water supply, knowledge-intensive services and a number of other service sectors) that had innovation activities at their domestic location in 2005, only 26.5% were engaged in any type of business activity abroad (regardless whether the foreign activity was related to innovation or not). Such activities may include production, supply of services, marketing, R&D, design etc. Surprisingly, this share does not vary much among sectors, indicating that among the (rather few) innovative SMEs in the other services, a significant part was able to internationalise its business. What is interesting to note is that the share of innovative SMEs planning to increase their business activities abroad in 2006/07 is of a similar magnitude as the share of already internationalised SMEs. While a rather small group of innovative SMEs plans to enter into international business for the first time (4.2% of all innovative SMEs), the vast majority (19.1% of innovative SMEs) plans to expand their existing international activities by either enlarging the scale of business at their present locations, or by establishing new business locations abroad. This means that most of SMEs engaged in international business activities in 2005 (26.5%) plan to further increase their engagement abroad.

Export activities are a much more widespread way of using business opportunities in other countries which is in line with the findings of other studies (see Hollenstein, 2005). 44.7% of all innovative SMEs had export sales in 2005, with a particularly high figure in manufacturing (60.7%) and still high ones in the services. Over one third of all innovative service SMEs were able to deliver services to customers outside Germany. This is clearly much higher than the average share of exporting service firms and emphasises the role of innovation for export success in services (see Ebling and Janz, 1999). 40% of innovative SMEs plan to increase export activity in 2006/07. 5.3% plan exports without having had one in 2005, while 34.7% were already exporting in 2005.

With respect to international innovation activities, just 5.2% of all innovative SMEs conducted R&D at foreign locations in 2005, while 10.4% are engaged in design and other preparatory work for developing and introducing innovations, and 9.9% produce new products or deliver new services abroad. Only 4.6% of all innovative SMEs have implemented process innovations at foreign locations in 2005. Differences between sector groups are rather small except for international R&D which is especially rare

among innovative SMEs in the other services, pointing to the fact that innovative SMEs show rather similar internationalisation behaviour in innovation regardless of the sector they belong to. We will come back to this issue when interpreting the model estimation results on sector effects. Significant sector differences can be observed with regard to the export of new products. 35.1% of all manufacturing SMEs with innovation activities sold new products to foreign customers, while only 18 to 19% did so in the service sectors. Comparing these figures with the share of innovative SMEs with any type of exports (new and old products) shows that there are a significant number of innovative SMEs selling only old products abroad, i.e. completely focussing innovative sales on their home market.

**Table 3: International innovation activities of innovative German SMEs 2005-2007**

**a. Share of innovative SMEs with international business or export activities**

| Sector | Business activities abroad[1)] | | | Export activities | | |
|---|---|---|---|---|---|---|
| | | planned increase 06/07 | | | planned increase 06/07 | |
| | 2005 | total | *new*[2)] | 2005 | total | *new*[2)] |
| Manufacturing | 26.8 | 26.2 | *5.9* | 60.7 | 53.7 | *5.8* |
| KIBS | 28.7 | 22.2 | *3.2* | 38.2 | 31.7 | *4.9* |
| Other Services | 22.7 | 21.6 | *3.7* | 35.5 | 36.5 | *5.2* |
| Total | 26.5 | 23.3 | *4.2* | 44.7 | 40.0 | *5.3* |

**b. Share of innovative SMEs with international innovation activities**

| Sector | R&D | | Design/ preparation | | Production of new products | | Implementat. of new processes | | Sales of new products | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | increase 06/07 | 2005 | increase 06/07 | 2005 | increase 06/07 | 2005 | increase 06/07 | 2005 | increase 06/07 |
| Manufacturing | 5.5 | 6.0 | 9.1 | 8.4 | 13.0 | 12.5 | 6.5 | 5.7 | 35.1 | 37.2 |
| KIBS | 7.1 | 7.8 | 10.4 | 9.0 | 8.1 | 3.7 | 3.0 | 2.5 | 18.2 | 19.8 |
| Other Services | 1.8 | 4.9 | 12.1 | 8.5 | 9.0 | 8.3 | 4.7 | 2.0 | 19.4 | 21.6 |
| Total | 5.2 | 6.4 | 10.4 | 8.7 | 9.9 | 7.7 | 4.6 | 3.4 | 23.9 | 25.8 |

1) Incl. production, supply of services, R&D, design as well as marketing, sales and other non-innovation activities.

2) Innovative SMEs that plan to engage in international business activities in 2006/07 but had no such international activities in 2005.

All figures refer to the population of innovative firms in Germany with 5 to 499 employees. Manufacturing: NACE 10-41; KIBS: knowledge-intensive services - NACE 64.3-67, 72-74.4, 92.1, 92.2; Other Services: NACE 51, 60-64.1, 74.5-74.8, 90.

Source: ZEW: Mannheim Innovation Panel, 2006 wave.

The share of innovative SMEs that plan to increase innovation activities abroad in 2006/07 does not differ much from the share of innovative SMEs with international innovation activities in 2005.[1] 8.7% plan to increase design and preparatory work for innovation, 7.7% want to increase the production of new products abroad, and 6.4%

[1] Note that the results based on weighted figures differ from those in the net sample (see table A2) due to weighting, differences in the sector coverage and differences in the sample base since the weighted results are based on all firm observations from the MIP 2006 wave, whereas the net sample for model estimations consists only of firms that participated in both the 2005 and 2006 waves.

intend to increase international R&D activities. What is interesting to note is that more innovative SMEs plan to increase R&D activities in 2006/07 than in 2005. The same is true with regard to export of new products. These results indicate relatively high dynamics in the internationalisation of innovation in the period under cover. A significantly improved business environment in Germany (with GDP growth rates of 3.0% in 2006 and 2.7% in 2007) coincided with an accelerated growth of the world economy. Under such an environment, SMEs may have been particularly optimistic about the opportunities of internationalisation.

Some critical information for interpreting the model estimation results is the geographic distribution of international innovation activities of German SMEs. While the notion of globalisation might suggest that internationalisation takes place on a global scale, the vast majority of German SMEs with innovation activities abroad conduct these in other European countries, particularly in Western Europe ( "old" EU plus EFTA countries). In 2005, 54.3% of SMEs' R&D activities outside Germany were located in Western European countries while for design and preparatory work for innovation this share was 46.3% (see table 4). For production of new products the share was 47.8% and for implementation of new processes it was 53.4%. Exports of innovative products show an even higher share of Western European locations of 55.0%. The second most important region in terms of foreign R&D is Asia, while for production of new products and implementation of new processes Eastern Europe holds position two. North America is a particularly important international location for sales of new products by innovative German SMEs.

**Table 4: Location of international innovation activities of German SMEs 2005-2007**

| | R&D | | Design/ preparation | | Production of new products | | Implementat. of new processes | | Sales of new products | |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | 2005 | increase 06/07 | 2005 | increase 06/07 | 2005 | increase 06/07 | 2005 | increase 06/07 | 2005 | increase 06/07 |
| Western Europe | 54.3 | 44.2 | 46.3 | 38.9 | 47.8 | 28.0 | 53.4 | 32.4 | 55.0 | 47.9 |
| Eastern Europe | 11.6 | 15.2 | 18.2 | 25.4 | 22.9 | 32.7 | 23.1 | 30.2 | 13.7 | 20.6 |
| North America | 13.4 | 21.6 | 18.7 | 12.2 | 8.6 | 7.2 | 5.9 | 10.9 | 14.7 | 13.6 |
| Asia | 19.3 | 16.1 | 10.2 | 18.4 | 18.8 | 24.2 | 15.0 | 20.4 | 8.0 | 10.6 |
| Rest of World* | 1.5 | 2.9 | 6.6 | 5.1 | 1.9 | 7.9 | 2.7 | 6.1 | 8.6 | 7.4 |

* Including "world-wide".

All figures refer to the population of innovative firms in Germany with 5 to 499 employees in manufacturing, knowledge-intensive services and other services.

Source: ZEW: Mannheim Innovation Panel, 2006 wave.

Planned internationalisation of innovation activities shows a slightly different geographic pattern. Western Europe locations are likely to lose in significance, particularly as a production site for new products or a location of implementing new processes. Eastern Europe and Asia are almost equally attractive as locations to host additional innovation activities. With regard to R&D, Western Europe remains the most prominent foreign location, though Eastern Europe and North America are gaining in importance. A similar shift can be seen for design/preparation work for innovations, although North America shows a smaller share in planned compared to

actual activities while Asia receives increasing attention. The geographic pattern of planned increases in export activities is quite similar to the one of actual exports, with a planned shift from Western to Eastern Europe as the main change.

# 6 Drivers of Internationalising Innovation Activities

Model (1b) is estimated by means of Probit models with robust standard errors. Information from about 1,000 innovative SMEs in Germany (excluding firms that are subsidiaries of non-German based companies) entered into the model estimations. 27% of observations are from firms in knowledge-intensive services, 25% from medium-to-high and high-tech manufacturing, 17% from manufacturing of industrial intermediaries, 15% from manufacturing of consumer products, and 16% from other services. The estimation results (marginal effects) are shown in table 5 and indicate the impact of a change in the explanatory variable on a firm's probability to expand its innovation activities of type *k* abroad in 2006/2007. The model fit is quite satisfying, though varying by dependent variable. The variation in planned foreign R&D activity, implementation of new process technology abroad and sales of new products can be explained rather well with the model variables whereas the models on non-innovative production activities abroad, design and preparatory work for innovation at foreign locations, the production of new products abroad and the export of old products perform less well.

The single most important driver of internationalisation of innovation activities in SMEs is prior export experience (EXP). The positive effect of export experience is straightforward with regard to planned increases in exports of old and new products. The probability to export increases by 15% and 19%, respectively, in case an innovative SME also had exports in 2004. But also all other types of international activities, both innovative and non-innovative ones, are driven by export experience. This is particularly true for producing new products abroad and for engaging in design and preparatory work for innovations. This result supports the incremental view on internationalisation (see Pedersen and Petersen, 1998), i.e. firms enter foreign markets with low cost and low risk activities first, before establishing activities associated with higher investment and a higher probability to fail.

Among the other variables on a firm's internal resources, continuous R&D activities at home and experience in effectively protecting intellectual property facilitate internationalisation. In-house R&D at the domestic location ($RD_c$) is obviously important for engaging in R&D abroad. The effect is considerable and leads to a 4.4% higher probability to increase R&D activities at foreign locations, compared to a mean of 5.6%. Domestic R&D also drives exports of new products and non-innovative production abroad, but has no significant effect on other types of international innovation activities. Experience in IP protection is important when a firm plans to engage in R&D, design/preparation of innovations and the production of new products at foreign locations, and it also facilitates the export of new products.

## Table 5: Drivers of Internationalising Innovation Activities in German SMEs: Marginal Effects of Probit Models

| Variable | $*II_A$ any type of inno-vation | | $*II_R$ R&D | | $*II_D$ design etc. | | $*II_P$ new products | | $*II_I$ new pro-cesses | | $*II_S$ sales of new products | | $*IN_P$ non-in-novation activity | | $*IN_S$ sales of old products | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Internal Ressources* | | | | | | | | | | | | | | | | |
| Continuous inhouse R&D | 0.077 | ** | 0.044 | *** | 0.026 | | -0.005 | | 0.014 | | 0.189 | *** | 0.053 | ** | 0.000 | |
| Occasional inhouse R&D | 0.040 | | 0.027 | | 0.011 | | 0.006 | | 0.012 | | 0.144 | *** | 0.060 | ** | 0.003 | |
| High skilled employees | 0.036 | | 0.027 | * | 0.000 | | 0.024 | | -0.038 | ** | 0.133 | * | 0.014 | | -0.003 | |
| Innovation cooperat. w. intl. partners | 0.031 | | 0.009 | | -0.002 | | 0.027 | | 0.009 | | 0.155 | *** | -0.008 | | -0.035 | |
| Export experience | 0.145 | *** | 0.021 | ** | 0.074 | *** | 0.094 | *** | 0.036 | *** | 0.192 | *** | 0.044 | ** | 0.147 | *** |
| Experienced usage of IPR | 0.062 | ** | 0.018 | * | 0.030 | | 0.051 | ** | 0.018 | * | 0.080 | ** | -0.003 | | 0.018 | |
| Profit margin >2% in 2003 and 2004 | 0.016 | | 0.010 | | 0.003 | | 0.037 | * | -0.003 | | -0.031 | | -0.014 | | -0.012 | |
| *Competitive Environment* | | | | | | | | | | | | | | | | |
| Price competition dominating | -0.004 | * | 0.005 | | -0.013 | | -0.040 | ** | -0.011 | | -0.078 | ** | -0.027 | * | -0.023 | |
| High pressure from market entries | -0.002 | | 0.005 | | 0.017 | | 0.015 | | 0.014 | * | -0.052 | * | -0.039 | *** | 0.008 | |
| Low number of competitors | 0.019 | | 0.011 | | -0.005 | | 0.013 | | 0.019 | *** | 0.089 | *** | -0.013 | | -0.060 | *** |
| Technological advantage | 0.039 | | 0.029 | ** | 0.029 | | -0.001 | | 0.006 | | 0.080 | ** | -0.022 | | -0.025 | |
| *Locational Disadvantages at Home* | | | | | | | | | | | | | | | | |
| Lack of customer response | -0.031 | | 0.012 | | -0.052 | ** | -0.022 | | -0.009 | | -0.006 | | 0.030 | | -0.003 | |
| Lack of qualified labour | 0.076 | ** | -0.010 | | 0.016 | | 0.079 | *** | -0.008 | | 0.028 | | -0.027 | | -0.008 | |
| Lack of external sources of finance | -0.017 | | 0.017 | | -0.015 | | 0.034 | | -0.002 | | 0.043 | | 0.013 | | 0.038 | |
| High innovation costs | 0.089 | ** | -0.008 | | 0.046 | * | 0.053 | ** | 0.026 | ** | 0.004 | | -0.002 | | -0.010 | |
| Lack of appropriate partners | 0.058 | | 0.013 | | 0.046 | | 0.011 | | 0.024 | | -0.009 | | 0.008 | | 0.008 | |
| Regulation as barrier tto innovation | -0.043 | | 0.005 | | 0.010 | | -0.032 | | 0.003 | | -0.030 | | 0.005 | | 0.051 | * |
| *Control Variables* | | | | | | | | | | | | | | | | |
| Firm size | -0.073 | * | -0.007 | ** | -0.010 | | 0.006 | | -0.024 | | 0.001 | | 0.008 | | 0.006 | |
| Firm size (squared) | 0.010 | * | | | | | | | 0.004 | ** | | | | | | |
| Firm age | -0.020 | | -0.001 | | -0.020 | * | -0.020 | | -0.008 | * | -0.022 | | -0.006 | | 0.004 | |
| Firm located in Eastern Germany | -0.056 | ** | -0.004 | | -0.032 | ** | -0.043 | ** | -0.019 | ** | -0.084 | *** | -0.031 | ** | 0.020 | |
| *Industry dummies* | | | | | | | | | | | | | | | | |
| Medium-tech/high-tech manufact. | 0.007 | | 0.041 | ** | 0.023 | | 0.008 | | -0.001 | | -0.010 | | 0.007 | | 0.006 | |
| Manufact. of intermediary products | -0.008 | | 0.005 | | -0.007 | | 0.005 | | -0.011 | | 0.006 | | -0.003 | | -0.008 | |
| Trade, construction, other services | -0.073 | | -0.011 | | -0.017 | | -0.013 | | -0.019 | | -0.109 | * | 0.000 | | 0.013 | |
| Transport, other business services | 0.079 | | 0.057 | | 0.023 | | 0.041 | | 0.014 | | -0.038 | | 0.033 | | -0.028 | |
| Knowledge-intensive services | -0.013 | | 0.002 | | 0.018 | | -0.056 | * | -0.014 | | -0.142 | *** | 0.033 | | 0.005 | |
| No. of Observations | 1,001 | | 1,011 | | 1,007 | | 1,009 | | 1,004 | | 1,022 | | 989 | | 1,010 | |
| Pseudo $R^2$ | 0.15 | | 0.25 | | 0.11 | | 0.16 | | 0.22 | | 0.25 | | 0.09 | | 0.131 | |
| Share of firms with activity *k* | 0.197 | | 0.056 | | 0.091 | | 0.120 | | 0.058 | | 0.303 | | 0.074 | | 0.109 | |

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

The share of highly skilled employees (HSE) is of minor relevance to driving foreign innovation activities of innovative SMEs. Only R&D and export of new products are affected significantly and positively by a large stock of human capital. This result is in line with the finding of Hollenstein (2005) on foreign activities of Swiss firms which show a strong positive impact of this variable on international R&D activities. The implementation of new process technology is negatively affected by this variable, however, indicating that this type of internationalising innovation is pursued by innovative firms that would rather focus on a less knowledge-based production.

Experience in international innovation co-operation (COP) does not affect decisions on increasing international innovation activities, except for exporting product innovations. This is in line with Hollenstein's (2005) findings on Swiss firms. Co-operation in innovation with foreign partners seems to be either an entry point to exploiting sales opportunities, or a substitute to innovation activities at foreign locations rather than a complement. The results are somewhat different, however, when looking at the actual internationalisation pattern (see table A3 in the Annex) rather than on planned increases in internationalisation. Co-operation with international partners has a strong positive impact on the probability that an SME conducts R&D abroad and a positive significant one on producing innovative products and implementing new process technologies at foreign locations. In case of R&D, this effect might be endogenous since a firm's presence at a foreign location with its own R&D obviously facilitates finding appropriate partners and establishing a co-operation in innovation.

Availability of financing sources, measured in terms of stable positive profit margin (FIN), affects a firm's decision to increase international innovation activities only with regard to producing new products abroad whereas increasing any other type of international activities is not affected by high profitability in the past. One should note, however, that the measure used is rather weak because it refers to a two year reference period only and it does not capture the availability of reserves built-up in earlier periods.

The competitive environment seems to play a very small role for a firm's decision to increase its innovation activities abroad. A fierce price competition in the home market (PRC) impedes the internationalisation of innovation activities, at least with regard to production of new products abroad, investments in new processes and sales of product innovation as well for the production of old products to foreign customers. Competitive pressure from market entries (ENT) is relevant for newly establishing or expanding new process technology investment at foreign locations but has a negative effect on non-innovation production as well as on exporting new products. A low number of competitors (CON) in the home market is positively associated with increasing exports of new products and negatively with increasing sales of old products to customers abroad. SMEs with a technology advantage that may result from owning patents or trade marks (in case of service firms) (PAT) are more likely to increase international R&D and show a higher propensity to export innovations. All these findings suggest that innovative SMEs tend to use a strong position in their home market in terms of absence of fierce price competition, a low threat by market entrants,

a low number of direct competitors and a technology advantage - which all together may characterise an innovation-based niche market position - to expand their innovation activities towards countries. Internationalisation of German SMEs thus seems to be rather a way to exploit opportunities from globalisation than to respond to threats from intensified competition.

The (dis)attractiveness of Germany as a location for innovation activities has some effect on internationalisation decisions. High innovation costs stimulate SMEs to establish non-R&D innovation activities abroad. The production of new products at foreign locations is also strongly affected by a lack of qualified personnel in Germany, while all other types of international innovation activities are not advanced by this obstacle. One may conclude that innovative SMEs faced with shortage in qualified labour try to maintain R&D and design/preparatory work at their domestic location and would rather shift production activities abroad. Finally, none of the other innovation obstacles - lack of demand for innovation, lack of external financing, lack of co-operation partners, regulation/red tape, in-house resistance - stimulate innovative SMEs to move outside Germany with their innovative efforts.

Among the control variables, size and age of an SME have little impact on internationalisation decisions. Considering all types of active innovation engagement at foreign locations, firms with 30 employees show the lowest propensity to increase their international activities, while very small firms and medium-sized firms are more likely to internationalise. This effect particularly comes from implementing new process technologies abroad. Interestingly, the probability to increase foreign R&D activities decreases by size. This may indicate a catching-up process among the very small firms, using the favourable environment for internationalisation in the period under cover to engage more broadly in international innovation activities, or to set up such activities for the first time.

Looking at the industry dummies shows that sector effects are small, indicating that internationalisation behaviour of *innovative* SMEs is quite similar across sectors, and sector differences in the internationalisation pattern of innovative activities primarily reflects sector differences in the propensity to innovate, rather than in the propensity to internationalise innovation.

# 7 Performance Effects of International Innovation Activities

Model (2b) is estimated by ordinary least square (OLS) regression models with robust standard errors. Model estimations are based on information from both innovative and non-innovative SMEs excluding firms that are subsidiaries of non-German based companies. A total of 1,703 observations with regard to employment growth and 1,650 with regard to sales growth with full information on all independent variables are available, covering a broad range of manufacturing and service sectors. In both models, we only consider firms with positive employment and sales in both years, i.e. we omit firms started their business after 2004 and those which closed down

prior in 2006. The estimation results are shown in table 6. The model fit shows that short term growth of SMEs can be explained by the model variables only to a small extent, especially in terms of changes in sales.

**Table 6: Effects of Internationalising Innovation Activities on Domestic Growth of German SMEs: Results of OLS Regressions**

| | *Growth in employees* | | *Growth in sales* | |
|---|---|---|---|---|
| | *Coefficient* | *t-value* | *Coefficient* | *t-value* |
| *Efficiency of the Firm* | | | | |
| Relative Labour Productivity (RLP) | 0.040 | 3.74 *** | -0.019 | -2.28 ** |
| Capital labour ratio (CLR) | -0.010 | -3.55 *** | 0.000 | -0.05 |
| High skilled employees (HSE) | -0.001 | -0.05 | 0.043 | 0.89 |
| *Market Situation* | | | | |
| Change in demand in home market (CDE) | 0.055 | 0.92 | 0.307 | 4.35 *** |
| Product Diversity (DIV) | -0.021 | -0.77 | -0.039 | -1.05 |
| Customer specific products (CUS) | 0.024 | 1.86 * | 0.025 | 1.44 |
| Product cycle length (PCL) | 0.012 | 1.70 * | 0.007 | 0.77 |
| *Innovation Activity* | | | | |
| Actual R&D activities abroad ($II_R$) | 0.095 | 2.51 ** | 0.050 | 1.03 |
| Only domestic R&D ($DI_R$) | 0.042 | 2.05 ** | 0.034 | 1.38 |
| Actual design activities abroad ($II_D$) | 0.008 | 0.21 | -0.048 | -1.14 |
| Only domestic design ($DI_D$) | 0.001 | 0.02 | -0.010 | -0.36 |
| Actual production activities abroad ($II_P$) | -0.048 | -1.45 | -0.043 | -1.05 |
| Only domestic production ($DI_P$) | -0.027 | -1.11 | -0.029 | -0.97 |
| Actual new processes abroad ($II_I$) | 0.016 | 0.39 | 0.040 | 0.95 |
| Only domestic new processes ($DI_I$) | 0.035 | 1.93 * | 0.018 | 0.74 |
| Actual innovation sales abroad ($II_S$) | 0.051 | 1.99 ** | 0.100 | 3.09 *** |
| Only domestic innovation sales ($DI_S$) | 0.007 | 0.25 | 0.042 | 1.13 |
| *Control Variables* | | | | |
| Non-innovative production abroad ($IN_P$) | 0.003 | 0.12 | 0.020 | 0.54 |
| Non-innovation sales abroad ($IN_S$) | 0.030 | 1.72 * | 0.044 | 1.93 * |
| Firm size (SIZ)[a)] | -0.012 | -1.78 * | -0.001 | -0.11 |
| Firm age (AGE) | -0.021 | -2.77 *** | -0.036 | -3.70 *** |
| Firm located in East Germany (EAS) | 0.011 | 0.81 | 0.013 | 0.67 |
| No. of Observations | 1,703 | | 1,650 | |
| $R^2$ | 0.089 | | 0.070 | |

a) ln(no. of employees at FTE in 2004) for employment growth model; ln(sales in 2004) for sales growth model.

Source: ZEW: Mannheim Innovation Panel, 2006 and 2007 waves.

Among the firm efficiency, market situation and control variables, most are statistically significant and show the expected sign. No significant effect can be found for the share of high skilled employees and the degree of product differentiation. Change in demand within a firm's 3-digit industry (CDE) is an important driver for sales growth, but has no significant impact on employment growth. Capital intensive firms show a lower growth rate in terms of employees. Age exerts the expected negative effect, indicating that young firms grow faster, which is in line with the literature on sub-optimal founding size of firms (see Almus, 2002). Smaller firms show higher employment growth but no higher growth in sales. While high relative labour productivity (RLP) stimulates employment growth, it does decrease sales growth indicating that the efficiency advance of high-efficiency SMEs diminished during the economic upswing between 2004 and 2006 as low-efficiency firms were

able to catch up by increasing their sales more than their employment. The prevalence of customer-specific products and the length of the product cycle both show small positive impacts on employment growth but no impacts on sales growth.

Innovation variables interacted with internationalisation can explain some of the variance in firm employment growth, but little in terms of sales. With regard to employment growth, SMEs conducting in-house R&D in 2005 show a significantly higher growth. This effect is more than twice as high in case firms also conducted R&D abroad ($II_R$) compared to conducting R&D only at the domestic location ($DI_R$). The growth rate of firms with R&D abroad is 9.5 percentage points higher, for firms with only domestic R&D this effect is 4.2 percentage points. Secondly, export activities contribute to domestic employment growth of SMEs. The effect is significantly larger in case of exporting innovative products ($II_S$, +5.1 percentage points) compared to non-innovative ones ($DI_S$, +3.0 percentage points). To evaluate the level of growth effects, one should know that the average size of an SME in 2004 was 70, the average growth rate was 1.1%, and the standard deviation was 26.6%.

A critical result is that neither the production of new products at foreign locations ($II_P$) nor the implementation of new processes at firm locations abroad ($II_I$) exerts negative growth effects at the domestic locations. The same holds true for non-innovative business activities at foreign locations ($IN_P$). Internationalisation of German SMEs is thus not dominated by shifting activities from domestic to foreign locations in order to exploit production advantages there, but is rather a strategy to leverage globalisation opportunities for obtaining a net growth in a firm's global activities, without hurting the level of economic activities in the home country. As pointed out previously, one should note, however, that the period that was covered was characterised by a quite favourable economic environment in Germany. Effects may be different in case of a more difficult business climate.

Interestingly, producing new products at domestic locations ($DI_P$) has no statistically significant impact on employment growth at home market locations, while process innovations at the domestic location ($DI_I$) do contribute to employment growth by 3.6 percentage points. In the literature, both theoretical models and empirical findings suggest stronger performance effects from product than from process innovations (see Peters, 2008), though some authors found stronger process than product innovation effects (see Greenan and Guellec, 2000). We interpret our results in the way that positive product innovation effects are covered by R&D activities and exports rather than by the mere fact that a firm produced new products. R&D activities indicate a high degree of novelty of innovations. Their positive effect is in line with empirical findings that market novelties affect especially firm performance much more than new products that imitate products of competitors (see Falk, 1999; Peters, 2008).

Sales growth is primarily stimulated by exploiting global demand. SMEs with export sales experience significantly higher growth in sales. Innovation clearly can help leveraging these opportunities as exports of innovative products contribute much more to sales growth (+10 percentage points) than exports of old products (+4.4 percentage points).

# 8 Conclusion

This paper investigated the drivers for international innovation activities of SMEs from Germany and analysed the effects of these activities on a firm's performance at its domestic location. A particular feature of the paper is to distinguish various types of international innovation activities and to consider the role of the home market environment, both in terms of competition and conditions for innovation. By linking innovation activities abroad with firm growth at its domestic location we are able to identify the effect of international innovation activities on a firm's development in its home market.

Our analysis is closely related to a policy question that came up with the process of globalisation, that is whether shifting innovative resources abroad is beneficial or harmful to the firms' home market activities. On the one hand, policy might regard internationalisation of innovation in SMEs as a sign of weakness which may undermine domestic activities and could lead to a loss in jobs and value added in the home market. Against this background, policy might feel the need to respond to internationalisation by preventing SMEs from going abroad, for example, by increasing the attractiveness of domestic locations for innovation, including offering subsidies. On the other hand, internationalisation of innovation might be perceived as a sign of strength since internationalisation can help SMEs to gain access to new knowledge sources and sales potentials which may positively impact their domestic activities. From such a viewpoint, policy might try to encourage SMEs to intensify their internationalisation activities, including public support for internationalising.

Based on a large, representative data set of German SMEs that covers their actual innovation activities at foreign locations in the year 2005 as well as the planned increase in innovation abroad in 2006 and 2007, we found that internationalising innovation is a sign of strength rather than of weakness. SMEs with innovation activities in Germany that go for international innovation tend to be stronger than those that innovate at their German locations only: They more often conduct in-house R&D on a continuous base, they have accumulated internationalisation knowledge in the past through successfully selling their products to customers abroad, and they have learned to protect their intellectual property effectively. What is more, German SMEs do not seem to be pushed to internationalisation by increased competition, but rather go abroad with innovative activities when they have an innovation-based niche market position, i.e. a low number of competitors, little threat from potential market entrants and a unique technology advantage. This is particularly true when it comes to exporting innovative products in other countries. Nevertheless, unfavourable conditions for innovative activity in Germany do have an effect of SMEs' decisions to engage in innovation at foreign locations. First, high innovation costs are an important factor for establishing or expanding non-R&D innovation activities at foreign locations. Internationalisation of innovation is also driven by a cost dimension. Secondly, a shortage in qualified personnel has a strong impact on increasing

production activities for new products abroad while there is no effect on any other international innovation activity.

At the same time, internationalising innovation activities is beneficial to an SME's economic performance in its home country. R&D activities abroad as well as selling innovative products to foreign customers significantly increase employment growth at domestic locations. This indicates that innovative SMEs are able to profit from knowledge transfer from their foreign locations for their domestic activities. They also benefit from exploiting new business opportunities from globalisation by geographically expanding the market for their innovative products. There are no negative effects from internationalising innovation on home market performance. This is even true for producing innovative products at foreign locations or by increasing the efficiency of foreign production through process innovations. Any likely negative impact of a potential shift in resources from domestic to foreign locations seems to be compensated by corresponding increases in a firm's competitiveness.

Our findings have some implications for policy. They show that internationalisation of innovative SMEs is no threat and thus does not demand fending policy reaction. Innovative SMEs should be encouraged to make more use of internationalisation opportunities, including establishing R&D activities abroad. There is one area, however, where shortcomings in Germany may have negative effects on innovation activities at home. A shortage in qualified labour puts pressure on SMEs to shift production of innovative products abroad. Though we could not identify a statistically significant negative effect of this shift on home market performance in the short run, this still may underpin the innovative potential of an SME in the long run, especially when ties to R&D and design as well as interaction with users, suppliers and the broader innovation environment is weakened.

In this paper we did not differentiate by geographic destination of international innovation activities. This might be especially interesting and relevant in the analysis of R&D abroad since factor endowments of host countries constitute the attractiveness of a country as a foreign R&D hub. The attractiveness of a host country as a pull factor for foreign corporate innovation activities can be assumed to be as relevant for the decision to offshore R&D as the location disadvantages as push factor of the home country. Moreover, to fully understand the internationalization process of corporate innovation activities the sequence of internationalizing innovation should be analyzed. Furthermore, based on a recent study on the back sourcing of production processes (Kinkel and Spomenka, 2008), i.e. relocating international production to the home base of the firms, it seems interesting to observe whether there is a similar trend in international innovation as well. These questions need to be researched further and answered for both groups of firms, SMEs and large enterprises.

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# Annex

**Table A1a: Descriptive Statistics of Model 1 Variables**

| Variable (Variable abbreviation) | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Planned internationalisation of R&D ($II_R$) | 0.197 | 0.056 | 0.23 | 0 |
| Planned internationalisation of Design/ Preparation ($II_D$) | 0.056 | 0.091 | 0.29 | 0 |
| Planned internationalisation of Production ($II_P$) | 0.091 | 0.120 | 0.33 | 0 |
| Planned internationalisation of new Processes ($II_I$) | 0.120 | 0.058 | 0.23 | 0 |
| Planned internationalisation of sales ($II_S$) | 0.058 | 0.276 | 0.45 | 0 |
| Planned internationalisation of any innovation activity ($II_A$) | 0.276 | 0.197 | 0.40 | 0 |
| Planned internationalisation of production of old products ($IN_P$) | 0.074 | 0.074 | 0.26 | 0 |
| Planned internationalisation of sales of old products ($IN_S$) | 0.110 | 0.110 | 0.31 | 0 |
| Continuous Inhouse R&D (RDc) | 0.383 | 0.383 | 0.49 | 0 |
| Occasional Inhouse-R&D (RDo) | 0.210 | 0.210 | 0.41 | 0 |
| High skilled employees (HSE) | 0.250 | 0.250 | 0.27 | 0 |
| Innovation cooperation with intl. partners (COP) | 0.086 | 0.086 | 0.28 | 0 |
| Export experience (EXP) | 0.568 | 0.568 | 0.50 | 0 |
| Experienced usage of IPR (IPR) | 0.466 | 0.466 | 0.50 | 0 |
| Financial Ressources (FIN) | 0.476 | 0.476 | 0.50 | 0 |
| Price competition (PRC) | 0.449 | 0.449 | 0.50 | 0 |
| High competitive pressure (ENT) | 0.519 | 0.519 | 0.50 | 0 |
| Low number of competitors (CON) | 0.610 | 0.610 | 0.49 | 0 |
| Technological advantage (TEC) | 0.291 | 0.291 | 0.45 | 0 |
| Lack of customer response (DEM) | 0.114 | 0.114 | 0.32 | 0 |
| Lack of qualified labour (LAB) | 0.126 | 0.126 | 0.33 | 0 |
| Lack of external sources of finance (EXF) | 0.182 | 0.182 | 0.39 | 0 |
| High innovation costs (COS) | 0.266 | 0.266 | 0.44 | 0 |
| Lack of appropriate partners (PAR) | 0.078 | 0.078 | 0.27 | 0 |
| Regulation as a barrier of innovation (REG) | 0.166 | 0.166 | 0.37 | 0 |
| Firm size ($SIZ_1$) | 3.594 | 3.594 | 1.41 | -0.69 |
| Firm age ($AGE_1$) | 2.598 | 2.598 | 0.79 | -0.69 |
| Firm located in East Germany ($EAS_1$) | 0.396 | 0.396 | 0.49 | 0 |
| Medium-tech/high-tech manufacturing | 0.172 | 0.378 | 0 | 1 |
| Manufacturing of intermediary products | 0.257 | 0.437 | 0 | 1 |
| Trade, construction, other services | 0.075 | 0.264 | 0 | 1 |
| Transport, other business services | 0.075 | 0.264 | 0 | 1 |
| Knowledge-intensive services | 0.270 | 0.444 | 0 | 1 |

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

## Table A1b: Descriptive Statistics of Model 2 Variables

| Variable | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Employee Growth (EG) | 0.011 | 0.27 | -2.26 | 3.31 |
| Growth in Sales (SG) | 0.091 | 0.32 | -2.70 | 2.34 |
| Relative Labour Productivity (RLP) | 0.909 | 1.24 | 0 | 29.38 |
| Capital labour ratio (CLR) | 0.254 | 2.35 | 0 | 81.17 |
| High skilled employees (HSE) | 0.199 | 0.25 | 0 | 1 |
| Change in demand in home market (CDE) | 1.143 | 0.14 | 0.64 | 2.62 |
| Product Diversity (DIV) | 0.719 | 0.24 | 0 | 1 |
| Customer specific products (CUS) | 0.585 | 0.49 | 0 | 1 |
| Product cycle length (PCL) | 2.321 | 0.98 | 0 | 3.91 |
| Actual R&D activities abroad ($II_R$) | 0.036 | 0.19 | 0 | 1 |
| Only domestic R&D ($DI_R$) | 0.271 | 0.44 | 0 | 1 |
| Actual design activities abroad ($II_D$) | 0.049 | 0.22 | 0 | 1 |
| Only domestic design ($DI_D$) | 0.443 | 0.50 | 0 | 1 |
| Actual production activities abroad ($II_P$) | 0.064 | 0.24 | 0 | 1 |
| Only domestic production ($DI_P$) | 0.278 | 0.45 | 0 | 1 |
| Actual new processes abroad ($II_I$) | 0.028 | 0.17 | 0 | 1 |
| Only domestic new processes ($DI_I$) | 0.251 | 0.43 | 0 | 1 |
| Actual innovation sales abroad ($II_S$) | 0.175 | 0.38 | 0 | 1 |
| Only domestic innovation sales ($DI_S$) | 0.115 | 0.32 | 0 | 1 |
| Non-innovation production abroad ($IN_P$) | 0.029 | 0.17 | 0 | 1 |
| Non-innovation sales abroad ($IN_S$) | 0.268 | 0.44 | 0 | 1 |
| Firm size ($SIZ_2$) | 3.282 | 1.39 | -0.69 | 6.55 |
| Firm age ($AGE_2$) | 2.622 | 0.86 | -0.69 | 5.54 |
| Firm located in East Germany ($EAS_2$) | 0.403 | 0.49 | 0 | 1 |

Source: ZEW: Mannheim Innovation Panel, 2006 and 2007 waves.

**Table A2a: Correlation Matrix of Variables of Model 1**

| | $II_R$ | $II_D$ | $II_P$ | $II_I$ | $II_S$ | $II_A$ | $IN_P$ | $IN_S$ | RDc | RDo | HSE | COP | EXP | IPR | FIN | PRC | ENT | CON | TEC | DEM | LAB | EXF | COS | PAR | REG | $SIZ_1$ | $AGE_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $II_D$ | 0.41 | 1.00 | | | | | | | | | | | | | | | | | | | | | | | | | |
| $II_P$ | 0.30 | 0.42 | 1.00 | | | | | | | | | | | | | | | | | | | | | | | | |
| $II_I$ | 0.30 | 0.42 | 0.50 | 1.00 | | | | | | | | | | | | | | | | | | | | | | | |
| $II_S$ | 0.28 | 0.27 | 0.34 | 0.28 | 1.00 | | | | | | | | | | | | | | | | | | | | | | |
| $II_A$ | 0.49 | 0.67 | 0.77 | 0.55 | 0.38 | 1.00 | | | | | | | | | | | | | | | | | | | | | |
| $IN_P$ | -0.06 | -0.09 | -0.10 | -0.07 | 0.12 | -0.13 | 1.00 | | | | | | | | | | | | | | | | | | | | |
| $IN_S$ | -0.04 | -0.02 | -0.01 | -0.07 | -0.22 | -0.01 | 0.22 | 1.00 | | | | | | | | | | | | | | | | | | | |
| RDc | 0.21 | 0.11 | 0.10 | 0.11 | 0.32 | 0.19 | 0.08 | 0.08 | 1.00 | | | | | | | | | | | | | | | | | | |
| RDo | -0.06 | 0.01 | 0.04 | 0.01 | 0.02 | 0.00 | 0.05 | 0.03 | -0.40 | 1.00 | | | | | | | | | | | | | | | | | |
| HSE | 0.14 | 0.04 | -0.01 | -0.06 | 0.10 | 0.06 | 0.07 | 0.00 | 0.25 | -0.06 | 1.00 | | | | | | | | | | | | | | | | |
| COP | 0.19 | 0.09 | 0.09 | 0.07 | 0.26 | 0.16 | 0.04 | 0.01 | 0.32 | -0.09 | 0.25 | 1.00 | | | | | | | | | | | | | | | |
| EXP | 0.15 | 0.16 | 0.20 | 0.17 | 0.37 | 0.24 | 0.12 | 0.24 | 0.31 | 0.09 | -0.02 | 0.18 | 1.00 | | | | | | | | | | | | | | |
| IPR | 0.19 | 0.15 | 0.15 | 0.15 | 0.34 | 0.20 | 0.08 | 0.09 | 0.44 | 0.01 | 0.18 | 0.26 | 0.35 | 1.00 | | | | | | | | | | | | | |
| FIN | -0.02 | -0.02 | 0.03 | -0.02 | -0.04 | -0.01 | -0.02 | -0.02 | -0.04 | -0.01 | -0.08 | -0.08 | -0.04 | -0.05 | 1.00 | | | | | | | | | | | | |
| PRC | -0.07 | -0.07 | -0.11 | -0.07 | -0.19 | -0.12 | -0.08 | -0.03 | -0.17 | 0.08 | -0.19 | -0.15 | -0.10 | -0.19 | -0.04 | 1.00 | | | | | | | | | | | |
| ENT | -0.02 | -0.02 | -0.01 | -0.03 | -0.06 | -0.03 | -0.01 | -0.01 | -0.05 | 0.04 | -0.05 | -0.07 | 0.07 | -0.02 | -0.01 | 0.14 | 1.00 | | | | | | | | | | |
| CON | 0.07 | 0.01 | 0.06 | 0.07 | 0.13 | 0.07 | -0.01 | -0.07 | 0.08 | -0.02 | -0.01 | 0.02 | 0.10 | 0.08 | -0.05 | -0.12 | -0.02 | 1.00 | | | | | | | | | |
| TEC | 0.23 | 0.14 | 0.12 | 0.14 | 0.31 | 0.21 | 0.02 | 0.03 | 0.45 | -0.09 | 0.18 | 0.32 | 0.28 | 0.51 | -0.09 | -0.11 | -0.01 | 0.05 | 1.00 | | | | | | | | |
| DEM | 0.05 | -0.02 | 0.02 | 0.00 | 0.01 | 0.02 | 0.05 | 0.02 | 0.08 | -0.05 | 0.07 | 0.02 | -0.01 | 0.02 | 0.01 | -0.04 | 0.05 | 0.00 | 0.03 | 1.00 | | | | | | | |
| LAB | 0.04 | 0.03 | 0.12 | -0.01 | 0.06 | 0.10 | -0.02 | 0.00 | 0.09 | -0.01 | 0.00 | 0.06 | 0.00 | 0.03 | 0.05 | -0.03 | 0.02 | 0.01 | 0.04 | 0.21 | 1.00 | | | | | | |
| EXF | 0.11 | 0.06 | 0.08 | 0.03 | 0.09 | 0.08 | 0.04 | 0.08 | 0.13 | 0.00 | 0.13 | 0.10 | 0.03 | 0.08 | -0.09 | 0.00 | -0.05 | 0.03 | 0.06 | 0.23 | 0.26 | 1.00 | | | | | |
| COS | 0.06 | 0.06 | 0.09 | 0.06 | 0.04 | 0.10 | 0.02 | 0.05 | 0.07 | 0.01 | 0.08 | 0.03 | 0.01 | 0.01 | -0.01 | 0.01 | 0.02 | -0.01 | 0.06 | 0.38 | 0.31 | 0.59 | 1.00 | | | | |
| PAR | 0.11 | 0.05 | 0.06 | 0.03 | 0.00 | 0.07 | 0.02 | 0.06 | 0.04 | 0.00 | 0.06 | 0.05 | 0.01 | 0.03 | -0.04 | 0.01 | 0.01 | 0.00 | 0.00 | 0.29 | 0.22 | 0.40 | 0.34 | 1.00 | | | |
| REG | 0.08 | 0.03 | 0.02 | 0.03 | 0.00 | 0.01 | 0.01 | 0.07 | 0.08 | -0.04 | 0.04 | 0.06 | -0.04 | 0.05 | 0.01 | 0.02 | 0.03 | 0.00 | 0.08 | 0.34 | 0.28 | 0.39 | 0.48 | 0.31 | 1.00 | | |
| $SIZ_1$ | -0.02 | 0.00 | 0.08 | 0.15 | 0.14 | 0.08 | 0.05 | 0.06 | 0.14 | 0.00 | -0.24 | 0.06 | 0.25 | 0.16 | 0.02 | 0.07 | 0.00 | 0.03 | 0.21 | 0.01 | 0.01 | -0.12 | -0.05 | -0.08 | 0.00 | 1.00 | |
| $AGE_1$ | -0.04 | -0.06 | -0.04 | 0.00 | -0.01 | -0.03 | -0.01 | 0.02 | -0.02 | -0.04 | -0.15 | -0.08 | 0.10 | -0.07 | -0.01 | 0.07 | 0.07 | -0.01 | -0.02 | 0.04 | 0.02 | -0.06 | -0.03 | 0.02 | -0.04 | 0.18 | 1.00 |
| $EAS_1$ | 0.00 | -0.04 | -0.08 | -0.10 | -0.09 | -0.07 | -0.06 | 0.00 | 0.08 | -0.01 | 0.18 | 0.03 | -0.09 | -0.05 | 0.00 | 0.06 | 0.00 | -0.02 | -0.04 | -0.03 | -0.05 | 0.05 | 0.07 | -0.04 | 0.05 | -0.10 | -0.25 |

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

**Table A2b: Correlation Matrix of Variables of Model 2**

| | EG | SG | RLP | CLR | HSE | CDE | DIV | CUS | PLC | $II_R$ | $DI_R$ | $II_D$ | $DI_D$ | $II_P$ | $DI_P$ | $II_I$ | $DI_I$ | $II_S$ | $DI_S$ | $IN_S$ | $IN_P$ | $SIZ_2$ | $AGE_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SG | 0.51 | 1.00 | | | | | | | | | | | | | | | | | | | | | |
| RLP | 0.17 | -0.07 | 1.00 | | | | | | | | | | | | | | | | | | | | |
| CLR | -0.01 | -0.03 | 0.40 | 1.00 | | | | | | | | | | | | | | | | | | | |
| HSE | 0.01 | 0.01 | 0.05 | 0.02 | 1.00 | | | | | | | | | | | | | | | | | | |
| CDE | 0.07 | 0.12 | -0.01 | 0.05 | -0.12 | 1.00 | | | | | | | | | | | | | | | | | |
| DIV | -0.02 | -0.05 | 0.05 | 0.06 | 0.03 | 0.01 | 1.00 | | | | | | | | | | | | | | | | |
| CUS | 0.05 | 0.04 | 0.00 | -0.06 | 0.09 | -0.06 | -0.02 | 1.00 | | | | | | | | | | | | | | | |
| PLC | 0.04 | 0.03 | 0.04 | 0.08 | -0.10 | 0.19 | 0.10 | -0.08 | 1.00 | | | | | | | | | | | | | | |
| $II_R$ | 0.06 | 0.03 | 0.04 | -0.01 | 0.13 | -0.05 | -0.02 | 0.03 | -0.05 | 1.00 | | | | | | | | | | | | | |
| $DI_R$ | 0.06 | 0.09 | -0.02 | -0.04 | 0.16 | -0.03 | -0.15 | 0.14 | -0.07 | -0.12 | 1.00 | | | | | | | | | | | | |
| $II_D$ | 0.04 | 0.01 | 0.05 | -0.01 | 0.08 | -0.01 | -0.06 | 0.05 | -0.06 | 0.44 | 0.08 | 1.00 | | | | | | | | | | | |
| $DI_D$ | 0.05 | 0.06 | 0.00 | -0.05 | 0.13 | -0.07 | -0.12 | 0.13 | -0.07 | 0.00 | 0.58 | -0.21 | 1.00 | | | | | | | | | | |
| $II_P$ | 0.03 | 0.04 | 0.05 | -0.02 | 0.02 | 0.01 | -0.12 | 0.07 | -0.05 | 0.29 | 0.16 | 0.48 | 0.06 | 1.00 | | | | | | | | | |
| $DI_P$ | 0.02 | 0.05 | -0.04 | -0.04 | 0.14 | -0.10 | -0.12 | 0.13 | -0.10 | 0.05 | 0.50 | 0.00 | 0.64 | -0.17 | 1.00 | | | | | | | | |
| $II_I$ | 0.03 | 0.04 | 0.05 | -0.01 | 0.01 | 0.04 | -0.05 | 0.04 | -0.04 | 0.30 | 0.07 | 0.41 | -0.01 | 0.46 | -0.03 | 1.00 | | | | | | | |
| $DI_I$ | 0.06 | 0.04 | 0.00 | -0.03 | 0.08 | -0.05 | -0.05 | 0.07 | -0.09 | 0.05 | 0.36 | 0.03 | 0.58 | 0.08 | 0.40 | -0.10 | 1.00 | | | | | | |
| $II_S$ | 0.08 | 0.11 | 0.05 | -0.04 | 0.12 | -0.05 | -0.17 | 0.11 | -0.08 | 0.28 | 0.42 | 0.32 | 0.31 | 0.45 | 0.30 | 0.28 | 0.20 | 1.00 | | | | | |
| $DI_S$ | -0.03 | -0.01 | -0.05 | -0.02 | 0.09 | -0.06 | -0.03 | 0.06 | -0.05 | -0.04 | 0.15 | -0.05 | 0.39 | -0.07 | 0.56 | -0.03 | 0.23 | -0.17 | 1.00 | | | | |
| $IN_S$ | 0.04 | 0.05 | 0.09 | -0.05 | -0.08 | 0.01 | -0.04 | 0.04 | -0.05 | 0.01 | 0.04 | 0.00 | 0.02 | -0.07 | -0.03 | -0.01 | -0.01 | -0.16 | -0.21 | 1.00 | | | |
| $IN_P$ | 0.03 | 0.03 | 0.05 | -0.02 | 0.09 | -0.02 | -0.05 | 0.03 | -0.04 | -0.03 | 0.13 | -0.04 | 0.14 | -0.05 | 0.10 | -0.03 | 0.14 | 0.10 | -0.02 | 0.13 | 1.00 | | |
| $SIZ_2$ | -0.01 | 0.05 | -0.01 | -0.08 | -0.21 | 0.08 | -0.18 | -0.02 | 0.01 | 0.03 | 0.18 | 0.10 | 0.15 | 0.15 | 0.11 | 0.14 | 0.14 | 0.19 | -0.05 | 0.13 | 0.04 | 1.00 | |
| $AGE_2$ | -0.08 | -0.10 | 0.01 | -0.01 | -0.11 | 0.02 | -0.08 | -0.02 | 0.05 | 0.02 | -0.02 | -0.02 | -0.02 | 0.03 | -0.03 | 0.04 | 0.00 | 0.03 | -0.08 | 0.05 | -0.01 | 0.13 | 1.00 |
| $EAS_2$ | 0.01 | 0.03 | -0.14 | 0.01 | 0.22 | -0.06 | 0.04 | 0.01 | -0.07 | -0.02 | 0.04 | -0.05 | 0.01 | -0.04 | 0.03 | -0.06 | 0.03 | -0.07 | 0.04 | -0.13 | -0.08 | -0.09 | -0.24 |

Source: ZEW: Mannheim Innovation Panel, 2006 and 2007 waves.

## Table A3: Drivers of Actual Innovation Activities of German SMEs: Marginal Effects of Probit Models

| Variable | *$II_A$ any type of inno-vation | | *$II_R$ R&D | | *$II_D$ design etc. | | *$II_P$ new products | | *$II_I$ new pro-cesses | | *$II_S$ sales of new products | | *$IN_P$ non-in-novation activity | | *$IN_S$ sales of old products | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Internal Ressources* | | | | | | | | | | | | | | | | |
| Continous inhouse R&D | 0.069 | * | 0.037 | ** | 0.013 | | 0.015 | | 0.016 | | 0.194 | *** | 0.015 | | 0.073 | * |
| Occational inhouse R&D | 0.015 | | 0.001 | | -0.032 | * | 0.027 | | 0.013 | | 0.145 | *** | 0.035 | * | 0.084 | ** |
| High skilled employees | 0.074 | | 0.023 | | 0.027 | | 0.029 | | -0.051 | *** | 0.122 | | 0.047 | * | -0.056 | |
| Innovation cooperat. w. intl. partners | 0.130 | *** | 0.096 | *** | -0.030 | | 0.056 | * | 0.024 | * | 0.183 | *** | -0.041 | ** | -0.093 | * |
| Export experience | 0.226 | *** | 0.046 | *** | 0.119 | *** | 0.109 | *** | 0.031 | *** | 0.134 | *** | 0.025 | * | 0.019 | |
| Experienced usage of IPR | 0.029 | | 0.011 | | 0.007 | | 0.049 | ** | 0.016 | ** | -0.101 | *** | 0.010 | | 0.018 | |
| Profit margin >2% in 2003 and 2004 | 0.027 | | 0.006 | | 0.021 | | 0.009 | | -0.002 | | -0.015 | | 0.013 | | -0.025 | |
| *Competitive Environment* | | | | | | | | | | | | | | | | |
| Price competition dominating | 0.052 | | 0.026 | | 0.055 | ** | 0.022 | | -0.004 | | -0.130 | *** | -0.005 | | 0.054 | * |
| High pressure from market entries | -0.03 | | -0.006 | | -0.002 | | -0.001 | | -0.012 | * | -0.029 | | -0.001 | | 0.048 | * |
| Low number of competitors | 0.044 | * | 0.006 | | 0.023 | | 0.035 | * | 0.015 | ** | 0.091 | *** | -0.016 | | -0.023 | |
| Technological advantage | 0.071 | *** | 0.035 | *** | 0.041 | *** | 0.048 | *** | 0.020 | *** | 0.089 | ** | -0.017 | | -0.032 | |
| *Locational Disadvantages at Home* | | | | | | | | | | | | | | | | |
| Lack of customer response | -0.001 | | 0.028 | * | -0.019 | | -0.014 | | 0.001 | | 0.045 | | -0.008 | | -0.072 | |
| Lack of qualified labour | -0.02 | | -0.002 | | -0.04 | ** | -0.008 | | -0.006 | | -0.005 | | 0.035 | | -0.025 | |
| Lack of external sources of finance | 0.006 | | -0.017 | | -0.004 | | -0.009 | | 0.009 | | 0.039 | | -0.038 | ** | -0.059 | |
| High innovation costs | -0.06 | * | 0.015 | | -0.045 | ** | -0.034 | | -0.012 | | 0.001 | | 0.029 | | 0.054 | |
| Lack of appropriate partners | 0.088 | ** | 0.011 | | 0.043 | * | 0.068 | ** | 0.012 | | 0.013 | | -0.023 | | 0.030 | |
| Legal innovation barriers | 0.039 | | 0.001 | | 0.095 | ** | -0.012 | | 0.003 | | -0.043 | | -0.013 | | -0.063 | |
| *Control Variables* | | | | | | | | | | | | | | | | |
| Firm size | 0.003 | | 0.011 | | -0.003 | | -0.019 | | 0.007 | | 0.158 | *** | 0.007 | | 0.121 | ** |
| Firm size (squared) | 0.015 | | -0.001 | | 0.009 | | 0.013 | * | 0.008 | *** | -0.021 | *** | 0.008 | * | -0.013 | * |
| Firm age | -0.01 | | 0.002 | | -0.02 | ** | -0.009 | | -0.007 | | 0.014 | | -0.007 | | 0.014 | |
| Firm located in Eastern Germany | -0.065 | *** | -0.024 | ** | -0.040 | *** | -0.032 | * | -0.017 | ** | -0.093 | *** | -0.023 | * | -0.040 | |
| *Industry dummies* | | | | | | | | | | | | | | | | |
| Medium-tech/high-tech manufact. | -0.017 | | 0.061 | ** | -0.03 | | -0.026 | | -0.006 | | -0.093 | ** | 0.039 | | 0.008 | |
| Manufact. of intermediary products | -0.06 | * | 0.014 | | -0.017 | | -0.045 | * | -0.015 | * | 0.002 | | 0.038 | | 0.005 | |
| Trade, construction, other services | -0.034 | | 0.036 | | 0.011 | | -0.037 | | -0.009 | | -0.198 | *** | 0.076 | ** | -0.115 | ** |
| Transport, other business services | 0.05 | | 0.052 | | 0.011 | | -0.021 | | -0.002 | | -0.194 | *** | 0.012 | | -0.155 | *** |
| Knowledge-intensive services | 0.046 | | 0.073 | ** | 0.028 | | -0.061 | ** | 0.003 | | -0.252 | *** | | | -0.094 | ** |
| No. of Observations | 1,038 | | 1,067 | | 1,041 | | 1,067 | | 1,109 | | 1,108 | | 1,061 | | 1,106 | |
| Pseudo $R^2$ | 0.168 | | 0.235 | | 0.155 | | 0.125 | | 0.217 | | 0.242 | | 0.120 | | 0.061 | |
| Share of firms with activity *k* | 0.210 | | 0.079 | | 0.095 | | 0.124 | | 0.052 | | 0.327 | | 0.060 | | 0.285 | |

a) Industries 4 and 5 combined to one dummy variable due to collinearity of industry dummy 5 and the dependent variable.

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