Stepping in and out the International Market: 
Internationalisation of Technology Oriented Firms in 
Germany and the UK ¹

by

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Abstract: For small high-tech firms international orientation is regarded as crucial for growth 
and long-term survival. The 2002 Observatory of European SMEs highlights that in 1998/1999 
65 per cent of all high-tech SMEs from 10 European countries operate internationally and receive 
19 per cent of their turnover from sales abroad. Even newly founded technology based firms 
(NTBFs) often have international business activities shortly after they have been founded (“infant 
multinationals”). However, in order to create jobs and have a sustainable influence on (macro) 
economic development, continuous growth of NTBFs is needed and research must focus on the 
continuous role of internationalisation. Based on longitudinal data, this paper therefore examines 
empirically the long-term internationalisation behaviour of German and British technology ori-
mented firms founded between 1987 and 1996. Applying a logit model, I am able to identify firm-
specific success factors that influence the probability of entry in and exit from the international 
market.

Keywords: High technology industries, start-up, internationalisation.

JEL Classification: F23, L20, L60, L80

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1 Introduction

For small high-tech firms international orientation is regarded as crucial for growth and long-term survival. The 2002 Observatory of European SMEs (European Commission 2002) highlights that in 1998/1999 65% of all high-tech small and medium-sized enterprises (SMEs) from 10 European countries operate internationally and receive 19% of their turnover from sales abroad. Since it is often argued that sales potential in European domestic markets are insufficient for the amortisation of high product research and development costs (see e.g. McDougall et al. 1994, Bürgel et al. 2000), international business activities are expected to help European SMEs to amortise R&D costs so that they are able to fulfil the hopes put on them with respect to structural change, innovation, and job creation. A lot of empirical studies have examined the relationship between internationalisation and firm performance indicators like employment growth or labour productivity. However, only few of them (e.g. Girma et al. 2002) find that internationalisation positively affects firm performance. Most other evidence (e.g. Clerides et al. 1998, Bernard and Jensen 1999, Arnold and Hussinger 2004) supports a reverse causation in the sense that the positive correlation between international business activities and superior firm performance is due to self-selection of firms with better performance into the foreign market.

Within the larger group of high-tech SMEs, the interest of economists and politicians is in particular focused on newly founded technology based firms (NTBFs). NTBFs constitute the smallest players in high-tech sectors so that the question arises how they can cope with the demanding challenges in high-tech markets. Entering the international market might be regarded as one of the greatest challenges for small and newly founded firms, but it is by now established knowledge that NTBFs often have international business activities shortly after they have been founded (“infant multinationals”, Lindqvist 1991). Therefore, numerous studies have investigated the internationalisation process of NTBFs during their start-up period (e.g. Lindqvist 1991, McDougall et al. 1994, Bürgel et al. 2000). However, in order to create jobs and have a sustainable influence on (macro) economic development, continuous, long-term growth is needed, and research must focus on the long-term development of NTBFs and the continuous role of internationalisation. To the best of my knowledge, there is no other study that observes NTBFs over a longer time period, investigating long-term internationalisation behaviour. This paper will try to address this gap. Based on longitudinal data, it examines empirically the long-term international business activities of young German and British technology oriented firms.
The empirical research of the present paper is based on two surveys that have been conducted simultaneously in Germany and the UK. In 1997/1998, a research team of London Business School and the Centre for European Economic Research (ZEW) contacted a stratified random sample of German and UK NTBFs founded between 1987 and 1996 by sending out a written questionnaire (see Bürgel et al. 2000). It turned out that about two thirds of the 600 responding firms had international business activities at the time of the survey. In summer 2003, the ZEW and the University of Exeter contacted once again all surviving firms of the original sample (about 25% of the firms of this sample have already died), which are now 12 years old on average. In order to ascertain a high response rate, a computer assisted telephone interview (CATI) was used. A response rate of 55% was obtained, and, after performing several consistency checks, a number of 217 companies could be retained for the longitudinal analyses.

The focus of this paper is the long-term internationalisation behaviour of surveyed firms. An advantage of our unique data set is that, in contrast to most other studies, it contains a large set of explanatory firm-specific variables motivated by the literature of international management and observed over time, for example R&D activities, product characteristics, and the managers’ profile. Thus, it is possible to identify “hard” success factors that are linked with long-term international business activities. The causality between internationalisation and firm performance is beyond the scope of this paper. However, understanding in which way firm-specific characteristics affect the firms’ internationalisation behaviour can help future research to explain the often observed positive correlation between performance and internationalisation.

Studying long-term internationalisation behaviour cannot be restricted to analysing foreign market entry. Although there is a high persistence in the internationalisation behaviour, we observe market entry and exit in our data set: just under 13% of firms which had international sales in 1997 have left the foreign market until 2003. This observation is in line with other empirical studies that examined long-term international business activities (see e.g. Roberts and Tybout 1997, Bernard and Jensen 2001). In order to analyse empirically entry in and exit from the foreign market, I apply logit models that explain, firstly, the transition from the internationalisation status “non-exporter” to the internationalisation status “exporter”, i.e. foreign market entry, and secondly, the transition from the status “exporter” to the status “exporter”, i.e. remaining internationally active.1 Of course, by trivial recoding, the second model explains exit from the foreign market.

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1 In this paper, only firms that export their products or services are regarded as internationally active firms. This means that only internationalisation on the sales market is considered. Of course, firms may import investment
The results show that there are minor differences between German and UK firms with respect to their internationalisation behaviour. Although the existence of sunk entry costs cannot be proved with our data set, the results are consistent with the sunk cost hypothesis. Firms can overcome high entry costs by acquiring firm-specific assets. Similarly, firm-specific resources prevent firms from exiting from the foreign market. Especially, the strategic role of investment in R&D is stressed by the data. Moreover, employing internationally experienced managers constitutes an intangible asset that facilitate the firms’ export activities. On the other hand, if the firms’ products or services require high individual client customisation, this represents an entry barrier into the foreign market and impedes a long-term international engagement.

The paper is organised as follows: Section 2 reviews the theoretical and empirical literature of internationalisation of firms. Section 3 describes the data used for the empirical analysis and shows some descriptive statistics. The empirical methodology and the operationalisation of variables used in the empirical model will be explained in section 4. The estimation results are presented and interpreted in section 5, and section 6 concludes.

2 Theoretical Considerations and Literature Review

As Bürgel et al. (2000) state, there is no single theoretical model that is able to explain the decision to internationalise if a firm is, like in our case, both young and operates in a high-technology sector. Therefore, we have to fall back on different models in order to motivate the empirical analysis and derive hypotheses that can be tested. Theories that try to explain the internationalisation behaviour of individual firms can be divided into models from the field of economics and theories from the field of international management. One basic approach in the field of economics is the model originally developed by Roberts and Tybout (1997), which was tested empirically by Roberts and Tybout themselves and by other authors in series of papers2. I will start the theoretical considerations by presenting the core arguments of this model.

The model of Roberts and Tybout includes a vector of firm-specific variables that influences the potential profit from international business activities and insofar determines the firm’s decision whether to internationalise or not. However, mostly due to data restrictions previous econometric

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goods or components, i.e. internationalise on the procurement market. Although the latter way of internationalisation may also be important for small high-tech firms, it will be neglected in this paper.
studies often contain only a relatively small number of observable firm characteristics. Since this study is based on survey data that were collected especially to analyse the internationalisation behaviour of young and small high-technology firms (see section 3), I am able to use a larger set of firm-specific characteristics. In order to identify variables that can be expected to discriminate between exporters and non-exporters, I used theories of internationalisation from the field of international management. I will review the main arguments of three strands of theory: internationalisation process models (Johanson and Vahlne 1977, 1990), a theory of internationalisation from an entrepreneurial perspective (McDougall and Oviatt 2000; Andersson 2000), and the resource based view of a firm (e.g. Wernerfelt 1984).

The first model, with which I start my theoretical considerations, was originally formulated by Roberts and Tybout (1997) and applied, for example, by Bernard and Jensen (2001) and Bernard and Wagner (2001). It is based on the theoretical literature on sunk costs as developed by Dixit (1989a, 1989b), Baldwin (1988), Baldwin and Krugman (1989), and Krugman (1989). Roberts and Tybout assume that in period $t$ a rational firm $i$ maximizes its profits $\pi_i$ that it receives by selling the profit-maximizing level of exports $q_i^*$ abroad. It is assumed that the firm is always able to produce the profit-maximizing level of exports $q_i^*$. The firm’s profit depends on factors exogenous to the firm $X_i$, such as exchange rates, and firm-specific variables $Z_i$, like firm size, age or product characteristics, and is given by

$$\pi_i(X_i, Z_i) = p_i q_i^* - c_v \left( X_i, Z_i, q_i^* \right).$$

where $p_i$ is the price of goods sold abroad, and $c_v$ is the variable cost of producing quantity $q_i^*$. As long as there are no entry costs, the firm will enter the foreign market in period $t$, if the period’s profit is non-negative. The variable $Y_i$ indicates the internationalisation status of firm $i$ in period $t$ and is defined as

$$Y_i = \begin{cases} 1 & \text{if } \pi_i \geq 0 \\ 0 & \text{otherwise} \end{cases}.$$ 

Entering a foreign market, however, often causes costs, e.g. the costs of a marketing campaign or of setting up foreign sales channels, that may be regarded as sunk costs. Assuming that these sunk

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3 Formulas and notation used in this paper are identical to those one used in Bernard and Jensen (2001) and Bernard and Wagner (2001).
costs \( N \) must fully be paid in each period \( t \), unless the firm had exports in the previous period \( t-1 \) (i.e. \( Y_{t-1} = 1 \)), the one-period profit becomes

\[
\pi^*_t (X_t, Z_t, Y_{t-1}) = p_t q^*_t - c_t \left( X_t, Z_t \mid q^*_t \right) - N \cdot (1 - Y_{t-1}) \quad .
\]

In a dynamic framework the firm chooses a sequence of export levels \( \{q^*_t\}_{t=1}^{\infty} \) that maximizes expected current and discounted future profits

\[
\Pi_t = E \left( \sum_{s=t}^{\infty} \delta^{s-t} \left( \pi^*_s \cdot Y_s \right) \right),
\]

where \( \delta \) is the one-period discount rate.

The introduction of sunk costs induces an option value of waiting and leads to a range of inaction, a phenomenon known as “hysteresis” (Dixit 1989a). In fact, the main interest of the study of Roberts and Tybout (1997) and the other papers cited above was to examine, whether sunk costs are present and, if this is the case, to quantify their effects on the decision to enter and exit the foreign market. If sunk costs are relevant, firms may continue to export even if foreign sales are no longer profitable in the current period in order to avoid re-entry costs. According to this theory, a transitory depreciation of the domestic currency will cause a permanent (or at least long-term) increase in the number of firms that have international sales, even if the domestic currency subsequently appreciates again.

To measure the effect of sunk costs on the decision to internationalise, Roberts and Tybout estimate a binary-choice non-structural model of the form

\[
Y_{it} = \begin{cases} 1 & \text{if } \beta X_{it} + \gamma Z_{it} - N \cdot (1 - Y_{i,t-1}) + \varepsilon_{it} \geq 0, \\ 0 & \text{otherwise} \end{cases}
\]

In order to consider unobserved firm-specific heterogeneity, the error term \( \varepsilon_{it} \) is assumed to consist of a permanent firm-specific element \( \kappa_i \) and a transitory component \( \eta_{it} \) that follows a first-order autoregressive process, \( \eta_{it} = \rho \eta_{i,t-1} + \nu_{it} \), so that

\[
\varepsilon_{it} = \kappa_i + \eta_{it}.
\]

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4 This is the simplest way of introducing sunk costs. Alternatively, it can be assumed that current profits are also affected by the status of internationalisation more than one period ago (cf. Roberts and Tybout 1997), or we can introduce exit costs from the foreign market. The basic argumentation, however, remains unchanged.
Using a data set of Colombian plants of the manufacturing sector, observed between 1981 and 1989 inclusively, Roberts and Tybout estimate a random effects probit model and find out that sunk costs are relevant. If a firm had exports in the previous year (i.e. \( Y_{t-1} = 1 \)), the probability of being international in the current period would increase by 63%. However, the effect of previous international activities depreciates rapidly: After a two-year absence from the foreign market the re-entry costs are no longer different from entry costs of firms which enter the international market for the first time. Apart from the effect of sunk costs, Roberts and Tybout confirm that observed and unobserved plant characteristics have a significant influence on the firms’ export behaviour. The probability to internationalise increases with firm size, age, and a dummy variable that indicates whether the plant is owned by a corporation.

Bernard and Jensen (2001) use data of U.S. manufacturing plants between 1984 and 1992 and estimate the same model as Roberts and Tybout. The former confirm the relevance both of sunk costs as well as of plant-specific variables on the plants’ export behaviour. Applying a random effects probit model, the probability that a plant has exports today would increase by 62%, if the plant exported in the previous year. The measure of the effect of the lagged export status, however, depends on the econometric method applied. Using a linear probability model with fixed effects, the marginal effect of the lagged internationalisation status drops substantially to 20%.

Beside the model of Roberts and Tybout, there are only few approaches from the field of economics modelling the internationalisation behaviour of individual firms. One alternative approach has been developed by Lautanen (2000). He interprets the entry into a foreign market as an innovation adopted by a firm. At least for small firms, as Lautanen argues, it is possible to draw analogies between the adoption process of a new technology and exporting: Both processes are associated with uncertainty, they involve learning behaviour, and they are (or might be) both initiated through personal contact that gives a stimulus for innovating and exporting respectively. Lautanen’s two-period model therefore consists of two parts: In the first part, the diffusion of information about international business activities is modelled as an epidemic learning process similar to technology

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5 Bernard and Jensen (2001) provide a detailed discussion of the role of different econometric methods when estimating the binary choice framework given in equation (5). They stress that the fixed effects estimator in a linear probability model is almost surely biased downward but gives a lower bound of the effect of previous export status.

6 Using data of German manufacturing firms in Lower Saxony, Bernard and Wagner (2001) get similar results for the effect of sunk costs. The lagged export status increases the probability of exporting today by 38% (linear probability fixed effects model), or 68% (random effects probit model) respectively.
diffusion models. The diffusion of information determines, which firms become interested in exporting in each period. The second part explains, which firms finally commit to exporting, conditional that they have become interested in exporting in the first stage of the model. The decision on committing to exporting is determined by three conditions. First, a profitability condition states that a firm will export, only if it receives non-negative (expected) profits from its export activities. As in Roberts and Tybout, the profitability condition depends on a set of firm-specific variables. Second, a firm will commit to exporting in the first period, only if it is not profitable to wait until the second period of the model before entering the foreign market (arbitrage condition). Finally, the third condition demands that the firm has enough resources for its planned export activities (feasibility condition).

Since the data set used for the empirical analysis of this paper does not contain information about the stimulus that leads to international business activities, the first part of Lautanen’s model cannot be tested empirically. However, the second part of the model shows some parallels to the model of Roberts and Tybout. In both models firms will enter the foreign market, if a profitability condition is met. The models contain an option of waiting, whereas in contrast to the model of Lautanen the model of Roberts and Tybout explicitly trace back a possible delay of entry (and exit) to the existence of sunk costs. Finally, the firms’ internationalisation behaviour in both theories depends on the availability of firm specific resources. So analysing empirically firm-specific variables that determine the export activities of high-tech firms, as it is the purpose of this paper, is consistent with both models.

In order to identify variables that can be expected to discriminate between exporters and non-exporters, it is helpful to fall back on theories of internationalisation from the field of international management. One of the most influential theories is the internationalisation process model developed by Johanson and Vahlne (1977, 1990). They regard internationalisation as a gradual process where firms incrementally increase their commitment in foreign markets. A commitment is always associated with uncertainty. The firm extends its international business activities until its firm-specific maximum tolerable risk is reached, which is a function of the degree of the firm’s risk aversion and the firm’s resource position. The commitment of resources in a foreign market increases the knowledge of the foreign market and thus reduces the existing uncertainty about the foreign environment. The internationalisation process is therefore combined with a dynamic

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7 Models of technology diffusion, among them epidemic learning models, rank, stock, and order effect models are described in detail in Stoneman (1983) and Karshenas and Stoneman (1993).
learning process over time. An initial involvement in a foreign market reduces uncertainty which induces an additional commitment in this market. As a consequence, firms start their international activities with relatively few resources, because the commitment of these resources is associated with relatively high risk. Better knowledge that is acquired over time through additional commitment in that market leads to more resource intensive international activities since the latter are now associated with less risk than the firm’s initial foreign activities.

The internationalisation process model is the basis of the so called stage models of internationalisation (e.g. Bilkey and Tesar 1977, Bilkey 1978). In these theories the internationalisation behaviour of a firm is linked with different stages of firm’s life cycle starting from no foreign sales and increasing its international activities incrementally by a more and more resource-intensive commitment in foreign markets until a final stage of foreign direct investment. Hence, the stage models not only try to explain the entry into a foreign market per se but also the choice of the optimal market entry mode used at different stages of the firm’s international involvement.

The most important criticism of the internationalisation process model and especially of stage theories is the quasi-deterministic character of the models (Reid 1983). The argument is that firms can and will decide on the optimal entry mode and on expansion of their international activities contingent on market conditions. There is no need to proceed in the incremental way described by the model. Johanson and Vahlne themselves already listed three exceptions where firms are likely to deviate from the gradual commitment predicted by their model. Firstly, large firms may have enough resources to take larger steps in their internationalisation process. Secondly, relevant knowledge that reduces uncertainty about a foreign market can be acquired by other means than own experience, for example by employing an international experienced manager. Finally, if market conditions in different foreign markets are homogenous, firms may generalize experience gained in one market to make larger internationalisation steps in another market.

The criticism of the process model with respect to its quasi-deterministic character has more recently led to theories that combine the research paths of international business and entrepreneurship. McDougall and Oviatt (2000, p. 903) define international entrepreneurship as “a combination of innovative, proactive, and risk-seeking behaviour that crosses national borders and is intended to create value in organisations”. The key idea of international entrepreneurship is that the availability of resources is not enough to initiated an internationalisation process (Andersson 2000). An acting entrepreneur is needed who triggers the internationalisation process. Entrepreneurs make strategic choices determining the optimal way of internationalisation conditional on the firm’s resources and their own capabilities and preferences. The entrepreneurial perspective, however, is
not restrictive to individuals or even firm founders. Entrepreneurial behaviour in large companies, often called “intrapreneurship”, is also covered by this concept.

The inclusion of entrepreneurship research allows us to trace back different pattern of the internationalisation process of firms to characteristics of the entrepreneurs. Based on a case study analysis of Swedish firms, Andersson (2000) identifies three different types of entrepreneurs. The technical entrepreneur is mainly interested in technology and the development of the production process. In this case, an unsolicited order from abroad may lead to exports (“pull strategy”). On the contrary, the marketing entrepreneur proactively creates the internationalisation process of his firm (“push strategy”). He creates new channels to reach foreign customers and is willing to invest a relatively large amount of resources in order to penetrate the foreign market quickly. The third type of entrepreneurs Andersson calls structural entrepreneurs. This concept is relevant for large companies and mature industries and insofar less important for the sample of NTBFs examined by this paper. Structural entrepreneurs regard internationalisation as one part of their overall strategy. They organize and restructure (large) firms and, in this context, create an international business strategy, e.g. by choosing mergers and acquisitions as an entry strategy.

The concept of international entrepreneurship as well as the model of Johanson and Vahlne emphasize the role of intangible resources like experience or entrepreneurial capabilities for the internationalisation process. This is also a main topic of the resource based view (RBV) of the firm (e.g. Wernerfelt 1984) and the more recent theories that regard organisational capabilities of firms as determinants of firms’ outcome (e.g. Teece et al. 1997, Madhok 1997). RBV models analyse how resources are accumulated and deployed by firms. A firm is interpreted as an idiosyncratic bundle of assets (physical resources as well as intangible resources like know-how, experience or tacit knowledge). Since physical assets are relatively easily obtained or imitated, a firm differentiates from its rivals by the intangible resources it possesses. The later determine how efficient physical assets are or can be used and are therefore decisive for the firm’s performance. With respect to the internationalisation process this means that costs of market entry can be reduced if intangible resources lead to a more efficient use of the firm’s physical resources.

Although RBV models offer a valuable approach on how intangible and physical resources interact, the theory stays vague in many respects. For example, it doesn’t derive hypotheses about causalities between specific assets and firm performance. In our context, RBV models neither explain the timing of entry into a foreign market nor the entry mode used by the firm. Nevertheless, RBV models can help us to deal with the peculiarities of the internationalisation process of firms that at the same time are small, young, and belong to a high-tech sector. A resource based
perspective seems to be particularly relevant for a sample of NTBFs as it was chosen for this study, especially because general variables like size and age probably cannot discriminate between exporters and non-exporters since nearly all selected firms are of similar age and similar size.\textsuperscript{8,9}

3 Data and Descriptive Analysis

This paper tends to examine the internationalisation behaviour of technology oriented firms in Germany and the UK. In order to identify technology oriented firms, the definition of high-technology manufacturing sectors in the UK established by Butchart (1987) was used. Butchart provides a definition based on, firstly, the ratio of R&D expenditures to sales and, secondly, the share of employees working in R&D. A sector is defined as a high-tech sector, if it is characterised by a “substantial above average” value in at least one of the two criteria and an “above average” value in the other. Thereby, Butchart identified 19 UK 1987 SIC codes. These codes were translated into the NACE Rev. 1 code and are listed in detail in Table 5 in the appendix. Table 5 defines four aggregated manufacturing sectors and augments Butchart’s list by a number of selected service sectors (cf. Bürgel et al. 2000).

The data for the empirical analysis of this paper result from two surveys simultaneously carried out in Germany and the UK. The source data set originates from Dun & Bradstreet in the UK and Creditreform\textsuperscript{10} in Germany. Using these databases, all firms with at least three employees in 1997 that operate in one or more high-tech sectors as defined by Butchart (1987) and that were founded as legally independent companies\textsuperscript{11} between 1987 and 1996 were selected. This resulted in a population of 3,562 firms in the UK and 5,045 in Germany. From the population a random sample

\textsuperscript{8} Oviatt and McDougall (1994), for example, regard new technology-based firms that internationalise quickly as firms with an intangible knowledge-based competitive advantage. This perspective is consistent with the resource based view of the firm.

\textsuperscript{9} The reasoning of RBV models that firm specific assets determine the internationalisation behaviour of firms is similar to the role of ownership advantages in Dunning’s OLI (ownership, location, internalisation) framework, also called the eclectic paradigm (Dunning 1993). According to Dunning himself, the eclectic paradigm intends to explain “what are” rather than, in the sense of a normative theory, “what should be” a firm’s international business activities.

\textsuperscript{10} As Germany’s largest credit rating agency, Creditreform has the most comprehensive database of German firms at its disposal. Creditreform provides data on German firms to the Centre for European Economic Research (ZEW) for research purposes.

\textsuperscript{11} Subsidiaries, de-mergers or firms that have been founded as a management by-out (MBO) or buy-in (MBI) were excluded from the analysis.
of 2,000 firms per country was drawn, stratified by size, sector (manufacturing versus service sector), and, for Germany, by region (West- and East-Germany).

The firms were first contacted in winter 1997/1998 by sending out a written questionnaire. The first survey was carried out by London Business School in the UK and the Centre for European Economic Research (ZEW) in Germany. The written questionnaire contains questions with respect to the profile of the firms’ founder(s), product characteristics, international business activities, entry modes in foreign markets, and perceived opportunities and risks of international activities. 362 completed questionnaires came back in the UK, 232 questionnaires in Germany, resulting in a combined net sample of nearly 600 NTBFs in Germany and the UK. The net sample showed no bias with respect to age, size, and sector compared with the random sample. A bias with respect to the internationalisation behaviour could, however, not be excluded.12

In order to ascertain the development and the status of internationalisation of this sample of 600 NTBFs, a research team of the University of Exeter and the ZEW prepared a new survey where all former responding firms should be contacted a second time. In 2003, the firms of the original sample were 12 years old on average. Thus, part of our firms no longer belong to what is commonly defined as new technology-based firms.13 Insofar, we shift our interest from analysing newly founded firms to a more longitudinal perspective of the firms’ development.

To determine the target sample of the second survey, at first all former responding firms that turned out to be mismatches (e.g. non-high-tech firms, non-independent foundations) were excluded. In Germany, we then selected all firms that were indicated in the database of Creditreform as dead (bankruptcy as well as voluntary firm closures) at the beginning of 2003.14 In the UK, the researchers themselves tried to identify already dead firms and excluded them from the target sample. As a result, we got a target sample of 188 German and 250 UK former responding firms that were contacted.

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12 The first survey is described in detail in Bürgel et al. (2000). This report also includes numerous descriptive and econometric analyses of this unique data set.

13 In his influential study, Little (1977) uses a definition a NTBFs which includes firms that are up to 25 years old. In contrast, the first survey this paper is based on considered only firms that were ten years of age or younger, which is in line with more recent studies of NTBFs (see e.g. Storey and Tether 1996).

14 According to the analysis of Prantl (2001), those firms that are indicated as dead by Creditreform have almost by sure left the market. The reverse, however, is not true: A voluntary firm closure is often recorded with a very large delay by Creditreform so that the number of closed firms is underestimated.
The second survey was conducted in 2003 as computer-aided telephone interviews (CATI). The research team decided on a telephone survey, because due to the restricted number of former responding firms that belong to the target sample, we had to assure a relatively high response rate in order to get a sufficiently high number of observations that may lead to reliable econometric results. Fortunately both in the UK and in Germany, the response rate exceeds 50 % that gives us a number of 244 completed interviews. After performing several consistency checks a number of 217 companies could be retained in the data set for econometric analyses.

On average, 26 employees worked in the firms of our sample in 2003. Considering only those firms that participated in both surveys, the average number of employees has increased by 7 employees or 37 % in average when compared with 1997. Since the main topic of this paper is the internationalisation behaviour of German and UK high-tech firms, Table 1 compares the mean number of employees between firms with and without international business activities. Both the 1997 and the 2003 survey reveal a higher mean value (and a higher median, not shown here) of the number of employees of firms with exports compared with non-exporting firms. Applying a t-test proves that the number of employees of exporting firms significantly exceeds the number of employees of firms with only domestic sales both in Germany and the UK. Regarding firm age (measured in years), the firms in our sample are 12 years old in average in 2003. The mean of firm age is always higher for exporting than for non-exporting firms (see Table 1). However, based on a t-test the differences are not significant.

Table 1: Comparison of Means between Exporters and Non-Exporters

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>UK</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>International sales</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of employees</td>
<td>11.57</td>
<td>18.85</td>
</tr>
<tr>
<td>Firm age (in years)</td>
<td>5.20</td>
<td>6.03</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>17.83</td>
<td>16.15</td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of employees</td>
<td>15.04</td>
<td>32.37</td>
</tr>
<tr>
<td>Firm age (in years)</td>
<td>11.44</td>
<td>11.91</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>3.40</td>
<td>14.67</td>
</tr>
</tbody>
</table>

* 10 % level of significance; ** 5 % level of significance; *** 1 % level of significance.
Remark: Only firms that participated in both surveys have been considered. Source: ZEW, University of Exeter, own calculations.
In 1997, German and UK technology oriented firms spent on average 15.4% of their total sales for research and development. Neither in Germany nor in the UK, the mean of R&D intensity of exporting firms is significantly different from the respective value of non-exporting firms, although it should be noted that for the UK this is the result of a high standard error. In 2003, R&D intensity decreased by two and a half percentage points to 12.8% on average. This is not necessarily a result of falling expenditures on R&D by may also be attributed to rising sales. During the early stage period that is covered by the 1997 survey many high-tech firms have high costs for developing a new product or service that can be commercialized. On the other hand, total sales might be relatively small until the firm becomes established in the market. Therefore, R&D intensity can be expected to be higher during an early stage of a high-tech firm’s life cycle than in a later stage so that it is not surprising that the mean R&D intensity has fallen between 1997 and 2003. It is, however, remarkable that the drop in R&D intensity is mainly caused by non-exporting firms, whereas the average R&D intensity of exporters has changed only slightly. As a consequence, the mean R&D intensity of firms with international sales is now significantly higher compared with the mean of non-exporting firms. In fact, among those firms that never had international sales (see Table 3 and the explanations below) three quarter didn’t carry out own R&D activities in 2003.

Table 2 shows the share of firms with and without international sales in 1997 and 2003 respectively, again considering only those firms that participated in both surveys. In both countries, more than two third of responding firms had international sales. Even the majority of firms from the service sector (mainly software firms) turned out to have international business activities, although the percentage of firms with foreign sales is smaller than in any aggregated manufacturing high-tech sector. Among the manufacturing industry, firms that belong to the sectors ICT-hardware, engineering, and health/life sciences more often export than other manufacturing firms. In the UK sample, all firms in the sectors ICT-hardware and health/life sciences even have international business activities. However, it should be mentioned that the number of observations in the two sectors ICT-hardware and health/life sciences is rather small. In Germany, there are only 5 ICT-hardware firms (15 firms in health/life sciences) that answered both surveys, in the UK there are 12 ICT-hardware firms (10 firms in health/life sciences).15

15 In fact, in contrast to the first survey where we didn’t find a bias with respect to sector, the sector of ICT-hardware is underrepresented in the German as well as in the UK sample. On the other hand, the sector health/life sciences (engineering) is overrepresented in the German (UK) sample.
When calculating the percentages of firms with foreign sales for the complete cross section of the 1997 survey, the percentages turn out to be in general smaller compared with the respective values of those firms that participated in both surveys and that are considered in Table 2. There are two possible selection processes that can lead to this result. Firstly, firms that answered the second survey may behave differently compared with the complete target sample of the 2003 survey. Since we didn’t carry out a non-response analysis, we don’t know whether there are differences between respondents and non-respondents in 2003, but the relatively high response rate is an indication that this interpretation is not very likely. Secondly, today’s still living firms may behave differently in 1997 compared with the whole cross section in 1997, i.e. including those firms that have already died since the first survey has been conducted. The higher percentage of internationally active firms in 1997 among those who survived the following six years may serve as an indication of a positive correlation between internationalisation and performance that needs further research but that is beyond the scope of this paper.\(^\text{16}\)

As Table 2 further shows, there is a slight increase in the firms’ international engagement between 1997 and 2003 in all sectors with the exception of other manufacturing firms in the UK. Apart from this sector, the share of firms with exports in 2003 is at least as high as in 1997. These numbers, however, don’t allow us to see how many firms have newly entered the foreign market for the first time since 1997 and how many firms have left the market. Roberts and Tybout (1997) have already shown that, although there is a high persistence in the individual status of internationalisation due to sunk costs, quite a high number of firms changes the internationalisation

\(^{16}\) The effect of internationalisation on firm survival has been examined for example by Bernard and Jensen (1999).
status, leading to entry and exit over time. The development of the status of internationalisation of the firms in our sample is listed in Table 3. This table also includes a separate column for the time of start-up. A firm is defined to have international sales at time of start-up, if it entered its first foreign market no later than one year after firm formation. These firms are called “infant multinationals” (Lindqvist 1991) or “born globals” (McKinsey 1993a).

Table 3: Development of the Status of Internationalisation

<table>
<thead>
<tr>
<th>Foreign sales (yes=1)</th>
<th>Germany</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1997</td>
<td>2003</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
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<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>94</strong></td>
</tr>
</tbody>
</table>

Source: ZEW, University of Exeter, own calculations.

About a quarter of all firms has international sales shortly after the firm was founded. Further, just under 31 \% of German firms and 46 \% of the firms in the UK didn’t export at time of start-up, but they were internationally active when the two surveys were conducted. On the other hand, 16 \% of German and almost 14 \% of UK firms never had any international sales. More interestingly for the purpose of this paper are those firms that have changed their status of internationalisation. Ignoring for the moment the firms’ behaviour at time of start-up, nearly 12 \% of German and 8 \% of UK firms have left the international market between 1997 and 2003. During the same time period, 14 \% of German firms and 8 \% of firms sited in the UK have entered the international market. Thus German high-tech firms more frequently change their status of internationalisation whereas UK firms show a higher persistence in their internationalisation behaviour.

The analysis of the development of the status of internationalisation in this paper has, however, one shortcoming. We can only determine the status in the year 1997 and 2003 respectively. We don’t know, whether firms had foreign sales in each year or whether they exit from the foreign market for a couple of years and re-entered just before the second survey has been conducted. In other words, we don’t have information of the firms’ export status trajectories on an annual basis.
4 Econometric Implementation

This paper concentrates on entry in and exit from the international market. Since the firms are observed only two times, dynamic probit models as they were used by Roberts and Tybout (1997) or Bernard and Jensen (2001) (see section 2) are not suitable for our data set, since strong restrictions would have to be imposed to identify the model (cf. Honoré and Kyriazidou 2000). Instead, I estimate the probability of a transition from one status of internationalisation to another or the same status in the next period. I apply a model inspired by Gouriéroux (2000) and used by Van Phu et al. (2000) in order to estimate the transitions between different states of firm performance.

As before, let \( Y_{it} \) denote the status of internationalisation \( j \) in which firm \( i \) is in time \( t \), with \( Y_{it} = 1 \) if firm \( i \) exports in time \( t \) and \( Y_{it} = 0 \) otherwise. The transition probabilities are modelled with the logistic formulation and depend on a set of explanatory variables. The probability of transition of firm \( i \) from status \( j \) in \( t-1 \) to status \( j' \) at time \( t \) is then given by

\[
(7) \quad P_{ij'}(t) = P(Y_{it} = j' | Y_{it-1} = j) = \frac{\exp(x_i \beta_{j'})}{\sum_{j=0}^{1} \exp(x_i \beta_{j'})},
\]

\( i = 1, \ldots, N, \ t = 0, 1, 2, \) and \( j, j' = 0, 1. \)

Imposing the identifying restriction \( \beta_{j0} = 0 \), we obtain

\[
(8) \quad P_{i0}(t) = \frac{1}{1 + \exp(x_i \beta_{1})},
\]

\[
(9) \quad P_{i1}(t) = \frac{\exp(x_i \beta_{1})}{1 + \exp(x_i \beta_{1})},
\]

with \( j = 0, 1. \) Thus, a logit model is specified for each row of the transition matrix. Let us define \( n_{i,t-1,t}(jj') = 1 \) if firm \( i \) occupies status \( j \) in \( t-1 \) and status \( j' \) at time \( t \), and 0 otherwise. Then the log-likelihood conditional on the status occupied at time \( t-1 \) is

\[
(10) \quad \ln L = \sum_{j=0}^{1} \sum_{j' = 0}^{1} \ln L_{ij'}, \quad \text{with} \quad \ln L_{ij'} = \sum_{i=1}^{N} \sum_{t=1}^{3} n_{i,t-1,t}(jj') \ln P_{ij'}(t).
\]
Since the quantity $\sum_{j=0}^{1} \ln L_{jj'}$ only depends on $\beta_{j1}$, the maximum likelihood estimators $\hat{\beta}_{j1}$ can be obtained by individually maximizing the elements of $\sum_{j=0}^{1} \ln L_{jj'}, j = 0, 1$.\(^{17}\)\(^{18}\)

In order to discriminate between firms that have entered the international market and firms that stay absent from the foreign market, I estimate a conventional logit model. Regarding the second element of the log-likelihood function, where I distinguish between firms that continued to have international sales and firms that left the international market between the two observed points in time, the problem occurs that an exit from the foreign market is rare compared with the event of staying internationally active. Based on McCullagh and Nelder (1989), King and Zeng (2001) show that in rare events data in finite samples the maximum likelihood estimator $\hat{\beta}$ is biased and that the bias is amplified the smaller the proportion of the rare event. Moreover, the estimated probability of the rare event, in our case the estimated probability of exit from the foreign market $\hat{P}_{h0}$, is too small, and hence the probability of the more frequent event, i.e. the probability of staying in the international market $\hat{P}_{h1}$, is overestimated.

King and Zeng (2001) show that the bias of $\hat{\beta}$ can be calculated applying a weighted least-squares estimation and thus leading to a bias-corrected estimate of $\beta$, denoted $\tilde{\beta}$. Furthermore, King and Zeng derive an analytical approximation for estimating the probability $P_{h1}$ as

\[
P_{h1} = \frac{1}{1 + \exp(x_i\tilde{\beta}_{l1})} + C_i = \tilde{P}_{h1} + C_i,
\]

\(^{17}\) It is important to note that the dependent variable is the transition probability and not the individual firm. Provided that there are no missing values for the independent variables, a single firm will enter the log-likelihood function twice: with the transition probability from the start-up period to 1997 and with the transition from 1997 to 2003.

\(^{18}\) I have also extended this model by allowing for the possibility of random effects, one for each firm and for each type of transition as proposed by Van Phu et al. (2000). The linear index, the transition probabilities depend on, now becomes $x_i\beta_{jj'} + \sigma_{\gamma'} u_{ij}$. The terms $\sigma_{\gamma'} u_{ij}$ are assumed to be mutually independent and independent of $x$, with mean 0 and variance $\sigma_{\gamma'}^2$. The random variable $u_{ij}$ has been assumed to be standard normal distributed. The parameters $\sigma_{\gamma'}$ have to be estimated. This model has been estimated by simulated maximum likelihood. However, a likelihood ratio test of the restricted model (i.e. with all $\sigma_{\gamma'}$ set to 0) against the unrestricted model cannot reject the Null hypothesis (LR $\chi^2(4) = 5.702; [\text{Prob} > \chi^2] = 0.223$). Apparently, the large set of firm-specific variables in my estimation equation (see below) is able to discriminate between exporters and non-exporters, i.e. a large part of firm-specific heterogeneity is in fact observed. Therefore, in the following I will restrict my analysis on a model without simulated heterogeneity.
where the correction factor is

\[
C_i = \left(0.5 - \hat{P}_{i1}\right)\hat{P}_{i1}\left(1 - \hat{P}_{i1}\right)x\text{Var}\left(\hat{P}_{i1}\right)x_i. \quad \text{(12)}
\]

The estimator \( \hat{P}_{i1} + C_i \), which is called an approximate Bayesian estimator, is not unbiased but it is superior in the sense that it has a smaller mean square error than other estimators of \( P_{i1} \) (see King and Zeng 2001). Therefore, I use this rare event logit model to estimate the second element of the log-likelihood function in equation (10).

The vector of explanatory variables \( x_i \) may contain both firm-specific variables, denoted \( Z_i \) in equation (5), and variables exogenous to the firm, denoted \( X_i \). According to the trade theories the dynamic model of Roberts and Tybout (1997) is based on (cf. Baldwin and Krugman 1989, Krugman 1989), exchange rates are supposed to play a crucial role in influencing a firm’s export decision. To determine the effect of an exchange rate movement, I constructed weighted real exchange rate indices for the euro (Deutsche Mark) and the British pound for each of the five high-tech sectors defined in Table 5. The weights are the share of exports of the respective industry to the industry’s ten most important export countries as revealed by the 1997 survey, computed separately for German and UK firms. Calculating exchange rate indices in this way, we are in principle able to estimate the reaction of (potential) exporters to changes in prices on the industry’s most important foreign markets (cf. Bernard and Jensen 2001). However, since the firms in the sample are observed only twice, the weighted exchange rate indices take only two different values for each industry in Germany and the UK respectively. Moreover, the calculated indices show only minor movements in the weighted real exchange rates of the euro (Deutsche Mark) or the pound from 1997 to 2003. As a consequence, in a logit regression the variable “industry real exchange rate” interacts with the integer. In fact, including the index in a regression with an integer leads to a numerically high point estimator of the integer, which is nevertheless not significant due to a very high standard error. For this reason, I decided to estimate the logit model without an integer but including the real exchange rate.

\[\text{[19]}\quad \text{For simplicity, I have neglected the time subscript } t \text{ in this formula.}\]


\[\text{[21]}\quad \text{The nominal exchange rate of the euro and the pound to the most important foreign currency, the US dollar, indeed changed significantly during the period from 1997 to 2003. But in 1997, the average rate was nearly the same as the average rate in 2003.}\]
Firm-specific variables can be derived from the literature of international management. Four dimensions of firm characteristics will be considered: firm size and age, R&D activities, product characteristics, and human capital and management capabilities.

Firm size and age are important elements of the internationalisation process model and of the stage models. If a firm increases its international activities gradually as predicted by the stage models of internationalisation, it will start with no international activities and will enter its first (unknown) foreign market at a later stage of its life cycle. Therefore, we hypothesise that firm age, measured by the logarithm of firm’s age at time of the respective survey, is positively correlated with an arrival status (status \( j \) at time \( t \) in equation (10)) “exporter”. Similarly, Johanson and Vahlne (1990) state that larger firms possess more resources and are more likely to take larger internationalisation steps - independent of their age. Thus, we can expect that firm size, measured by the logarithm of the firm’s number of employees at time of the respective survey, increases the probability of staying an exporter or of changing the internationalisation status in order to become an exporter at time \( t \).

Resource-based theories emphasise that firms discriminate from their rivals by intangible resources. One way to gain such firm-specific assets that are imperfectly imitable by other firms is by conducting R&D activities and by developing novel technology to produce the firm’s product (cf. Bürgel et al. 2000). Firms’ R&D activities are measured by the percentage of R&D expenditures of total sales. A higher R&D intensity should lead to a higher propensity of being engaged in international markets. Further, firms were asked to describe the innovativeness of their best selling product or service by indicating the technology incorporated in the firm’s product. In the econometric analysis, a dummy variable will be included the takes the value 1, if, according to the firms’ representatives, the technology used by the firm can best be described as “tried and tested technology”. We suppose that the use of “tried and tested technology” negatively affects the firms inclination to export to a foreign market, since such a technology can easily be imitated by the firm’s rivals.

Product characteristics may influence the internationalisation behaviour of firms. High customisation requirements may act as a constrain to enter the foreign market, since they involve close contacts to end-users, inducing high transaction costs prior to selling the product. Similarly, regular maintenance and the necessity of frequent upgrades lead to high transaction costs after the product has been sold (cf. Williamson 1985 for a presentation of transaction cost economics). The questionnaires used in both surveys measure the degree of customisation and necessary maintenance on a five point Likert scale ranging from 1 “unimportant” to 5 “very important”. For the
econometric estimations, two dummy variables are used that take the value 1, if the firm has classified the requirement of customisation and maintenance respectively as “important” (4) or “very important” (5). Moreover, a dummy variable that indicates whether the firm’s best selling product is sold to end-users is included. This variable is also hypothesised to reduce the probability of staying or getting an exporter due to higher communication and distribution costs when selling a product to end-users.

Human capital and the capabilities of the management team are highlighted by all presented theories of international management in section 2. As an exclusion of the internationalisation process model, Johanson and Vahlne (1990) mention the possibility that the necessary knowledge to reduce uncertainty about a foreign market can be acquired by employing an international experienced manager. Therefore, the firms were asked, whether a member of the firm’s management team has work experience abroad or whether a manager was educated abroad before joining the company. These factors can also be regarded as constituting an intangible asset that is decisive for the firms’ internationalisation behaviour from a resource based view of the firm. However, not only former experience but also and in the first line capabilities and skills that are in concrete available from the members of the management team are likely to increase the probability of an international engagement. Therefore, we asked the firms’ representatives to indicate on a five point Likert scale, whether they experience a shortage of skills in different areas, among them sales, distribution, production, and R&D. The econometric model will include two dummy variables that take the value 1, if the firms’ manager experience a “serious” (4) or a “very serious shortage” (5) in sales/distribution and production/R&D respectively. These two variables also reflect the entrepreneurial perspective developed by Andersson (2000). The absence of a serious shortage in sales and distribution may reflect that the manager behaves like a marketing entrepreneur who proactively creates the internationalisation process of his firm. On the contrary, the absence of a shortage in production or R&D may be a hint for a technical entrepreneur, who is mainly interested in technology and the development of the production process.

Moreover, the econometric model includes two dummy variables that point out whether a firm is sited in West Germany and East Germany respectively. The empirical analyses based on the cross section of the first survey revealed a significant positive marginal effect on the propensity to internationalise of West German firms compared with East German and UK firms, whereas there was no difference between East German and UK firms (see Bürgel et al. 2000). Hence, I distinguish not only between German and UK firms but also between West and East German firms in order to reconsider this effect observed in the first survey. Finally, I add industry dummies to the estimation equation. As Table 2 shows, in the manufacturing sectors ICT-hardware and health/life
sciences almost 100 % of the firms have international sales in 1997 and 2003 respectively. Including a dummy variable for the manufacturing sector health/life sciences therefore leads to the inclusion of a variable that perfectly predicts the international engagement of firms in this sector. Hence, I include only three dummy variables for the sectors engineering, ICT-hardware, and a combined dummy variable for the sectors health/life sciences and other high-tech manufacturing industries, thus using the software/service industry as the base category.

5 Empirical Results

The results of the empirical model are given in Table 4. The second column shows the vector of coefficients $\hat{\beta}_{01}$, explaining the transition from the status “non-exporter” at time $t-1$ to the status “exporters” at time $t$, or, in other words, explaining foreign market entry. The third column includes the vector $\hat{\beta}_{11}$ that discriminates between firms that stay in the international market (transition from status “exporter” to status “exporter”) and firms that exit from the international market. Remember that the coefficient vectors $\hat{\beta}_{00}$ and $\hat{\beta}_{10}$ were set to 0 in order to identify the model.

An appreciation of the industry real exchange rate reduces the probability of entering the foreign market. On the other hand, there is no effect of the exchange rate on probability to exit. This result is consistent with the existence of sunk costs: a depreciation of the domestic currency increases the number of exporting firms, but a subsequent appreciation doesn’t reduce the number of exporters by the same amount, because, once entered, firms keep on exporting in order to avoid re-entry costs. However, since the firms are observed only twice with a six year lag between the two surveys, the results are not a proof of the sunk costs hypothesis but consistent with the theory of sunk costs and with other empirical studies (e.g. Roberts and Tybout 1997, Bernard and Jensen 2001).

---

22 As mentioned above, the dependent variable in the logit models is the transition between different states of internationalisation. Due to some missing values in the independent variables, we don’t observe firms with varying transitions in the sector health/life sciences. This is not the case for ICT-hardware firms so that the respective dummy variable is not a perfect predictor.

Table 4: Propensities of Transition

<table>
<thead>
<tr>
<th>Transition</th>
<th>Transition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>non-exporter → exporter</td>
</tr>
<tr>
<td></td>
<td>Logit model</td>
</tr>
<tr>
<td>Number of observations = 150</td>
<td>LL = -67.953</td>
</tr>
<tr>
<td></td>
<td>chi² (17) = 48.12</td>
</tr>
<tr>
<td></td>
<td>Prob &gt; chi² (17) = 0.000</td>
</tr>
<tr>
<td></td>
<td>McFadden’s R² = 0.307</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Coeff.</th>
<th>Robust stand. error</th>
<th>Coeff.</th>
<th>Robust stand. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry real exchange rate</td>
<td>-0.360</td>
<td>0.017 **</td>
<td>0.158</td>
<td>0.022</td>
</tr>
<tr>
<td>West-German</td>
<td>-0.696</td>
<td>0.583</td>
<td>0.329</td>
<td>0.839</td>
</tr>
<tr>
<td>East-German</td>
<td>-1.387</td>
<td>0.640 **</td>
<td>-0.982</td>
<td>0.965</td>
</tr>
<tr>
<td>Engineering</td>
<td>0.828</td>
<td>0.593</td>
<td>1.787</td>
<td>0.917 *</td>
</tr>
<tr>
<td>ICT-Hardware</td>
<td>2.576</td>
<td>1.193 **</td>
<td>0.419</td>
<td>1.159</td>
</tr>
<tr>
<td>Other manufacturing industries</td>
<td>1.466</td>
<td>0.592 **</td>
<td>0.830</td>
<td>0.807</td>
</tr>
<tr>
<td>Log (number of employees)</td>
<td>1.228</td>
<td>0.279 ***</td>
<td>0.566</td>
<td>0.335 *</td>
</tr>
<tr>
<td>Log (age)</td>
<td>0.604</td>
<td>0.557</td>
<td>-0.790</td>
<td>0.753</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>0.052</td>
<td>0.028 *</td>
<td>0.057</td>
<td>0.035 *</td>
</tr>
<tr>
<td>Tried and tested technology</td>
<td>-0.041</td>
<td>0.497</td>
<td>-0.297</td>
<td>0.646</td>
</tr>
<tr>
<td>Working experience abroad</td>
<td>0.837</td>
<td>0.475 *</td>
<td>0.675</td>
<td>0.790</td>
</tr>
<tr>
<td>Education abroad</td>
<td>-0.710</td>
<td>0.750</td>
<td>1.553</td>
<td>0.790 **</td>
</tr>
<tr>
<td>Shortage in competencies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales/distribution</td>
<td>0.089</td>
<td>0.516</td>
<td>0.153</td>
<td>0.595</td>
</tr>
<tr>
<td>Production/R&amp;D</td>
<td>-0.915</td>
<td>0.596</td>
<td>0.071</td>
<td>0.700</td>
</tr>
<tr>
<td>Intense product customisation</td>
<td>-1.168</td>
<td>0.491 **</td>
<td>-1.749</td>
<td>1.056 *</td>
</tr>
<tr>
<td>Regular maintenance and upgrades</td>
<td>-0.260</td>
<td>0.460</td>
<td>-0.691</td>
<td>0.724</td>
</tr>
<tr>
<td>Consumer good</td>
<td>-0.556</td>
<td>0.501</td>
<td>0.584</td>
<td>0.723</td>
</tr>
</tbody>
</table>

* 10 % level of significance; ** 5 % level of significance; *** 1 % level of significance.

\(^a\) The value of the log-likelihood function and McFadden’s R² are not reported since the rare event logit is an unbiased estimator and not a likelihood technique. Thus, it doesn’t maximize a likelihood function.

Base category: UK software firm using “novel technology” with arrival status “non-exporter”.

Source: own estimation.

The country-specific dummy variables reveal a lower probability of East-German firms to enter the foreign market than both West-German and UK firms. East-German firms in our sample have been founded shortly after German reunification. Foreign trade of former East Germany was traditionally oriented towards Eastern Europe and all East-German firms had to learn how to access Western European markets. Of course, since the firms in our sample are newly founded firms, all individual firms had to learn about a potential foreign market in order to reduce the uncertainty of their first entry – whether they are sited in East Germany, in West Germany, or in the UK. However, West-German and UK firms may profit from regional spillover effects that
reduce the costs of entry into the foreign market but that don’t exist in Eastern Germany. In particular, the presence of multinational firms may increase the availability of specialised capital and labour inputs, thereby facilitating foreign market entry for future exporters (Aitken et al. 1997). In Eastern Germany, multinational firms were absent at least in the first years after German reunification. On the other hand, once the firms have overcome the barrier of the first foreign market entry, there is no significant difference with respect to market exit between firms from West Germany, East Germany, and the UK.24

Comparing this results with the estimated propensity to internationalise of the first survey, we see that in contrast to earlier results25, West-German firms no longer have a higher probability of exporting than UK firms. Thus when regarding a longer time period, the difference between West-German and UK firms that was observed during the firms’ early stage period disappears.

Firms from the manufacturing sectors ICT-hardware and other manufacturing industries (including health/life sciences) have a higher probability to enter the foreign market compared with engineering and software firms. Software and service firms often offer their services locally, acting as contract developers for larger firms. The lower probability of foreign market entry by software/service firms is consistent with the descriptive statistics in Table 2. Surprisingly and in contrast to the descriptive analysis, engineering firms differ from the two other manufacturing sectors. They also have a lower probability of entering the foreign market. Possibly, there are industry specific entry costs that are not captured by the remaining firm-specific variables. High entry costs might hamper engineering firms in starting exporting. Given the earlier descriptive results that the share of engineering firms with international sales is comparable with the other manufacturing sectors, we might conclude that engineering firms are better equipped with assets that enhance their international business activities so that they are able to overcome the possibly high industry specific entry barriers. The existence of high entry costs in engineering industries is also supported by the estimated exit probability. Engineering firms have a lower probability to exit from the international market compared with all other industry sectors. If there are high entry costs, engineering firms will tend to avoid these high industry specific re-entry costs by staying in the international market. On the other hand, if re-entry costs do not vary significantly between the

24 Bernard and Jensen (2001) tested for geographical spillover effects in the US manufacturing industry, but they didn’t find any evidence for the existence of spillover effects that were hypothesised to reduce entry costs. According to the authors, this may result from the selection of only large manufacturing plants.

25 In this section, in some cases it seems reasonable to compare the empirical results of this paper with the results of the cross-sectional analyses of the first survey. The results of the first survey are given in Bürgel et al. (2000) and I will refer to this report although I will not mention it explicitly in each case.
other industries, firms will leave the international market with the same probability. This includes software firms once they have entered the foreign market.

As predicted by the internationalisation process model, larger firms, measured by the logarithm of the number of employees, are more likely to enter the international market. We should, however, be careful when interpreting the correlation between firms’ export behaviour and firm size. There is an intense discussion in the empirical literature about the causality between export and performance, and a large firm size can be regarded as an outcome of good firm performance in the past. Bernard and Jensen (1999) appropriately entitled their paper “Exceptional exporter performance: cause, effect, or both?”. The result of the latter paper is very clear-cut: “Good plants become exporters”, (Bernard and Jensen 1999, p. 23).26 Taken this result as given, the empirical specification of this paper is correct: an above average employment growth rate prior to the time of the survey, leading in average to a higher observed number of employees, causes a higher probability to enter the international market. The direction of causality is beyond the scope of this paper. Nevertheless, we might suspect that the very clear result that good firms become exporters will not hold for our sample of young high-tech firms, since we observe a fairly high number of firms that export from start-up (“born globals”). For born globals it is just not possible that they have grown faster in the years prior to the start of their international activities as it is the case for the US manufacturing firms studied by Bernard and Jensen. Thus, the estimated positive correlation between firm size and international business activities in this paper might reflect reverse causality or a feedback relationship between these two variables so that firm size would be endogenous in the above regression.

The relationship between firm size and the predicted probability of entering the foreign market is depicted by the upper left graph in Figure 1 in the appendix. Setting all other variables to their mean, the graph clearly reflects the positive correlation between the number of employees and the (predicted) propensity to internationalise. The graph has a relatively steep slope only if the number of employees is small. The predicted probability of entering exceeds 80 % for a number of 17 employees. Thereafter, the graph becomes flat reaching almost a 100 % probability of starting exports for firms with more than 100 employees. If there exists a minimum size for international business activities, it is quite low and overcome by the average firm in our sample.27

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26 This result is confirmed, for example, by Bernard and Wagner (1997), Clerides et al. (1998), and Arnold and Hussinger (2004).

27 Remember that the average firm of our sample had 19 employees in 1997 and 26 in 2003 (see section 3).
Firm size not only positively affects the probability of foreign market entry, it is also correlated with a higher persistence in the firms’ exporting activities, i.e. large firms exit from the foreign market with a lower probability than small firms. This result can be interpreted in two ways: Firstly, shrinking firms may stop exporting because they no longer have enough resources to carry out international business activities. Alternatively, an exit from the international market may cause a drop in the number of employees, e.g. because firms are no longer exposed to international competition and best practise technology, or because an exit signals failure to domestic customers (McKinsey 1993b, Bernard and Wagner 1997). As before, it is beyond the scope of this paper to analyse the direction of causality. In the literature, the relationship between foreign market exit and the development of employment is nearly neglected. One exception is the study of Girma et al. (2003) for UK firms. Applying matching techniques, they find out that employment and output fall in the year of exit and in the two subsequent years, while total factor productivity does not fall after exit. For German plants, Bernard and Wagner (1997) also find a significant drop in employment after exiting from the foreign market.

The upper right graph in Figure 1 depicts the predicted probability of staying in the international market in dependence of the number of employees, all other variables set to their mean. Since a market exit constitutes a rare event in our data, the predicted probability of staying an exporter is high, mostly exceeding 90 %. The graph shows that only firms with less than about 10 employees have a significantly lower probability of keeping on exporting. Interestingly, if international business activities require a minimum size, the threshold for staying in the foreign market is even smaller than the threshold for market entry. Once the firms have paid sunk entry costs like accessing information on foreign markets or setting up foreign sales channels, operating costs in the foreign market can in general be borne even by very small firms.

Firm age shows no significant effect on the transition probabilities. This result contradicts to the stage models of internationalisation. Interestingly, the cross-sectional analysis of the first survey resulted in a positive influence of firm age on the propensity of internationalisation. Obviously, when regarding a longer time period, firm age is no more relevant, probably because the surveyed

28 Setting all independent variables, including the number of employees, to their mean, the predicted probability of remaining an exporter in the rare event logit model is 93.31 %. In comparison, applying the conventional logit model, i.e. without the correction described in section 4, results in a predicted probability of 98.06 %. The observed share of transitions with an arrival status “exporter” is 90.27 %. Thus, both models, the rare event logit and the conventional logit model, overestimate the probability of the more frequent event and underestimate the rare event of foreign market exit. However, the bias is clearly smaller for the rare event logit model, which justifies the choice of applying the rare event logit estimator.
firms are now 12 years old in average and no longer belong to what is in general defined as newly founded technology oriented firms (see section 3). For “mature” high-tech firms, firm age seems to be unable to discriminated between exporters and non-exporters. The relationship between firm age and foreign market entry and exit is displayed in detail by Figure 1 in the appendix. Although the probability of market entry is positively correlated with firm age, reflecting an expansion of international business activities when the firms grow older, the prediction of market entry in the first years after firm foundation is associated with a high uncertainty. The predicted probability of staying an exporter has a negative slope. This is, however, a result of the composition of our sample: Nearly all exits from the foreign market occur between the 1997 and the 2003 survey. In 2003, firms are at least 7 years old. There is only one firm that left the foreign market between start-up and 1997. Thus for young firms, we de facto observe only transitions from the status of exporter to the status of exporter, resulting in a negative but insignificant coefficient.

The share of R&D expenditures to total sales is positively significant in both columns in Table 4, thus indicating a higher chance of arrival status “exporter” for firms that invest intensively in R&D. R&D activities can be expected to create assets within the firm that are difficult to imitate by the firm’s rivals and thus facilitate the internationalisation process of the firm as predicted by the resource based view of the firm. The positive relationship between R&D intensity and the predicted probabilities of transition can also be seen in the lower graphs of Figure 1. The coefficient of the second variable that was included in the estimation equation to approximate the innovativeness of the firms’ production process (dummy for “tried and tested technology”) shows the expected sign but is not significant at any conventional level of significance. Since both variables are intended to approximate the firms’ innovative production process, the effect of applying a “novel technology” (the base category to “tried and tested technology”) might already be covered by the R&D intensity. Moreover, it can be argued that a dummy variable indicating those firms that produce with tried and tested technology is no longer suitable to discriminate between firms as it was the case for the cross section of the first survey – at least for UK firms. In 2003, the share of firms that produce with a tried and tested technology is significantly smaller than it was in the cross section of the first survey. Firms that participated in both surveys have often changed their production technology from a tried and tested technology 1997 to a novel technology in 2003.\(^{29}\) Hence, this variable has no more discriminatory power.

\(^{29}\) Although we cannot prove it with our data, it is consistent to our results that using a novel technology is a pre-requisite to survive until 2003.
All cited theories from the field of international management emphasize the role of experienced managers for the internationalisation process. The results show that managers, who acquired international experience before entering the firm, facilitate the firm’s international business activities: If one member of the management team has work experience abroad, the firm is more likely to enter the foreign market. Similarly, if at least one manager was educated abroad, his firm is less likely to exit from the foreign market. Entering a foreign market obviously requires that the firm’s manager is familiar with foreign business practices and market conditions that can be best acquired by working abroad. A permanent international engagement, however, can be better assured by managers that have living experience abroad, gained while studying in a foreign country. Managers with living experience abroad are able to assess preferences and needs of foreign customers so that they can develop long-term business relations. This results both support the internationalisation process model, which states that an internationally experienced management team can overcome the uncertainty present in foreign markets, and the resource based view of the firm that regards international experience as an intangible asset that differentiates firms from their competitors. On the other hand, the entrepreneurial perspective of the firm cannot explain foreign market entry and exit. The (absence of) shortages in sales/distribution and production/R&D respectively are not significant in any of the two coefficient vectors. Performing a Wald test of joint significance cannot find any significant effect of the dummy variables of shortages in competencies either (transition from non-exporter to exporter: \( \chi^2(2) = 2.37, [\text{Prob } > \chi^2] = 0.306 \); transition from exporter to exporter: \( \chi^2(2) = 0.08, [\text{Prob } > \chi^2] = 0.959 \)).

As expected, intense customisation is a barrier for international business activities. Even firms that have exports tend to exit from the foreign market, probably because they have underestimated the costs that arise from the requirement of high customisation of their product. The necessity of regular maintenance and upgrades, on the other hand, doesn’t show any effect on the firms’ exporting activities. Furthermore, it is not important to whom the product is sold. The dummy variable identifying the product as a consumer good or service is not significant. Hence, assessing the chances and risks of an international engagement should not be done by identifying a typical customer of the firm’s product, but by evaluating the product’s transaction costs, especially the need of individual client customisation.

The empirical model fits well with the data. In the logit model explaining the determinants of a transition from the status “non-exporter” to the status “exporter”, McFadden’s R² reaches a value of 0.307. This value is quite high, indicating that a large part of firm-specific heterogeneity is in fact observed and able to discriminate between exporters and non-exporters. For the rare events logit model that determines the probability of staying an exporter, however, McFadden’s R² is not
of much use, because the rare event logit is an unbiased estimator that doesn’t maximize a likelihood function. In fact, the rare event logit estimator fits the data worse than the ordinary logit model, but the former has a smaller mean square error.

6 Conclusion

In order to fulfil the expectations put on them with respect to growth and job creation, newly technology based firms have to reach continuous long-term growth. It is often argued that sales potential in European domestic markets is insufficient for the amortisation of high product research and development costs so that long-term international business activities are seen as decisive for growth perspectives of NTBFs. This paper focuses on the long-term internationalisation behaviour as a potential basis of long-term firm development, although the relation of firm performance and internationalisation is left for future research. I have investigated a longitudinal data set of about 200 German and British technology oriented firms that have been founded in the period between 1987 and 1996 inclusively. The firms were contacted by two surveys conducted in 1997 and 2003 respectively. The first result of this study is that German and UK firms are broadly similar with respect to their internationalisation behaviour. With the exception that East-German firms enter the foreign market with a lower probability, I don’t find significant differences between the two countries.

The second result of this study already becomes apparent by the descriptive analysis. Although there is a high persistence in the firms’ international business activities, we observe entry in and exit from the foreign market. Only 15% of the firms in our sample never had international sales. The phenomenon of non-persistent export participation trajectories was already highlighted by Roberts and Tybout (1997) and confirmed e.g. by Bernard and Jensen (2001). Analysing long-term international business activities therefore requires examining both entry and exit. However, the theories from the field of international management that were described in this paper and that were used to identify firm-specific variables that may influence firms’ internationalisation behaviour (stage models of internationalisation, the entrepreneurial perspective of internationalisation) restrict themselves on foreign market entry. This paper extends this restricted view by examining empirically firm-specific characteristics that are, on the one hand, able to discriminate between firms that enter the foreign market and firms that stay absent from the international market, and, on the other hand, to discriminate between firms that exit from the foreign market and those that remain internationally active. Understanding why firms enter and exit the foreign market will help future research to explain the relation of performance and international business activities.
Former empirical studies of firms’ export activities focus on sunk costs as the main reason for the observed persistence in the firms’ export behaviour. Although our data set is not suitable to prove empirically the existence of sunk costs, our results are consistent with the sunk costs hypothesis. We not only observe a high persistence in the internationalisation status which can be expected if sunk costs are relevant. Moreover, some results of the logit regressions can best be interpreted by assuming the existence of sunk costs. Especially, the effect of the industry real exchange rate is consistent with the sunk cost hypothesis: a depreciation of the domestic currency promotes foreign market entry, but an appreciation has no significant effect on exit, probably because firms keep on exporting in order to avoid re-entry costs.

Sunk costs form an entry barrier to the international market. The ability of a firm to overcome this barrier is influenced by the firm’s idiosyncratic bundle of assets as predicted by the resource based view of the firm and as supported by the data. Especially, the results highlight the strategic role of investment in R&D. R&D activities generate assets by which a firm distinguishes from its rivals. These assets not only facilitate foreign market entry, they also support a long-term engagement in the international market. Firms that never had international sales until 2003 and firms that exit from the foreign market spend a significantly smaller share of total sales on R&D in 2003 as shown by the descriptive analysis. Just because all firms of our sample operate in high-tech sectors, the firms’ R&D activities constitute an essential asset that discriminates between firms and that is associated with the firms international business activities. Beside the R&D intensity, the international experience of the firms’ managers is an important asset that helps firms to internationalise. Interestingly, foreign market entry and exit depend on different knowledge. Whereas market entry requires that the firm’s manager is familiar with foreign business practices, staying in the foreign market is supported by a manager, who is able to assess preferences and needs of foreign customers.

The success of the firm’s international engagement finally depends on characteristics of the firm’s product. High client-specific product customisation is a barrier to entry into the foreign market. If the firm has to consider the special needs of each customer, it will be difficult to realise economies of scale and fully profit from the foreign market’s sales potential. Firms that have entered the foreign market with a product that requires intensive product customisation, have often stopped exporting, probably because they recognized that exporting is not profitable for them. Exporting a customised product may only be profitable if the firm can sell its product to a limited number of key foreign customers that represent sufficient sales potential for the supplying firm.
7 References


Bernard, A. B., and J. Wagner (2001), Export Entry and Exit by German Firms, in: Review of World Economics, 137 (1), 105-123.


European Commission. (2002), High-Tech SMEs in Europe, in: Observatory of European SMEs, No. 6, Luxembourg.


Appendix

Table 5: Definition of High-tech Sectors

<table>
<thead>
<tr>
<th>Aggregated industries used</th>
<th>NACE Rev. 1</th>
<th>Short description according to NACE Rev.1</th>
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<tbody>
<tr>
<td>R&amp;D Intensive Service Industries</td>
<td>64.20; 72.20; 72.30; 72.40; 72.60; 73.10</td>
<td>Telecommunication, Computer Programming and Software Services, Data Processing, Misc. Computer Services, R&amp;D in Natural Sciences and Engineering</td>
</tr>
<tr>
<td>ICT-Hardware</td>
<td>30.01; 30.02; 32.20; 32.30</td>
<td>Office Equipment; Computers and other Information Processing Equipment; Television and Radio Transmitters and Apparatus for Line Telephony and Line Telegrapghy; Television and Radio Receivers, Sound or Video Recording and Reproducing Apparatus</td>
</tr>
<tr>
<td>Engineering Industries</td>
<td>33.20; 33.30; 33.40</td>
<td>Electronic Instruments and Appliances for Measuring, Checking (except Industrial Process Control); Electronic Industrial Process Control Equipment; Optical Instruments; Photographic Equipment</td>
</tr>
<tr>
<td>Health and Life Sciences</td>
<td>24.41; 24.42; 33.10</td>
<td>Pharmaceutical Products and Preparations; Medical and Surgical Equipment and Orthopaedic Appliances</td>
</tr>
<tr>
<td>Other High-tech Manufacturing</td>
<td>24.16; 24.17; 31.10; 31.20; 32.10; 35.30</td>
<td>Plastics and Synthetic Rubber in Primary Form; Electric Motors, Generators and Transformers; Electricity Distribution and Control Apparatus; Electronic Valves, Tubes and other Components; Aircraft and Spacecraft Manufacturing</td>
</tr>
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</table>

Figure 1: Predicted Probability of Transition

Transition non-exporter $\rightarrow$ exporter (0$\rightarrow$1)

Predicted probability in dependence of the number of employees

Predicted probability in dependence of firm age (in years)

Predicted probability in dependence of R&D intensity (in %)

Solid line: predicted probability of transition in dependence of the continuous variable, all other variables set to their mean.
Dotted lines: simulated 90 % confidence interval, using 1,000 simulations for the transition from the status of non-exporter to the status exporter (left column) and 10,000 simulations for the transition from the status exporter to the status exporter (right column).
Source: own calculation.