High-Tech Firms' Long-Term Export Behaviour –

The Experience of German and UK Companies

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Preface

Shortly after I started to work at the Centre for European Economic Research (ZEW) in Mannheim in November 1998, the head of my department, Georg Licht, introduced me to the topic of internationalisation of young technology-oriented firms. At that time, a joint research team comprised of Oliver Bürgel and Gordon Murray from London Business School and Andreas Fier and Georg Licht from the ZEW was investigating a unique data set of 600 newly founded technology-oriented firms in Germany and the UK that were surveyed in winter 1997/1998. Although I did not contribute to the analyses of the Anglo-German research team at that time, I had the opportunity of doing some econometric research of my own. Thereby, I became familiar with the questionnaires the conducted survey was based on, the resulting data set, and the theoretical and empirical literature related to individual firms' export activities.

Thus, it was almost self-evident that when Gordon Murray (now working at the University of Exeter) and Georg Licht planned to contact the original sample of 600 respondent firms a second time via a telephone survey in 2003, I became a member of the new research team which was completed by Marc Cowling from London Business School. I greatly enjoyed the work on this research project, in particular, because I had the opportunity to participate in each individual step of the project – starting with the development of the questionnaires, through supervising the German telephone survey conducted at the ZEW, preparing the data set, and finally carrying out the empirical analyses that constitute the key part of this thesis. Using data of both the first and the second survey, I examined the long-term export behaviour of the firms sampled. Such a longitudinal perspective has rarely been found in the related literature to date, leading to new interesting research questions, some of which are investigated in this thesis.

Of course, the completion of this thesis was only possible with the help and the support of numerous individuals and institutions. First of all, I gratefully acknowledge financial support from the HSBC Innovation and Technology Group and the Anglo-German Foundation for the Study of Industrial Society which financed the 2003 survey. Further, I thank the Centre for European Economic Research (ZEW) for providing me with the opportunity to write my thesis whilst working at the institute for the last two years.

Special thanks go to my supervisor Joachim Wagner. Since individual firms' export behaviour belongs to his main research interest, it was an optimal decision to contact him and he fortunately agreed to supervise my dissertation. However, Joachim Wagner did not only make useful suggestions in terms of the theoretical background, the econometric methods applied, and the interpreta-

tion of the empirical results. He also always encouraged me to realise my ideas and always promptly answered my questions. In these ways, he contributed significantly to the rapid completion of this thesis.

Since this study is an empirical work, its quality heavily depends on the data set used for the analyses. Thus, I am deeply indebted to Oliver Bürgel, Andreas Fier, Georg Licht, and Gordon Murray for their efforts in conducting the 1997 survey and preparing the resulting data set. To the same degree, I am obliged to Marc Cowling, Georg Licht, and Gordon Murray for their valuable contributions in our joint work on the research design of the second survey and the development of the questionnaires used for the computer-aided telephone interviews in 2003. I also thank Thorsten Doherr for programming both the German and the English versions of the questionnaires. Special thanks go to Marc Cowling and Gordon Murray for carrying out the 2003 survey in the UK.

The empirical analyses of this thesis are actually an extension of the 1997 study. Thus, when carrying out my empirical research, I not only profited from the data the Anglo-German research team collected in 1997. I also benefited from the corresponding research report when it came to the specification of my econometric models and the interpretation of the results. The careful work of the research team that conducted the first survey is therefore gratefully acknowledged. Helpful comments and proposals that significantly improved different parts of this study were also put forward by Dirk Czarnitzki, Ulrich Kaiser, François Laisney, and Michael Woywode and are highly appreciated.

Furthermore, I thank Marc Rennert, Martin Becker, Natalie Gaier, Stefan Hoffmann, and Thea Platz for their competent research assistance and Tyler Schaffner and Andrew Flower for excellent proofreading. Last but not least, many thanks go to my colleagues at the ZEW who patiently endured me and my bad moods on days when I was frustrated by the work on this thesis and dissatisfied with the progress I made. Today, however, having successfully completed my thesis, I primarily think back to the pleasure I had when dealing with the interesting topic of the internationalisation of firms and I hope that this pleasure is reflected for the reader of the following pages.

Helmut Fryges

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1 Introduction

Since the late 1970s, small and medium-sized enterprises (SMEs) have attracted growing attention from both policy makers and academics. In his pioneering study, Birch (1979) pointed out that about two-thirds of all new jobs created in the USA in the period from 1969 to 1976 can be attributed to the expansion of small firms with less than 20 employees. Birch's study led to an extensive debate on the contribution of SMEs to total employment and to the net creation of new jobs (see Storey [1994] for an overview). Although Birch's methodology was subsequently criticised and many scholars argued that he overestimated the extent of jobs created by SMEs (cf. Davis et al. 1996), it is today unquestioned that SMEs do in fact provide a large number of new jobs.[1]

Within the larger group of SMEs, the interest of economists and politicians is focused in particular on newly founded technology-based firms (NTBFs). Although NTBFs constitute the smallest players in high-tech sectors, the highest hopes with respect to employment creation are placed upon them – or at least have been in the past: During the late 1990s, exaggerated expectations and investors' hopes contributed to the high-tech bubble on stock markets that burst in 2000 (cf. Bank of England 2001). In today's post-bubble world, former expectations and hopes have been reduced. Nevertheless, the potential of NTBFs to create jobs is still a subject of intense discussion among policy makers and economists.

Although policy makers may primarily be interested in job creation, only those firms that possess a competitive advantage over their rivals are able to fulfil this expectation (Porter 1985). The ability of a high-tech start-up[2] to grow and provide new jobs thus depends essentially on its innovative capacity. NTBFs are therefore also expected to play an important role with respect to innovation, structural change, and regional development. NTBFs may contribute to the effective dissemination and commercialisation of knowledge, in particular of knowledge generated at universities and other public research institutions (e.g., institutes of the Max Planck Society in Germany). Scientists from universities or research institutes may decide to start an NTBF – a spin-off – to commercialise their scientific insights.[3] This is probably the most direct way of knowledge transfer from

1 In their study on Germany, Boeri and Cramer (1991) revealed that in the period from 1977 to 1987 newly founded SMEs created 750,000 new jobs, whereas incumbent companies that already existed in 1977 increased the aggregated number of employees by only 350,000.

2 The terms "new technology-based firm" (NTBF) and "high-tech start-up" will be used interchangeably in this study.

3 Egeln et al. (2003b) provided a comprehensive study on public research spin-offs in Germany.

academia to industry. Moreover, entrepreneurs of NTBFs often cooperate with scientists from universities and research institutes (see Beise et al. 1995), transferring knowledge and technology into their production processes and incorporating it into their products and services. Finally, NTBFs themselves carry out substantial research and development (R&D) activities. Therefore, NTBFs are an important element of a country's innovation system.

All highly developed countries are currently evolving towards knowledge-intensive economies. Traditional industries like mining and quarrying or iron and steel manufacturing are stagnating or decreasing, reducing their number of employees and gross value added. Conversely, new industries like computer manufacturing, data processing, and biotechnology are arising. Moreover, in today's developed economies service sectors surpass manufacturing sectors with respect to employment, gross value added, and growth. NTBFs are a driving force of an economy's structural change. They are by definition founded in high-technology, presumably growing industries, thus increasing a country's stock of knowledge-intensive enterprises. They contribute to the transfer and commercialisation of research results (see above), create knowledge-based workplaces, and produce high-tech products and services. A country's structural change is, however, not restricted to knowledge-intensive industries. Companies operating in traditional industries like machinery or motor vehicle manufacturing may purchase NTBFs' products and services, integrating them as investment goods into their production processes or incorporating them as intermediate goods or business services into their own products. Thus, NTBFs aid incumbent firms in restructuring their production processes and improve the innovativeness of their products.

Policy makers' interest in the regional development role of NTBFs was in particular induced by the economic growth of concentrated areas of high-technology activity in the United States from the early 1970s. California's Silicon Valley and Route 128 around Boston, Massachusetts, are still the most prominent examples policy makers refer to when discussing regional technology clusters. Although there are no comparable European regions exhibiting such a concentration of incumbent and newly founded high-tech firms cooperating with each other in established networks, some European regions (e.g., Cambridge UK, Munich, Milan) were quite successful in attracting firm formations in high-technology industries. NTBFs may improve supply conditions and regional competitiveness as well as reducing the regional unemployment rate by creating new jobs[4]. Keeble (1989) and Murray (1998) found empirical evidence of the contribution of NTBFs to the development of fast-growing regions in Europe.

[4] Conversely, the market entry of high-tech start-ups may also endanger jobs since incumbent competitors may be crowded out (cf. Fritsch and Müller 2004).

In order to fulfil the expectations and hopes placed upon them, an international orientation is regarded as crucial for high-tech SMEs and, in particular, for NTBFs. The 2002 Observatory of European SMEs (European Commission 2002) highlighted that in 1998/1999, 65 % of all high-tech SMEs from ten European countries were operating internationally and receiving 19 % of their turnover from sales abroad. Since it is often argued that sales potential in European domestic markets is insufficient for the amortisation of high product research and development costs (see, e.g., McDougall et al. 1994, Bürgel et al. 2004), international business activities are expected to help European NTBFs amortise R&D costs, thereby enabling them to realise the expectations of policy makers and academics.

Entering the international market can be regarded as one of the greatest challenges faced by NTBFs. Firms are confronted with different market regulations and foreign social norms. Therefore, they have to collect information about the foreign business environment, which is an expensive and time-consuming task. Moreover, firms have to conduct a marketing campaign, set up foreign sales channels, and adapt their products and services to foreign regulatory requirements. Of course, these costs must be borne by all firms when entering a new target market – irrespective of their size and age. However, large firms can be assumed to possess more financial resources, enabling them to bear the additional costs of an international engagement. Furthermore, large companies may be able to place the responsibility of planning and organising foreign market entry on a qualified and experienced member of their workforces, whereas entrepreneurs of small, newly founded firms have to carry out all of the tasks related to an engagement in the foreign market themselves. Similarly, old firms that enter into the international market during a later stage of their life cycles are presumably established in their domestic markets. At the time they initiate their international business activities, they have probably already realised efficiency gains due to learning processes (Ericson and Pakes 1995, Jovanovic 1982). Conversely, newly founded firms do not yet know the value of their business ideas. Particularly in high-tech industries, launching a new product or service is connected with high uncertainty as to whether the new product will be accepted by the market. Thus, when entering the foreign market, a high-tech start-up is not yet established in its domestic market, does not yet fully exploit potential efficiency gains from learning processes and tends to export a product that has not yet proven its competitiveness. Nevertheless, it is now established knowledge that a relatively high percentage of NTBFs are internationally active shortly after their inception ("infant multinationals", Lindqvist 1991, "born globals", McKinsey 1993a).

How can NTBFs, the smallest players in the high-tech market, cope with the challenges of an international engagement? To what extent do NTBFs actually have international sales? What are

the differences between internationally active firms and those which only sell their products on the domestic market? Does exporting in fact improve the performance of NTBFs and help them fulfil the expectations placed upon them? These were the primary questions a joint research team comprised of analysts from the London Business School and the Centre for European Research (ZEW) intended to answer. To this end, the Anglo-German research team contacted a stratified random sample of German and UK-based NTBFs founded between 1987 and 1996 by sending out a written questionnaire in 1997/1998 (see Bürgel et al. 2004). It turned out that about two-thirds of the 600 responding firms had international sales at the time of the survey. Further, the sample's exporters generated 33 % of their total sales in the foreign market. These figures are very impressive, considering the barriers to foreign market entry discussed above. The 1997 study was also able to ascertain firm-specific characteristics that facilitate a firm's export activities: The probability of entering the foreign market increases with the firm's age and size, with R&D intensity (measured by a firm's expenditure on R&D as a percentage of total sales), and with firm managers' international experience. Conversely, an international engagement is impeded if the firm's product is highly customised. Finally, the Anglo-German research team found out that exporting did indeed improve the firms' labour productivity and increased their annualised sales growth rates between start-up and the time of the survey (i.e., 1997), but did not affect employment growth. This is an encouraging result for policy makers, although internationalisation did not have any impact on employment growth, that is, the number of new jobs created by NTBFs.

Of course, the internationalisation of firms has multiple dimensions (cf. Sullivan 1994b). In addition to their export activities, firms may import investment goods or components, i.e., internationalise on the procurement market. They may persuade foreign investors to invest in their company or they may themselves invest in foreign companies or build up a production subsidiary of their own abroad. Although imports of investment goods or components may be very important for small high-tech firms, it must be emphasised that the Anglo-German research team that conducted the survey in 1997 neglected these dimensions of a firm's internationalisation (cf. Bürgel et al. 2004). Thus, only firms that exported their products or services were regarded as internationally active firms, that is, only internationalisation on the sales market was considered.

One special feature of the survey conducted in 1997 and described in detail by Bürgel et al. (2004) was the comparison between German and UK NTBFs. There are two major reasons why such a comparison is helpful: Germany is often regarded as an example of a highly regulated economy, whereas the UK is usually referred to as a more deregulated economy. According to Hofsteede (1980, 1991) a regulated economy reflects a culture of strong uncertainty avoidance. Since the foreign market entry of an NTBF is always connected with high uncertainty, German NTBFs are,

ceteris paribus, expected to be less outwardly oriented than their UK-based counterparts. The second reason for an Anglo-German comparison is the fact that the directions of trade flows are significantly different between the two countries (see IMF 1994). Whereas for the UK trade with North America and the British Commonwealth plays an important role, German exports and imports are traditionally oriented towards neighbouring countries, France in particular. Furthermore, German trade with Eastern European countries increased significantly during the 1990s.[5] Therefore, Bürgel et al. posed the question of whether German and UK NTBFs differ from each other with respect to their probability of exporting and the geographical distribution of the firms' target markets. The main result of the 1997 survey regarding country-specific differences was that German and UK high-tech start-ups were very similar in their firm-specific characteristics, in particular with respect to their export behaviour. Nevertheless, the percentage of firms that had international sales in 1997 was indeed higher for the UK subsample, although the difference was smaller than might have been expected. Furthermore, the geographical scope of the sampled firms' target markets did indeed reflect the traditional directions of each country's trade flows: German NTBFs were more oriented towards Germany's neighbouring countries (including Eastern Europe), whereas North America and the British Commonwealth were more important for the export activities of UK-based high-tech start-ups.

The study by Bürgel et al. (2004) belongs to a series of studies that investigated the internationalisation processes of NTBFs during their start-up periods.[6] 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 ongoing role of internationalisation. To the best of my knowledge, no study has been performed that observes NTBFs over a relatively long time period to investigate long-term internationalisation behaviour. Nevertheless, there are important questions regarding the international engagement of the firms in our sample: How many firms continued exporting after 1997, and how many terminated their international engagements? Did those firms that did not have international sales in 1997 enter into the foreign market, or did they remain confined to their respective domestic market? Were the exporters in our sample able to expand their export activities (e.g., increase their shares of total sales generated abroad)? Did the observed causal effects of exporting on firm performance remain valid as high-tech firms aged? In order to answer these important questions, a joint research team

5 A third reason for a comparison between Germany and the UK is the debate on national innovation systems (Nelson 1992). The behaviour of NTBFs is definitely influenced by the domestic institutional context. However, an analysis of this relationship is beyond the scope of this study as well as the study of Bürgel et al. (2004).

6 Other examples are the studies of Lindqvist (1991) and McDougall et al. (1994).

from the ZEW and the University of Exeter conducted a second survey in summer 2003. All surviving firms from the original sample, which were then 12 years old on average (about 25 % of the firms had already dissolved), were contacted again. In order to ensure a high response rate, computer-aided telephone interviews (CATI) were used. A response rate of 55 % was obtained, and, after several consistency checks were performed, 217 companies were retained for the longitudinal analyses.

This study will examine empirically the long-term internationalisation behaviour of the firms in our sample of young technology-oriented companies from Germany and the UK. In accordance with the preceding study of Bürgel et al. (2004), I will restrict my analyses to the firms' export activities, that is, an internationalisation on the sales market.[7] In this context, the changing behaviour of the firms in the period between the two surveys will be of major interest. In order to interpret the export behaviour of the sampled firms, it is helpful to consider the macroeconomic conditions young high-tech firms were faced with from 1997 to 2003. Chapter 2 will therefore discuss firm dynamics (firm formations and closures) in high-tech sectors in Germany and the UK and the demand for high-tech products and services. The data set this study is based on will be described in detail in chapter 3. Thereafter, three dimensions of the firms' export activities will be analysed in chapter 4. In section 4.1, various theories of internationalisation will be reviewed in order to derive hypotheses that can be tested in the subsequent econometric analyses. The probabilities of foreign market entry and exit will be estimated in section 4.2. The related research literature is particularly thin on the ground when it comes to the identification of firm-specific variables that explain an exit from the foreign market. According to the theories discussed in section 4.1, a firm decides simultaneously on its foreign market participation *and* its optimal volume of exports. Thus, the firms' degrees of internationalisation (measured as the share of non-domestic revenues) will be examined in section 4.3. After entering the foreign market, one of the most important decisions firm managers have to make is the choice of the optimal sales mode. This choice depends on the firms' available resources and capabilities. However, these resources and capabilities change over time, compelling an exporter to adjust its foreign sales mode to these changing firm-specific conditions. The change of foreign sales modes will be examined in section 4.4. Chapter 5 will refer to the relationship between exporting and firm performance. It was already mentioned that, based on data from the 1997 survey, Bürgel et al. (2004) found that internationalisation improved the firms' labour productivity and enhanced their sales growth rates from the time of firm foundation to the time of the first survey. In order to test whether this causality remains valid

7 Throughout this study, the terms "internationalisation" and "exports" are therefore used interchangeably.

throughout later stages of the firms' life cycles, I will re-examine the export-performance relationship using data from the second survey. The results of this study will be summarised in chapter 6: The validity of the applied theories of internationalisation to explaining the firms' international business activities will first be discussed, followed by the differences in the firms' internationalisation behaviour over time. Similarities and differences between German and UK-based high-tech firms will be elaborated before I will discuss the managerial and policy implications derived from this study.

2 Development of High-Tech Industries

In order to interpret the export behaviour and performance of our sample of technology-based firms from Germany and the UK, it is useful to consider the macroeconomic conditions young high-tech firms are faced with. Since the changing behaviour of our sample's firms in the period between 1997 and 2003 will be of major interest in this study, the following chapter will concentrate on macroeconomic development during the last decade. After presenting a definition of high-tech industries, firm dynamics in high-tech sectors will be discussed. A high number of firm foundations can be regarded as an indicator of market growth. On the other hand, numerous newly founded firms show that incumbent firms are constantly challenged by new rivals. As a result of intense competition, some firms are forced to exit the market. Thus, the number of firm closures is the second indicator of firm dynamics that will be investigated.

The development of a firm is, of course, influenced by different factors. In this chapter, I will restrict myself to examining the development of the demand for high-tech products and services in Germany and the UK in order to evaluate high-tech firms' sales prospects in the two countries. Finally, the impact this chapter's findings have on analysis of high-tech firms will be presented in the last section.

2.1 Definition of High-Tech Industries

In this study, technology-oriented firms are identified using the definition of high-technology industries in the UK established by Butchart (1987). He provided a definition based on two criteria: firstly, the ratio of R&D expenditures to total sales (R&D intensity)[8] and secondly, the share of scientists, professional engineers, and technicians in the total number of employees. The primary measure for identifying a high-tech industry is its R&D intensity. A manufacturing industry will automatically be included in the list of high-tech sectors if its R&D intensity lies "substantially above" the manufacturing average. In order to determine a value that is "substantially above" the average of all manufacturing industries, Butchart took a threshold value of 20 %, i.e., all industries whose respective R&D intensities amount to at least 120 % of the manufacturing average automatically qualify for inclusion in the list of high-tech sectors. Those industries that reveal an R&D

[8] Butchart (1987) also discussed whether gross value added should be preferred to total sales in measuring R&D intensity. Butchart argued in favour of total sales because firstly, data on firms' total sales are more often available than data on gross value added and secondly, total sales are less influenced by a firm's decision to outsource parts of its production process.

intensity higher than the manufacturing average but lower than the chosen threshold value become "candidates" for inclusion. Whether these doubtful cases will ultimately be defined as high-tech industries depends on the second criterion, i.e., the share of scientists, professional engineers, and technicians in the labour force. High-tech candidates qualify for inclusion in Butchart's list if this second measure is substantially above the manufacturing average, i.e., achieves a value of at least 120 % of the average share of all manufacturing industries. It is also important to note that almost all of the industries that automatically enter Butchart's list of high-tech industries because of their substantially above-average R&D intensity have a substantially above-average proportion of scientists and professional engineers in their respective workforces. Thus, the second criterion is only necessary to resolve doubtful cases as described above. In this way, Butchart identified sixteen UK 1987 SIC codes from the manufacturing sector, which were translated into the NACE Rev. 1 code and are listed in detail in Table 2-1.

Taking the manufacturing industries identified by Butchart, Bürgel et al. (2004) defined four aggregated manufacturing sectors: information and communication technology (ICT-)hardware, engineering industries, health and life sciences, and a sector consisting of miscellaneous high-technology manufacturing industries, labelled "other high-tech manufacturing". In the following, the descriptive statistics and the definition of several dummy variables used in this study's econometric analyses are based on these aggregated sectors.

Table 2-1: Definition of High-Tech Sectors

Aggregated industries used	NACE Rev. 1	Short description according to NACE Rev.1
R&D-Intensive Service Industries	64.20; 72.20; 72.30; 72.40; 72.60; 73.10	Telecommunication, Computer Programming and Software Services, Data Processing, Misc. Computer Services, R&D in Natural Sciences and Engineering
ICT-Hardware	30.01; 30.02; 32.20; 32.30	Office Equipment; Computers and Other Information Processing Equipment; Television and Radio Transmitters and Apparatus for Line Telephony and Line Telegraphy; Television and Radio Receivers, Sound or Video Recording and Reproducing Apparatus
Engineering Industries	33.20; 33.30; 33.40	Electronic Instruments and Appliances for Measuring, Checking (except Industrial Process Control); Electronic Industrial Process Control Equipment; Optical Instruments; Photographic Equipment
Health and Life Sciences	24.41; 24.42; 33.10	Pharmaceutical Products and Preparations; Medical and Surgical Equipment and Orthopaedic Appliances
Other High-tech Manufacturing	24.16; 24.17; 31.10; 31.20; 32.10; 35.30	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

Source: Manufacturing sector: Butchart (1987); service sector: Bürgel et al. (2004).

Bürgel et al. (2004) augmented the four aggregated manufacturing sectors by adding a fifth sector containing R&D-intensive service industries (see Table 2-1). Butchart (1987) himself emphasised the necessity of considering service-sector industries when defining the high-technology sector. However, due to data restrictions, Butchart was somewhat arbitrary in choosing three service-sector industries to add to his list of high-tech industries: telecommunications, computing services, and research and development institutions. Of course, R&D institutions seem to be predestined for inclusion in any list of high-tech industries that is based on firms' R&D intensities. Additionally, more recent studies, e.g., by Harhoff et al. (1996), Licht et al. (1997), and Nerlinger (1998), revealed that, at least in Germany, service firms in some industries carry out extensive R&D and innovation activities. These results confirm that the service sector industries selected by Butchart do indeed fall into the category of R&D-intensive industries. Thus, the aggregated service sector established by Bürgel et al. (2004) both corresponds to Butchart's arbitrary choice and is justified by recent empirical results.[9]

Butchart's list of high-technology industries is a rather short one. An alternative definition that is frequently applied when examining the German high-technology manufacturing sector was derived by Grupp and Legler (2000). In addition to those manufacturing industries already included in Butchart's list, Grupp and Legler in particular allowed for several classes of the industries "manufacturing of machinery and equipment" (NACE code 29.00) and "manufacturing of motor vehicles" (NACE code 34.00). Considering further that these two industries amount to just under one-third of total turnover in the German manufacturing sector in 2003 and to 44 % of the German manufacturing sector's expenditures on in-house R&D in 2001 (cf. Stifterverband 2004), neglecting these two industries constitutes a severe shortcoming when examining newly founded technology-based firms in Germany.[10] Nevertheless, all of the industries on Butchart's list are also included in Grupp and Legler's definition. This is particularly encouraging to note because Butchart's definition is based on data from the beginning of the 1980s and, as the rate of technological change accelerates, definitions of high-technology industries are subject to frequent revisions. Thus, this study analyses manufacturing (and service) industries that have belonged to the high-technology sector over the last two decades.

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9 The studies cited above further identified two other R&D-intensive service industries that were not considered by Bürgel et al. (2004): architectural and engineering activities and related technical consultancy (NACE code 74.20) and technical testing and analysis (NACE code 74.30).

10 In the UK, the two indicated manufacturing industries generated only 18 % of the manufacturing sector's total turnover in 2003. The sources of the turnover data will be described in section 2.3 and appendix A.1.

2.2 Firm Dynamics in Aggregated High-Tech Sectors

Newly founded firms play an important role in the development of technology-oriented markets. They introduce and commercialise new products, services, and production processes, thus stimulating and intensifying competition on their high-tech markets. New firms occupy market niches that (large) incumbent companies do not recognise or are not interested in, e.g., because they regard the innovative idea in question as unprofitable, or because of a lack of flexibility to adjust their production processes to the requirements of the new product or service. Thus, the development of the number of firm foundations is an important indicator in characterising the dynamics on high-technology markets. The introduction of innovative products and services is, however, connected with high uncertainty. In the long run, only a fraction of all newly founded firms can establish itself in the market. On the other hand, if a firm's innovative product achieves acceptance by the customer, the firm will be able to realise high growth rates and put its rivals out of the market. Firm closures are therefore the opposite of firm formations.

In this section, firm formations and closures as the two main indicators of high-tech markets' firm dynamics will be discussed in detail. The related literature normally regards firm growth as a third indicator of firm dynamics (see, e.g., Klepper 1996). However, it is difficult to acquire data on growing and shrinking firms on an aggregate level. Therefore, firm growth will be neglected in this section.[11] After a description of the German and the UK databases that are used for the analysis, the development of the number of firm formations in the five high-tech sectors will be examined for both Germany and the UK. Since the absolute numbers of firm formations are not comparable between the two countries, I will focus on *changes* in the number of start-ups with respect to the base year 1995. In a second step, the sectoral structure of all technology-oriented firm formations (as defined by Butchart 1987) will briefly be described, highlighting the numerical importance of newly founded firms from the software and service sector. Thereafter, the development of firm closures will be analysed analogously to the number of start-ups. Firm formations and closures determine the net gain or loss in a sector's stock of enterprises, contributing to an economy's structural change. Unfortunately, the German data do not allow calculation of changes in the stock of enterprises (see the explanations of the data bases below). Thus, we have to restrict ourselves on UK data when examining changes in the stock of enterprises during the last decade.

[11] Instead, chapter 5 will examine growth processes of the firms in this study's sample in detail.

Box 2-1: The ZEW Foundation Panel

Since 1989 the ZEW has been working in cooperation with Creditreform in setting up several panel data sets regarding firms in Western and Eastern Germany. As Germany's largest credit rating agency, Creditreform has the most comprehensive database of German firms at its disposal and provides its data on German firms to the ZEW for research purposes.

The statistical unit of the Creditreform database is the legally independent firm. Information from various public registers (in particular the trade register) as well as from daily newspapers and company reports are regularly collected. The information available in the Creditreform database includes firm names, addresses, industry classifications, and foundation dates. In most cases, Creditreform records the entire history of each firm. It is thus generally possible to distinguish original start-ups from transfers of already existing firms to new owners and other derivative foundation events like (de-)mergers or changes of legal form (for methods of identifying an original foundation when a complete firm history is not available, see Almus et al. 2000a).

Since new firms in the trade register are checked on a regular basis by Creditreform, almost all firm foundations recorded in the trade register are contained in the Creditreform database. The probability of an unregistered firm entering Creditreform's database depends on the scope of its credit demands and the extent of its business activities. Hence, coverage of micro firms remains incomplete. Moreover, newly founded unregistered firms in particular enter the Creditreform database with a significant delay. Based on estimates of the percentage of firms that are recorded by Creditreform after a certain time lag, the number of firm foundations in recent cohorts is predicted. This guarantees accurate comparisons over time.

Firm liquidations, defined as the final termination of a firm's entire business activities and the selling off of its assets, are also recorded by Creditreform. However, reliable information on firm closures only exist in the case of an insolvency (i.e., a forced liquidation due to an incessant inability to pay or over-indebtedness) since these data are easily available due to compulsory publication in official registers. Voluntary firm closures (e.g., a firm whose owner is still able to settle all of its financial obligations but has decided to exit from the market because the firm's financial situation has deteriorated) often enter the database long after their realisations; accurately predicting the number of such closures is therefore impossible. Thus, in this study we have to restrict ourselves to the number of insolvencies when describing the development of firm closures below.

Source: Almus et al. (2000a, 2000b), Engel and Fryges (2002).

An international comparison of the development of firm formations and closures is rather difficult since no standardised data sources currently exist. In particular, the numbers of start-ups and closures can hardly be compared between different countries because the statistical units that are examined by the various databases are often not identical (e.g., plants versus legally independent companies). However, in this section we are primarily interested in the *development* of the number

Box 2-2: VAT Registrations and De-Registrations in the UK

The Small Business Service Statistics Team annually publishes the number of VAT (value added tax) registrations and de-registrations in the UK. The data are taken from the Office for National Statistics' Inter-Departmental Business Register (IDBR). All companies registered for VAT and all businesses operating a Pay As You Earn (PAYE) scheme are recorded in the database. Very small businesses are not covered by the IDBR. The threshold for compulsory VAT registration at the beginning of 2003 was an annual turnover of £ 56,000. Below that value businesses can register voluntarily. Thus, like in the Creditreform database for Germany, micro firms are not entirely covered.

One advantage of the database is the fact that VAT registrations and de-registrations are indicators of firm foundations and closures which are comparable to one another – i.e., VAT de-registrations do not only include insolvencies but also voluntary firm closures. This allows calculation of the annual net gain or loss in the stock of registered enterprises in the UK. It should be noted that, in a minority of cases, VAT de-registrations occur because a firm's turnover has fallen below the registration threshold. However, this does not affect the validity of VAT de-registrations as an approximation of the number of firm closures.

Registrations and de-registrations are sometimes recorded in the IDBR database with a moderate time lag. In order to guarantee an accurate comparison over time, the Small Business Service Statistics Team adjusts the latest data from IDBR to produce the best estimates of the number of firm foundations and closures in most recent cohorts.

The data are available online at http://www.sbs.gov.uk/content/analytical/statistics. Unfortunately, it is only possible to compile time series for the cohorts from 1994 to 2003. Older data on registrations and de-registrations do exist, but they are not disaggregated to the level of the three-digit UK 2003 SIC code (a classification equivalent to the NACE code), which is necessary to determine the number of firm foundations and closures in the high-tech industries identified by Butchart (1987).

Source: Small Business Service (2004a, 2004b).

of firm formations and closures in Germany and the UK and not in the number itself. For this purpose, it is sufficient that the data are consistent over time. Moreover, the data should allow a country-specific comparison of different sectors, in particular between those defined in the previous section. In order to describe firm dynamics in German high-tech sectors, the ZEW Foundation Panel is used. Since this panel also provides the basis for drawing the random sample the two surveys of this study are based on (see chapter 3), it is illustrated in greater detail in Box 2-1. The UK data on firm dynamics originate from the Small Business Service based on VAT (value added tax) registrations and de-registrations. They are described in Box 2-2.

Figure 2-1 shows the development of firm foundations in the selected high-tech sectors in Germany and the UK. As the description of the data sources revealed, the absolute number of firm

foundations is not comparable between the two countries. Moreover, the number of firms that were founded in the five high-tech sectors considered also differs significantly.[12] Therefore, Figure 2-1 displays index series which are normalised such that the sector-specific number of start-ups in 1995 is set to the index value 100. The index series cover the entire available time span, i.e., the development of firm foundations in Germany is described from 1990 to 2003, whereas in the UK we are restricted to the period from 1994 to 2003 (cf. Box 2-2).

The development of high-tech start-ups is analysed separately for the Western and the Eastern states of Germany. This is particularly important during the first six years after German reunification (i.e., from 1990 to 1995) when an entirely new stock of independent, privately owned firms had to be built up in Eastern Germany. As a consequence, in this period the number of firm formations was high, but decreasing. This development is reflected by the index series in Figure 2-1. Thus, the indices for Eastern Germany (including former West Berlin) should not be compared with those of Western Germany and the UK before 1995.

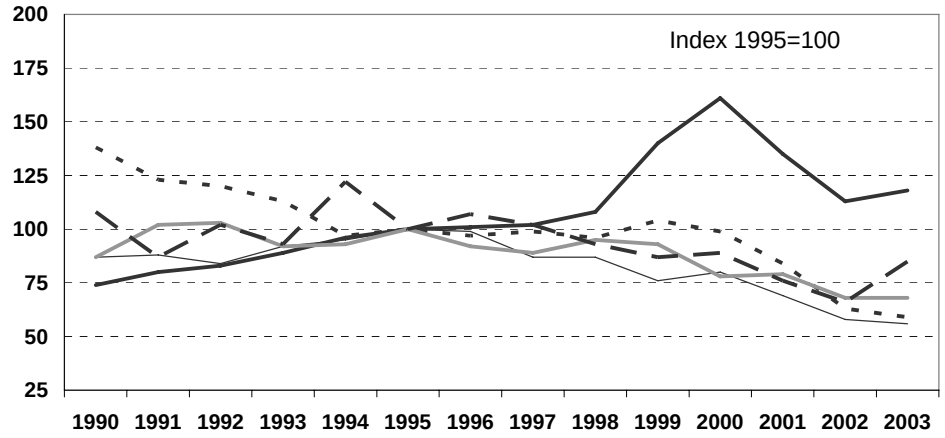
Examining the course of the index series in Figure 2-1, the most outstanding result is the tremendous increase in the number of start-ups in the software and service sector in both Germany and the UK. In Western Germany, the number of newly founded software and service firms rose over one decade, reaching a (global) maximum in 2000, when the number of firm foundations was 60 % higher than in 1995. Similarly, in Eastern Germany the quantity of service start-ups in 2000 exceeded the 1995 figure by 79 %. The highest number of newly registered service firms in the UK was already observed in 1998, attaining an index value of 174. In the subsequent year, the number of firm foundations decreased, but ascended again to a second local maximum in 2000. The dynamic of the service sector in the nineties of the last century clearly mirrors the emergence of new business opportunities due to an increased diffusion of information and communication technologies.

However, there was a downturn in the number of start-ups in the software and service sector after 2000 in both countries. The turning point of the UK index series dates back to as early as 1998, whereas the decline of the number of newly founded service firms was only interrupted by a slight rise in 2000. In Eastern Germany and the UK, the downturn continued until 2003, although at a decreasing rate. Nevertheless, the number of newly registered service firms in the UK was smaller in 2003 than in 1995. In contrast, the level of firm foundations in Western Germany rose again by 4.6 % from 2002 to 2003. It remains to be seen whether this development is the first sign of a new

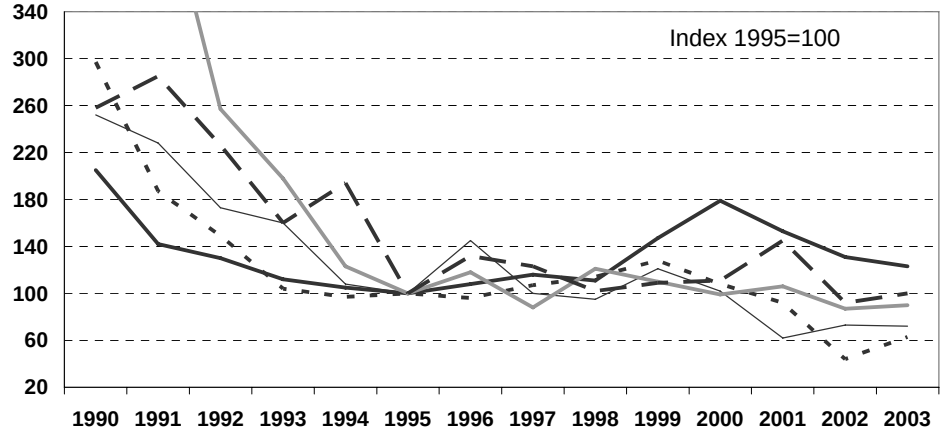
[12] The sectoral structure of all firm foundations in the high-technology sector as defined by Butchart (1987) is discussed below.

Figure 2-1: Firm Foundations in Aggregated High-Tech Sectors

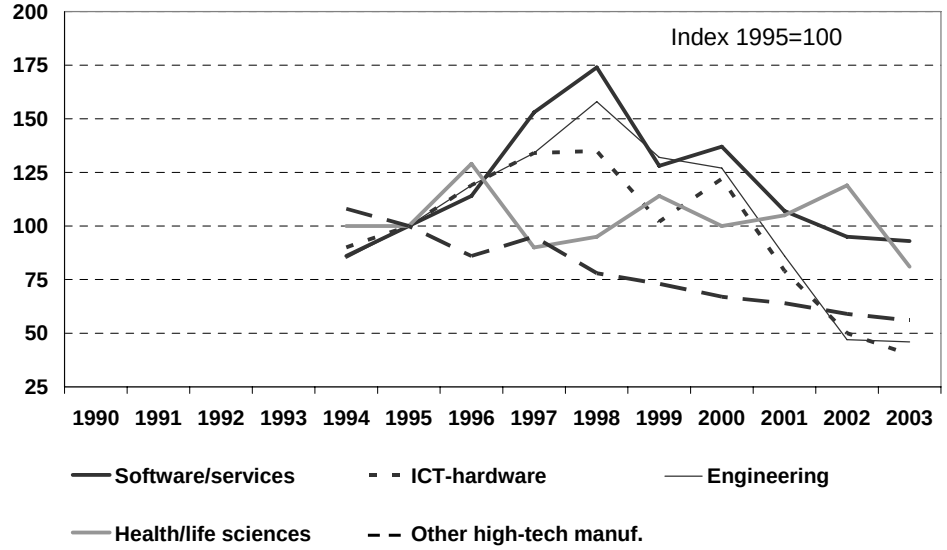
West Germany



East Germany



UK



The UK sector "other high-tech manufacturing" includes the complete NACE group 24.1.

Source: ZEW Foundation Panel, Small Business Service Statistics Team, own calculations.

boom in the number of start-ups in the service sector or whether the observed increase is only a transitory event.[13]

As regards the four aggregated manufacturing sectors, the number of firm formations declined in the most recent years in nearly all analysed manufacturing sectors. In 2003, no single index series attained a value higher than 100, i.e., in all manufacturing sectors the number of start-ups in 2003 was smaller than in 1995. However, the courses of the index series differ between Germany and the UK. In Western Germany, the two sectors health/life sciences and other high-tech manufacturing industries revealed a relatively constant level of newly founded firms during the nineties, although in some years the number of start-ups exceeded or fell below the 1990s mean. In 2002, however, the number of firm foundations amounted to only two-thirds of the respective quantity in 1995. In the sector of other manufacturing firms the level of firm formations increased again from 2002 to 2003, but the index remained below its average value from the previous decade. Thus, similarly to the software and service sector, there was a downturn in the number of newly founded firms after 2000 in these two sectors. The level of start-ups of new engineering firms in Western Germany rose from 1990 to 1995, reaching its maximum during the time period examined. Afterwards, however, it declined continuously until 2003, attaining a level just over half of its maximum. Finally, the number of firm formations in the Western German ICT-hardware sector decreased from 1990 to 1994, remained constant until 2000 and, in accordance with the development in the other manufacturing sectors, declined again thereafter. At first glance, this finding is somewhat surprising: Arguing that the tremendous rise in newly founded software and service firms in the nineties was a result of the increased diffusion of information and communication technologies, one should expect numerous business opportunities for start-ups that intend to manufacture hardware components. Obviously, the rising demand for ICT hardware in (Western) Germany was only to a small extent accommodated by newly founded firms. Instead, a combination of growing sales in incumbent German firms, the establishment of subsidiaries of foreign multinational companies in Germany, and imports probably met the increased demand for hardware components.[14] [15]

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13 In 2003, the number of firm formations in Germany was significantly influenced by a newly introduced government aid that intends to encourage formerly unemployed persons to set-up a new business (catchword: "Ich-AG"). Unfortunately, the Creditreform database does not allow us to determine which firms were founded by a formerly unemployed entrepreneur, and, therefore, the extent to which the observed increase in the number of start-ups in the service sector results from this new government aid. However, it can be argued that unemployed persons are more likely to start a new business in sectors with low barriers to entry, e.g., low (sunk) investment costs. Thus, it is more likely to find an entrepreneur supported by this new measure in the service sector than in the manufacturing sector.

14 Recall that the statistical unit of the Creditreform database is the legally independent firm. Thus, the formation of a new plant by a German or a foreign company is not recorded in the database.

The development of Eastern German high-tech manufacturing sectors is more encouraging than that of the respective Western German sectors. The index series in Figure 2-1 indicate that the number of firm foundations in each manufacturing sector increased in the period from 1995 to 2001, reaching a maximum that was significantly higher than the level of start-ups in the reference year 1995. For example, in 1999 the number of newly founded ICT-hardware firms in Eastern Germany was 28 % higher compared with the respective number in 1995. In the sector of other high-tech manufacturing industries, the level of firm foundations in 2001 exceeded that of 1995 by 45 %. However, the number of start-ups in more recent cohorts declined again and, with the exception of other high-tech manufacturing industries, fell significantly below the 1995 level.

In order to assess the foundation activities in the Eastern German high-tech manufacturing sectors, it should first be noted that the absolute number of high-tech firm foundations in Eastern Germany recorded by Creditreform is very small. For example, in 1995 only 53 firms were set up in the sector of other high-tech manufacturing industries. The most firm foundations were observed in the sector of health/life sciences, where 103 start-ups were recorded in 1995. Thus, even a sharp increase in the Eastern German index series only reflects one or two dozen additional firm foundations. Moreover, although the development of firm formations in Eastern German manufacturing sectors was more positive than in the western part of Germany, the foundation intensities, defined as number of start-ups per one million inhabitants aged between 18 and 65, were generally smaller in Eastern Germany. For example, whereas in Western Germany the foundation intensity of the ICT-hardware sector was 9.9 in 1995, there were only 6.1 newly founded ICT-hardware firms per one million inhabitants aged between 18 and 65 in Eastern Germany. Similarly, the Western German foundation intensity of the sector of heath/life sciences was 14.6 in 1995; in Eastern Germany the respective value amounted to only 8.9. Since, in contrast to West Germany, the number of newly founded manufacturing firms in Eastern Germany increased after 1995, the Eastern German foundation intensities approached to the respective West German values. In the engineering sector and the sector of other high-tech manufacturing, the Eastern German foundation intensities even exceeded those of Western Germany when the number of firm foundations reached their maximum. However, due to the decline in the number of start-ups in most recent years, the foundation intensities of Eastern German manufacturing sectors again fell below the

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15 These arguments are supported by the development of German plants' turnover as depicted in Figure 2-3: Sales of plants operating in the ICT-hardware sector and located in Germany doubled from 1995 to 2000. The plants were able to generate higher sales on the German as well as the foreign market (see the discussion below). Taking into account that the number of start-ups remained constant during this period, the increasing demand in Germany was at least partly met by growing incumbent plants.

reference values of the West German sectors.[16] Considering the important role of newly founded high-tech firms with respect to technology transfer and the creation of new, internationally competitive jobs, the relatively small foundation intensities of high-technology sectors in East Germany may constitute an obstacle to realising macroeconomic growth (see Engel and Fryges 2005).

In the UK, the number of newly registered manufacturing firms in the ICT-hardware and engineering sectors rose significantly from 1994 to 1998. In the latter sector, the level of firm foundations then decreased continuously until 2003, when it attained an index value of 46, i.e., in 2003 the number of newly founded engineering firms was less than half of the respective quantity in 1995 and less than one-third of its maximum level in 1998. Likewise, firm formations in the ICT-hardware sector declined after 1998, although, analogous to the UK software and service sector, the index series has another local maximum in 2000. Nevertheless, the number of newly founded ICT-hardware firms in the UK reduced by two-thirds within the following three years. The decrease was less dramatic in the sector of other manufacturing firms. With the exception of 1997, the number of start-ups in this sector fell steadily from 1994 to 2003, whereas in the last observed year the number of firm foundations amounted to just over half of the respective value in 1994. The development of firm formations in the smallest UK manufacturing sector, namely the sector of health/life sciences, is characterised by considerable fluctuations around the reference index value 100.[17] In 2003, the number of start-ups decreased by one-third in comparison to the previous year.

Table 2-2: Sectoral Structure of High-Tech Firm Foundations in 1996 (in %)

	West Germany	East Germany	UK
Software/services	77.87	70.11	92.60
ICT-hardware	5.13	5.28	2.97
Engineering	5.81	9.70	2.04
Health/life sciences	7.21	9.47	0.79
Other high-tech manuf.	3.98	5.43	1.60
Total	100	100	100

The UK sector "other high-tech manufacturing" includes the complete NACE group 241.

Source: ZEW Foundation Panel, Small Business Service Statistics Team, own calculations.

16 The difference is even more distinct in the software and service sector: Whereas the Western German foundation intensity in this sector amounted to 144.6 in 1995, the respective Eastern German value was only 72.2. Since the development of newly founded software and service firms was similar in both parts of Germany after 1995, the difference remained relatively unchanged (foundation intensities in 2000: West Germany: 232.8; East Germany: 130.6).

17 The Small Business Service Statistics Team recorded 105 newly registered enterprises in the sector health/life sciences in 1995.

However, it is not yet possible to determine whether this reduction corresponds to the downturn in foundation activities the other manufacturing sectors have experienced in most recent years, or whether this is just a transitory reduction and the index series will turn upward again.

As already mentioned, the index series do not provide any information about the level of firm foundations in the examined sectors. Moreover, the absolute numbers of start-ups are not comparable between the two countries. However, the databases allow an analysis of the sectoral structure of each country's high-tech firm formations. Table 2-2 shows the sectoral distribution of the high-tech start-ups in Germany and the UK. I chose the year 1996 as an example for the analysis in Table 2-2. This is the last cohort that was selected for drawing the random sample this study's empirical analysis is based on (see chapter 3). Of course, since the development of the number of newly founded firms differed between the observed sectors in subsequent years, the share of a particular sector in all high-tech firm formations changed accordingly, especially in favour of the software and service sector. Nevertheless, the main results remain unaltered.

In both countries, most new firms were founded in the software and service sector. Setting up a new business in the service sector generally requires less (financial) resources then establishing a new manufacturing firm. This implies lower barriers to entry for service firms, leading to a higher fluctuation in the stock of enterprises operating in the market. Interestingly, the percentage of new software and service firms in the UK is considerably higher than in Germany. Thus, the foundation activities in the UK high-tech sector are far more dominated by service providers than in Germany. On the other hand, the share of firm formations in the sector of health/life sciences in Germany exceeds the respective UK value significantly. This higher percentage is mainly attributed to a large number of newly founded firms manufacturing medical and surgical equipment. Whereas in Germany the number of firm foundations in this group is more than five times larger than the number of start-ups in the sector's second group, i.e. manufacture of pharmaceuticals, the quantity of firm formations in these two groups is on the same level in the UK.

It is rather difficult to explain the varying development of the number of firm foundations in the two countries and the five examined high-tech sectors. The individual decision to set up a new enterprise is influenced by numerous factors affecting the individual's decision-making process from the supply side as well as from the demand side (for an overview, see Steil [1999] or Egeln et al. [2003a]). For example, in the course of the increased diffusion of information and communication technologies, the German economy experienced a lack of qualified ICT personnel, leading to higher wages for the firms' ICT workforce. Thus, it cannot be excluded a priori that the decreasing number of firm formations in the Western German ICT-hardware sector results from this

supply side restriction: Higher wages in the incumbent ICT companies increase the individual's opportunity costs of self-employment, reducing the probability of setting up a new business.[18] On the other hand, the growing diffusion of information and communication technologies improves the sales prospects of a newly founded firm, raising the individual's inclination to start a business. It is possible that this demand-side effect was dominant in the UK, resulting in a rising number of start-ups in the country before 1998. Without a profound econometric analysis it is not possible to determine which factors have a causal impact on the observed number of firm foundations. Such an analysis is, however, beyond the scope of this study. Instead, in the following section I will focus on a possible demand-side effect by investigating the development of sales as a measure for the demand for the firms' (high-tech) products and services.

First, however, the development of firm closures as the second indicator of high-tech markets' firm dynamics has to be discussed. Data on firm closures are even more difficult to obtain than data on firm foundations. For the UK, the Small Business Service Statistics Team annually publishes the number of businesses de-registering from VAT, which is an appropriate estimate of the number of firm closures and is directly comparable with the number of newly registered firms that was used as a measure of firm formations. The development of firm closures in Germany is approximated by the number of insolvencies. This approximation has two shortcomings. Firstly, the large number of voluntary firm closures is neglected. Unfortunately, this number cannot be predicted using the Creditreform database, which restricts the following analysis to forced firm liquidations, i.e., insolvencies (see Box 2-1). According to Prantl (2002) insolvencies account for only 20 % of all liquidations of young firms (six years old and younger at the time of firm closure) in Western Germany. In high-technology industries (as defined by Grupp and Legler [2000] and Nerlinger [1998]; see section 2.1), at least, the share of insolvencies amounts to 44 % of all closures of young firms in Western Germany (see Egeln et al. 2003a). Secondly, due to amendments made to the German Insolvency Statute[19] in 1999 and 2001 an insolvency does not necessarily induce a firm's liquidation, that is, an exit from the market. Instead, the Insolvency Statute allows a continuation of a firm's businesses by the insolvency administrator or the debtor himself. This may lead to a reorganisation of the firm, although it can be expected that in most cases the insol-

18 The lack of qualified ICT personnel in Germany before the year 2000 was analysed, e.g., by Licht et al. (2002). 64 % of all German firms in the ICT sector (according to the definition of OECD [2000] which includes ICT-hardware as well as software, ICT-services, and wholesale trade of ICT products) offered candidates higher wages in response to a lag of ICT personnel they were experiencing. In 72 % of the firms the existing ICT employees had to work overtime, probably being paid an overtime premium.

19 The new Insolvency Statute which came into effect on 1 January 1999 replaced the previous Bankruptcy and Settlement Codes (Konkursordnung and Vergleichsordnung) in Western Germany as well as the Act on Collective Enforcement (Gesamtvollstreckungsordnung) in the Eastern German states.

vency procedure will eventually result in liquidation of the firm. Further, an insolvency procedure can now be initiated in cases which were not permitted before 1999, e.g., in the case of only a risk of insolvency.[20] Therefore, an increase in the number of insolvencies in Germany after 1999 may at least partly be attributable to the reform of the Insolvency Statute, leading to a structural break in the time series and thus limiting its ability to approximate the development of firm closures.

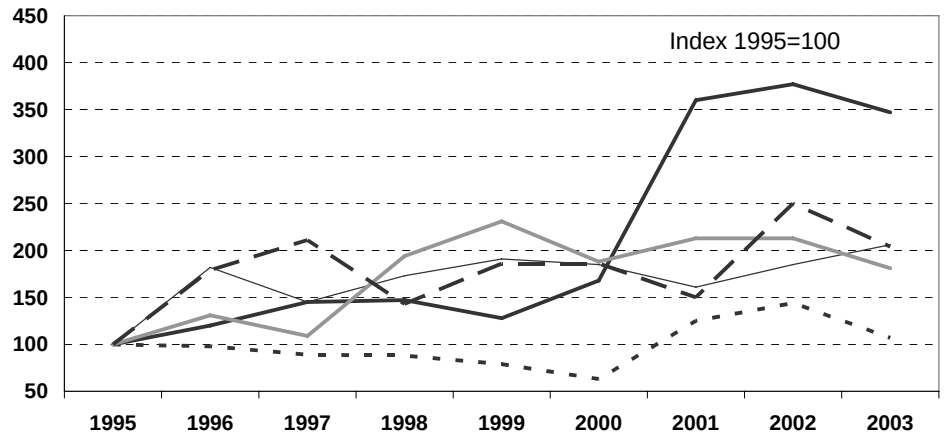
The development of insolvencies in Western and Eastern Germany as well as the course of de-registrations in the UK are depicted in Figure 2-2. As in the case of firm foundations, Figure 2-2 shows index series which are normalised such that the sector-specific number of insolvencies (de-registrations) in 1995 is set to the index value 100. The number of insolvencies in the Western German software and service sector rose tremendously from 2000 to 2001. This development corresponds to a contemporaneous decrease in the number of newly founded software and service firms. Those factors that are responsible for the downturn of foundation activities in the service sector likewise deteriorate the business situations of incumbent companies – either on the demand or the supply side – resulting in a higher number of firms exiting the market. Moreover, the rising number of firm closures in most recent years is likely a result of increased competition on the market: As shown above, a growing number of firms entered into the (Western German) software and service sector during the 1990s. These newly founded firms compete with incumbent companies for a limited number of customers. Only firms that launch superior software programmes and services are able to survive, while the other enterprises will be put out of business. In this respect, the rising number of firm closures after 2000 reflects the dynamic foundation activities in this sector during the 1990s.

Similarly to Western Germany, the index series of firm closures in the software and service sectors in Eastern Germany and the UK increased steadily from 1995 to 2002, while the increase of the Eastern German series was temporarily interrupted by a reduction in the number of insolvencies from 1997 to 1998. The downturn in the number of firm foundations in the UK after 1998 (in Eastern Germany: after 2000) was accompanied by a growing number of firm closures, although the rise was less pronounced than in the Western German case. Both in (Western and Eastern) Germany and in the UK, these developments militate in favour of increased competition in the software and service sectors in both countries. In the last year recorded by the databases, the number of insolvencies and de-registrations in the software and service sector declined slightly in

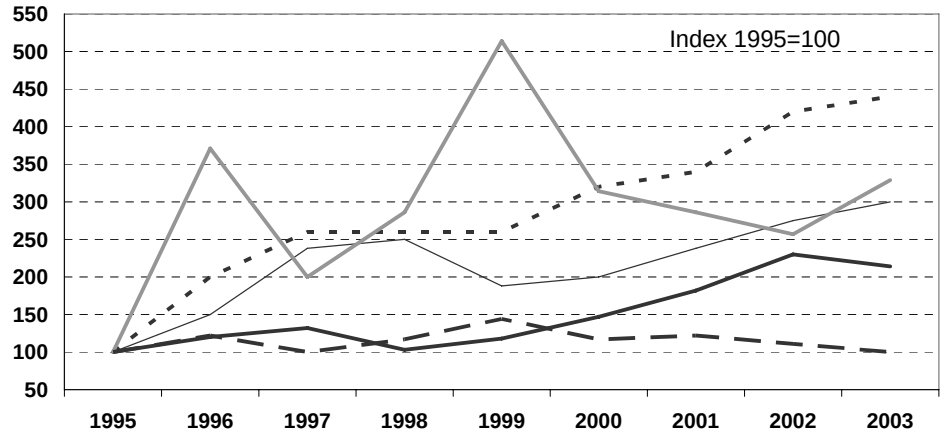
[20] Note that in the ZEW foundation panel, an insolvency is recorded when the insolvency procedure is either opened or refused. Such a refusal occurs if the firm has been judged to be unable to cover even the direct bankruptcy costs (Almus et al. 2000a, p. 38).

Figure 2-2: Firm Closures in Aggregated High-Tech Sectors

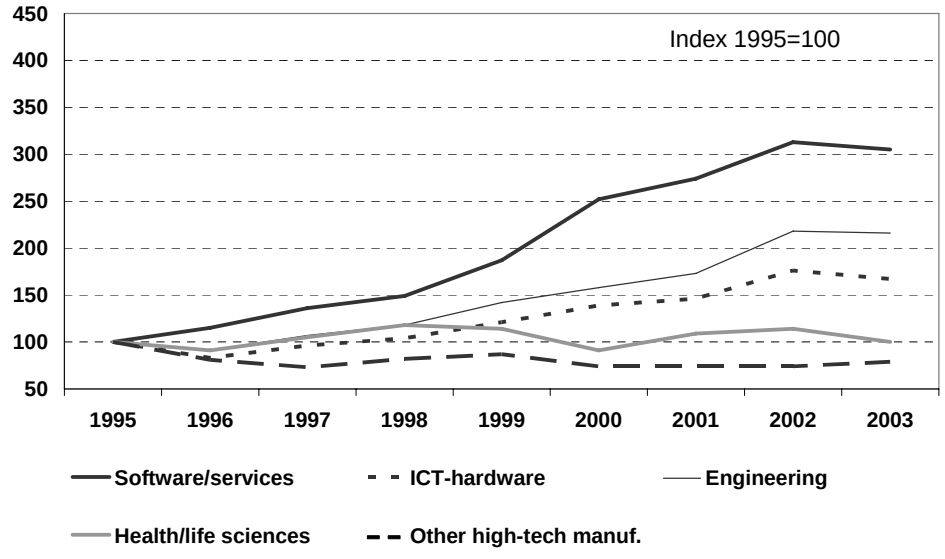
West Germany



East Germany



UK



The UK sector "other high-tech manufacturing" includes the complete NACE group 241.

Source: ZEW Foundation Panel, Small Business Service Statistics Team, own calculations.

Germany as well as in the UK. In Western Germany, this decline was associated with a slight increase in the number of newly founded service firms from 2002 to 2003 – perhaps initial evidence of an economic rebound in this sector.

The number of insolvencies in three of four Western German manufacturing sectors (engineering, health/life sciences, other high-tech manufacturing) doubled from 1995 to 2003. In conjunction with the downturn in the number of firm foundations in these sectors after 2000, a rather discouraging picture emerges: The poor prospects in most high-tech manufacturing sectors induce an incrementally decreasing number of entrepreneurs to start new businesses. At the same time, the rising number of insolvencies seems to confirm the entrepreneurs' pessimistic expectations. The development of the level of insolvencies in the ICT-hardware sector was slightly different: The number of insolvent ICT-hardware firms in Western Germany declined from 1995 to 2000. In the following year (i.e., from 2000 to 2001), however, the level of insolvencies doubled and rose further by 15 % from 2001 to 2002. In the 1990s, the increasing diffusion of information and communication technologies presented favourable business conditions for incumbent Western German firms in the ICT-hardware sector, improving their chances of survival – in particular because there were relatively few newly founded firms that challenged incumbent companies. In most recent years, however, the demand for ICT components in Western Germany decreased (see below). Thus, the increased competition for a declining amount of demand led to a rising number of bankruptcies and market exits.

In Eastern Germany, the index series in Figure 2-2 indicate a tremendous increase in the number of insolvencies in the aggregated manufacturing sectors. Only in the sector of other high-tech manufacturing did the level of insolvencies remain constant over the regarded time period. However, we should be cautious in interpreting index series: In 1995, there were just five insolvency proceedings in the Eastern German ICT-hardware sector. Similarly, in the engineering sector the number of insolvencies amounted to eight in 1995. In the sector of health/life sciences there were seven insolvencies recorded in the Creditreform database. In contrast, the sector of other high-tech manufacturing revealed 18 insolvencies in 1995. In this case, the respective index series does not show a percentage increase similar to that of the other manufacturing sectors. In 2003, the number of insolvencies in each high-tech manufacturing sector in Eastern Germany amounted to approximately 20 cases. As discussed above, the number of firm foundations in East Germany is also relatively small. Considering further that insolvencies represent only a part of all firm closures it does not come as a surprise that such a small number of insolvencies is recorded in the database. Moreover, it has been argued that the first half of the 1990s in East Germany was characterised by the build-up of an entirely new stock of privately owned, independent firms. Thus, in 1995, the

Eastern German stock of enterprises consisted of some heavily subsidised, privatised companies and a large number of newly founded firms. According to Prantl (2003), small start-ups in East Germany seem to have occupied market niches that were empty before, and thus experience low exit risks. During the first years of the transition from a planned to a market economy, start-ups were able to profit from first-mover advantages in their market niches. Further, as Prantl argued, Eastern German entrepreneurs seem to have taken time to gain market experience before realising liquidations in way comparable to Western German firms. This may explain the relatively small number of insolvencies in Eastern Germany in 1995. Nevertheless, like their Western German counterparts, East German manufacturing firms are confronted with the same demand- and supply-side effects that aggravate the business conditions faced by high-tech firms and that are probably responsible for the observed rising number of insolvencies in most recent years.

The number of de-registrations in the UK manufacturing sectors evolved differently. In those sectors which experienced a below-average dynamic of firm foundations, notably the sectors of health/life sciences and other high-tech manufacturing, the number of firm de-registrations has remained constant over the past eight years. In the ICT-hardware as well as in the engineering sector the number of firms de-registering from VAT increased after 1998, the year in which the sector-specific number of firm formations attained its maximum. As has already become apparent for most (but not all) German sectors, the number of start-ups and the number of firm closures – the latter approximated by the number of insolvencies and VAT de-registrations – often develop in direct opposition to one another. Those (demand- or supply-side) factors that discourage entrepreneurs from setting up new businesses also deteriorate the business situations of incumbent firms, leading to a rising number of bankruptcies and voluntary firm closures.

Firm formations and closures are not only a result of macroeconomic factors influencing the individual decision to start a new business or the probability of a firm being liquidated. Formations and closures are also key elements of an economy's structural change. Thus, it is not sufficient only to examine the development of firm foundations and closures. The ratio between these two figures is important, since it determines the net gain or loss in a sector's stock of enterprises. Unfortunately, the German data do not allow calculation of changes in the stock of enterprises, since it is not possible to give an accurate estimate of voluntary firm liquidations. Thus, the following analysis is restricted to the UK.

As shown in Table 2-3, the stock of firms in the sector of heath/life sciences remained constant from 1994 to the beginning of 2004. Neither the number of start-ups nor the number of firms de-registering from VAT revealed any significant increases or declines. Between 100 and 130 start-

ups and closures were recorded annually in the database. Thus, the foundation rate in this sector, defined as the proportion of firms observed on January 1st that were founded in the previous year, amounted to 6.8 % in 2002. The sector of other high-tech manufacturing is the largest manufacturing sector in the UK. However, the number of firms operating in the market is decreasing continuously. Between 1994 and 2004, the number of registered firms fell by 18 %. This decline is not a result of a rising number of firm closures but of a falling number of newly founded firms. This finding becomes even more evident when the foundation rates in this sector are calculated: Whereas in January 1995 6.6 % of all registered firms were founded in the previous year, this ratio decreased to a value of 4.1 % in January 2004. Thus, the sector of other high-tech manufacturing is characterised by a falling rate of replacement of its stock of enterprises. In the two remaining manufacturing sectors, notably the ICT-hardware and engineering sectors, the stock of firms rose considerably from 1994 to 2000. Accordingly, the foundation rates increased and attained their maximum values in 1999: In January 1999, 13.2 % (10.4 %) of all firms operating in the ICT-hardware (engineering) sector were founded in 1998. However, as a consequence of the declining number of firm formations and the contemporaneous rise in the number of firm closures, the stock of enterprises decreased significantly in both sectors and even fell below its 1994 value.

Table 2-3: Stock of VAT-Registered Enterprises in the UK

	Software/ services	ICT-hardware	Engineering	Health/life sciences	Other high-tech manuf.
1994	43.755	3.750	3.810	1.635	5.310 [a]
1996	59.120	3.740	3.905	1.640	5.115
1998	82.895	4.185	4.210	1.655	5.055
2000	106.865	4.385	4.480	1.630	4.840
2002	112.620	4.235	4.370	1.620	4.635
2004	105.535	3.385	3.675	1.600	4.350

[a] Number includes the complete NACE group 24.1.

Number of registered firms on January 1st. Numbers are rounded to the nearest five.

Source: Small Business Service Statistics Team, own calculations.

The software and service sector not only exhibits the largest stock of enterprises, it also experienced the highest growth rates in the stock of firms during the 1990s. Establishing a new service firm generally requires less resources than forming a manufacturing firm, leading to lower barriers to entry and hence to higher foundation rates: From 1995 to 1999, the annual foundation rates amounted to about 25 %, i.e., one quarter of all service firms that were operating in the market at any given time within the period did not yet exist one year before. Since the number of firm closures in the UK service sector was significantly smaller than the respective number of firm founda-

tions, the stock of service firms increased in the 1990s. Even after 1998, when the level of start-ups was already declining, a net gain in the sector's stock of enterprises occurred. Only in the last two years (i.e., 2002 and 2003) did the number of de-registered service firms exceed the number of start-ups in this sector. The stock of high-tech service firms thus declined by 6.3 % from January 2002 to January 2004. Nevertheless, the number of firms in the service sector had more than doubled in the previous decade. In the 1990s most newly founded firms were able to establish themselves in the market and only relatively few incumbent companies were crowded out. This development was only possible because it was accompanied by a rising demand for software and other high-tech services.[21] However, this convenient situation has changed: Although the number of newly founded software and service firms has declined significantly, the firms are currently faced with increased competition compelling a rising number of firms to exit the market.

The development of the stock of high-technology service firms is an indicator of a structural change towards a service-oriented and technology-based economy: Whereas in 1994 the share of software and service firms in all VAT-registered enterprises in the UK amounted to only 2.7 %, this ratio increased to 5.8 % in 2004. The structural change in the UK economy is less evident when regarding the manufacturing sector: In 1994 the stock of high-tech manufacturing firms (i.e., the sum of the four sectors) accounted for 8.8 % of all registered manufacturing firms.[22] Due to the dynamic foundation activities in the ICT-hardware and engineering sectors, this proportion rose to 9.3 % in 2000. Afterwards, however, it declined again, reducing to a value of 8.4 % in 2004.

2.3 Development of Sales in Aggregated High-Tech Sectors

Sales prospects are a major factor that determines the individual's decision to set up a new business. Similarly, a firm's growth prospects and its probability of survival are both influenced by the (potential) demand for the firm's products and services. Therefore, this section examines the development of the demand for high-tech products and services, with demand approximated by domestic firms' sales. In a first step, the importance of high-tech (manufacturing) sectors is illustrated by calculating the share of sales generated by each high-tech manufacturing sector in the manufacturing sector's total sales. Thereafter, I will discuss the development of sales in the five high-tech sectors during the last decade. In particular, the extent to which the development of sales at the time of the first survey this study is based on (i.e., 1997) differs from the situation at the time

21 The development of the demand for high-tech services will be discussed in the following section.

22 The share of high-tech manufacturing firms in all registered firms in the UK is less than one percent, since the stock of enterprises is numerically dominated by service firms.

of the second survey (i.e., 2003) will be pointed out. Considering the purpose of this study, i.e., examining the export behaviour of young high-tech firms, sales prospects on the foreign market are an important aspect when describing the demand conditions for high-tech firms. The available data on the German manufacturing sectors allow a distinction between domestic and foreign sales. Therefore, the percentage of sales German manufacturing firms generate in the foreign market is briefly discussed at the end of this section.

Of course, sales and demand are not equal. Sales are the equilibrium quantity, valued at the equilibrium price, where demand on a market equals the amount supplied. If at a given time the demand exceeds the supply, the equilibrium price will rise, inducing either market entry of new firms, an expansion of incumbent firms' production, or increasing imports. Such a situation can be expected on growing, high-technology markets – at least during the market's expansion stage. Since demand will be approximated by domestic firms' sales, the share of domestic demand which is accommodated by imports is not considered. On the other hand, domestic firms' sales also include exports, reflecting the firms' sales prospects on the international market.

Data on sales generated by German high-tech firms are collected by the Federal Statistical Office. In order to compute aggregated sales in the four manufacturing sectors, data from the office's monthly reports on manufacturing plants are used, which cover all plants in the German manufacturing sector with at least 20 employees. Sales data on the German software and service sector were taken from VAT statistics. The UK sales data originate from the small and medium-sized enterprise statistics collected by the Small Business Service Statistics Team. All sales data exclude VAT and are discounted using producer price indices (PPI).[23]

For both Germany and the UK, I excluded telecommunication services (NACE code 64.2) from the sales data of the software and service sector presented below. Admittedly, the telecommunication industry plays an important role in the development of the high-tech sector. Its sales exceed those of computer services (NACE code 72.0) in the majority of cases.[24] However, this section intends to approximate the demand conditions of the technology-oriented firms that will be examined in the following chapters. Among those firms that were retained for the econometric analyses, there is not a single telecommunication firm. Even the random sample that contains all of the firms that were contacted by the joint Anglo-German research team (see chapter 3) includes only a few

23 The data sources are explained in more detail in appendix A.1.

24 In 2003, the sales of the UK computer service sector (NACE code 72.0) amounted to £ 55,590 million, whereas £ 59,450 million were generated by the telecommunication industry (NACE code 64.2).

Table 2-4: Sales in Aggregated High-Tech Manufacturing Sectors in 2003

	Germany		UK	
	in € millions	%	in £ millions	%
ICT-hardware	42,200	3.15	17,886	4.01
Engineering	22,818	1.70	10,113	2.27
Health/life sciences	42,064	3.14	16,647	3.74
Other high-tech manuf.	111,640	8.33	45,283 [a]	10.16
in comparison:				
Manufacturing sector [b]	1,340,578	100	445,565	100

[a] Number includes the complete NACE group 24.1; [b] NACE code section D.

For further explanations of data sources: see text and appendix A.1.

Source: Federal Statistical Office, Small Business Service Statistics Team, own calculations.

telecommunication firms. Thus, the relevant demand for the service firms in our sample is best represented by sales generated in the computer service industry.[25]

Table 2-4 illustrates the turnover of German and UK-based firms in the four high-tech manufacturing sectors.[26] In order to demonstrate the importance of the high-tech sectors examined in this study, the share of sales generated by each of the four high-tech sectors in the manufacturing sector's total sales was calculated. In Germany, 16.3 % of the manufacturing sector's sales in 2003 corresponded to a high-technology industry. The respective value in the UK amounted to 20.2 %. Measured by the volume of sales, the sector of other high-tech manufacturing is the largest among the four sectors in both countries. This finding corresponds to the data presented in Table 2-3, which reveal that the UK sector of other high-tech manufacturing accounted for the largest stock of enterprises among the four regarded manufacturing sectors. However, with respect to the number of newly founded firms, the sector of other high-tech manufacturing did not have a leading position during the last decade. In particular, the number of firm formations in the ICT-hardware and engineering sectors exceeded the corresponding figure for the sector of other manufacturing firms, militating in favour of a structural change between the different high-technology manufacturing industries.[27]

25 The firms in our sample were founded between 1987 and 1996. In Germany, however, the telecommunication sector was not liberalised until 1998. Before the liberalisation, the number of newly founded telecommunication firms was very small in Germany, since, in most cases, market entry was prohibited by law. Thus, the probability for selecting a German telecommunication firm by the chosen sampling procedure was relatively small.

26 Note that due to the varying coverage of the two country-specific data sources the absolute volumes of sales given in Table 2-4 are not comparable between Germany and the UK.

27 Due to the significant decline in most recent years, the level of firm foundations in the ICT-hardware and engineering sectors in the UK fell below the respective value of other high-tech manufacturing in 2003.

The development of the sectors' aggregated sales during the last decade is depicted in Figure 2-3. As before, the data are normalised, setting the sector-specific volume of sales generated in 1996 to the index value 100.[28] Sales in the software and service sector increased tremendously during the observation period. Even in most recent years, which have been characterised by a significant decline in the number of newly founded service firms and a contemporaneous rise in the number of firm closures, domestic service firms' sales kept on increasing. However, UK data revealed that despite the observed downturn in the number of firm foundations, the stock of service firms operating in the market continued to rise until 2002. Anticipating further a result of the analyses in chapter 5 indicating that most service firms examined by this study exhibited positive sales growth rates between 1997 and 2003, the increasing volume of domestic firms' sales does not come as a surprise. In the UK, merely the annual growth rate of the aggregated volume of sales declined from 2002 to 2003. In Germany, on the other hand, domestic service firms experienced a slight decrease in their sales from 2001 to 2002 (the last year for which sales data on the service sector are available), but this reduction is probably only a temporary phenomenon and not a first indication of a long-run downturn in the sector's volume of sales: From 2002 to 2003, the number of insolvencies in the service sector (approximating the level of firm closures) decreased in both Western and Eastern Germany. Moreover, the number of newly founded service firms rose in Western Germany during the same period. Arguing that the development of the number of firm formations and closures is influenced by the entrepreneurs' sales prospects, the observed firm dynamics give reasons to expect a recovery in the German service sector. Thus, it can be concluded that, measured by the volume of sales, the software and service sector can be characterised as a growing market, although the growth rates slackened in the last recorded year.

The sales generated in the German ICT-hardware sector rose significantly from 1996 to 2000. This development reflects the increasing diffusion of information and communication technologies during the 1990s. Since the number of newly founded ICT-hardware firms was in steady decline in Germany during the nineties, the demand for ICT-hardware components was obviously accommodated by expanding sales of incumbent companies.[29] After 2000, aggregated (discounted) sales of German ICT-hardware plants decreased by 15 % until 2003. This decrease was accompanied by a tremendous rise in the number of insolvencies in the ICT-hardware sector in both Western and

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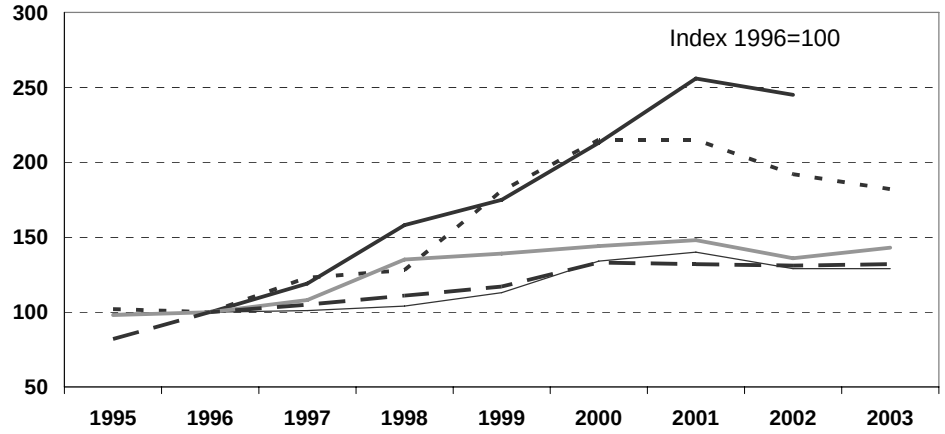
[28] Before 1996, the German VAT statistics, from which the sales data for the German software and service sector were taken, were compiled on a biennial cycle. Thus, there are no data available for 1995.

[29] Additionally, Germany increased its imports of ICT-hardware products. According to the Federal Statistical Office (Statistisches Bundesamt 2003), the import of ICT goods (as defined by OECD [2000]) increased by 107 % from 1995 to 2000.

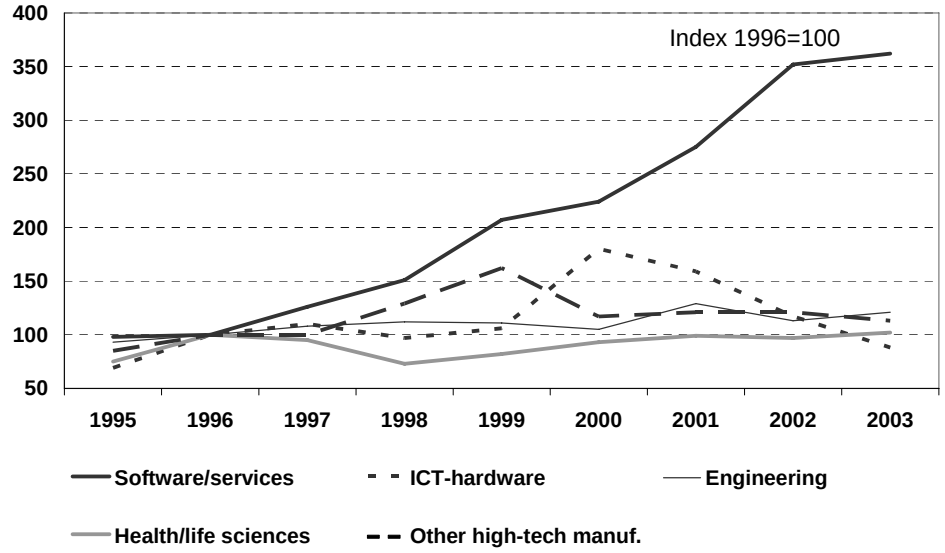
Eastern Germany. According to Hempell (2004), a major reason for the decline in sales of German ICT-hardware plants was the relatively high dependence of investments in ICT hardware on the business cycle. Due to the macroeconomic stagnation in Germany in recent years, many firms abandoned or postponed a planned investment in ICT hardware (see Hempell 2004). Interestingly, firms' inclination to save was more pronounced with respect to ICT hardware than to software, for which the volume of sales decreased only slightly.

Figure 2-3: Development of Sales in Aggregated High-Tech Sectors

Germany



UK



Index for the German software and service sector only covers computer services (NACE code 72).
Index for the UK service sector does not include telecommunication services (NACE code 64.2).
The UK sector "other high-tech manufacturing" includes the complete NACE group 24.1.
Indices were calculated using discounted sales.
Source: Federal Statistical Office, Small Business Service Statistics Team, own calculations.

In the three other high-tech manufacturing sectors in Germany, plants increased their sales from 1996 to 2000: Plants' turnover rose by 34 % in the engineering sector, 44 % in the sector of health/life sciences, and 33 % in the sector of other high-tech manufacturing. Afterwards, domestic plants' sales remained constant in these three sectors. Thus, as in the ICT-hardware sector, the positive development in the 1990s which offered favourable (growth) conditions for domestic enterprises in high-tech markets passed into a period of stagnating or even decreasing demand from 2000 to 2003.

UK-based ICT-hardware firms increased their sales by 80 % from 1996 to 2000. This development can be explained by a rise in the stock of ICT firms by 17 % in the respective period (see Table 2-3) and by growing sales on the part of incumbent companies. However, in accordance with the significant drop in the number of newly founded ICT-hardware firms and the declining stock of enterprises in this sector, the volume of sales generated by UK-based ICT-hardware firms decreased from 2000 to 2003, attaining a mere 88 % of the volume of (discounted) sales that were generated in this sector in 1996. Similar to Germany, the decrease in aggregated sales may be a reflection of UK-based firms abandoning or postponing investments in new ICT hardware, following a decade of continuously rising diffusion of information and communication technologies. Nevertheless, the extent of the reduction is surprisingly high, indicating that UK-based ICT-hardware firms are even more affected by declining demand than their German counterparts.

The sector of other high-tech manufacturing industries and the engineering sector in the UK both experienced rising demand after 1996. Although aggregated sales in 2003 fell below the maximum volume of sales the sector of other high-tech manufacturing industries (engineering sector) attained in 2001 (1999), sales were still significantly greater in 2003 than in 1996.[30] Thus, these two sectors are no longer characterised by growing demand, but the drop in demand was far less pronounced than in the UK-based ICT-hardware sector. However, it should be noted that the stock of enterprises that generated the 2003 volume of sales in both the engineering sector and the sector of other high-tech manufacturing firms was smaller than the respective stock of enterprises in 1996 (see Table 2-3 and the discussion in the previous section). Since the sector-specific volume of sales in 2003 exceeded that of 1996, the average volume of (discounted) sales generated by an individual firm had to be higher in 2003. Regarding the engineering sector, which exhibited the most significant rise in the number of firms de-registering from VAT among the UK-based manu-

30 In some of the regarded industries, in particular aircraft and spacecraft manufacturing, sales data on an annual basis may be a bit misleading due to contract work the companies receive (e.g., to manufacture a certain number of airplanes). Thus, the variance of the demand for this sector's products is probably smaller than that of the reported time series indicating the development of sales.

facturing sectors, this means that competition in this sector led to increasing crowding out, but at the same time provided growth opportunities for incumbent firms. In the sector of other high-tech manufacturing industries the number of firm closures remained constant. However, since at the same time the number of firm formations declined continuously in this sector, the rising demand had to be accommodated by incumbent firms. In the smallest UK manufacturing sector, i.e. health/ life sciences, the volume of sales changed only slightly during the time period considered – neglecting the transitory decline in aggregated sales observed in 1998. This development corresponds to the below-average dynamic of firm foundations and closures in this sector.

Table 2-5: Share of German High-Tech Manufacturing Plants' Sales Generated Abroad (in %)

	1996	2003
ICT-hardware	35.95	44.09
Engineering	36.85	46.64
Health/life sciences	34.90	50.90
Other high-tech manuf.	45.85	52.81

Source: Federal Statistical Office, own calculations.

In globalised markets, high-tech enterprises do not solely depend on domestic demand. They rather generate an increasing percentage of their total sales in the international market. This trend is highlighted in Table 2-5, which shows the share of exports in total turnover of German high-tech manufacturing plants.[31] From 1996 to 2003, the share of sales German plants generated abroad rose in each examined manufacturing sector. In 2003, approximately half of each sector's turnover was sold abroad. The large increase in German plants' sales which is depicted in Figure 2-3 is therefore mainly attributable to rising foreign sales. The plants were nevertheless able to extend the volume of sales they generated on their domestic (read: German) market, even though the growth rate of aggregated domestic sales was smaller than the respective rate plants realised on the foreign market. However, although the international market offers German plants additional market potential, this did not prevent a decrease in some sectors' volumes of sales. The declining sales in the ICT-hardware sector after 2000 were a result of a reduction in sales generated in both the domestic and the foreign market.

[31] Comparable data for UK-based manufacturing companies or firms from the service sector are unfortunately not available.

2.4 Conclusion

The macroeconomic conditions young high-tech firms are faced with have changed during the last decade in both Germany and the UK. In the second half of the 1990s, high-tech markets were characterised by rather favourable conditions. In particular, aggregated sales generated by German and UK-based companies increased in almost all of the high-tech sectors examined. Technology-oriented firms did not only profit from increasing demand on their respective domestic markets. At least for German manufacturing firms, it was shown that the rise in sales was to a large extent attributable to firms' increasing sales generated on the foreign market. Although it cannot be proven with the data available, it is very likely that the foreign market is of similar importance for the UK manufacturing sector and, to some degree, for the software and service sectors in both countries. The favourable sales prospects in the late 1990s attracted new firms entering into the market. The number of firm formations increased tremendously in the software and service sector and, to a smaller extent, in most manufacturing sectors in Eastern Germany and the UK. The number of start-ups in the Western German manufacturing sectors decreased, but the rate of decline was rather modest – at least when compared with the development in most recent years. Of course, the large number of firm formations challenged incumbent firms, causing the market exit of the least efficient firms. Thus, on the other side of the coin, in most high-tech sectors the number of firm closures also increased in the late 1990s. However, the rising demand enabled newly founded firms to establish themselves in the market. As revealed by UK data, this led to a rise in the stock of enterprises in most of the high-tech sectors that were examined.

However, the high-tech sector experienced a downturn after the year 2000. The turning point in the development of the high-tech sector is in general associated with the end of the high-tech bubble on public markets (cf. Bank of England 2001). From 2000 to 2002, the number of firm foundations decreased in the five examined high-tech sectors in both Germany and the UK. In Western Germany, where the number of newly founded high-tech manufacturing firms was already declining in the late 1990s, the rate of decline rose significantly after 2000. In some German high-tech sectors, the number of start-ups increased again from 2002 to 2003 – possibly a first sign of recovery on these high-tech markets. The falling number of firm formations was accompanied by a further increase in the number of firm closures. At least in the UK, these two developments led to a reduction in the stock of enterprises. The downturn on high-tech manufacturing markets is also reflected by decreasing or constant sales. Thus, the period of growing aggregated sales has ended. At least for German manufacturing firms, this is true for both the domestic and the foreign market. Interestingly, aggregated sales generated by software and service firms continued to increase despite the decline in the number of newly founded service firms and the contemporaneous rise in

the number of firm closures. In Germany, aggregated sales in the software and service sector decreased from 2001 to 2002 only; in the UK merely the annual growth rate of the aggregated volume of sales declined from 2002 to 2003.

The changing macroeconomic environment has important consequences when examining the development of young high-tech firms. As will be discussed in the next chapter, this study's empirical analyses are based on a sample of high-tech firms that were surveyed in 1997 and again in 2003. Hence, the first survey was conducted when macroeconomic conditions were rather favourable for high-tech firms. Conversely, at the time of the second survey technology-oriented firms were faced with demand-side constraints. The demand for high-tech products is no longer growing, but constant or even decreasing in most sectors.[32] Thus, high-tech companies are challenged by intensified competition for a limited number of customers. Aggregated data reveal that the intensified competition led to a rising number of firm closures in both Germany and the UK. Thus, at the time of the second survey (i.e., 2003), the threat of failure was greater than at the time of growing high-tech markets before 2000. Firm managers have therefore had to develop appropriate strategies in order to guarantee their firms' survival and growth. For instance, firms may extend their R&D activities, and indeed, the subsequent empirical analyses will confirm the strategic role of investments in R&D. There are many strategic decisions firm managers have to make that will not be examined by this study. In particular, firms' financial strategies will be neglected. For instance, a successful firm may be able to finance its investment using previously earned profits. Alternatively, a high-tech firm that has become established in the market may be able to acquire long-term loans from banks. However, among the wide range of strategic options firm managers may exercise, this study will concentrate on firms' export strategies and their effect on the performance of the firms surveyed. In fact, the rising importance of globalised markets was already highlighted in Table 2-5, where it was shown that the share of aggregated sales German manufacturing plants generated in the foreign market increased significantly from 1996 to 2003.

Since the econometric analyses of this study are based on survey data, the observed strategies of the firms in our sample were at least successful in the sense that they guaranteed the firms' survival over the entire period from 1997 to 2003. Nevertheless, survey data reveal that there are still significant differences between individual firms with respect to other performance indicators like productivity or growth. Whereas some companies shrank after 1997, other firms exhibited relatively high (positive) growth rates from 1997 to 2002 (see chapter 5). This finding is in line with

[32] Of course, high-tech firms may also be constrained from the supply-side, for instance, by a limited availability of finance and skilled employees. Regardless of the importance of supply-side restrictions for the development of young technology-oriented firms, they are neglected in this section.

the development of aggregated sales as discussed above. In almost all German and UK high-tech sectors the aggregated volume of sales in 2003 was higher than in 1996. In particular, aggregated sales generated in each country's software and service sector increased tremendously after 1996 and continued rising even after the year 2000. Thus, the intensified competition in the high-tech sector after 2000 led to increasing crowding-out of the least efficient firms, but at the same time provided growth opportunities for surviving firms. This study will try to discover which firm-specific characteristics facilitate the firms' growth processes and enable them to exploit growth opportunities even in a period when firms are faced with demand-side (and supply-side) constraints.

3 Description of the Data Set

The data for this study's empirical analysis result from two surveys carried out simultaneously in Germany and the UK. The firms were first contacted in winter 1997/1998 via a written questionnaire. The first survey was carried out by the London Business School in the UK and the Centre for European Economic Research (ZEW) in Germany. 362 completed questionnaires returned from the UK and 232 returned from Germany, resulting in a combined net sample of nearly 600 NTBFs from the two countries. In order to determine the development and internationalisation status of this sample of 600 NTBFs, a joint research team from the University of Exeter and the ZEW prepared a new survey in which all previously responding firms were to be contacted a second time. The second survey was conducted in 2003 via computer-aided telephone interview (CATI). 244 firms from the original sample participated in the second survey. After performing several consistency checks, 217 companies were retained in the data set for this study's econometric analyses. This chapter will describe the research designs of both surveys – including the stratification and sampling procedures – starting with a presentation of the mail survey conducted in 1997. In this chapter's last section, I will discuss to which extent the data set is affected by a survival bias and a non-response bias.

One major objective of the first survey was a comparison between the export behaviours of German and UK-based firms. Differences in the firms' international business activities can be traced back to a varying endowment with firm-specific resources, to different effects of the exogenous variables on high-tech firms' export activities, or to "soft" factors like differences in business culture. The last effect is indeterminable based on our data set. The other two effects could in principle be estimated. This would require country-specific econometric analyses. However, since our final data set comprises only 217 companies, country-specific estimations are impossible. The consequences of this shortcoming of our data set will briefly be discussed at the end of section 3.2.

3.1 Mail Survey Methodology (1997)

The first survey, conducted in 1997, was described in detail in the corresponding research report (Bürgel et al. 2004). This section summarises the main steps of the postal survey.

The rationale of the 1997 research project was to address the internationalisation, that is, export behaviour of newly founded technology-based firms (NTBFs). In his influential study, Little (1977) defined an NTBF using three criteria: The firm must not be older than 25 years, it must have been founded as a legally independent company by one or more individuals – thereby exclud-

ing subsidiaries, de-mergers or firms that were founded as a management buy-out (MBO) or buy-in (MBI) – and the firm's business idea must be based on the exploitation of an invention or a technological innovation (a firm's technological focus).

Little's definition includes firms as old as 25 years. However, more recent studies (e.g., Storey and Tether 1996) regard firms of this age as already having reached a mature stage of their life cycles. Thus, in accordance with other studies on NTBFs, the research team responsible for the first survey restricted themselves to firms that were ten years of age or younger at the time the survey was taken. In order to meet the criterion of legal independence, firm representatives were asked whether their company was founded as an independent new firm or was set up as a subsidiary, or following a de-merger, a management buy-out or a buy-in. Only legally independent firms were retained for the analyses.[33] Finally, only firms that were operating in one or more high-tech sectors as defined by Butchart (1987, see section 2.1) were selected, satisfying Little's criterion of a technological orientation.

In addition to the three above-mentioned selection criteria, the research team from the London Business School and the ZEW imposed one further condition: Only firms with at least three employees (in full-time equivalents, including the entrepreneurs) at time of the latest update of each individual firm's record in the databases of Creditreform and Dun & Bradstreet were considered for the sampling procedure (see below). This additional criterion was included for the following reasons: In the databases of credit rating agencies like Creditreform and Dun & Bradstreet, micro firms are not entirely covered. This impedes generalising our findings for the whole population of micro firms since it is unknown whether the micro firms included in the databases appropriately represent the population. For example, micro firms that tend to pro-actively exploit their domestic and foreign markets are more likely to be recorded in the databases of Creditreform and Dun & Bradstreet because of their above-average scope of credit demands and business activities (see Box 2-1). Thus, the databases of credit rating agencies are likely to be biased samples of the populations of micro firms. This problem does not disappear altogether for larger firms, but the extent of the bias decreases with firm size.

Another reason for the introduction of the additional size criterion was the well-known fact that the probability of responding to (mail) surveys is positively correlated with firm size; this means that

[33] The source data sets used for the survey originate from Dun & Bradstreet in the UK and from Creditreform in Germany (see the explanations below and in Box 2-1). The statistical unit of both databases is the legally independent company. Thus, in most cases it is possible to distinguish between an original start-up and other derivative foundation events. However, in some cases the firm history might not be recorded entirely, prohibiting identification of a possible derivative foundation. Therefore, in order to guarantee that only original start-ups were analysed, firm representatives were asked to indicate the mode of firm formation in the written questionnaire.

the smallest firms generally exhibit the lowest inclination to participate in a survey. In order to obtain a sufficiently high number of responses enabling us to draw reliable conclusions for the population of micro firms, a relatively high amount of resources would be necessary. Considering that time as well as financial and human resources are always limited, firms with fewer than three employees were neglected.

The final reason for the exclusion of micro firms from the target sample was the assumption of the Anglo-German research team that these firms are not very likely to be engaged in international markets – for example, because of their limited resources. Under this assumption, the internationalisation behaviour of young technology-based firms can best be represented by firms whose size exceeds a certain threshold. However, taking into account the results of the first survey, this assumption cannot be confirmed. Even within the group of the smallest firms that were contacted, a relatively high percentage of firms were internationally engaged at the time of the first survey. Thus, it became evident *ex post* that if a minimum size required for international business activities exists, it will be far smaller than the research team's initial expectations.

After determining the selection criteria, suitable sources of primary data had to be identified. The research team decided to use the database of the respective country's leading credit rating agency, i.e., Creditreform in Germany and Dun & Bradstreet in the UK. Creditreform and Dun & Bradstreet both have a comprehensive database of firms at their disposals. Moreover, since their data are collected for the same purposes and in a similar way, the choice of these two data sources guaranteed that the sample selection process would be comparable in the two countries.

Applying the selection criteria discussed above, it was possible to identify 26,433 German companies from the Creditreform database that were still alive in 1997: 19,125 in Western Germany and 7,308 in the eastern part of Germany. 381 Eastern German firms had to be excluded because they were identified as former state firms of the German Democratic Republic (so-called "Treuhandunternehmen", or "trustee firms"). Public limited companies ("Aktiengesellschaften", AG), registered societies ("eingetragene Vereine", e.V.), and registered co-operative societies ("eingetragene Genossenschaften", e.G.) were excluded. Furthermore, firms of which more than 25 % of the individual firm's equity were owned by other companies and firms with more than 50 employees at the time of start-up were also left out of the sample. The former group of firms was assumed to be controlled by another company, thus violating the criterion of legal independence. Similarly, since most original firm formations are very small (cf. Harhoff and Steil 1997), only enterprises that were established with a workforce of less than 50 employees were defined as original start-ups. Larger firm foundations were assumed to be derivative foundation events or subsidiaries of

other companies. It was supposed that Creditreform had not recorded the entire history of these firms, leading to their incorrect classification as original start-ups. This procedure corresponds to that used for the preparation of the ZEW foundation indicators (see Engel and Fryges 2002). Likewise, it is applied in other studies examining foundation activities (see, e.g., Audretsch and Fritsch 1992). In the UK, 7,788 technology-based firms that had been founded between 1987 and 1996 and had survived until 1997 were identifiable in the Dun & Bradstreet database. Dun & Bradstreet generously made this data set freely available to the Anglo-German research team.

In addition to the codified information, the databases of both Creditreform and Dun & Bradstreet contain free-flow texts describing each firm's line of business. All of these descriptions were carefully screened by members of the research team in order to ensure that the selected firms really were engaged in at least one high-tech industry and were not misleadingly coded. This was carried out using various "negative" criteria for a text field search. More precisely, firms whose aforementioned free-flow texts included keywords like "retail", "wholesale", "distribution", "maintenance", or "repair" were identified and excluded from the sample. Further, firms that only ran a computer call centre (NACE code 74.83, secretarial activities) were often incorrectly codified as providers of telecommunication services (NACE code 64.2). They were likewise removed from the sample.

Another problem emerged because the database of Dun & Bradstreet was classified by the US 1982 SIC code. According to this classification, computer-related services (SIC codes 73.72 and 73.79) include firms that primarily provide preparation of computer software documentation and installation of software on a contract- or fee basis. Since it is not very likely that the normal business activities of these firms entail regular R&D activities, they were identified using the text field search described above and were not considered for the sampling procedure. Altogether, a final sample of 5,045 German and 3,562 UK-based firms (hereafter called the "population") was obtained and deemed appropriate for the subsequent sampling procedure.

Each country's population was stratified by size class, sector (manufacturing versus services), and, for Germany, by region (West and East Germany). The sample composition of the population is given in Table 3-1. In order to obtain a target sample of 2,000 firms in each country for the mail survey, a target number of firms per cell was determined. The research team decided on separate strata for West and East Germany because there are no Eastern German NTBFs that were founded before 1990. Moreover, due to the exceptional economic situation in Eastern Germany after German unification, Eastern German firms were faced with macroeconomic conditions different from those experienced by firms in established market economies like Western Germany or the UK. In

Table 3-1: Sample Composition of the Population and the Target Sample (1997)

	Population (still living firms)			Target Sample		
Employees	Manufacturing	Services	Total	Manufacturing	Services	Total
West Germany						
3-5	522	997	1,519	183	100	283
6-9	273	499	772	192	87	279
10-19	358	463	821	323	116	439
20 and more	379	300	679	379	117	496
Total	1,532	2,259	3,791	1,077	420	1,497
East Germany						
3-5	115	244	359	46	29	75
6-9	128	155	283	64	31	95
10-19	167	133	300	94	33	127
20 and more	242	70	312	171	35	206
Total	652	602	1,254	375	128	503
UK						
3-5	673	742	1,415	345	111	456
6-9	474	370	844	384	111	495
10-19	472	292	764	427	133	560
20 and more	362	177	539	345	144	489
Total	1,981	1,581	3,562	1,501	499	2,000

Source: Bürgel et al. (2004).

order to examine whether these varying macroeconomic conditions affect the internationalisation behaviour of Eastern German NTBFs, the latter were overrepresented in the target sample.

The research team intended to include approximately 1,500 manufacturing firms and 500 service firms in the target sample. Since its members were interested in estimating and testing industry-specific effects, each of the four high-tech manufacturing sectors had to be entered into the sample with a sufficiently high number of observations. In the case of a proportional random sample, half of the target sample would originate from the service sector. The overrepresentation of the manufacturing sector guaranteed that a sufficiently high number of firms from each manufacturing sector would be contacted by the first survey. Finally, a roughly equal distribution of firms among different size classes was decided upon. Theory suggests that larger firms are more likely to have international business activities. Thus, an overrepresentation of larger firms increased the *ex ante* probability that a sufficient number of internationally active firms would be included in the target sample. Moreover, a broadly even distribution of firms among different size classes facilitates an examination of systematic differences between firms of different size. The sample composition of the target sample is shown in Table 3-1.

Table 3-2: Drawing Probability per Stratum

	West Germany		East Germany		UK	
Employees	Manufacturing	Services	Manufacturing	Services	Manufacturing	Services
3-5	37 %	10 %	43 %	13 %	51 %	15 %
6-9	75 %	18 %	52 %	21 %	81 %	30 %
10-19	92 %	26 %	60 %	25 %	90 %	46 %
20 or more	100 %	41 %	77 %	50 %	98 %	81 %

Note: The table shows the final drawing probabilities after inclusion of 74 (62) firms from the German (UK-based) reserve sample.
Source: Bürgel et al. (2004), own calculations.

Based on the target number of firms per cell, a stratified random sample of 2,000 companies for each country was drawn from the population. This procedure results in the drawing probabilities per stratum that are displayed in Table 3-2. Furthermore, a reserve sample of 617 German and 671 UK firms was drawn, roughly a third of the target sample for each country. The reserve sample was intended to replace firms in the second mailing that had ceased to exist or had moved and whose questionnaires returned unopened in response to the first mailing.

In parallel to drawing the target and the reserve samples, the written questionnaires were developed based on the existing literature on the internationalisation process of NTBFs. The written questionnaires contained questions regarding the profile of the firms' founders, product characteristics, international business activities, entry modes into foreign markets, and perceived opportunities and risks of international activities. After designing the questionnaires, the research team carried out six pilot case studies in the two countries (four in the UK and two in Germany). These case studies allowed the research team to discover whether the questions were exhaustive and

Table 3-3: Response Codes of the Mail Survey (1997)

	Germany		UK	
Description	*N*	%	*N*	%
Usable Questionnaires	*232*	*11.2*	*362*	*17.6*
Answered only the first questions	15	0.7	7	0.3
Refusal, questionnaire sent back	4	0.2	27	1.3
Refusal by mail or telephone	6	0.3	34	1.6
Firm does not belong to the target population	21	1.0	94	4.6
Firm not known at the address or firm moved, address unknown	5	0.2	134	6.5
Firm failed, no longer exists or is in receivership	3	0.1	9	0.4
No response at all	1,788	86.2	1,395	67.7
Total [a]	2,074	100	2,062	100

[a] 74 German and 62 UK firms that were involved in the first mailing were replaced by firms from the reserve sample.
Source: Bürgel et al. (2004).

understandable and whether they really measured what was intended by the team. The questionnaires were then modified in terms of both the layout and wording of the questions. The final questionnaires are presented in appendices A.2 (English version) and A.3 (German version).

The questionnaires were sent out to the target firms in October 1997, followed by three reminders at intervals of three to four weeks after the last mailing. 62 British and 74 German firms involved in the first mailing were replaced by firms taken from the reserve samples. These were firms that had ceased to exist or moved. As a result, 362 completed questionnaires returned from the UK and 232 returned from Germany (see Table 3-3). This corresponded to a (uncorrected) response rate of 11.2 % in Germany and 17.6 % in the UK. The net sample showed no bias with respect to age, size, or sector when compared with the target sample.

3.2 Telephone Survey Methodology (2003)

The data collected by the 1997 survey enabled the research team to carry out profound descriptive and econometric analyses, extending the knowledge of the export behaviour of technology-oriented firms in Germany and the UK during early stages of their life cycles. However, our knowledge of the development and the internationalisation status of high-tech companies as firms age and reach more "mature" stages of their life cycles is still limited. Therefore, a joint research team from the University of Exeter and the ZEW prepared a new survey in which all previously responding firms were to be contacted a second time.

In 2003, the companies from the original sample were an average of twelve years old. Thus, some of them were no longer definable as NTBFs – at least not according to the definition chosen by the Anglo-German research team, where only firms that were ten years of age or younger were regarded as "newly founded" firms. Considering this notion, we shifted our interest from analysing high-tech start-ups to a more longitudinal perspective of firm development.

The second column of Table 3-4 shows each country's 2003 population of high-tech firms; that is, those companies of the 1997 population that survived the following six years. Since we do not have reliable information on the survival status of each individual firm, the figures given in Table 3-4 constitute only an estimation of the 2003 population.[34] In Germany, 79 % of the 1997 popula-

[34] The estimation of the 2003 German population is based on the Creditreform database's information on firm closures. As explained in section 2.1, those firms labelled as "dead" by Creditreform have almost certainly left the market. The reverse, however, is not true: Voluntary firm closures are often only recorded after a considerable delay by Creditreform, causing the number of closed firms to be underestimated. In the UK, the research team drew a random sample for each stratum and subsequently determined the survival status of these companies using different data sources only available to the UK research team. Based on this information, the 2003 population of high-tech firms in the UK was estimated.

tion was still alive in 2003 (manufacturing sector: 82 %; service sector: 77 %). The survival rate of Western German firms (80 %) was only slightly higher than that of their Eastern German rivals (77 %). There are likewise only minor differences with respect to the size class German firms were assigned to in 1997, i.e., at the beginning of the time period that will be examined in this study. The overall survival rate of UK-based firms amounted to 83 %.[35] Interestingly, in contrast to the German subsample, the survival rate of firms in the smallest UK size class (87 %) is considerably higher than that of firms with 20 or more employees in 1997 (78 %).[36]

Table 3-4: Sample Composition of the Population and the Target Sample (2003)

	Population (still living firms)			Target Sample		
Employees	Manufacturing	Services	Total	Manufacturing	Services	Total
West Germany						
3-5	426	779	1,205	18	12	30
6-9	231	409	640	21	12	33
10-19	301	367	668	22	10	32
20 and more	319	213	532	27	3	30
Total	1,277	1,768	3,045	88	37	125
East Germany						
3-5	82	180	262	4	9	13
6-9	107	108	215	9	1	10
10-19	136	96	232	12	3	15
20 and more	196	56	252	21	4	25
Total	521	440	961	46	17	63
UK						
3-5	581	643	1,224	35	12	47
6-9	405	286	691	45	19	64
10-19	411	210	621	64	14	78
20 and more	277	141	418	36	18	54
Total	1,674	1,280	2,954	180	63	243

Note: The 1997 assignment of a single firm to a stratification cell was used.

Seven firms from the UK sample were no longer assignable to their old stratification cells.

Source: ZEW, University of Exeter.

35 Since the survival rates for the German and the UK subsample are determined in very different ways, they are not directly comparable. At best, it can be concluded that the data do not contain any evidence of significant differences between the country-specific overall survival rates. However, the survival rates can be compared between the four different size classes in each country.

36 These descriptive results contradict various econometric analyses (e.g., Mata and Portugal 1994, Audretsch and Mahmood 1995) which found a positive effect of firm (start-up) size on the probability of survival. The relationship between firm size and survival is, however, beyond the scope of this study.

To determine the target sample of the second survey, all formerly responding firms that turned out to be mismatches (e.g., non-high-tech firms, non-independent foundations) were first excluded. Furthermore, each German firm labelled as "dead" in the Creditreform database (due to bankruptcy or voluntary firm closure) at the beginning of 2003 was eliminated from the new target sample. In the UK, firms that could be identified as dead by the researchers themselves were also excluded from the target sample. As a result, we produced and subsequently contacted a final target sample of 188 German and 250 UK-based former respondent firms. The sample composition of the 2003 target sample is presented in Table 3-4.

The second survey was conducted in summer 2003 via computer-aided telephone interview (CATI). The research team decided on a telephone survey because, due to the limited number of former respondent firms in the 2003 target sample, the assurance of a relatively high response rate and thereby a sufficiently high number of observations was necessary to obtain reliable econometric results.

The questionnaires of the telephone interviews were essentially based on the written questionnaires used for the first survey. The structure and the wording of the individual questions were almost identical in both surveys. This was necessary since the research team intended to compare the situations of the firms in the sample at the time of the two surveys and the firms' development over the period in between. Therefore, the wording of the questions was merely adjusted to meet the peculiarities of a telephone survey. Moreover, some minor changes in the wording of the questions were made when the research team was convinced that these changes would improve the comprehensibility of the individual questions – in particular in the German translation of the English questionnaire.[37] In both countries, about 30 companies were interviewed by phone in order to test the understandability of the questionnaires. Based on the experiences reported by the interviewers, the questionnaires were modified, resulting in the final versions shown in appendices A.4 (English version) and A.5 (German version).

Fortunately, in both the UK and Germany, the response rate exceeded 50 %, giving us a pool of 244 completed interviews (see Table 3-5). After performing several consistency checks, 217 companies were retained in the data set for econometric analysis. However, in contrast to the first survey in which a bias with respect to sector was not found, the ICT-hardware sector 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 2003 German (UK) sample. An absolutely anony-

[37] For example, the research team decided to use another German translation of the English expression "tried and tested technology".

Table 3-5: Response Codes of the Telephone Sample (2003)

	Germany		UK	
	N	%	*N*	%
Completed interview	*103*	*54.79*	*141*	*56.40*
Refusal	45	23.94	49	19.60
Line occupied	7	3.72	0	0.00
Free line/answering machine	14	7.45	0	0.00
Open appointment (not realised)	3	1.60	0	0.00
Firm dead	4	2.13	31	12.40
No phone number available	2	1.06	0	0.00
Wrong phone number	7	3.72	0	0.00
Computer crash	1	0.53	1	0.40
Firm not contacted	2	1.06	28	11.20
Total	188	100	250	100

Source: ZEW, University of Exeter.

mous version of the data set (in STATA format), including a detailed description of the data, is available from the ZEW upon request.

The most important shortcoming of the data set is that due to the limited number of observations, country-specific econometric analyses are almost impossible. This is particularly true for the German subsample which comprises only 95 companies. The UK subsample is larger, but nevertheless contains only 122 firms. Considering further that the number of observations in a specific econometric model is typically reduced due to item non-response, a country-specific estimation of the models that will be derived in chapters 4 and 5 would eventually be based on less than 100 observations. Moreover, in the logistic regressions in chapter 4, the "success" sometimes constitutes a rare event in our data (e.g., the exit from the foreign market or the change of the foreign sales mode used). Thus, in each country-specific subsample the absolute number of "successes" is still smaller than in the pooled data set, making an estimation of the probability of the rare event impossible. But even if the respective econometric model can be estimated using the two country-specific subsamples, the resulting differences between the estimated coefficients in the two country-specific regressions are not significant in most cases. It is therefore difficult to prove econometrically whether the functional form of the regression model differs between the German and the UK subsamples. For these reasons, I will not present country-specific regressions in chapters 4 and 5. It has, however, to be borne in mind that differences between German and UK-based firms' export activities that are apparent from the descriptive analyses are either a result of different effects of the exogenous variables on the firms' export behaviour, that is a different functional

form of the regression model between the two country-specific subsamples, or of the firms' varying endowments with firm-specific resources. Due to the limited number of observations in our data set, a decomposition of these two effects is, unfortunately, not possible.

3.3 Survival Bias and Non-Response Bias

The chosen research design implies that this study's empirical results may be affected by a survival bias as well as a non-response bias. The survival bias occurs because some firms of the examined cohorts from 1987 to 1996 did not survive until the time when the two surveys were conducted. Even the population from which the target sample of the first survey was drawn (cf. Table 3-1) did not represent all start-ups of the analysed cohorts since some firms already left the market until 1997. However, based on the available data sets, it is not possible to determine the number of firms that did not survive from start-up until 1997. As described above, about 20 % of the firms of the 1997 population left the market in the period from 1997 to 2003, leading to a second survival bias that influences the composition of the longitudinal data set this study's analyses are based on.

The survival bias has two important consequences: Firstly, the results are not representative for all technology-oriented firms founded between 1987 and 1996, but only for those that survived. The cross-sectional data set of the first survey represents young high-tech firms that were an average of six years old in 1997. Similarly, the cross-sectional data set of the second survey represents technology-oriented firms that were an average of twelve years old in 2003. Of course, the cross-sectional data set of the first survey comprises firms that exited from the market in the period between the two surveys. Thus, when comparing (descriptive) statistics that are calculated on the basis of the 1997 cross section with results that are obtained using the cross-sectional data set of the second survey, the comparison is inevitably affected by the survival bias. If the sample of still living firms is characterised by different characteristics than non-surviving firms, the (descriptive) statistics do not only reflect changes in the firm-specific characteristics over time, they also mirror differences between dissolved and surviving firms. Therefore, as the second important consequence of the survival bias, all statistics in this study will be restricted to those firms that participated in both surveys. This guarantees that increases or decreases in the statistics presented can be traced back to changing behaviour of the firms in our sample over time.[38]

[38] Restricting ourselves to those firms that participated in both surveys further implies that all statistics that are related to the time of the first survey deviate from those presented in Bürgel et al. (2004). It should further be noted that Bürgel et al. calculated weighted descriptive statistics (based on the drawing and responding probabilities in the individual strata), whereas I will only present unweighted descriptive statistics.

In addition to the survival bias, this study's results are affected by a non-response bias. Whenever the firm-specific characteristics of respondents deviate from those of non-respondent firms, the results are no longer representative for the population of young high-tech firms in Germany and the UK. Since we did not carry out a non-response analysis, we do not know whether there are differences between respondents and non-respondents. The non-response bias is particularly important for the first survey where we realised a response rate of only 11.2 % in Germany and a corresponding rate of 17.6 % in the UK. In the second survey, the response rates in both countries were relatively high (54,8 % in Germany and 56,4 % in the UK). This can be regarded as an indicator that the respondents of the 2003 survey do not differ systematically from the complete target sample from the 2003 survey (i.e., all respondents of the first survey that survived until 2003). This is important, because throughout this study we will compare the results of the first survey, as presented in Bürgel et al. (2004), with our own empirical results. Thus, it is unlikely that such a comparison is affected by a non-response bias in addition to the survival bias that was described above. Nevertheless, it is impossible to determine the extent to which the non-response bias influences the representativeness of our longitudinal data set with respect to the population of (still living) NTBFs in 2003 (cf. Table 3-4). Since only the respondents of the first survey were contacted a second time, a possible non-response bias that was prevalent in the 1997 survey also affects the representativeness of both the 2003 target sample and the 2003 sample of responding firms.

4 Export Behaviour of Technology-Oriented Firms

The internationalisation of firms has multiple dimensions (cf. Sullivan 1994b). Perhaps the most apparent and most frequently discussed dimension of international business activities is the firms' export behaviour. Additionally, firms may import investment goods or components, i.e., internationalise on the procurement market. They may persuade foreign investors to invest in their company or they may themselves invest in foreign companies or build up a production subsidiary of their own abroad. Internationalisation is a demanding task for firm managers that involves having to make numerous decisions. For example, managers have to decide whether they want to expand their firms' business activities onto the international market or to remain a firm with domestic sales only. Provided that firm managers decided on entering the foreign market, they must select the target country to which they will export their products or services. In each target country the time of market entry and the optimal sales mode have to be determined. Of course, an international engagement is connected with various costs firm managers have to consider. Selling abroad may require adaptation of the firm's product or service to foreign regulations. Packaging and sales documentation may have to be modified. Reliable foreign partners must be identified and foreign sales channels must be set up. Furthermore, a firm's international engagement may be impeded by various factors, for instance, the limited international experience of firm managers or just a scarcity of management time. Thus, firm managers have to develop strategies in order to overcome these restrictions. Moreover, macroeconomic conditions as well as each firm's situation (e.g., a firm's available resources and capabilities) change over time. In this case, firm managers may be obliged to adjust their export strategy. As an extreme example, firm managers may regard it as optimal to exit from the foreign market.

Even though the aforementioned list is by far not exhaustive, it makes it clear that it is impossible to analyse firms' export behaviour in all its dimensions in this chapter. Considering this study's focus on high-tech firms' long-term international business activities, I will restrict myself to three dimensions of firms' international engagement: firms' foreign market entry and exit, the degree of internationalisation, and changes of sales modes in international markets. Before examining these three dimensions, I will discuss various theories of internationalisation that will provide a basis for the subsequent empirical analysis. As Bürgel et al. (2004) stated, there is no single theoretical model that is able to explain the internationalisation behaviour of a firm that is both young and operates in a high-technology sector – such as those that were observed by the two surveys. Therefore, I will fall back on different models in order to motivate my empirical analysis (section 4.1).

Each of the three following sections 4.2 to 4.4, which contain this chapter's empirical analyses, is structured in the same way. Firstly, empirical studies that deal with the dimension of internationalisation examined in the respective section will be reviewed. I will also discuss the extent to which previous empirical results are transferable to the context of the long-term export behaviour of young and small technology-oriented firms. The second subsection will comprise descriptive analyses, followed by a presentation of the econometric model. Based on the theories reviewed in section 4.1, I will derive testable hypotheses on how the export behaviour of NTBFs is affected by various exogenous factors, i.e., the general internationalisation theories are transferred to the special case of NTBFs. In connexion with the derivation of the econometric model, I will also show how the different theoretical concepts are operationalised in the estimation equations. The fourth subsection presents the empirical results, and a final subsection concludes.

4.1 Theories of Internationalisation

Theories that try to explain individual firms' export activities can be categorised into models of economics and theories 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 a series of papers (see, in particular, Bernard and Jensen [2004] and Bernard and Wagner [2001]). My theoretical considerations begin with a presentation of this model's core arguments. The second model of economics that will be presented is the dynamic model derived by Lautanen (2000). According to Lautanen, there are analogies between the adoption process of a new technology and small firms' decision to enter into the foreign market. Therefore, Lautanen's theory is based on models of technology diffusion.

Both Roberts and Tybout's and Lautnen's model include a vector of firm-specific variables that influence potential profit from international business activities and insofar determine a firm's decision to internationalise or not. However, mostly due to data restrictions, previous econometric studies have often contained only a relatively small number of observable firm characteristics. Since this study is based on survey data that were specifically collected to analyse the internationalisation behaviour of young and small high-technology firms, 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 internationalisation theories from the field of international management. In the following, 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 (RBV) of a firm (e.g., Penrose 1959, Wernerfelt 1984). After entering into a

foreign market, a firm has to decide on an appropriate sales mode. The internationalisation process model and the RBV are also suitable for explaining a firm's choice of its foreign sales mode (see Malhotra et al. 2003). Additionally, I will discuss the organisational capability (OC) perspective of the firm (Madhok 1997), which is rooted in the RBV, and the transaction cost analysis theory (e.g., Williamson 1985, Anderson and Gatignon 1986) insofar as these two theories are relevant for an analysis of a firm's sales mode choice. Finally, the eclectic paradigm developed by Dunning (1993) will be presented. As a multitheoretical framework, Dunning's eclectic paradigm combines elements of all the theoretical approaches reviewed in this section.

Models of Economics

The first model under theoretical consideration was originally formulated by Roberts and Tybout (1997) and applied by Bernard and Jensen (2004) and Bernard and Wagner (2001), among others.[39] It is based on the theoretical literature on sunk costs 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* maximises the profits π_{it} it receives by selling the profit-maximising level of exports q_{it}^* abroad. It is assumed that the firm is always able to produce the profit-maximising level of exports q_{it}^*. A firm's profit depends on factors exogenous to the firm X_{it}, such as exchange rates, and firm-specific variables Z_{it}, like firm size, age or product characteristics. Firm profit is given by

$$\pi_{it}\left(X_{it}, Z_{it}\right) = p_t q_{it}^* - c_{it}\left(X_{it}, Z_{it} \middle| q_{it}^*\right). \tag{4.1}$$

where p_t is the price of goods sold abroad and c_{it} is the variable cost of producing quantity q_{it}^*. 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_{it} indicates the internationalisation status of firm *i* in period *t* and is defined as

$$Y_{it} = \begin{cases} 1 & if\ \pi_{it} \geq 0 \\ 0 & otherwise \end{cases}. \tag{4.2}$$

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

[39] Formulas and notation used in this section are identical to those used by Bernard and Jensen (2004) and Bernard and Wagner (2001).

costs N must be fully paid in each period t unless the firm had exports in the previous period t-1 (i.e. $Y_{it-1}=1$), the one-period profit becomes

$$(4.3) \qquad \tilde{\pi}_{it}\left(X_{it}, Z_{it}, Y_{it-1}\right) = p_t q_{it}^* - c_{it}\left(X_{it}, Z_{it} \middle| q_{it}^*\right) - N \cdot \left(1 - Y_{it-1}\right).^{40}$$

In a dynamic framework the firm chooses a sequence of export levels $\left\{q_{is}^*\right\}_{s=t}^{\infty}$ that maximises expected current and discounted future profits

$$(4.4) \qquad \Pi_{it} = E_t\left(\sum_{s=t}^{\infty} \delta^{s-t}\left[\tilde{\pi}_{is} \cdot Y_{is}\right]\right),$$

where δ is the one-period discount rate.

The introduction of sunk costs induces an option value of waiting and leads to a spell of inaction, a phenomenon known as "hysteresis" (Dixit 1989a). In fact, the main interest of Roberts and Tybout's study 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 respective domestic currency will cause a permanent (or at least long-term) increase in the number of firms involved in the international market, even if the domestic currency subsequently re-appreciates.

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

$$(4.5) \qquad Y_{it} = \begin{cases} 1 & \text{if } \beta X_{it} + \gamma Z_{it} - N \cdot \left(1 - Y_{it-1}\right) + \varepsilon_{it} \geq 0 \\ 0 & \text{otherwise} \end{cases}.$$

In order to consider unobserved firm-specific heterogeneity, the error term ε_{it} is assumed to consist of a permanent firm-specific element κ_i and a transitory component η_{it}. The latter term follows a first-order autoregressive process, $\eta_{it} = \rho \eta_{it-1} + \nu_{it}$, so that

$$(4.6) \qquad \varepsilon_{it} = \kappa_i + \eta_{it}.$$

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40 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 from periods prior to the immediately preceding interval (cf. Roberts and Tybout 1997), or we can introduce exit costs from the foreign market. The basic argumentation, however, remains unchanged.

Beside Roberts and Tybout's model, there are only a few approaches in the economics literature to modelling the export behaviour of individual firms. One alternative approach has been developed by Lautanen (2000). He interpreted entry into a foreign market as an innovation adopted by a firm. At least for small firms, Lautanen argued, 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 both are (or can be) initiated through personal contact-related stimuli. 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 diffusion.[41] 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 on becoming interested in exporting in the first stage of the model.

More concretely, taken the share of firms that were interested in exporting in period 1 (s_1) and the share of firms that actually exported in period 1 (e_1) as given, the diffusion of information about exporting from period 1 to period 2 follows an epidemic learning process so that the share of firms interested in exporting in period 2 is determined by

$$s_2 = s_1 + d + g \cdot (1 - s_1) \cdot (e_1), \tag{4.7}$$

with d representing exogenous learning between the two periods of the model and g capturing the effectiveness of the learning process. This formula shows that the share of firms interested in exports in period 2 (s_2) is composed of three elements: firstly, the share of firms that were already interested in exporting in period 1; secondly, the share of firms that have been stimulated exogenously (i.e., without contact to other exporters of the same product); thirdly, those firms that have been stimulated by other firms. These are represented by the product of former exporters[42] and of those that were not interested in exports in period 1, multiplied with the parameter of effectiveness g.

Given that a firm is interested in exporting, the decision on committing to exporting in period 1 is represented by three equations. The first equation is the profitability condition, stating that a firm will only export if it receives non-negative (expected) profits from its export activity. Taking the same notation as for the model of Roberts and Tybout, the profitability condition in period 1 is given by:

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41 Models of technology diffusion, among them epidemic learning models and rank, stock, and order effect models are described in detail in Stoneman (1983) and Karshenas and Stoneman (1993).

42 In this model, the decision to internationalise is irreversible and exit is not considered.

(4.8) $$\Pi_1(Z_i) = E_1\left(\pi_1(Z_i) + \delta^{-1}\pi_2(Z_i) - N_1\right) \geq 0,$$

where Π_1 is the expected profit if the firms enters the foreign market in period 1. As before, it depends on a set of firm-specific variables Z_i.

The second equation is the arbitrage condition. A firm will commit to exporting in period 1 only if it is not profitable to wait until period 2 before entering the foreign market, that is, if the arbitrage profit *a* from postponing exports is non-positive:

(4.9) $$a(Z_i) = \delta^{-1}\Pi_2(Z_i) - \Pi_1(Z_i) \leq 0.$$

Finally, the third equation is a feasibility condition that demands that the firm has enough resources *W* for its planned export activities:

(4.10) $$W_1 \geq 0.$$

If the firm does not have export activities in period 1, either because one of the three conditions above was not satisfied or because the firm was not interested in exporting, the two conditions of entering the foreign market in period 2 are simply $\Pi_2(Z_i) \geq 0$ and $W_2 \geq 0$ – provided that the firm is interested in exporting in period 2 according to equation (4.7).

Since the data set used for this study's empirical analysis does not contain information on 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 Roberts and Tybout model explicitly traces a possible delay of entry (and exit) back to the existence of sunk costs. Finally, firms' internationalisation behaviour in both theories depends on the availability of firm-specific resources. Hence empirically analysing firm-specific variables that determine the export activities of high-tech firms, as it is the purpose of this study, is consistent with both models.

Theories of International Management

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

in which firms incrementally increase their commitment in foreign markets. A commitment is always associated with uncertainty. The firm extends its international business activities until its particular maximum tolerable risk is reached. This is a function of the degree of the firm's risk aversion and resource position. The commitment of resources to a foreign market increases knowledge of that market and thus reduces any existing uncertainty about the foreign environment. The internationalisation process is therefore combined with a dynamic learning process over time. An initial involvement in a foreign market reduces uncertainty, which in turn induces an additional commitment to this market. As a consequence, firms start their international activities with relatively few resources because the commitment of these resources is associated with a relatively high level of risk. Improved knowledge acquired over time through additional commitment to the market leads to more resource-intensive international activities, since the latter become 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 the firm's life cycle. According to this model, a firm goes through the following stages: (i) no regular exports; (ii) exports via an intermediary; (iii) foreign sales subsidiary; (iv) foreign direct investment and foreign production. Hence, the stage models try to explain not only the entry into a foreign market per se, but also the choice of the optimal market sales 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 an optimal sales 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 have themselves already listed three exceptions where firms are likely to deviate from the gradually expanding commitment predicted by their model. Firstly, large firms may have enough resources to take larger, i.e. more resource-intensive, steps in their internationalisation process. Secondly, relevant knowledge that reduces uncertainty in a foreign market can be acquired by means other than one's own experience, for example by employing an internationally experienced manager. Finally, if market conditions in different foreign markets are homogenous, firms may generalise experience gained in one market to make larger internationalisation steps in another.

The criticism of the process model's 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, pro-active, 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 alone is not enough to initiate an internationalisation process (Andersson 2000). Action on the part of an entrepreneur is needed to trigger the internationalisation process. Entrepreneurs make strategic choices that determine the optimal method of internationalisation conditional on their firm's resources and their own capabilities and preferences. The entrepreneurial perspective, however, is not restricted to 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 different patterns of the internationalisation processes of firms back to characteristics of the entrepreneurs. Based on a case study analysis of Swedish firms, Andersson (2000) identified 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 pro-actively creates his firm's internationalisation process ("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 thus less important for the sample of NTBFs examined by this study. Structural entrepreneurs regard internationalisation as but one part of their overall strategy. They organise and restructure (large) firms and, in this context, create an international business strategy, for example by choosing mergers and acquisitions as a method of entry.

The concept of international entrepreneurship as well as Johanson and Vahlne's model emphasise the role of intangible resources like experience or entrepreneurial capabilities in the internationalisation process. This is also a main topic when discussing the resource-based view (RBV) of a firm (e.g., Penrose 1959, Wernerfelt 1984) and the more recent theories that regard organisational capabilities of firms as determinants of their 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 itself from its rivals by the intangible resources it possesses. These determine how efficiently physical assets can be used and are therefore vital to the firm's performance. With respect to the internationalisation process, this means that the 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 perspective on how intangible and physical resources interact, the theory remains vague in many respects. For example, it does not derive hypotheses about causalities between specific assets and firm performance. In our context, RBV models do not explain the timing of entry into a foreign market. Nevertheless, RBV models can help us deal with the peculiarities of the internationalisation process of firms that are small, young, and belong to a high-tech sector. A resource-based perspective seems to be particularly relevant for samples of NTBFs similar to the one chosen for this study. Indeed, general variables like size and age probably cannot discriminate between exporters and non-exporters since nearly all selected firms are of similar age and size.[43]

Based on the RBV, Madhok (1997) developed an organisational capability (OC) perspective of a firm's choice of its appropriate sales mode when entering into the foreign market. Madhok proposed that a firm's entry mode depends on the nature of the resource advantage a firm possesses. If a firm's advantage is inimitable and difficult to transfer to other firms like an intermediary without loss in value (e.g., tacit knowledge), the exporter will prefer a high level of control over transactions (hierarchical structure, internalisation). In contrast, if the firm's routines and strategies (i.e., its particular way of doing business) are highly specific and thus difficult to transfer to a foreign environment without loss in value, use of an intermediary will be the favoured sales mode. Madhok called this the "locational effect" (Madhok 1997, p. 48).

Thus, the internationalisation process model and the OC framework both emphasise the role of the firm's intangible assets (in particular, experiential knowledge) in its choice of the optimal entry mode. However, whereas the former theory only distinguishes between different entry modes according to the level of resource commitment, the OC framework differentiates by the level of control, i.e., whether transactions are carried out internally or whether a third partner, an intermediary, is involved.[44]

In contrast to theoretical approaches that concentrate on firm-specific resources, the transaction cost analysis (TCA) theory regards a firm as a governance structure (Williamson 1985). A transaction is conducted internally if the costs of an economic exchange in a market exceed those of a transaction within the organisational structure of a firm. The TCA theory assumes bounded rationality and opportunistic behaviour on the part of decision-makers. However, the unit of analysis is

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43 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.

44 As usual in the related literature, this study assumes that the concepts of control and internalisation/integration are closely related (Andersen 1997).

not the decision-maker itself, but the individual transaction. According to the TCA theory, the optimal foreign market entry mode is chosen by minimising the transaction costs. Anderson and Gatignon (1986) described the entry mode choice as a trade-off between control (the benefit of internalisation) and the costs of resource commitment (the costs of internalisation) under conditions of risk and uncertainty. The authors derived several propositions of how transaction-specific assets may influence the desired level of control. A high level of control will be preferred if a firm's product is technically sophisticated (i.e., it incorporates a higher proprietary knowledge), is unstructured and poorly understood, requires intense product customisation, or can be classified as an immature product. Novel technology that is incorporated into a (new) product is often not yet codified and therefore difficult to transmit to an intermediary. Thus, direct exporting is preferable. Intense product customisation demands close contact to customers, leading to a high reliance of the decision-maker (i.e., the domestic firm) on these working relationships with its key customers. It is proposed that the domestic firm is interested in controlling these important relationships.[45]

In addition to transaction-specific assets, Anderson and Gatignon hypothesised how external and internal uncertainty affect the entry mode decision. External uncertainty is related to a firm's environment and is typically labelled "country risk" (e.g., political instability, economic fluctuations). Anderson and Gatignon argued that in the absence of transaction-specific assets, a low-control entry mode is appropriate. The domestic firms are able to retain flexibility and shift country risk to their foreign partners, since the latter can easily be replaced if the outcome is unsatisfactory. If, however, transaction-specific assets, as described above, are prevalent, switching between different foreign partners is expensive, making a partner almost irreplaceable. These difficulties in selling a technically sophisticated product abroad are intensified in an uncertain environment. As a result, Anderson and Gatignon hypothesised that the *combination* of transaction-specific assets and external uncertainty leads to a higher degree of control. Internal uncertainty describes the lack of experience in international business activities firm managers might perceive. Moreover, internal uncertainty increases with the sociocultural distance between its domestic market and the foreign market entered by the firm. A low-control entry mode, an intermediary for instance, will be preferred if internal uncertainty prevails.[46] [47]

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45 Technically sophisticated products also impede the monitoring of foreign distributors and agents. In this case, accurate measures of distributors' performance might not be available. Thus, we have a classic principle-agent situation, where problems like adverse selection and/or moral hazard might occur (see, e.g., Zacharakis 1997).

46 Anderson and Gatignon (1986) further proposed that a high-control entry mode will be more efficient the higher the intermediary's free-riding potential. If the domestic firm possesses a high-value brand name, the foreign partner can "free ride" on the international recognition of the domestic firm, realising a high turnover without making its own sales efforts. Therefore, the domestic firm might prefer a high level of control in order to shield their

The main limitation of the TCA theory is that firms do not only evaluate the benefits of internalisation in terms of the reduction of transaction costs. Other considerations, like the desired market penetration in a foreign market, might be relevant as well. If these motives are taken into account firms will arrive at different entry mode choices (Andersen 1997, Madhok 1997).

Dunning's Eclectic Paradigm

The eclectic paradigm developed by Dunning (1993) is a multitheoretical framework that combines elements of all the theories already presented in this section. Dunning argues that the success of firms' international business activities depends on three factors: ownership advantages (O), locational advantages (L), and internalisation advantages (I). Dunning's eclectic paradigm is therefore also called the OLI framework. Ownership advantages are firm-specific assets and skills. They comprise experiential knowledge and other intangible assets by which a firm differentiates from its rivals according to the resource-based view of a firm and the internationalisation process model. They further include the firm's size and its physical and financial resources, which enable larger firms to take more resource-intensive steps in the internationalisation process according to Johanson and Vahlne (1990). Locational advantages describe the attractiveness of a foreign country. They include the foreign market potential as well as country risk, which was called external uncertainty by Anderson and Gatignon (1986) in their TCA model. Finally, internalisation advantages reflect the firm's ability to conduct a transaction within its hierarchical organisation efficiently, for example because of efficient control procedures. Thus, internalisation advantages are closely linked to the TCA theory.

Dunning's eclectic paradigm predicts that a firm will choose the status of internationalisation (for the firms in our sample: exporter versus non-exporter) and the entry mode (in our case: direct exports versus exporting via an intermediary) most suited to the "advantages" it possesses. The main improvement of the eclectic paradigm in comparison with other theories is that it includes a large set of explanatory variables and, most importantly, that it points out how different influenc-

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brand name from degradation by free-riders. However, the domestic, i.e. German and UK-based, firms of this study's sample are young and small. They do not (yet) possess an internationally recognised brand name. Quite the opposite applies: If the firms of our sample decide on an intermediary for entering a foreign market they might be interested in profiting from the recognition of the chosen distributor in that market.

47 Nakamura and Xie (1998) developed a model of ownership structure for technology-oriented manufacturing firms' foreign direct investment (FDI). Due to the high-tech firms' intangible assets (e.g., novel technology that is not fully contractible) full ownership, i.e., a high level of control, is the first best solution as proposed by Anderson and Gatignon (1986). If, however, selling a firm's product in a foreign country requires transaction-specific assets that only a local partner possesses (e.g., familiarity with local business practices), the investing firm will choose a joint venture with a local firm as a second-best solution. This corresponds to Anderson and Gatignon's effect of internal uncertainty.

ing factors interact. For example, a firm that generates an intangible asset by carrying out intense R&D activities so that its product incorporates novel, self-developed technology (the firm's ownership advantage) only chooses an integrated entry mode if it is also able to organise the distribution of its product abroad efficiently (the firm's internalisation advantage). However, the large set of explanatory variables is also the eclectic paradigm's greatest weakness. If every imaginable variable is included in a theory it is difficult to derive testable hypotheses (Andersen 1997). Itaki (1991) claimed that a detailed eclectic paradigm becomes virtually tautological. According to Dunning (1993) himself, the eclectic paradigm intends to explain "what is" rather than, in the normative sense, "what should be" the level and structure of a firm's internationalisation behaviour.[48]

4.2 Foreign Market Entry and Exit

The focus of this section is the long-term internationalisation behaviour of the firms surveyed. 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 (e.g., R&D activities, characteristics of a firm's best-selling product or service, managerial profile) motivated by the literature of international management and observed over time. Thus, it is possible to identify "hard" success factors that are linked with long-term export activities.

Studying long-term export behaviour cannot be restricted to the analysis of foreign market entry. Although there is a high persistence in export behaviour, we observe market entry and exit in our data set. Just under 13 % of firms that recorded international sales in 1997 had left the foreign market by 2003 (see section 4.2.2 for more details). This observation is in line with other empirical studies that have examined long-term international business activities (see, e.g., Roberts and Tybout 1997, Bernard and Jensen 2004). In this section, I will empirically analyse entry into and exit from the foreign market by applying logit models that firstly explain the transition from the internationalisation status "non-exporter" to that of "exporter", i.e. foreign market entry, and secondly the transition from the internationalisation status "exporter" to that of "exporter", i.e. remaining internationally active. Of course, by trivial recoding, the second model explains exit from the foreign market. I will begin, however, with a short review of empirical studies that have examined firms' long-term internationalisation behaviour.

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48 If, in the normative sense, the OLI framework gave advice to firm managers as to what they should do, selecting foreign entry mode based on the firm-specific OLI advantages should lead to better performance than that of firms that do not match their entry mode choice to their OLI advantages. Brouthers et al. (1999) found empirical support for the OLI framework as both a descriptive and a normative model.

4.2.1 Literature Review

Most empirical studies that have analysed firms' long-term export behaviour go back to the dynamic model of Roberts and Tybout (1997) that was presented in the previous section. Using a data set of Colombian plants in the manufacturing sector observed between 1981 and 1989, inclusive, Roberts and Tybout (1997) themselves estimated their binary-choice model (4.5) by applying a random effects probit model. As a major result of their analysis, they discovered that sunk costs are relevant. If a firm had exported in the previous year, the probability of it being international in the current period would increase by 63 %. However, the effect of previous international activities has been shown to depreciate rapidly. After a two-year absence from the foreign market, re-entry costs are no longer different from the costs faced by firms entering the international market for the first time. Apart from the effect of sunk costs, Roberts and Tybout confirmed that observed and unobserved plant characteristics have a significant influence on the firms' export behaviour. The probability of internationalising increases with firm size, age, and a dummy variable that indicates whether the plant is owned by a corporation.

Bernard and Jensen (2004) used data collected on U.S. manufacturing plants between 1984 and 1992 to estimate the same model as Roberts and Tybout. They confirmed the relevance of both sunk costs and plant-specific variables in the plants' export behaviour. Applying a random effects probit model, the probability of a plant exporting in a certain year would increase by 62 % if the plant had 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 %.[49] Moreover, the observed plant-specific characteristics size, productivity, and share of white collar workers are significantly positively correlated with exporting. Using data from German manufacturing plants 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.

All of the aforementioned studies examined samples of large and mature manufacturing firms. However, it is questionable whether these studies' results are transferable to a sample of newly founded technology-based manufacturing and service firms. There are numerous studies that have investigated the internationalisation processes of NTBFs during their start-up period (e.g.,

[49] Bernard and Jensen (2004) provided a detailed discussion of the role of different econometric methods when estimating the binary choice framework given in equation (4.5). They stressed that the fixed effects estimator in a linear probability model is almost certainly biased downward but gives a lower bound of the effect of previous export status.

Lindqvist 1991, McDougall et al. 1994, Bürgel et al. 2004). However, to the best of my knowledge, no other study has been performed that observes NTBFs over a relatively long time period, investigating long-term internationalisation behaviour. This study will try to address this disparity by empirically examining the long-term export activities of our sample of young German and British technology-oriented firms.

4.2.2 Descriptive Analysis

Comparing the firms in our sample with and without international business activities, significant differences in some key firm-specific characteristics become evident (see Table 4-1). On average, 26 employees worked in the sampled firms in 2003. Considering only those firms that participated in both surveys, the average number of employees had increased by an average of 7 employees (or 37 %) since 1997. The 1997 and 2003 surveys both reveal a higher mean value (and a higher median, not shown here) of number of employees for firms with exports compared with non-exporting firms. Applying a t-test proves that total employment of exporting firms significantly exceeds that of firms with only domestic sales in both Germany and the UK. Regarding firm age (measured in years), the firms in our sample were an average of 12 years old in 2003. The mean of firm age is always higher for exporting firms. However, based on a t-test the differences are not significant.

Table 4-1: Comparison of Means between Exporters and Non-Exporters

	Germany			**UK**		
	International sales			International sales		
	No	Yes	*t-test*	No	Yes	*t-test*
1997						
Number of employees	11.57	18.85	***	14.80	22.87	*
Firm age (in years)	5.20	6.03		7.03	7.40	
R&D intensity (in %) [a]	17.83	16.15		9.73	15.68	
2003						
Number of employees	15.04	32.37	**	18.57	28.19	*
Firm age (in years)	11.44	11.91		13.11	13.29	
R&D intensity (in %) [a]	3.40	14.67	***	5.36	16.58	***

[a] Expenditures on R&D as percentage of sales.

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

Note: Only firms that participated in both surveys were considered.

Source: ZEW, University of Exeter, own calculations.

In 1997, German and UK-based technology-oriented firms spent an average of 15.4 % of their total sales on research and development. Neither in Germany nor in the UK is the mean of R&D intensity of exporting firms 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 an average of 12.8 %. This is not necessarily a result of falling expenditures on R&D. It may also be attributed to rising sales. During the early stage period covered by the 1997 survey, many high-tech firms incur high costs developing new products or services that can be commercialised. On the other hand, total sales might be relatively modest 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, making the declining mean R&D intensity between 1997 and 2003 less surprising. It is, however, remarkable that the drop in R&D intensity has been caused mainly by non-exporting firms, whereas the average R&D intensity of exporters has changed only slightly. As a consequence in 2003, the mean R&D intensity of firms with international sales is significantly higher than the mean of non-exporting firms. In fact, among those firms that have never had international sales (see Table 4-3 and the explanations below) three-quarters did not carry out any own R&D activities in 2003.

Table 4-2 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-thirds 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 international sales is smaller than in any aggregated high-tech manufacturing sector. In the manufacturing industry, firms that belong to the sectors ICT-hardware, engineering, and health/life sciences export their products more often than other manufacturing firms. In the UK-based 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 these two sectors is rather small. In Germany, only 5 ICT-hardware firms (15 firms in health/life sciences) answered both surveys; in the UK there are 12 ICT-hardware firms (10 in health/life sciences).[50]

[50] Recall that in contrast to the first survey where no sector bias was found, the ICT-hardware sector is underrepresented in the German as well as in the UK-based sample. Conversely, the health/life sciences sector (engineering sector) is overrepresented in the German (UK-based) sample (cf. chapter 3).

Table 4-2: Firms with International Sales, by High-Tech Sector (in %)

	Germany				UK			
	1997		2003		1997		2003	
Sector	No	Yes	No	Yes	No	Yes	No	Yes
Software/services	50.0	50.0	45.5	54.5	40.6	59.4	35.5	64.5
ICT-hardware	20.0	80.0	20.0	80.0	0.0	100	0.0	100
Engineering	15.8	84.2	10.5	89.5	20.0	80.0	13.8	86.2
Health/life sciences	20.0	80.0	20.0	80.0	0.0	100	0.0	100
Other high-tech manuf.	27.3	72.7	27.3	72.7	25.7	74.3	31.4	68.6
Total	31.6	68.4	28.7	71.3	23.5	76.5	22.2	77.8

Note: Only firms that participated in both surveys were considered.
Source: ZEW, University of Exeter, own calculations.

When calculating the percentages of firms with foreign sales for the complete cross section of the 1997 survey, the percentages turn out to be generally smaller compared with the respective values of the firms that participated in both surveys, those considered in Table 4-2. As already discussed in section 3.3, there are two possible selection processes that can lead to this result. Firstly, firms that answered the second survey may have behaved differently compared with the complete target sample from the 2003 survey (non-response bias). Since we did not carry out a non-response analysis, we do not 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, the firms still currently living may have behaved differently in 1997 compared with the period's general cross section, i.e., including those firms that had already dissolved between the two surveys (survival bias). The higher percentage of internationally active firms in 1997 among those that survived the following six years may serve as an indication of a positive correlation between internationalisation and firm survival. This needs further research but is beyond the scope of this study.[51]

As Table 4-2 further shows, there was 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 was at least as high as in 1997. These numbers, however, do not allow us to see how many firms had entered the foreign market for the first time since 1997 and how many firms had left the market. Roberts and Tybout (1997) already showed that although there is a high persistence in the individual firm's status of interna-

[51] The effect of internationalisation on firm survival has been examined empirically, for example, by Bernard and Jensen (1999).

tionalisation due to sunk costs, quite a high number of firms change internationalisation status, leading to entry and exit over time. The development of internationalisation status of the sampled firms is listed in Table 4-3. This table also includes a separate column for the time of start-up. A firm is defined as having international sales during its start-up period 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 4-3: Development of Internationalisation Status

Foreign sales (yes=1)			**Germany**		**UK**	
Start-up	1997	2003	%	*n*	%	*n*
1	1	1	27.7	26	25.0	29
1	1	0	3.2	3	0.9	1
1	0	1	0.0	0	0.9	1
0	1	1	30.9	29	45.7	53
1	0	0	0.0	0	0.0	0
0	1	0	8.5	8	6.9	8
0	0	1	13.8	13	6.9	8
0	0	0	16.0	15	13.8	16
Total			100	94	100	116

Source: ZEW, University of Exeter, own calculations.

About a quarter of all firms had international sales shortly after their formation. Further, just under 31 % of the German firms and 46 % of the firms in the UK did not export during their start-up period, but 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 interesting for the purpose of this section are the firms that have changed their status of internationalisation. Ignoring the firms' behaviour at time of start-up for the moment, nearly 12 % of German and 8 % of UK-based firms left the international market between 1997 and 2003. During the same period, 14 % of German firms and 8 % of firms sited in the UK 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 internationalisation status in this section has, however, one shortcoming: We can only determine the status in the two years 1997 and 2003. We do not know whether firms had foreign sales in each year or whether they left the foreign market for a couple of years and re-entered just before the second survey was conducted. In other words, we do not have annual information on the firms' export status trajectories.

4.2.3 Econometric Implementation

This section concentrates on foreign market entry and exit. Since the firms have been observed only twice, dynamic probit models, as used by Roberts and Tybout (1997) or Bernard and Jensen (2004) (see section 4.2.1), are not suitable for our data set. 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 et al. (2004) in order to estimate the transitions between different states of firm performance of German service firms.

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

$$(4.11) \quad \Pr_{ijj'}(t) \equiv \Pr\left(Y_{it} = j' \middle| Y_{it-1} = j\right) = \frac{\exp\left(x_{it}\beta_{jj'}\right)}{\sum_{j'=0}^{1} \exp\left(x_{it}\beta_{jj'}\right)},$$

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

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

$$(4.12) \quad \Pr_{ij0}(t) = \frac{1}{1 + \exp\left(x_{it}\beta_{j1}\right)},$$

$$(4.13) \quad \Pr_{ij1}(t) = \frac{\exp\left(x_{it}\beta_{j1}\right)}{1 + \exp\left(x_{it}\beta_{j1}\right)},$$

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

$$(4.14) \quad \ln L = \sum_{j=0}^{1}\sum_{j'=0}^{1} \ln L_{jj'}, \quad \text{with} \quad \ln L_{jj'} = \sum_{i=1}^{N}\sum_{t=1}^{2} n_{i,t-1,t}(jj') \ln \Pr_{ijj'}(t).$$[52]

[52] 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.

Since the quantity $\sum_{j'=0}^{1} \ln L_{jj'}$ only depends on β_{j1}, the maximum likelihood estimators $\hat{\beta}_{j1}$ can be obtained by individually maximising the elements of $\sum_{j'=0}^{1} \ln L_{jj'}$, $j = 0, 1$.[53]

In order to discriminate between firms that have entered the international market and firms that stay absent from it, 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 emerges 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) showed 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 $\widehat{\Pr}_{i10}$ – is too small, and hence the probability of the more frequent event, i.e., the probability of staying in the international market $\widehat{\Pr}_{i11}$, is overestimated.

King and Zeng (2001) showed that the bias of $\hat{\beta}$ can be calculated applying a weighted least-squares estimation, thereby leading to a bias-corrected estimate of β, denoted $\tilde{\beta}$. Furthermore, King and Zeng derived an analytical approximation for estimating the probability $\Pr_{i11}$ as

$$(4.15) \qquad \Pr_{i11} \approx \frac{1}{1+\exp\left(x_i \tilde{\beta}_{11}\right)} + C_i = \widetilde{\Pr}_{i11} + C_i ,$$

where the correction factor is

$$(4.16) \qquad C_i = \left(0.5 - \widetilde{\Pr}_{i11}\right)\widetilde{\Pr}_{i11}\left(1 - \widetilde{\Pr}_{i11}\right) x_i \, Var\left(\tilde{\beta}_{11}\right) x_i' .$$[54]

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53 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 et al. (2004). The linear index that the transition probabilities depend on now becomes $x_{it}\beta_{jj'} + \sigma_{jj'}u_{ijj'}$. The terms $\sigma_{jj'}u_{ijj'}$ are assumed to be mutually independent and independent of x, with mean 0 and variance $\sigma^2_{jj'}$. The random variable $u_{ijj'}$ has been assumed to be standard normal distributed. The parameters $\sigma_{jj'}$ 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 $\sigma_{jj'}$ set to 0) against the unrestricted model cannot reject the null hypothesis (LR $\chi^2(4) = 2.836$; [Prob > χ^2] =0.586). 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 to a model without simulated heterogeneity.

54 For simplicity, I have neglected the time subscript *t* in this formula.

The estimator $\widetilde{\Pr}_{i11}+C_i$, 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 $\Pr_{i11}$ (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 (4.14).

The vector of explanatory variables x_{it} may contain both firm-specific variables, denoted Z_{it} in equation (4.5), and variables exogenous to the firm, denoted X_{it}. 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 decision to export. 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.[55] The weights are defined by the share of exports of each respective industry to that 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 essentially able to estimate the reaction of (potential) exporters to changes in prices on the industry's most important foreign markets (cf. Bernard and Jensen 2004).

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 export activities and will enter its first (unknown) foreign market at a later stage of its life cycle. Therefore, I hypothesise that firm age, measured by the logarithm of firm age (in years) at time of the respective survey, is positively correlated with an arrival status (status *j*' at time *t* in equation (4.14)) "exporter". Similarly, Johanson and Vahlne (1990) state that larger firms posses more resources and are more likely to take larger internationalisation steps – independent of their age. Thus, it can be expected that firm size, measured by the logarithm of the number of employees at time of the respective survey, increases the probability of remaining an exporter or of changing internationalisation status to become an exporter at time *t*.

Resource-based theories emphasise that firms stand apart from their rivals by intangible resources. The latter also constitute ownership advantages according to Dunning's OLI framework. One way

55 The data sources of nominal exchange rates and consumer price indices used to calculate real exchange rates are described in detail in appendix A.1.

to gain such firm-specific assets that are only imperfectly imitable by other firms is by conducting R&D activities and developing novel technology to produce the firm's product (cf. Bürgel et al. 2004). Firms' R&D activities are measured by the percentage of total sales spent on R&D. A higher R&D intensity should lead to a higher propensity to be engaged in international markets. Further, firms were asked to describe the innovativeness of their best-selling product or service by indicating the technology incorporated into the firm's product. In the econometric analysis, two dummy variables will be included. The first dummy takes the value 1 if, according to the representatives of the firm, the firm's product incorporates novel technology that had to be developed specifically for this product by the company itself. The second dummy variable indicates whether the firm's product incorporates novel technology that has been developed by other firms. Thus, both dummy variables represent novel technology, but only in the first case the company has to carry out own R&D activities. I assume that the use of novel technology positively affects firms' inclination to export to a foreign market, since such technology cannot easily be imitated by rival companies – at least, the novel technology has to be bought from other companies, for example, by paying a licence fee to the company which developed the novel technology.

Product characteristics may influence the internationalisation behaviour of firms. High customisation requirements may act as a constraint to entering the foreign market. They involve close contact with 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 will be used taking the value 1 if the firm has classified the requirements of customisation and maintenance, respectively, as "important" (4) or "very important" (5). Moreover, a dummy variable indicating whether the firm's best-selling product is sold to end-users will be included. This variable is also presumed to reduce the probability of beginning or continuing to export due to the higher communication and distribution costs involved in selling a product to end-users.

Human capital and the capabilities of the management team are highlighted by the theories of international management presented in section 4.1. As an exception to the internationalisation process model, Johanson and Vahlne (1990) mentioned the possibility that the knowledge necessary to reducing uncertainty about a foreign market can be acquired by employing an internationally experienced manager. Therefore, the firms were asked whether a member of the firm's management team had 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 decisive in determining firms' internationalisation behaviour from a resource-based view of the firm and according to Dunning's OLI framework. However, not only previous experience but also and in the first line integral capabilities and skills possessed by members of the management team are likely to increase the probability of an international engagement. Therefore, the firms' representatives were asked 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 taking the value 1, if a firm's managers experience a "serious" (4) or a "very serious shortage" (5) of skills 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 of skills in sales and distribution may indicate that the managers in question are behaving like marketing entrepreneurs who pro-actively create the internationalisation process for their firm. On the contrary, the absence of a shortage of skills in production or R&D may hint at the involvement of a technical entrepreneur, who is mainly interested in technology and the development of the production process.

Moreover, the econometric model will include two dummy variables that signify whether a firm is sited in Western Germany and Eastern Germany, respectively. The empirical analyses based on the cross section of the first survey revealed a significantly positive marginal effect on the Western German firms' propensity to internationalise compared with Eastern German and UK firms, whereas there was no difference between Eastern German and UK firms (see Bürgel et al. 2004). Hence, I will distinguish not only between German and UK firms but also between Western and Eastern German firms in order to reconsider the effect observed in the first survey. Finally, I will add industry dummies to the estimation equation. As Table 4-2 shows, in the manufacturing sectors ICT-hardware and health/life sciences almost 100 % of the firms had international sales in 1997 and 2003. Including dummy variables for each of these two manufacturing sectors will thus lead to the inclusion of variables that will almost perfectly predict the international engagement of firms in these sectors. Hence, I will include only one dummy for the engineering sector and a combined dummy variable for all remaining high-tech manufacturing industries, thus using the software/service sector as the base category.

4.2.4 Empirical Results

The results of the empirical model are given in Table 4-4.[56] 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 "exporter" at time *t*, i.e., foreign market entry. The third column includes the vector $\tilde{\beta}_{11}$, which 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 β_{00} and β_{10} were set to 0 in order to identify the model.

The industry real exchange rate has no effect either on the probability of entry or on the probability of exit. This contradicts to the findings of other empirical studies (e.g., Roberts and Tybout 1997, Bernard and Jensen 2004). However, it should be noted that the firms in the sample are observed only twice with a six year interval between the two surveys. The weighted exchange rate indices, thus, 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) and the British pound from 1997 to 2003.[57] Therefore, the results should not be interpreted as a disproof of the importance of the real exchange rate for the firms' internationalisation behaviour.

The country-specific dummy variables reveal a lower probability of East German firms entering the foreign market than both West German and UK firms. East German firms in our sample were founded shortly after German reunification. Foreign trade in former East Germany was traditionally oriented towards Eastern Europe and all East German firms have had to learn how to access Western European markets. Of course, since all firms in our sample are newly founded firms, each individual firm had to investigate potential foreign markets in order to reduce the uncertainty of its first entry – whether it is 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 and do not 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

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56 The results were obtained using the statistical software package STATA, version 8.2 SE. The estimator of the rare events logit, programmed by Michael Tomz, Gary King, and Langche Zeng, is available at http://GKing.Harvard.Edu (cf. King and Zeng 2001). For analysing the results, I further used the STATA-based programme CLARIFY, written by Michael Tomz, Jason Wittenberg, and Gary King, and also available at http://GKing.Harvard.Edu (cf. King et al. 2000).

57 The nominal exchange rate of the euro and the pound to the most important foreign currency, the US dollar, did indeed change significantly during the period from 1997 to 2003. But in 1997, the average rate was nearly the same as the average rate in 2003.

Table 4-4: Propensities of Foreign Market Entry and Exit

	Transition non-exporter→ exporter			**Transition exporter → exporter**		
	Logit model			**Rare events logit**		
	Number of observations = 150 LL = -66.920 $\chi^2(17) = 47.47$ Prob > $\chi^2(17) = 0.000$ McFadden's $R^2 = 0.317$			Number of observations = 185 $\chi^2(17) = 18.28$ Prob > $\chi^2(17) = 0.365$ [a]		
	Coeff.	*Robust stand. error*		*Coeff.*	*Robust stand. error*	
Industry real exchange rate	-0.211	0.155		0.206	0.248	
West Germany	-0.932	0.575		1.060	1.348	
East Germany	-1.806	0.697	**	-0.202	1.425	
Engineering	0.768	0.622		1.993	0.985	**
Other manufacturing industries	1.649	0.549	***	1.209	1.018	
Log (number of employees)	1.236	0.265	***	0.570	0.323	*
Log (age)	0.643	0.572		-0.236	0.702	
R&D intensity	0.063	0.035	*	0.076	0.040	*
Novel self-developed technology	-0.376	0.538		-0.278	0.519	
Novel techn., developed elsewhere	-0.801	0.627		0.855	1.062	
Working experience abroad	0.979	0.471	**	0.569	0.766	
Education abroad	-0.748	0.794		1.854	0.922	**
Shortage of competencies						
Sales/distribution	0.308	0.530		-0.126	0.594	
Production/R&D	-1.016	0.548	*	0.126	0.710	
Intense product customisation	-1.109	0.537	**	-1.587	0.966	*
Regular maintenance and upgrades	0.032	0.450		-0.870	0.708	
Consumer good	-0.688	0.491		0.668	0.741	
Constant	17.611	14.904		-21.381	26.842	

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

[a] The value of the log-likelihood function and McFadden's R^2 are not reported since the rare event logit is an unbiased estimator and not a likelihood technique. Thus, it does not maximise a likelihood function.

Base category: UK software/service firm with arrival status "non-exporter".

Source: own estimation.

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 firms have overcome the barrier presented by foreign market entry, there is no significant difference with respect to market exit among firms from West Germany, East Germany, and the UK.[58]

[58] Bernard and Jensen (2004) tested for geographical spillover effects in the US manufacturing industry, but did not find any evidence of the existence of spillover effects that were hypothesised to reduce entry costs. According to the authors, this may result from the exclusive selection of large manufacturing plants.

Comparing these results with the estimated propensity to internationalise from the first survey, we see that in contrast to earlier results[59], 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 stages disappears.

Firms from the other manufacturing industries (including health/life sciences and ICT-hardware) are more likely to enter the foreign market than 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 4-2. Surprisingly and in contrast to the descriptive analysis, engineering firms differ from the other manufacturing industries. 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 to export. Given the earlier descriptive results showing that the share of engineering firms with international sales is comparable to that of the other manufacturing sectors, we might conclude that engineering firms are better equipped with assets that enhance their international business activities, enabling them 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 of exiting from the international market than all other industry sectors. If there are high entry costs, engineering firms 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 among the other industries, firms will have the same probability of leaving the international market. 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 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. The causality between exporting and performance is a matter of intense empirical discussion. 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 this paper is very clear-cut: "Good plants become exporters", (Bernard and

[59] In this section, it often seems reasonable to compare the empirical results of this study with the results of the cross-sectional analyses of the first survey. The results of the first survey are given in Bürgel et al. (2004); I will refer to this report, although I will not mention it explicitly in each case.

Jensen 1999, p. 23).[60] Taking this result as given, the empirical specification chosen in this section is correct: An above-average employment growth rate prior to the time of the survey, which typically leads to a higher observed number of employees, causes a higher probability of entering the international market. It might be suspected 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 have exported since start-up ("born globals"). It is simply not possible for born globals to have grown faster in the years prior to the start of their international activities as in the case of the US manufacturing firms studied by Bernard and Jensen. Thus, the estimated positive correlation between firm size and export activities in this section might reflect reverse causality or a feedback relationship between these two variables, making firm size endogenous in the above regression. The direction of causality will therefore be analysed extensively in chapter 5.

The relationship between firm size and the predicted probability of entering the foreign market is depicted by the upper left graph in Figure 4-1. Setting all other variables to their mean, the graph clearly reflects the positive correlation between number of employees and (predicted) propensity to internationalise. The graph only has a relatively steep slope where the number of employees is small. The predicted probability of entering exceeds 80 % at 17 employees. The graph becomes flat thereafter, nearly reaching a 100 % probability of starting exports for firms with more than 100 employees. If a minimum size for international business activities exists, it is quite low and already exceeded by the average firm in our sample.[61]

Firm size not only positively affects the probability of foreign market entry, it is also correlated with a higher persistence in firms' exporting activities, i.e., large firms are less likely to exit from the foreign market 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 may no longer be exposed to international competition and best practise technology, or because an exit may signal failure to domestic customers (McKinsey 1993b, Bernard and Wagner 1997). In the literature, the relationship between foreign market exit and the development of employment is practically neglected. One exception is the study of Girma et al. (2003) on UK firms. Applying matching techniques, they discovered that employment and output drop in the year of exit and in the two subsequent years, while total factor

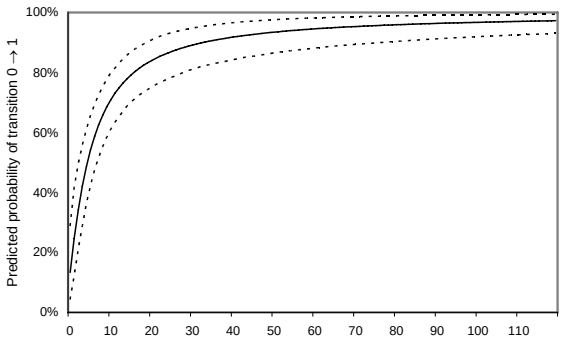
60 This result is confirmed, for example, by Bernard and Wagner (1997), Clerides et al. (1998), and Arnold and Hussinger (2005).

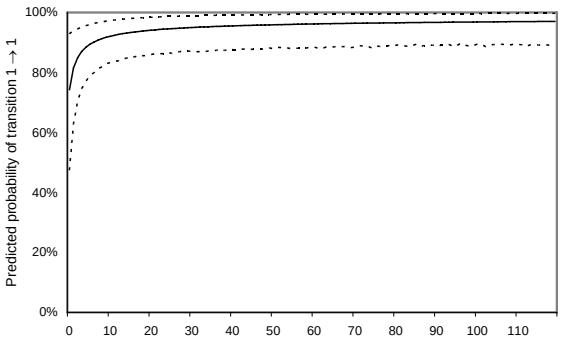
61 Recall that the average firm in our sample had 19 employees in 1997 and 26 in 2003 (see section 4.2.2).

Figure 4-1: Predicted Probability of Foreign Market Entry and Exit

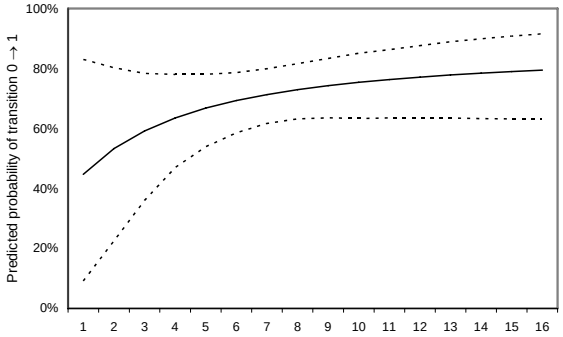
Transition non-exporter→ exporter (0→1) **Transition exporter → exporter (1→1)**

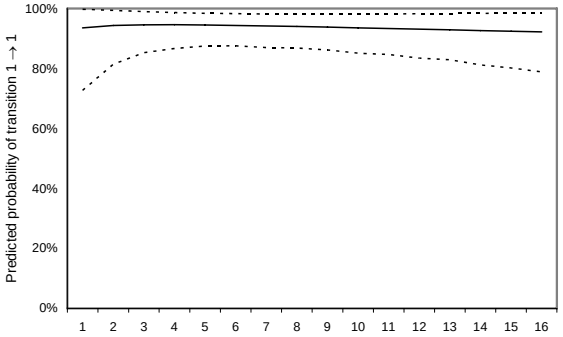
Predicted probability in dependence of the number of employees



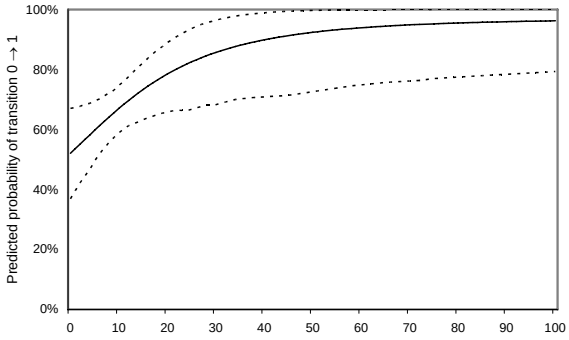


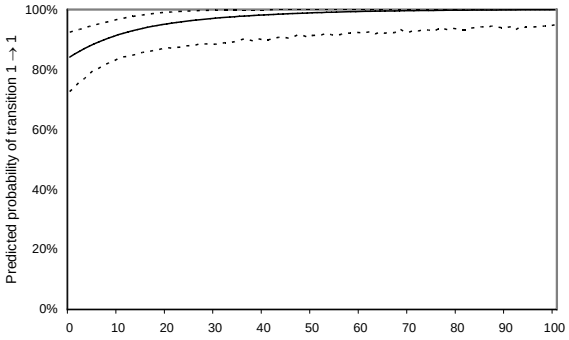
Predicted probability in dependence of firm age (in years)





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.

productivity does not decrease after exit. For German plants, Bernard and Wagner (1997) also noted a significant drop in employment after exiting the foreign market.

The upper right graph in Figure 4-1 depicts the predicted probability of staying in the international market in dependence of the number of employees, with all other variables set to their mean. Since a market exit constitutes a rare event in our data, the predicted probability of remaining an exporter is high, in most cases exceeding 90 %.[62] The graph shows that only firms with fewer than approximately 10 employees have a significantly lower probability of continuing to 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 has no significant effect on the transition probabilities. This result contradicts 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 towards internationalisation. Obviously, when regarding a longer time period, firm age is no longer relevant, probably because the surveyed firms are now an average of 12 years old and no longer belong to what is in general defined as newly founded technology-oriented firms (see section 2.1). For "mature" high-tech firms, firm age seems unable to discriminate between exporters and non-exporters. The relationship between firm age and foreign market entry and exit is displayed in detail by Figure 4-1. Although the probability of market entry is positively correlated with firm age, reflecting an expansion of international business activities as 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 remaining 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 surveys. In 2003, the firms were at least 7 years old. Only one firm left the foreign market between start-up and 1997. Thus, for young firms, we only observe 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 4-4, indicating a higher chance of firms that invest intensively in R&D reaching the status "exporter".

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62 Setting all independent variables, including number of employees, to their mean, the predicted probability of remaining an exporter in the rare event logit model is 93.61 %. In comparison, applying the conventional logit model, i.e., without the correction described in section 4.2.3, results in a predicted probability of 98.70 %. Thus, in contrast to the unbiased estimator (i.e., the rare event logit model), the conventional logit model overestimates the probability of the more frequent event, that is, the probability of staying in the foreign market.

R&D activities can be expected to create assets within a firm that are difficult for the firm's rivals to imitate. This facilitates the firm's internationalisation process as predicted by the resource-based view of the firm and Dunning's OLI framework. The positive relationship between R&D intensity and the predicted probabilities of transition can also be seen in the lower graphs of Figure 4-1. The coefficients of the other two variables, included in the estimation equations to approximate the innovativeness of the firms' products (dummies for novel technology that was either developed in-house or elsewhere by another company), are not significant at any conventional level. Since all three variables are intended to approximate the firms' innovative products, the effect of applying a novel technology might already be covered by the R&D intensity. Moreover, it can be argued that dummy variables indicating those firms that produce with novel technology are no longer suitable to discriminate between firms as was the case for the cross section of the first survey. In 2003, the share of firms that produced using a novel and self-developed technology was significantly higher than it was in the cross section of the first survey. Conversely, the percentage of firms of which the best-selling product merely incorporates "tried and tested" combinations of existing technology (i.e., the lowest degree of innovativeness among the list presented to the interviewees) was considerably smaller in 2003 than at time of the first survey. Furthermore, firms that participated in both surveys often changed their production technology from a tried and tested technology to a novel technology between 1997 and 2003.[63] Hence, a dummy variable indicating a novel (and self-developed) technology no longer has discriminatory power.

All cited theories from the field of international management emphasise the role of experienced managers in 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 the foreign market. Entering a foreign market obviously requires the firm's manager to be familiar with foreign business practices and market conditions. Such familiarity can be best acquired by working abroad. A permanent international engagement, however, can be better assured by managers that have experience of living abroad, gained while studying in a foreign country. Managers with experience of living abroad are able to assess the preferences and needs of foreign customers, allowing them to develop long-term business relations. These results support both the internationalisation process model, which states that an internationally experienced management

63 Although this is beyond the capacity of our data to prove, it is consistent with our results that using a novel technology was a prerequisite for survival until 2003.

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, there is no evidence for the entrepreneurial perspective of the firm's internationalisation process. Shortages of skills in sales/distribution are not significant in either of the two coefficient vectors. Shortages of skills in production/R&D do not affect the probability of remaining an exporter, but reduce the probability of entering the foreign market – although the respective dummy variable is only significant at the 10 % level. If a firm is managed by a technical entrepreneur (i.e., someone without shortages) who is mainly interested in technology, the firm is more likely to become an exporter. This result even contradicts the entrepreneurial perspective and the hypotheses derived by Andersson (2000). However, a technical entrepreneur has the ability to create intangible assets which facilitate a firm's international engagement. Nevertheless, performing a Wald test does not reveal any joint significant effect of the two dummy variables indicating shortages of competencies (transition from non-exporter to exporter: $\chi^2(2) = 3.71$, [Prob > χ^2] = 0.157; transition from exporter to exporter: $\chi^2(2) = 0.07$, [Prob > χ^2] = 0.967).

As expected, intense customisation is a barrier for international business activities. Even firms that have exports tend to exit the foreign market, probably because they have underestimated the costs that arise from their products' high customisation requirements. The necessity of regular maintenance and upgrades, on the other hand, does not show any effect on firms' exporting activities. Furthermore, to whom the product is sold is not important. The dummy variable identifying the product as a consumer good or service is also not significant. Hence, assessing the chances and risks of exporting should not be done by identifying a typical customer of a firm's product, but by evaluating the product's transaction costs, especially the need for 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 R^2 reaches a value of 0.317. 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 R^2 is not of much use, because the rare event logit is an unbiased estimator that does not maximise a likelihood function. In fact, the rare event logit estimator fits the data less well than the ordinary logit model, but the former has a smaller mean square error. In the transition equation explaining foreign market entry, a Wald test of joint significance of the entire vector of exogenous variables clearly rejects the null hypothesis that all coefficients (except of the integer) are equal to zero. In the rare event logit model, however, the same null hypothesis cannot be rejected. This is probably

a result of the large number of (individually insignificant) variables that are included in the model. Estimating a reduced rare event logit model that merely comprises those five variables that are significant in rare event logit estimation presented in Table 4-4 reveals that these five variables are jointly significant and can explain a firm's exit from the international market ($\chi^2(5) = 19.44$, $[\text{Prob} > \chi^2] = 0.002$).

4.2.5 Conclusion

This section focuses on the long-term export behaviour of our sample's firms. The first conclusion is that the shares of German and UK firms that sell their products and services abroad are comparably high in both 1997 and 2003. Moreover, in both countries we observe a relatively high persistence in the firms' foreign market participation. The econometric analysis reveals that firms located in Eastern Germany have a lower probability of entering the foreign market. The other country-specific dummy variables are not significant, indicating that further differences between German and UK firms with respect to foreign market entry and exit are covered by our model. However, as already discussed in chapter 3, it is impossible to determine econometrically whether these differences are a result of a varying endowment with firm-specific resources or whether the influence on the exogenous factors differs between German and UK-based firms.

The second result of this section already becomes apparent from the descriptive analysis. Although there is a high persistence in the firms' international business activities, we observe entry into and exit from the foreign market. Only 15 % of the firms in our sample have never had international sales. The phenomenon of non-persistent export participation trajectories has already been highlighted by Roberts and Tybout (1997) and confirmed, among others, by Bernard and Jensen (2004). 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 section 4.1 and that were used to identify firm-specific variables that may influence firms' internationalisation behaviour (stage models of internationalisation, the entrepreneurial perspective of internationalisation) are limited to foreign market entry. This study goes beyond this restricted view by examining empirically firm-specific characteristics that are able to discriminate between firms that enter the foreign market and firms that eschew it, and, additionally, to discriminate between firms that exit from the foreign market and those that remain internationally active.

Previous empirical studies of firms' export activities have focused on sunk costs as the main reason for the observed persistence in export behaviour. Although our data set is not suitable for providing empirical proof of the existence of sunk costs, our results are consistent with the sunk

costs hypothesis. Not only do we observe a high persistence in the internationalisation status which can be expected if sunk costs are relevant, but some results of the logit regressions can also best be interpreted by assuming the existence of sunk costs, for instance, the lower probability of engineering firms exiting the foreign market.

Sunk costs present a barrier to entering 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 as well as Dunning's eclectic framework and supported by the data. In particular, the results highlight the strategic role of investment in R&D. R&D activities generate assets by which a firm distinguishes itself from its rivals. These assets not only facilitate foreign market entry, but also support a long-term engagement in the international market. Firms that had never had international sales before 2003 and firms that had exited the foreign market spent a significantly smaller share of total sales on R&D in 2003, as shown by the descriptive analysis. Since all of the firms in our sample operate in high-tech sectors, the firms' R&D activities constitute an essential asset that differentiates between firms and correlates with their international business activities. In addition to R&D intensity, the international experience of firms' managers is an important asset that helps firms internationalise. Interestingly, foreign market entry and exit depend on different knowledge. Whereas market entry requires managers' familiarity with foreign business practices, staying in the foreign market is supported by managers who are able to assess preferences and needs of foreign customers.

Finally, the success of a firm's international engagement depends on the characteristics of its product. High client-specific product customisation is a barrier to entry into the foreign market. If a 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 had entered the foreign market with a product requiring intensive product customisation often stopped exporting, likely because they recognised that exporting was not profitable for them. Exporting a customised product may only be profitable if a firm can sell its product to a limited number of key foreign customers that represent sufficient sales potential for the supplying firm.

4.3 The Degree of Internationalisation

The second dimension of a firm's international engagement that is examined in this chapter is the degree of internationalisation. In the related literature, the share of non-domestic revenues is the most widely adopted measure of the degree of internationalisation (see Sullivan 1994b for an extensive review) and is therefore also used in this section.[64] Of course, a firm's international business activities can have multiple dimensions. It has already been mentioned that in this study only internationalisation on the sales market is considered, neglecting the import of investment goods or components, i.e., internationalisation on the procurement market. Sullivan (1994b) discussed other dimensions of a firm's involvement in foreign markets and proposed an alternative measurement he called the "degree of internationalisation scale", which is a linear combination of five ratio variables: foreign sales as a percentage of total sales, foreign assets as a percentage of total assets, foreign subsidiaries as a percentage of total subsidiaries, the number of years of work experience abroad of the top management team as a percentage of their total number of years of work experience, and the psychic dispersion of international operations.[65] Sullivan argued that this multidimensional measure is superior to a single item criterion like the share of total sales generated abroad, in particular because the latter is vulnerable to random and systematic measurement errors. In fact, the export-sales ratio is not only influenced by a firm's decision to expand or reduce its export activities: A random shock in the (real) exchange rate can inflate or deflate a firm's foreign sales, leading to a substantial change in the export-sales ratio. Similarly, increasing sales on the domestic or foreign market due to a demand shock in the respective market may alter a firm's export intensity, even if firm managers did not pursue any plan to adjust their degree of internationalisation. An observed change in a firm's export intensity may even be misleading. The firm may have been successful in increasing its volume of exports, indicating an expansion of its international business activities. However, if the firm's domestic sales have grown faster than its exports the export-sales ratio decreases, reflecting a reduced engagement abroad. A multidimensional criterion can lower the risk of a misleading interpretation since it is less sensitive to random shocks that influence one single item but have no effect on the other items of the criterion.

Sullivan's measurement of a firm's degree of internationalisation seems, nevertheless, to be inappropriate for our purpose. Some ratios that were included in Sullivan's multidimensional criterion are not observed in our data set. In particular, we do not have any information about the volume of

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64 In some studies, the degree of internationalisation is denoted as the export-sales ratio or as a firm's export intensity. In the following, these three expressions will be used interchangeably.

65 This ratio is an estimate of the psychic dispersion of the firms' subsidiaries among the ten "psychic zones" of the world (see Sullivan [1994b] and Ronen and Shenkar [1985] for more details).

foreign assets a firm holds, nor about the number of its subsidiaries that are located abroad. However, considering that our sample consists of young and small firms, most of them are not expected to have more than one (domestic) subsidiary. In fact, in 2003 only 11 % of our sample's firms (i.e., 18 companies) indicated having production facilities in at least one foreign country. Moreover, the most frequently used sales modes in the firms' foreign markets were direct exports and exporting via foreign intermediaries (see section 4.4). This means that most firms do not even possess a foreign sales subsidiary, i.e., they are likely to own only a small amount of international assets. Therefore, these two items Sullivan proved to be relevant for his sample of large US-based manufacturing firms are probably not suitable for describing the extent of our sampled firms' international business activities.

Similarly, it is questionable whether the psychic dispersion of international operations is able to discriminate between firms in our sample of small technology-oriented companies. As will be shown in section 4.4.2, more than 70 % of the firms' three most important target countries either belong to the European or the North American market. Thus, the psychic distance between the domestic country (Germany or the UK) and most of the chosen destination countries is unlikely to be very large. Finally, in this study the last item Sullivan included in his multidimensional criterion, i.e., the firm managers' work experience abroad, is regarded as an independent variable that is supposed to explain the firms' internationalisation behaviour. Since firm managers were asked to indicate whether they had work experience in a foreign country *before* joining the company, this variable is clearly exogenous and not a result of the firms' decisions.

Thus, although a multidimensional criterion has some advantages, I follow most other studies and measure a firm's degree of internationalisation by its share of total sales generated abroad.[66] Some studies, e.g., Calof (1993) and Wolff and Pett (2000), use the degree of internationalisation as an indicator of a firm's performance on the foreign market. This interpretation of export intensity is problematic. Firstly, export performance should be related to each single target market rather than to the worldwide volume of exports. Secondly, as argued above, even in the case of a decreasing export intensity, a firm might have been successful in the foreign market if domestic sales grew faster than foreign sales. Nevertheless, as the descriptive analysis will show, the firms in our sample were on average able to raise their export-sales ratio from 1997 to 2003. Considering that

[66] Moreover, Ramaswamy et al. (1996) argued that although an aggregate measure that captures the different aspects of internationalisation is desirable, a simple linear index like that of Sullivan (1994b) is not suitable for reflecting the complexity of a firm's internationalisation behaviour. Since our current knowledge about internationalisation is still limited and we do not yet understand how the varying components are related to one another, the use of a simple index in an econometric analysis may prevent us from gaining further insights into the relationships between the different dimensions of internationalisation.

during the same period total (discounted) sales of most of our sample's firms grew significantly, it becomes evident that young high-tech firms in Germany and the UK increased their volume of exports as well as their export-sales ratio. In this sense, the firms in our sample can be regarded as successful exporters. Before presenting descriptive statistics of our firms' export intensities, this section starts with a short discussion of the theoretical and empirical literature on how to appropriately model the degree of internationalisation.

4.3.1 Literature Review

According to Roberts and Tybout's (1997) dynamic model explained in detail in section 4.1, a rational firm *i* maximises its profits π_{it} by selling the profit-maximising level of exports q_{it}^* abroad. It is further assumed that the firm is always able to produce the profit-maximising level of exports q_{it}^*. The firm will export q_{it}^* in period *t* if the period's profit is non-negative. Otherwise, the firm will not have any international sales and will confine itself to the domestic market. As already discussed, this rule is moderated if sunk costs of foreign market entry, for instance, the costs of a marketing campaign or of setting up foreign sales channels, are prevalent. In this case, firms may continue to export even if foreign sales are no longer profitable in the current period in order to avoid re-entry costs. Regardless of the existence of sunk costs[67], it is important to note that the decision to internationalise and the choice of the profit-maximising level of exports are made simultaneously. Consequently, both decisions are determined by the same independent variables, i.e., in the case of Roberts and Tybout's model, a set of variables exogenous to the firm, X_{it}, and firm-specific variables Z_{it} such as firm size or product characteristics.

Wagner (2001) outlined this relationship when discussing how to model the export-sales ratio appropriately. Since foreign market entry and the profit-maximising volume of exports are chosen simultaneously, the firm's decision-making process has to be modelled as a one-step approach. In the related literature, however, the degree of internationalisation is often examined econometrically using two-step approaches (see, among others, Wakelin 1997). In the first step, the firm decides whether to internationalise or not and in the second step the optimal volume of exports is selected. The second equation is, of course, only defined for the subsample of firms with international sales. Estimating the second step econometrically therefore demands consideration of the probability of being an exporter, which is determined by the first equation (i.e., a possible sample

67 Even if some costs can be regarded as sunk costs after entering the foreign market (i.e., ex post), there are no sunk costs ex ante. Firms have to consider these costs when deciding whether to export or not.

selection bias has to be taken into account; see, e.g., Greene 2000). In order to identify the first equation, two-step approaches require independent variables that can explain the decision of foreign market entry but do not affect the degree of internationalisation, that is, the dependent variable of the second equation. However, as has been argued from a theoretical point of view, a one-step approach is best to explain the degree of internationalisation, and all variables relevant to the market entry decision are also expected to influence the volume decision. Thus, it is not a surprise that Heckman's selection approach estimated by Bürgel et al. (2004) when examining the export intensity of the firms participating in the first survey did not perform very well. It was not possible to identify the first step of the econometric model.

Since the export-sales ratio is determined by the same independent variables as the probability of export market participation, the theories from the field of international management that were presented in section 4.1 are also suitable to explain varying degrees of internationalisation. For example, process models and stage theories (e.g., Johanson and Vahlne 1977, 1990) suggest that firm size and export intensity are positively correlated. Similarly, firms carrying out R&D activities more intensively, thereby creating firm-specific intangible assets, are expected to have a higher degree of internationalisation according to the resource-based view of the firm (e.g., Penrose 1959, Wernerfelt 1984) and Dunning's eclectic framework (Dunning 1993).

The positive relationship between a firm's R&D activities and its export intensity is confirmed in the related econometric literature. Estimating a Tobit model[68], Bürgel et al. (2004) proved that R&D intensity positively affects the degree of internationalisation of those German and UK-based high-tech firms that participated in the 1997 survey. Further, the regression results showed that a higher degree of innovativeness incorporated into the firm's best-selling product increases the observed export intensity. Wakelin (1997), estimating a truncated regression model using a data set of exporting UK manufacturing firms, found that firm-specific R&D intensity boosts a firm's export-sales ratio. A positive correlation between a firm's R&D intensity and its degree of internationalisation could also be confirmed by Dhanaraj and Beamish (2003) for a sample of US-based and Canadian exporters and by Barrios et al. (2003) for a sample of Spanish firms.[69] Similarly, examining a sample of German manufacturing firms from Lower Saxony, Wagner (2001) obtained positively significant coefficients for three dummy variables indicating different levels of R&D

68 The Tobit model is a special case of Heckman's sample selection model. In this case, the selection equation is the same as the level equation being estimated (see, e.g., Greene 2000). The application of the Tobit model for estimating the degree of internationalisation can be criticised from an econometric point of view. For a detailed discussion, see Wagner (2001) and section 4.3.3.

69 Barrios et al. (2003) found further evidence of positive effects of R&D spillovers on firms' export ratios.

intensity (compared with firms without any R&D activities). Further, the firms in Wagner's sample exhibited a higher export intensity if they had registered at least one patent or if they had introduced at least one new product. These relationships are independent of the econometric method applied (OLS, Tobit, Beta regression, GLM regression [cf. Wagner 2001]). Thus, it could be regarded as an econometrically proven fact that firms that possess intangible assets, which are primarily created by intense R&D activities, can realise higher export-sales ratios.

It is also a well-known stylised fact that the degree of internationalisation increases with firm size. Wagner (1995, 2001) summarised theoretical arguments as to why firm size may be important for a firm's international business activities: Larger firms can fully exploit the potential of the foreign market by realising economies of scale in production. They can profit from bulk purchasing if they are able to exploit the additional potential of the foreign market. Large firms can raise financial resources at a lower cost than small firms and are able to bear higher risks when entering the foreign market (e.g., due to internal diversification). The latter argument corresponds to Johanson and Vahlne (1990), who expect large firms to have enough (financial) resources to take larger steps in their internationalisation process. Finally, some costs related to a firm's international business activities are fixed costs, for example, carrying out market studies or finding a foreign distributor or agent. The larger the firm, the smaller the unit costs of these activities. On the other hand, if a firm increases its international engagement the costs of coordination will also rise and sometimes begin to escalate when some critical threshold of internationalisation is exceeded. Managers interviewed by Geringer et al. (1989) reported having to institute new organisational structures and mechanisms of control when expanding their international business activities in order to avoid a decrease in their firms' profits.[70]

Thus, the relationship between export intensity and firm size is expected to be positive but non-linear and to decrease with size. Econometric studies estimating the impact of firm size on the firm's degree of internationalisation therefore contain not only a measure of firm size (e.g., the number of employees) but also its squared value in the regression equation. Consistent with the theoretical considerations, most studies, including Wagner (1995, 2001), Wakelin (1997), and Barrios et al. (2003), found a positively significant coefficient of firm size and a negatively significant one for its squared value. However, Wagner (2001) showed that this inversely *U*-shaped relationship is confirmed for some but not for all manufacturing industries in Germany. Moreover,

[70] The main focus of the analysis by Geringer et al. (1989) is the relationship between firm performance and the firms' degree of internationalisation, which is beyond the scope of this study. Geringer et al. found an "internationalisation threshold" beyond which firms' profit margins erode. See also Sullivan (1994a) for a thorough discussion of the work of Geringer et al.

Wagner (2003) extended his own analysis by controlling for unobserved firm heterogeneity in his data set. More precisely, he applied a fixed-effects version of the fractional logit regression developed by Papke and Wooldridge (1996) (see section 4.3.3). If, however, unobserved heterogeneity was considered when estimating the model, firm size (and its squared value) became insignificant. Both the results of Wagner (2001) and of the same author's 2003 study suggest that it is not size *per se* that allows a firm to increase its degree of internationalisation. At least in some industries, smallness need not be a barrier to becoming a successful exporter. These insights are of interest in particular for the small technology-oriented firms in our sample. In fact, Bürgel et al. (2004) did not find an effect of (start-up) size on the degree of internationalisation when estimating a Tobit model using data of those firms that participated in the first survey in 1997.[71] Although firm size turned out to be relevant for the decision to enter or exit the foreign market (see section 4.2), it did not discriminate between firms with varying shares of foreign revenues in 1997. This section will therefore investigate whether these results stay valid if, firstly, a more appropriate econometric method is used in order to estimate the firms' export intensity (i.e., a fractional logit model instead of a Tobit model) and, secondly, as the firms in our sample reach a "mature" stage of their life cycles while growing and, in most cases, expanding their international engagement.

4.3.2 Descriptive Analysis

The econometric analysis in the subsequent section will be based on data from the surveys conducted in 1997 and 2003. I will estimate a fractional logit model as developed by Papke and Wooldridge (1996) using the pooled sample (i.e., data from both surveys) and a separate sample for each of the two points in time observed in order to test whether there are differences in the determinants of the degree of internationalisation between 1997 and 2003. The following descriptive analysis therefore includes statistics for the pooled sample as well as for the respective subsamples of 1997 and 2003.

In 1997 the firms in our sample generated an average of 23 % of total sales in the foreign market. In the period between the two surveys, the average export intensity rose by 8 percentage points to a value of 31 % in 2003. It is important to note that these average numbers include not only exporting firms but also companies without international sales. The latter group of firms decided that their optimal volume of exports was zero. Thus, the degree of internationalisation has many limit observations at the value zero (about a quarter of all observations).

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71 The squared value of firm size, measured by (the logarithm of) the number of employees, was not included in their specification (see Bürgel et al. 2004).

As discussed in section 4.2.2, the percentage of internationally active firms in our sample increased only slightly from 1997 to 2003. Hence, the higher average export intensity is only to a small extent a result of additional firms entering the international market. The rise in the sample's export-sales ratio is mainly caused by the expanding international business activities of continuously exporting firms: The average share of total turnover the sample's *exporters* generated through foreign sales went up from 33 % in 1997 to 43 % in 2003. Similarly, the percentage of exporting firms in which non-domestic revenues exceeded 50 % of total revenues increased from 26 % in 1997 to 37 % at the time of the second survey. These numbers become even more impressive if we consider that (discounted) sales of firms that had exports in 2003 grew on average by 14.6 % per year from 1997 to 2002 (see section 4.1 for a detailed discussion of firm growth and its relationship to the firms' international business activities). Thus, the annualised growth rates of the firms' volume of exports had to be even higher so that the mean ratio of exports to total sales could increase.

Table 4-5: Comparison of Mean Degree of Internationalisation

Exporters and non-exporters

	Germany	**UK**	*t-test*
Pooled sample	19.8	33.5	***
1997	16.5	28.9	***
2003	23.2	38.2	***
	West Germany	**East Germany**	
Pooled sample	23.5	12.8	***
1997	20.7	8.3	***
2003	26.5	17.2	*

Exporters only

	Germany	**UK**	*t-test*
Pooled sample	28.6	44.5	***
1997	24.2	38.8	***
2003	33.0	50.1	***
	West Germany	**East Germany**	
Pooled sample	31.2	22.1	**
1997	27.8	14.8	**
2003	34.8	28.9	

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

Note: Only firms that participated in both surveys were considered.

Source: ZEW, University of Exeter, own calculations.

This development corresponds to the trend highlighted in Table 2-5. The share of German manufacturing plants' total sales generated in the foreign market increased from 1996 to 2003. Moreover, the growth rate of aggregated domestic sales was smaller than the respective rate German manufacturing plants realised on the foreign market. Hence, the rising degree of internationalisation observed for the firms in our sample is not an exception but the rule and mirrors the increasing globalisation of high-tech markets.

On average, the degree of internationalisation of UK-based firms exceeds that of German firms (see Table 4-5). The difference is significant according to a conventional t-test. This statement is valid for the pooled sample as well as for the two subsamples of 1997 and 2003. Restricting ourselves to the group of exporting firms, Table 4-5 shows that the average export intensity of UK-based (German) firms rose from 39 % (24 %) in 1997 to 50 % (33 %) in 2003. In 2003, 51 % of UK firms with international sales generated more than 50 % of their total revenues abroad. In Germany, for only 17 % was the foreign market, in terms of sales, more important than the home market. Obviously, the degree of internationalisation was higher for UK-based exporters than for their German counterparts. This was the case at the time of the first survey and remained valid, although both UK and German firms had, on average, intensified their international engagement. As Bürgel et al. (2004) argued, this might be the case because British exporters more pro-actively exploit the sales potential of foreign markets or because German firms are less dependent on the international market due to the larger size of their domestic market.

Firms located in Western Germany achieve a significantly higher share of their total turnover abroad than firms from the eastern part of Germany. Recall that Eastern German firms demonstrate a lower probability of entering the foreign market. Thus, the smaller degree of internationalisation of Eastern German firms in the combined sample of exporters and non-exporters results from the smaller percentage of internationally active Eastern German firms as well as from the lower export intensity of Eastern German exporters. The latter fact is shown in the lower part of Table 4-5, where the degree of internationalisation is calculated for our sample's exporters only. Interestingly, whereas the difference of the average degree of internationalisation between exporters from the two parts of Germany amounted to 13 percentage points in 1997, this difference dropped to only 6 percentage points in 2003 and was no longer significant at the time of the second survey. Obviously, Eastern German firms face an initial drawback that reduces their probability of exporting and their degree of internationalisation during early stages of their engagement in the foreign market, e.g., because the regional spillover effects Western German firms may profit from were absent in Eastern Germany in the first years after German reunification. However, Eastern German exporters were able to overcome this disadvantage in the period leading up to 2003 and reach an

export intensity comparable with that of Western German exporters. This finding is consistent with the estimation results in section 4.2.4, where we found that, once they have entered the foreign market, Eastern German firms do not have a significantly higher probability of market exit compared with Western German (and UK-based) firms.

Table 4-6 shows the degree of internationalisation separated into the five aggregated high-tech sectors, considering data of exporting and non-exporting firms. In each sector at the time of both surveys, UK firms generated a higher share of total sales in the foreign market than their German rivals. With the exception of the sector of other high-tech manufacturing firms in the UK, the average export-sales ratio increased in both countries and in all the sectors examined from 1997 to 2003.[72] In Germany, software and service firms evinced the lowest average degree of internationalisation. On the one hand, the share of internationally active firms in the German service sector was smaller than in any manufacturing sector. However, even if a German service firm decided to enter the foreign market, its export intensity would, on average, fall behind that of a German manufacturing firm with international sales. In the UK, the observed mean degree of internationalisation of service firms was also smaller than that of manufacturing firms. Only firms from the sector of other high-tech manufacturing had on average a lower degree of internationalisation than British service and software companies in 2003. Further, in the UK all firms in the sectors ICT-hardware and health/life sciences had international sales in 2003. The reported degree of internationalisation in the last column of Table 4-6 is therefore higher than in any other sector where information on exporters and non-exporters was used in order to calculate the export intensities.

Table 4-6: Degree of Internationalisation, by High-Tech Sectors

	Germany		UK	
Sector	1997	2003	1997	2003
Software/services	9.6	12.9	20.6	32.2
ICT-hardware	20.2	34.0	36.0	55.4
Engineering	24.7	38.5	33.7	48.5
Health/life sciences	19.3	30.4	54.0	63.8
Other high-tech manuf.	17.6	19.5	25.0	24.9
Total	16.5	23.2	28.8	38.2

Note: Combined sample of exporters and non-exporters was used.
Only firms that participated in both surveys were considered.
Source: ZEW, University of Exeter, own calculations.

[72] Recall that the sector of other manufacturing firms in the UK was the only sector where the share of internationally active firms decreased from 1997 to 2003 (see Table 4-2).

Table 4-7: Degree of Internationalisation, by Size Classes

	Germany		UK	
Number of employees	1997	2003	1997	2003
5 or less	9.1	13.8	22.1	24.4
6 – 10	14.6	11.9	22.9	27.6
11 – 20	17.4	30.1	33.3	42.6
21 – 50	16.3	25.6	36.3	49.4
more than 50	53.0	31.1	29.8	44.1
Total	16.5	23.2	28.8	38.2

Note: Combined sample of exporters and non-exporters was used.
Only firms that participated in both surveys were considered.
Source: ZEW, University of Exeter, own calculations.

The relationship between the degree of internationalisation and firm size is of particular interest in this section. Therefore, Table 4-7 contains the average export intensities of our sample's firms in different size classes, where size is measured by the number of employees. The export-sales ratios for the subsample of UK firms exhibit the theoretically expected relationship. That is, the degree of internationalisation increases with firm size, but firms in the largest class (more than 50 employees) generate a smaller share of their total revenues abroad than firms in the second-largest class (between 21 and 50 employees), probably due to rising costs of coordinating their international business activities. The subsample of German firms does not show such an even picture. Nevertheless, firms with up to five employees reach a relatively small degree of internationalisation compared with larger firms. The majority of the firms in this size class do not even have international sales. At the time of the first survey, German firms with more than 50 employees generated on average 53 % of their total revenues in the foreign market. However, this impressively high figure is based on only four observations, all of which had international sales. In 2003 there were eleven firms in the German subsample that had more than 50 employees. Some of the firms that grew in the period between the two surveys, exceeding the threshold value of 50 employees, did not export in 2003, making the average degree of internationalisation significantly smaller when compared with the respective value in 1997.

4.3.3 Econometric Implementation

Wagner (2001) argued that all methods used before in the related literature in order to estimate the degree of internationalisation are seriously flawed. We have already discussed (in section 4.3.1) why two-step approaches like Heckman's sample selection model are not appropriate for explaining firms' export intensities. Some studies, including Wagner (1995), Wakelin (1997), and Bürgel

et al. (2004), used a Tobit model for estimating the export-sales ratio. However, the Tobit model is a censored regression, which is appropriate if the endogenous variable is only observed if it exceeds a limit observation (zero in most cases). Nevertheless, the endogenous variable can be less than the limit observation, but these observations are unobservable. In contrast to this, the degree of internationalisation cannot be smaller than zero. The limit observations arise because individual firms choose zero as their optimal volume of exports. There are no negative degrees of internationalisation that we simply cannot observe because of censoring. Therefore, the Tobit model is not suitable for our purpose (cf. Wagner 2001, Maddala 1991).

Following Wagner (2001, 2003), I instead apply the fractional logit model developed by Papke and Wooldridge (1996) for estimating the export intensity of the firms in our sample. Let Y_i denote the export-sales ratio of firm i, where $0 \leq Y_i \leq 1$. Papke and Wooldridge assumed that, for all i, the expected value of Y_i conditional on a vector of explanatory variables X_i is given by

$$E\left(Y_i \middle| X_i\right) = F\left(X_i\beta\right), \tag{4.17}$$

with $0 < F\left(X_i\beta\right) < 1$ for all $X_i\beta \in \mathbb{R}$, ensuring that the predicted values of Y_i lie in the interval (0, 1). Nevertheless, equation (4.17) is defined even if Y_i takes the limit observations zero or one. The function $F(\cdot)$ is assumed to be the cumulative distribution function (cdf) of the logistic distribution:[73]

$$F\left(X_i\beta\right) \equiv \Lambda\left(X_i\beta\right) \equiv \frac{\exp\left(X_i\beta\right)}{1+\exp\left(X_i\beta\right)}. \tag{4.18}$$

Papke and Wooldridge proposed a quasi-maximum likelihood estimator (QMLE) of β, following Gouriéroux et al. (1984) and McCullagh and Nelder (1989). The Bernoulli log-likelihood function that is maximised is given by

$$\ln L = \sum_i \left\{ Y_i \ln\left[\Lambda\left(X_i\beta\right)\right] + \left(1-Y_i\right)\ln\left[1-\Lambda\left(X_i\beta\right)\right]\right\}. \tag{4.19}$$

The QMLE of β is consistent and asymptotically normal – *regardless* of the distribution of Y_i, i.e., Y_i could be a discrete variable or, as in our case, a continuous variable bounded between zero and one (see Papke and Wooldridge 1996, p. 622). Equation (4.19) is maximised using the generalised linear models (GLM) framework developed by McCullagh and Nelder (1989). However, the GLM approach assumes that

73 However, Papke and Wooldridge (1996) emphasised that $F(\cdot)$ may not necessarily be a cdf.

(4.20) $Var\left(Y_i \middle| X_i\right) = \sigma^2 \Lambda\left(X_i\beta\right)\left[1 - \Lambda\left(X_i\beta\right)\right], \qquad \text{with} \qquad \sigma^2 > 0.$

This assumption may not be satisfied, e.g., if there are unobserved group effects. Therefore, Papke and Wooldridge suggested applying a robust estimate of the asymptotic variance of $\hat{\beta}$.

As discussed in section 4.3.1, the decision whether to enter the foreign market and the choice of the optimal volume of exports are made simultaneously and are therefore determined by the same independent variables. Thus, the set of exogenous variables used for estimating the degree of internationalisation is broadly identical with that explaining foreign market entry and exit in section 4.2, i.e., it will contain the industry real exchange rate[74] as a variable exogenous to the firm as well as a set of firm-specific variables that were derived from the literature of international management. The latter will include the logarithm of firm size (measured by the number of employees), its squared value, and the logarithm of firm age (measured in years). A firm's human capital is approximated by the two dummy variables indicating whether the firm's managers had work experience abroad or were educated in a foreign country; the absence of key management capabilities is measured by two dummy variables taking the value 1 if a firm's managers experienced a serious shortage of skills in sales/distribution and production/R&D, respectively. Further dummy variables indicating the requirement of intense product customisation and regular maintenance, respectively, and whether a firm's product or service is directly sold to end-users cover product characteristics that may influence the degree of internationalisation. Moreover, the innovativeness of a firm's best-selling product is determined by two dummy variables revealing whether the product incorporates novel technology that had been developed in-house or whether it merely incorporates novel technology that had been developed elsewhere by other companies.

In contrast to the econometric model explaining foreign market entry and exit, I will not use the firms' R&D intensities in this section's specification. Instead, I will consider two dummy variables that indicate whether a firm carries out R&D on a permanent basis or occasionally. In addition to R&D intensity, these two variables were gathered by the two surveys. Firms without any R&D activities are used as the base category. I also estimated fractional logit models that contained R&D intensity as an independent variable, but surprisingly, R&D intensity was not significant in these specifications. I do not have a convincing explanation for the different effects of two variables that are both intended to measure a firm's R&D activities.

[74] To estimate a potential effect, the industry real exchange rate has to vary over time. Thus, the exchange rate is only included in the pooled regression.

To control for regional and sector-specific peculiarities, I will add two dummy variables for firms located in Western and Eastern Germany respectively, using UK firms as the base category, and two industry dummies for the engineering sector and other high-tech manufacturing industries (including the relatively small sectors of ICT-hardware and health/life sciences). Thus, software and service firms will be the base category. Finally, when estimating the pooled sample I will include a year dummy taking the value 1 if the observation falls in the second period, i.e., in 2003. Of course, there will be no year dummy if data from only one survey (i.e., 1997 or 2003) are used.

4.3.4 Empirical Results

The estimation results of the fractional logit models are presented in Tables 4-8 (pooled sample) and 4-9 (subsamples of 1997 and 2003).[75] It is immediately apparent that the results of the pooled regression are very similar to those of the two separated regressions. Thus, both in 1997 and 2003 the degree of internationalisation is determined by essentially the same independent variables. There are no variables that lose their influence in the period between the two surveys and no additional variables that affect the export intensity only during a later stage of the firms' international engagement – at least no variables that were observed. However, looking at the results of the pooled regression we find that the time dummy indicating all observations of the second survey is positively significant. Setting all other variables to their mean, a discrete change of this time dummy variable from 0 to 1 (i.e., a hypothetical switch from 1997 to 2003) increases the export-sales ratio by just under 13 percentage points.[76] Thus, there is a shift of the endogenous variable in the period between the two surveys that is not covered by the remaining set of exogenous variables. In other words, our model is able to explain varying export intensities at a given point in time reasonably well, but it is unsuitable for representing the expansion of the firms' international business activities over time. Observing the firms in our sample over a longer time period and thus building up a panel data set may be a way to discover determinants of our firms' international expansion. For example, according to theory, firms decide simultaneously on foreign market entry and their preferred volumes of exports. However, due to limited resources exporters are probably not able to realise their optimal volumes of exports immediately after foreign market entry. Thus, firms may start their international engagement with a suboptimal volume of exports, gradually increasing their exports until the optimum volume is reached. This argument corresponds to that

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75 The model was estimated using the `glm` command of the software package STATA, version 8.2 SE. For a detailed discussion of estimating generalised linear models with STATA see Hardin and Hilbe (2001).

76 Note that Table 4-8 shows the estimated coefficients and not marginal effects or discrete changes of the dummy variables included.

explaining growth processes of newly founded firms: Start-ups are founded with a sub-optimal size, approaching their minimum efficient scale (MES) in the early years after firm formation (cf. section 5.2 for a discussion of young firms' growth processes). However, whether the rising degree of internationalisation from 1997 (i.e., an early stage of the firms' export activities) to 2003 can be regarded as an approach to an optimal value is beyond the scope of the analysis in this section. Alternatively, the increasing export-sales ratio can be interpreted as mirroring the rising globalisation on high-tech markets that was shown in Table 2-5 – at least for German manufacturing plants. In this case, the firms in our sample simply followed a global trend that cannot be explained by the firm-specific variables in our data set.

Table 4-8: Fractional Logit Estimation Results: Pooled Sample

	Number of observations = 356 LL = -151.852 $\chi^2(20) = 146.63$ Prob > $\chi^2(20) = 0.000$ $R^2 = 0.279$		
	Coeff.	*Robust stand. error*	
Time dummy (2003=1)	0.674	0.272	**
Industry real exchange rate	0.005	0.030	
West Germany	-0.460	0.187	**
East Germany	-1.097	0.239	***
Engineering	0.903	0.229	***
Other manufacturing industries	0.551	0.199	***
Log (number of employees)	0.474	0.417	
Log (number of employees) ^{2}	-0.036	0.065	
Log (age)	-0.059	0.304	
Permanent R&D activities	0.936	0.308	***
Occasional R&D activities	0.685	0.330	**
Novel self-developed technology	-0.169	0.168	
Novel techn., developed elsewhere	0.426	0.213	**
Work experience abroad	0.573	0.168	***
Education abroad	0.371	0.202	*
Shortage of competencies			
Sales/distribution	-0.255	0.173	
Production/R&D	0.082	0.188	
Intense product customisation	-0.506	0.165	***
Regular maintenance and upgrades	-0.156	0.177	
Consumer good	0.062	0.175	
Constant	-3.625	3.124	

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

Base category: UK-based software firm without R&D activities.

Source: own estimation.

In section 4.3.1 it was argued that the decision to internationalise and the choice of the optimal export intensity are made simultaneously and that both decisions are thus determined by the same set of independent variables. Comparing the results of the fractional logit model with that of the logit regression explaining a transition from the internationalisation status "non-exporter" to the status "exporter" (i.e., foreign market entry) in section 4.2.4 confirms this theoretical assumption. The regressions reveal largely the same variables that significantly affect the probability of foreign market entry and the conditional mean of the export-sales ratio, respectively. Moreover, in both models all of the significant variables have the same signs. In the following I will therefore concentrate on discussing commonalities and minor differences between the two models.

Table 4-9: Fractional Logit Estimation Results: Subsamples 1997 and 2003

	1997			**2003**		
	Number of observations = 173 LL = -70.615 $\chi^2(18) = 66.01$ Prob > $\chi^2(18) = 0.000$ $R^2 = 0.224$			Number of observations = 183 LL = -80.071 $\chi^2(18) = 93.32$ Prob > $\chi^2(18) = 0.000$ $R^2 = 0.210$		
	Coeff.	*Robust stand. error*		*Coeff.*	*Robust stand. error*	
West Germany	-0.269	0.297		-0.690	0.287	**
East Germany	-1.269	0.402	***	-1.041	0.286	***
Engineering	0.861	0.357	**	0.879	0.314	***
Other manufacturing industries	0.671	0.313	**	0.350	0.271	
Log (number of employees)	0.582	0.667		0.499	0.542	
Log (number of employees) ^{2}	-0.056	0.111		-0.038	0.082	
Log (age)	-0.034	0.372		0.002	0.505	
Permanent R&D activities	0.896	0.471	*	1.053	0.386	***
Occasional R&D activities	0.892	0.489	*	0.387	0.446	
Novel self-developed technology	-0.098	0.262		-0.338	0.239	
Novel techn., developed elsewhere	0.444	0.284		0.369	0.347	
Working experience abroad	0.630	0.276	**	0.552	0.224	**
Education abroad	0.219	0.309		0.398	0.259	
Shortage of competencies						
Sales/distribution	-0.126	0.297		-0.335	0.228	
Production/R&D	0.049	0.301		0.052	0.265	
Intense product customisation	-0.470	0.239	**	-0.616	0.229	***
Regular maintenance and upgrades	-0.180	0.291		-0.148	0.225	
Consumer good	0.040	0.233		0.280	0.289	
Constant	-3.498	1.382	**	-2.413	1.595	

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

Base category: UK-based software firm without R&D activities.

Source: own estimation.

The industry real exchange rate influences neither the probability of foreign market entry nor the degree of internationalisation. As argued above, this is probably due to the small variance of this variable. In accordance with the descriptive statistics, the export intensity of German firms is significantly smaller than that of UK-based firms. Whereas firms from Eastern Germany are less likely to enter the foreign market and show a significantly lower export-sales ratio than UK firms, the probability of internationalisation of Western German firms is comparable with that of UK-based firms. Nevertheless, the degree of internationalisation of West German firms is smaller than the respective value of their British counterparts. For 1997, this difference can be explained by the remaining vector of exogenous variables. Between 1997 and 2003, both West German and UK-based firms raised their export intensity, but the expansion in the subsample of UK firms was larger. This resulted in an increased difference in the export intensity that can no longer be traced back to either varying firm-specific characteristics of German and UK technology-oriented firms or a different, country-specific functional form of the regression equation.

The two dummy variables indicating the two aggregated manufacturing sectors are both positively significant. In contrast to the estimated probability of foreign market entry, there is no difference between engineering firms and the other manufacturing industries. Recall, however, that the share of engineering firms with international sales is *not* smaller than that of the other manufacturing sectors.[77] Accordingly, the degree of internationalisation of engineering firms is similar to other manufacturing companies and higher than the export intensity in the software and service sector. For 2003 the dummy variable for the sector of other manufacturing firms is not significant, implying that at the time of the second survey there is no difference between this sector and software and service firms. This corresponds to the findings of the descriptive analysis.

R&D activities through which firms generate intangible assets in order to distinguish themselves from their rivals positively affect the degree of internationalisation. Whether a firm carries out permanent or only occasional R&D activities is not decisive. It is sufficient when a firm conducts any R&D activities at all – at least in 1997. At the time of the second survey, the dummy variable indicating occasional R&D activities is no longer significant. This variable likely no longer has discriminatory power in 2003 because the share of firms in our sample with occasional R&D activities reduced significantly from 1997 to 2003. Firms tended to decide to carry out either permanent R&D activities or no R&D activities at all. Moreover, the share of total sales that firms with occasional R&D activities spent on R&D also decreased. Whereas in 1997 the mean R&D

[77] In section 4.2.4 it was argued that these seemingly contradictory results might be due to the existence of sector-specific entry costs. Engineering firms are probably better equipped with firm-specific resources, enabling them to overcome these additional costs of entering the foreign market.

intensity of these firms amounted to 10.3 %, this value fell to 5.8 % in 2003. As a result, there is no significant difference in terms of the degree of internationalisation between firms with occasional R&D activities and companies that refrain from researching. The importance of (permanent) R&D activities for the firms' export intensity is consistent with the significant effect R&D intensity has on the transition into the foreign market, although the probability of internationalisation is positively related to the extent of a firm's R&D activities and not only to the fact that it carries out any research at all (see Figure 4-1). The remaining two variables that are intended to reflect the innovativeness of a firm's product, i.e., the two dummy variables indicating the firms' adoption of novel technology, are both not significant in the fractional logit estimations based on the two subsamples of 1997 and 2003. However, in the pooled regression the dummy reflecting the use of novel technology that was developed by other companies is positively significant, whereas the dummy variable indicating the adoption of self-developed technology has no effect on the degree of internationalisation. The impact of the latter variable is probably already covered by the two dummy variables indicating the extent of a firm's R&D activities. However, a firm can also create intangible assets by buying novel technology from other companies and incorporating this technology into its production process, i.e., without conducting its own R&D activities. Thus, the effect of the dummy variable indicating the use of technology that was developed elsewhere is plausible, although it was not found in other regression models of this study.

A firm's engagement in the foreign market is facilitated by the international experience of the members of its management team. If at least one firm manager has work experience abroad, this increases the probability of foreign market entry as well as the degree of internationalisation. The results of the fractional logit models reveal that the respective dummy variable is positively significant using data from the pooled sample and the two subsamples from 1997 and 2003. If a firm manager is familiar with foreign business practices and market conditions due to experience acquired while working in a foreign country, the company is able to attain a higher export-sales ratio. The dummy variable indicating whether at least one manager was educated abroad before joining the company is only significant in the regression using pooled data and at the 10 % level. Estimating the two subsamples, this dummy remains insignificant at any conventional level. Arguing that the choice of the optimal volume of exports is determined by the same variables as foreign market entry, it is, at first glance, not surprising that firm managers' work experience abroad is more important than an education received in a foreign country. In fact, in section 4.2.4 we did not find any effect of foreign education on the probability of entering the international market. However, this variable significantly reduces the probability of exit from the foreign market. Those firms that refrain from exiting the international market generate a positive volume of exports. In this way, an

education received in a foreign country increases the degree of internationalisation, although the (marginal) effect is smaller than that of firm managers' work experience abroad.[78] [79] The other two dummy variables, reflecting firm managers' capabilities by indicating experienced shortages of skills in sales/distribution and production/R&D, are neither individually nor jointly significant.[80] This finding is in line with the results of the logit regressions estimating foreign market entry and exit, although the dummy variable reflecting a shortage of skills in production/R&D has a slight significant effect on the probability of becoming an exporter. Nevertheless, the two variables approximating firm managers' capabilities are jointly insignificant in the logit models explaining foreign market entry and exit.

The requirement for intense customisation is the only product-specific variable that affects the probability and the extent of our firms' international business activities. Neither the necessity of regular maintenance nor distinguishing to whom a firm's best-selling product is sold (directly to end-users or to other companies as an intermediate or investment good) enables us to discriminate between the firms in our sample. Product customisation is a barrier to entry into the foreign market. It impedes realising economies of scale and, as a consequence, restricts the volume of exports even if the firm has overcome barriers to entry. If a product requires client-specific customisation, the firm will often export its product to only a limited number of foreign customers, realising a degree of internationalisation that makes its international business activities profitable but that is smaller than the export intensity of other firms. The lower export intensity may nevertheless be optimal for the firm, given its additional (transaction) costs caused by the requirement for intense customisation.

Firm size and age are two core elements of the internationalisation process model developed by Johanson and Vahlne (1977, 1990). According to the model, a firm gradually increases its international business activities, resulting in a positive correlation between firm age and the degree of internationalisation. However, (the logarithm of) firm age reveals its insignificance in our econometric model. Again, this finding corresponds to the result obtained in section 4.2.4, where firm age was also not suitable for explaining foreign market entry and exit. Interestingly, the coefficient of firm age is not significant, even if the regression is based on the subsample of 1997. Some of

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78 Based on the pooled regression, the marginal effect of a firm manager's work experience abroad, i.e., the effect of a discrete change in the dummy variable from 0 to 1 on the degree of internationalisation (all other variables set to their mean) amounts to 11.0 percentage points; the respective value of the dummy indicating a foreign education is equal to 7.6 percentage points.

79 Following the aforementioned argumentation, the relatively small effect of foreign education may be a result of the relatively small number of foreign market exits we observed during the time period covered by our surveys.

80 Wald test of joint significance, based on the pooled regression: $\chi^2(2) = 2.30$, [Prob > χ^2] = 0.317.

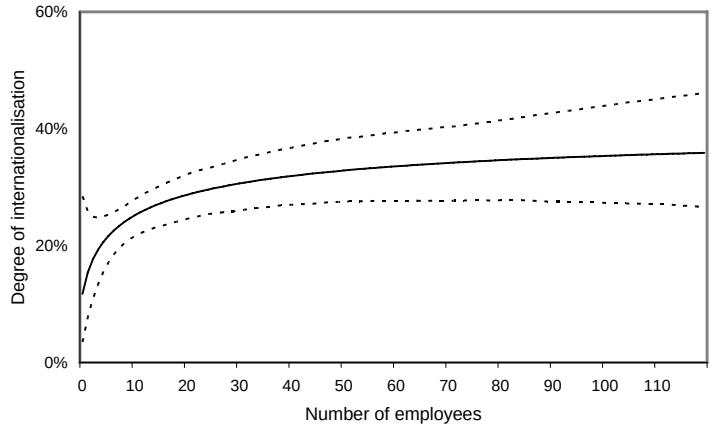
the firms in our sample (e.g., the group of "born globals") may pro-actively exploit opportunities on the foreign market, reaching their optimal export intensity at an early stage of their life cycle. These firms may overcome uncertainty present in the international market or other barriers to entry by, for example, employing internationally experienced managers. In fact, we found that this variable positively affects the degree of internationalisation. Thus, youth is not necessarily an obstacle to realising a high export intensity.

As discussed in section 4.3.1, the relationship between firm size and the degree of internationalisation is of major interest in the related literature. Most studies cited above found that firm size positively influences the export-sales ratio, but that this relationship is non-linear and decreases with size. The estimated coefficients of the fractional logit models do indeed show the expected signs, i.e., a positive sign for (the logarithm of) the number of employees and a negative one for its squared value. However, in contrast to other studies these effects are not significant. Figure 4-2 displays the predicted degree of internationalisation in dependence of the number of employees, with all other variables set to their mean. Each of the three graphs reveals the same picture: The predicted export intensity increases with firm size, but the marginal effect (i.e., the slope of the solid lines in Figure 4-2) declines as the number of employees rises. The confidence intervals point out that the uncertainty associated with predicting the export-sales ratio is larger for very small firms (read: less than 10 employees) than for medium-sized firms.[81] This means that in the group of very small firms, the share of firms without any international sales is comparably high. At the same time, there are some firms that generate the majority of their total sales in the foreign market, in spite of having less than 10 employees. Thus, the variance and the associated confidence intervals of the (predicted) degree of internationalisation are relatively large for the group of very small firms. Some small firms in our sample are able to overcome the barriers to entry into the foreign market since they possess intangible assets, e.g., generated by (permanent) R&D activities. We can conclude that firm size is not necessary to attain a high export-sales ratio. This finding supports the conclusion of Wagner (2003), who emphasised that it is not size *per se* that makes a successful exporter. However, Wagner (2003) had only little information on firm-specific variables that facilitate a firm's international business activities and enable the company to increase its export intensity. In Wagner's study, firm-specific differences were therefore considered by controlling for

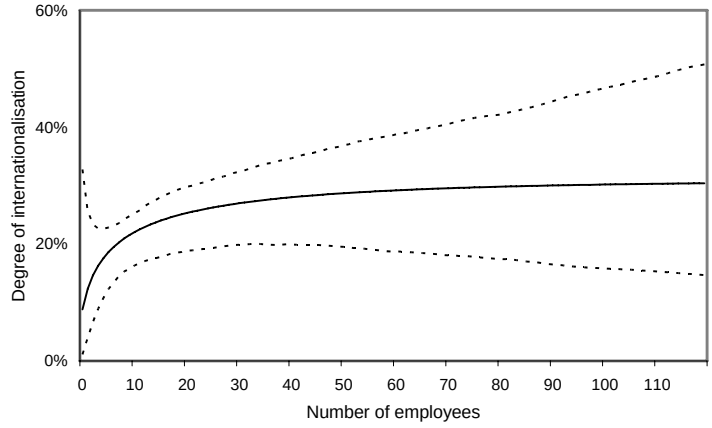
[81] The confidence intervals of the predicted degree of internationalisation for firms with more than 50 employees are very large, in particular if data from the first survey only are used. In 1997 very few firms in our sample exceeded the threshold of 50 employees. For large firms, Figure 4-2 therefore constitutes an out-of-sample forecast. Whereas the probability of foreign market entry of large firms can be predicted with low uncertainty since most firms with more than 20 employees have foreign sales (see Figure 4-1), predicting large firms' export intensities is more difficult because the export-sales ratio varies considerably in our sample.

Figure 4-2: Predicted Degree of Internationalisation in Dependence of the Number of Employees

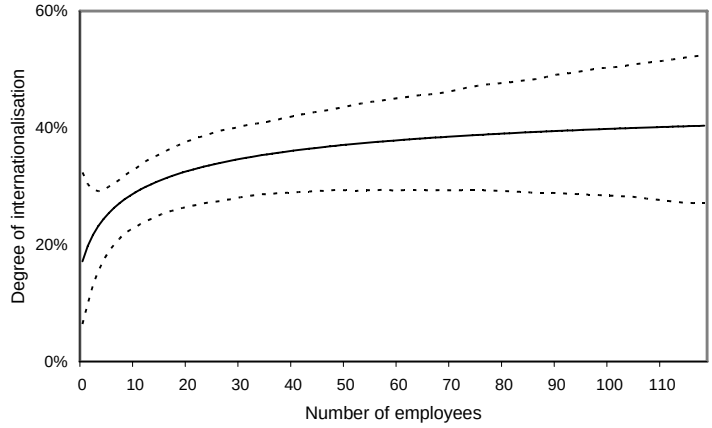
Pooled Sample



1997



2003



Solid line: predicted degree of internationalisation in dependence of the number of employees, all other variables set to their mean.
Dotted lines: simulated 90 % confidence interval, using the 5 % and 95 % percentiles of the bootstrap distribution (1,000 replications).
Source: own calculation.

unobserved firm heterogeneity. In this study, we can go one step further. Our data set enables us to identify firm-specific characteristics that determine the degree of internationalisation as discussed above, allowing firm-specific heterogeneity to be (at least partly) observed.

In order to test the validity of the model, I applied a specification test derived by Pregibon (1979). The concept behind the test is as follows: If the model is correctly specified, then in an auxiliary GLM regression of the degree of internationalisation on the prediction and the prediction squared, the prediction squared should not have any explanatory power. Thus, the alternative model is:

$$(4.21) \qquad E\left(Y_i \middle| X_i\right) = F\left(X_i\beta + \gamma\left(X_i\beta\right)^2\right),$$

where, again, $F(\cdot)$ is the logistic function $\Lambda(\cdot)$. Under the null hypothesis $H_0 : \gamma = 0$, the model is correctly specified, i.e., the test statistic is the conventional t-statistic of the quadratic term in the auxiliary GLM regression.[82] The specification test based on the pooled regression cannot reject the null hypothesis (t-statistic: -0.26). The quadratic term is likewise insignificant in the two auxiliary regressions that are related to the two subsamples (1997: t-statistic: 0.09; 2003: t-statistic: -0.53). Thus, Pregibon's specification test reveals no problems with the chosen specification.

The fractional logit model fits reasonably well with the data. As Papke and Wooldridge (1996) pointed out, the simple R^2, conventionally defined as 1 – SSR/SST (with SSR = sum of squared residuals and SST = total sum of squares), is the most appropriate goodness-of-fit measure, since only the conditional expectation of the degree of internationalisation is modelled, with other features of the conditional distribution left unspecified (see Papke and Wooldridge 1996, p. 629). The R^2 for the pooled regression is 0.279, which is satisfactory for a cross-sectional data set. The respective values for the regressions based on the two subsamples are only slightly smaller (1997: 0.224; 2003: 0.210).

4.3.5 Conclusion

After having examined the probability of foreign market entry and exit, this section analyses the share of total sales the firms in our sample generate abroad. While the participation rate in the international market increased only slightly from 1997 to 2003, the group of exporters in our sample expanded their international business activities significantly, raising the average degree of

82 Papke and Wooldridge (1996) used a similar specification test by extending Ramsey's (1969) Reset procedure. In addition to the quadratic term in equation (4.21), they further included the cubic term of the prediction in the alternative model. Under the null hypothesis, the regression coefficients of both the squared and the cubic term have to be jointly insignificant.

internationalisation from 33 % in 1997 to 43 % in 2003. At the time of the second survey, 37 % of the exporters even generated more than 50 % of their total revenues abroad. These are indeed impressive findings, indicating that the majority of newly founded technology-oriented firms in Germany and the UK were able to establish themselves in the international market. Unfortunately, the econometric model used in this section cannot explain the shift in export intensity in the period between the two surveys. Nevertheless, our model describes varying degrees of internationalisation at a given point in time reasonably well.

According to theory, a firm decides simultaneously on its participation in the foreign market and the optimal volume of exports. As a consequence, two-step econometric approaches are not appropriate for modelling the degree of internationalisation. Moreover, the Tobit model that is often used in the related literature is a censored regression and therefore also not suitable for estimating an endogenous variable that has many limit observations. These limit observations result from firms choosing zero as their optimal volume of exports. Thus, following Wagner (2001, 2003), I applied the fractional logit model developed by Papke and Wooldridge (1996) for estimating the degree of internationalisation.

The simultaneity of the two decisions implies that the probability of entry into the international market and (the conditional mean of) the degree of internationalisation are both to be determined by the same set of explanatory variables. In fact, comparing the regression results in section 4.2.4 with those presented above reveals that both decisions are affected by virtually the same variables. Essentially, firms that generate intangible assets through (permanent) R&D activities achieve a higher share of their total sales abroad. Similarly, if a firm employs internationally experienced managers it will be able to increase its export-sales ratio. These results confirm the resource-based view of the firm and emphasise the importance of ownership advantages according to Dunning's eclectic framework (cf. Dunning 1993). On the other hand, the optimal volume of exports is negatively influenced by the requirement of intense product customisation as predicted by the transaction costs analysis theory. The entrepreneurial perspective of the firm is, however, not supported: The (absence of) shortages of skills in sales/distribution and production/R&D are not significant.

The key result of this section is that neither youth nor smallness are necessarily an obstacle to realising a high export intensity. Firms that internationalise shortly after their inception ("born globals") pro-actively exploit the foreign market and reach a relatively high degree of internationalisation at an early stage of their international engagement. Similarly, even firms that have less than 10 employees are able to attain a high export-sales ratio. However, this requires that the firms possess firm-specific assets in order to overcome barriers to entry into the foreign market. As our

analysis shows, these firm-specific assets may be acquired via a firm conducting its own R&D activities, through buying novel technology from other companies, or by employing internationally experienced managers. It is important to note, however, that there is a considerable heterogeneity within the group of young and/or small firms. Figure 4-1 in the previous section reveals that a prediction of whether a firm belongs to the group of born globals, that is, whether it entered into the international market no later than one year after firm formation, is associated with high uncertainty (i.e., large confidence intervals). The same is true for a prediction of (the conditional mean of) the degree of internationalisation for very small firms (less than 10 employees). This implies that, apart from exporters like those in the group of born globals that pro-actively exploit the foreign market, there are firms that gradually increase their international engagement according to the internationalisation process model of Johanson and Vahlne (1977, 1990). In fact, the shift in the average export intensity that occurred in the period between the two surveys and could not be explained by our econometric model can be interpreted as a result of firms' step-by-step approaches to their optimal volumes of exports. Thus, for the latter group of firms the export-sales ratio may be causally linked with the firms' age and size. Nevertheless, for a large proportion of the firms in our sample, size and age are not prerequisites for realising a high degree of internationalisation. This leads to insignificant coefficients in the regression equations. If young and small technology-oriented firms in Germany and the UK acquire the necessary firm-specific resources, they will have the best qualifications for becoming successful exporters, or, as Wagner (2003) called them, "hidden export champions".

4.4 The Change of Sales Modes in International Markets

The choice of the appropriate sales mode belongs to the firm's most important strategic decisions after entering into a foreign market. Firstly, it determines the amount of resources a firm has to invest in establishing business relationships with its foreign partners and customers. Secondly, the way of organising the firm's distribution and logistics depends crucially on the chosen sales mode. For example, if a firm decides to export directly by using the Internet it will have to build up an electronic trade platform on its server and reorganise its logistics and workplaces in order to guarantee smooth handling of the orders it receives from abroad via the Internet. Alternatively, a firm that sells its product via a foreign distributor or agent needs to provide, for instance, technical training of the foreign intermediary's sales personnel and has to create incentives and monitoring mechanisms for controlling the foreign partner. Finally, the sales mode used determines the level of control the exporting firm possesses over its international transactions. If the exporter chooses a sales mode that is integrated in its hierarchical structure, like direct exporting or foreign direct

investment (FDI), this will ensure a high level of control. On the other hand, firms that export their products via an intermediary or that enter the foreign market via an acquisition or a joint venture with a strategic foreign partner have only a limited control over production and distribution of their products in the target country. Moreover, working together with a foreign partner also means that the domestic firm has to transfer its (technological) know-how to the foreign partner in order to enable it to produce or distribute the domestic firm's products. Thus, using a non-integrated sales mode implies a loss of control over the firm-specific know-how that often constitutes the firm's competitive advantage.[83]

Considering the far-reaching consequences of a sales mode choice, it is important that the foreign sales mode selected is best suited to a firm's available resources and capabilities. However, these resources and capabilities change over time. Firms grow and shrink, accumulate financial and physical capital, develop new products and introduce them into their domestic and foreign markets. Accordingly, it might be necessary for a firm to adjust its foreign sales mode to these changing firm-specific conditions. Otherwise, its selected sales mode might become inappropriate for selling the firms' products abroad. Unfortunately, the theoretical and empirical literature almost entirely neglects changes of sales modes. The internationalisation process model derived by Johanson and Vahlne (1977, 1990) describes a sequence of sales modes. However, this theoretical model is rather deterministic and its only, or at least its most important explanatory variable is the experiential knowledge a firm has acquired in a foreign target market. Thus, it is questionable whether this model is able to account for all the changing conditions a firm might be faced with. Probably due to data restrictions, most empirical studies that examine foreign sales modes concentrate on the firm's entry mode, i.e., the first sales mode a firm uses in a particular target market. Subsequent changes of sales modes are, or have to be, neglected.[84]

This section will address this gap. It analyses changes of sales modes of our sample of technology-based firms in Germany and the UK. Firms operating in high-tech sectors presumably experience profound changes during an early stage of their life cycles. Thus, provided that the firms have internationalised, it is of special interest to find out under which conditions the exporters in our sample change their foreign sales modes.

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83 The importance of choosing the appropriate sales mode also suggests that the firm's success in a particular target market will likely depend on the chosen sales mode. This question is, however, beyond the scope of this study. The relationship between foreign sales mode and firm performance is examined, e.g., by Beamish and Nitsch (1999), Zahra et al. (2000), and Lu and Beamish (2001).

84 Beamish and Nitsch (1999) provided a longitudinal analysis of sales modes. However, they did not focus on the firm-specific conditions for a sales mode change but attempted to explain why they did not find any performance differences between a joint venture and a greenfield investment when examining a longitudinal data set.

4.4.1 Theoretical Consideration and Literature Review

Several theories have been developed to explain firms' foreign market entry modes. The main strands of theory were summarised by Malhotra et al. (2003) who synthesised these different theories in order to derive a multitheoretical framework of internationalisation and entry mode choice. The theories reviewed by Malhotra et al. include: internationalisation process theory, the resource-based view of the firm in which theories of organisational capabilities are rooted, transaction cost analysis theory, and the eclectic paradigm.[85] All these theories have already been discussed in section 4.1. Most of them do not explicitly deal with sales mode changes but are restricted to the choice of the optimal sales mode when the firm is entering into the foreign market for the first time. Thus, at the end of this subsection the extent to which the reviewed theories are relevant for explaining changes in foreign sales modes will briefly be discussed.

Two notes have to be made first. Most theories investigating foreign market entry consider large companies that have to choose, for example, between exporting and foreign direct investment (FDI). Even in the case of internationalisation process theory where a small firm starts its international business activities with no regular exports and a low resource commitment, the final stage is FDI and foreign production – assuming continuous firm growth during the internationalisation process. However, the majority of firms stay small, never growing into a multinational firm with foreign subsidiaries. Nevertheless, the arguments derived in the existing theories remain appropriate, although, when examining young and small firms, we distinguish only between two alternative ways of exporting (direct exporting to end-users versus exporting via an intermediary; see section 4.4.2). The degree of resource commitment and the level of control of transactions are both relevant to discriminating between different modes of exporting, even if, for instance, the resources actually committed to the foreign market are markedly smaller than in the case of FDI. Further, it should be noted that in the following, the decision whether to export or not is taken as given, i.e., only the group of exporters will be considered. However, the theories discussed in section 4.1 proved to be appropriate for deriving firm-specific variables that influence the firms' export deci-

[85] Additional to these theories, the review of Malhotra et al. (2003) includes, among others, international product life cycle theory, originally developed by Vernon (1966). This theory describes a four-stage sequence (domestic production and exports, foreign production, competition of foreign firms in the foreign market, foreign firm production and importing to the domestic market) contingent on the stage of the product's life cycle. However, since the firms in our sample all belong to a high-tech sector, presumably producing a product at an early stage of its life cycle, this theory is not suitable for discriminating between the varying foreign market entry modes of our sampled firms. Another theoretical approach neglected is network theory (e.g., Coviello and McAuley 1999, Coviello and Martin 1999, Bell 1995). Of course, networks are extremely important for young and small high-tech firms like those in our sample. However, the two surveys this study's analyses are based on do not include any information on networks used by the firms in the context of their internationalisation process. Thus, we are unable to examine any hypothesis that could be derived from network theory.

sion. Thus, the decision on the optimal entry mode might not be independent of the decision to sell abroad. This possible correlation will nevertheless be neglected.

The theoretical models reviewed in section 4.1 are complementary rather than substitutable. They contain some of the same explanatory variables, although the argumentation as to how these variables affect the firms' entry mode choice differs. It is thus not surprising that all the theories reviewed found empirical support. The validity of a theory for explaining the choice of the appropriate foreign entry mode depends, among other things, on the sector and size of the firms that have been examined. The key results of several empirical studies are summarised in Table 4-10.

Most theoretical and empirical research on entry mode choice is concentrated in manufacturing firms. Services, however, differ from manufactured goods. They tend to be personnel-intensive, inseparable (production and consumption are geographically and temporally linked), and perishable (services cannot be stored). Of course, many internationally marketed services are, in fact, separable. They are produced in the domestic country and transferred as a document, a disk, or via the Internet. This is especially true for computer and software services. Nevertheless, theories that were developed to explain the entry mode choice of manufacturing firms are not necessarily also applicable to service firms. Due to its general applicability, the eclectic paradigm is valid for manufacturing as well as for service firms. Brouthers et al. (1996) analysed theoretically and empirically whether Dunning's eclectic paradigm (Dunning 1993) could explain the entry mode selection of small software firms in the United States. They confirmed two hypotheses: (i) Software firms with greater ownership advantages are more likely to choose an integrated entry mode; (ii) Firms with greater locational advantages prefer an integrated entry mode.[86] The authors stressed that software firms in their sample behave like larger manufacturing firms. However, it is questionable whether these findings are transferable to other service sectors.

Similarly to the eclectic paradigm, the transaction cost analysis (TCA) theory is also applicable to both manufacturing and service firms. In order to consider the characteristics peculiar to services, Erramilli and Rao (1993) modified the TCA approach. They hypothesised that, e.g., inseparability causes additional costs and risks that have to be borne either by the firms themselves (an integrated entry mode) or by the chosen foreign partner (a non-integrated mode). According to Erramilli and Rao, a firm chooses a higher degree of integration the higher the transaction costs specificity of the firm's service is (e.g., a technically sophisticated service). Brouthers and Brouthers (2003) pointed out, however, that in the case of (external and internal) uncertainty, internal organisational costs

86 In their empirical analysis Brouthers et al. (1996) neglected internalisation advantages.

Table 4-10: Empirical Studies on the Decision on Foreign Market Entry Modes

Internationalisation Process Model	Resource-Based View / Organisational Capabilities (OC)	Transaction Cost Analysis (TCA)	Dunning's Eclectic Paradigm
Barkema et al. (1996) 225 FDIs of 13 large Dutch firms; firms learn from their previous experience when gradually expanding their international business activities. Learning effects are only relevant in the case of low-control FDIs (acquisitions or joint ventures). *Delios and Henisz (2003)* FDIs of Japanese manufacturing firms; firms with a high level of experiential knowledge are less sensitive to the effects of uncertain policy environments on investments. *Sharma / Johanson (1987)* Swedish technical consultancy firms; resource commitment is of minor significance for the internationalisation process. *O'Farrell et al. (1995)* Small and medium sized UK-based business service firms; the process model was rejected, the most common entry mechanism was responding to a particular ad hoc order.	*Madhok (1998)* US and European multinational manufacturing firms; the OC perspective is most efficient in explaining firms' entry mode decision. Firms may often need to trade off transaction cost-related concerns against capability-related ones. *Ekeledo / Sivakumar (2004)* US manufacturing and non-separable service firms; the resource-based theory has good explanatory abilities for entry mode strategies of both manufacturing and non-separable service firms. However, the impact of firm-specific resources on entry mode choice differs sometimes between the two groups of firms. *Bürgel and Murray (2000)* Newly founded technology-oriented firms in the UK; the entry mode choice of high-tech start-ups can better be explained by an OC framework than by transaction cost or stage theory.	*Hennart (1991)* Japanese manufacturing firms investing in the US; high transaction costs on the US market increase the degree of ownership taken by Japanese firms in their US subsidiaries. *Brouthers / Brouthers (2003)* Manufacturing and service firms from Western Europe entering Central and Eastern European Markets; due to the investment-intensive nature of manufacturing, environmental uncertainties influence manufactures' mode choice; due to the personnel-intensive nature of services, behavioural uncertainties influence service providers' entry mode choice. *Erramilli and Rao (1993)* US service firms, including software, banking, engineering firms, and hotels and restaurants; service firms choose their entry mode according to a modified TCA model that considers inseparability or capital intensity if relevant. A low-control entry mode is selected if the cost of integration rises and the firm's ability to integrate is limited.	*Tse et al. (1997)* Multinational firms investing in China; locational advantages affect the probability of choosing an equity-based entry mode and whether a firm will enter with a partner or not. *Brouthers et al. (1999)* German and Dutch firms entering into Central and Eastern Europe; firms that possess high OLI advantages tend to prefer more integrated entry modes. *Nakos / Brouthers (2002)* Small and medium sized Greek firms entering into Central and Eastern Europe; OLI advantages explain 85 % of mode choices. *Brouthers et al. (1996)* US software firms; the probability of an integrated sales mode increases with a firm's ownership and/or locational advantages.

Source: own presentation.

might be very high and could exceed the cost savings of an integrated entry mode. If an inseparable service is sold abroad using an integrated sales mode, the service has to be produced abroad, requiring a resource-intensive investment in the foreign market (e.g., hotels or hospitals).

Neither the resource-based view of the firm nor the internationalisation process model was developed to account for the entry mode choice of service firms. However, whereas the notion of the

RBV and Madhok's organisational capabilities perspective of the firm are also appropriate to explain foreign sales modes of service firms, the internationalisation process model is less valid in service industries, especially in technology-oriented sectors. Bell (1995) claimed that there is only little empirical support for the view that software firms increase their engagement in one particular foreign market in small incremental steps. The growing commitment to exporting is expressed by an expansion into new destination countries rather than by an increasingly resource-intensive sales mode in one market. Sharma and Johanson (1987) demonstrated for a sample of Swedish technical consultancy firms that the latter bypass some of the incremental steps proposed by the stage models since "resource commitments are of minor significance" for them (Sharma and Johanson 1987, p. 28). Of course, there are services for which an international engagement might entail large-scale investments. For software and consultancy firms, however, comparatively cheap sales modes are available (e.g., transferring a digital document via the Internet), allowing firms to expand their engagement in a foreign market without a large-scale commitment of physical resources.

The main focus of this section is to examine how firms change their foreign sales mode over time. The internationalisation process model and the stage models describe a time-dependent sequence of sales modes where firms start with no regular exports and move step by step to more resource-intensive sales modes. This process is pushed ahead by experiential knowledge an exporter accumulates over time. The other theories do not explicitly deal with sales mode changes. However, the models' explanatory variables (firm-specific intangible assets, transaction costs, OLI advantages) might fluctuate and it might thus be optimal for a firm to change its sales mode and adjust its internationalisation strategy to changing conditions (Calof and Beamish 1995). Replacing the sales mode currently used is, however, not without cost. A firm has to consider the cost of switching. Moreover, choosing a sales channel requires an investment, e.g., an investment in a marketing campaign if an integrated sales mode is selected, or an investment in finding a good distributor or agent in the case of a non-integrated sales mode. Such investments might be regarded as sunk costs. Considering further that selecting an appropriate sales mode is a decision made under uncertainty, this induces an option value of waiting: Even if the currently used sales mode is not optimal according to a cost-benefit analysis, it might be best to retain the present sales mode in order to avoid (sunk) costs of switching back in the foreseeable future. This argumentation leads to a spell of inaction similar to the model of export market participation as developed by Roberts and Tybout (1997).[87] Thus, we expect to observe a relatively high persistence over time in the selected sales modes.

[87] This phenomenon is known as "hysteresis" (Dixit 1989).

4.4.2 Descriptive Analysis

It is self-evident that a firm may use different sales modes in different foreign markets. In this section, I will analyse the changes of sales modes in an exporter's three most important foreign countries (in terms of their contribution to total sales). Therefore the descriptive analysis starts with a discussion of the geographical focus of our sampled firms' international business activities.

At the time of the first survey, UK-based exporters had sales in an average of just over 9 foreign countries, whereas German firms supplied 7 foreign countries on average. These numbers rose until the second survey in 2003 to 19 foreign destinations for UK firms and just under 12 foreign countries for German firms. Similarly, as discussed and econometrically examined in the previous section, both UK-based and German exporters were able to enlarge the share of foreign sales in their total sales. The average share of total turnover of UK (German) exporters generated by foreign sales rose from 39 % (24 %) in 1997 to 50 % (33 %) in 2003. Obviously, the degree of internationalisation, measured by the number of foreign countries entered as well as the share of foreign sales, was higher for UK-based exporters than for their German counterparts.[88] This was the case at the time of the first survey and remained valid, although both UK and German firms had on average intensified their international engagement. As Bürgel et al. (2004) argued, this might be the case because British exporters more pro-actively exploit the sales potential of foreign markets or because German firms are less dependent on the international market because of the larger size of their domestic market.

When entering their first foreign market, both German and UK firms were an average of three years old. In both countries, about one-third of the firms that have ever had international sales entered their first foreign market no later than one year after firm formation ("born globals"). There are, however, differences between German and UK firms with respect to the geographical focus of their first international market. The five most frequently stated countries where German firms had their first foreign sales were, in order of frequency, Austria, Switzerland, the Netherlands, the United States, and Belgium. Thus, German firms preferred neighbouring countries as their initial target countries, although the US market still occupied the fourth place for German firms. On the contrary, UK-based exporters most frequently indicated Germany, the United States, France, the Republic of Ireland, and the Netherlands. British technology-oriented start-ups obviously favoured countries with a large market potential. The nearest neighbour of the UK, the Republic of Ireland, only took the fourth place among the most popular initial markets. The differ-

88 According to t-tests, the means for UK firms are significantly larger than the means for German firms. This is true for both measures and for both points in time.

ences between German and UK firms might again be due to the more pro-active behaviour of UK firms (see Bürgel et al. 2004). The latter firms operated a "push-strategy" (Andersson 2000), i.e., from their first international business activities they actively created the internationalisation process of their firm and exploited the sales potential of the foreign market. In contrast, the first international sales of German firms were often a result of an unsolicited order from abroad ("pull-strategy", Andersson 2000). This interpretation is supported by the fact that UK firms more often chose distant, non-European markets as their first target market as compared to German firms (in addition to the United States, e.g., Canada, South Africa, or Japan).[89]

Table 4-11: Geographical Focus of the Three Most Important Target Countries

	Germany		UK	
	1997	2003	1997	2003
EU 15 (incl. Norway, Switzerland, and Iceland)	67.63	70.27	54.07	48.37
Rest of Europe	10.79	7.03	4.78	3.25
NAFTA (USA, Canada, Mexico)	9.35	9.19	16.75	21.14
Latin America (without Mexico)	2.16	0.54	0.48	1.63
Asia	8.63	11.89	12.92	17.48
Australia	0.72	0.54	6.70	5.69
Africa	0.72	0.54	4.31	2.44
Total	100	100	100	100

Source: ZEW, University of Exeter, own calculation.

Beside their first target countries, the two surveys asked the sample's exporters to indicate the three most important countries (in terms of their contribution to total sales) where they had international sales. Aggregating these countries shows that countries from the European Union (15 member states, plus Switzerland, Norway, and Iceland [EU 15]) represented the main regional group for both German and UK-based firms (see Table 4-11).[90] Countries from the EU 15 were even more important for German than for UK firms. As in the case of the firms' first target countries, more distant markets were of greater importance for UK firms than for their German rivals. This is partly due to the more prominent role of English-speaking countries from the British Common-

89 In connection with the first survey conducted in 1997, 40 case studies (20 in each country) were carried out in order to illustrate the statistical findings of the large mail survey. The interviews, which are documented in detail by Bürgel et al. (2004), also support the interpretation that the internationalisation process of German firms can be described as a "pull-strategy", whereas UK firms rather follow a "push-strategy".

90 Note that the unit of analysis for these figures is not the individual firm but the single country entered by the firm. Exporters that have international sales in only one country enter the figures in Table 4-11 once; exporters that indicated their three most important foreign markets contribute three observations to these figures.

wealth (Australia, South Africa, Canada). Essentially, the broader geographical focus of UK-based firms' most important target countries is a result of these firms' push-strategy as described above.

Comparing the regional distribution of each nation's three most important countries in 1997 and 2003, a similar pattern emerges between the two points in time. However, whereas the role of countries from the EU 15 had increased for German firms, the share of EU 15 member countries among the three most important destinations had fallen for UK firms. Moreover, for German firms, Asian markets became more prominent and the role of Eastern European markets decreased in return. For UK firms, the share of both North American and Asian markets increased. Obviously, UK firms continued to pro-actively exploit remote, non-European foreign markets and expand their position in those markets. The United States presented the single most important destination for UK firms both in 1997 and 2003. On the contrary, the most important country for German firms in 1997 was Austria; in 2003 this place was occupied by Switzerland. Neighbouring countries did not only play a dominant role as regards initial target markets. German exporters continued to prefer them even at a later stage of their internationalisation process. Large and distant markets were exploited to a lesser extent by German firms than by their UK-based rivals.

Referring to the three most important target countries, the first survey asked the firms' representatives to indicate the sales modes used to sell to these three countries, at the time of market entry and in 1997. The second survey also referred to the three most important markets the companies had identified in 1997. Firms were first asked whether they still had foreign sales in each of these countries. If this was the case, firms had to indicate the dominant sales channel they were currently using in each respective market in 2003. Thus, we arrived at a sequence of three foreign sales modes in each of the firms' most important foreign markets of 1997. Such a sequence is required since we are interested in explaining *changes* in foreign sales modes. Of course, the markets investigated may no longer represent the firms' most important markets of 2003. In fact, a good one-third of the foreign markets analysed lost this property between the two surveys.[91]

German firms most frequently used direct exporting to end-users as their entry mode in foreign markets (see Table 4-12). In contrast, foreign distributors that sell on a regular basis were the preferred entry mode for UK exporters. The more prominent role of direct exporting among German firms might reflect that they more often started exporting due to an unsolicited order from abroad before they had made any contractual agreement with a foreign distributor (pull-strategy).

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91 The second survey also provides information on the sales modes in the firms' three most important markets of 2003 as they were summarised in Table 4-11. The distribution of sales modes used in these markets is similar to that shown in Table 4-12, although direct exporting is even more prominent for both German and UK firms.

Table 4-12: Sales Modes Used in Most Important Foreign Markets of 1997 (in %)

	Germany			UK		
Sales Mode	entry mode	1997	2003	entry mode	1997	2003
Direct exporting	42.31	35.77	47.31	37.81	30.57	35.71
Agents	11.54	12.20	5.38	10.95	9.84	13.49
Distributors	40.00	44.72	38.71	45.27	49.74	45.24
Sales joint venture	0.77	0.81	1.08	2.49	4.66	1.59
Wholly-owned subsidiary	0.77	2.44	3.23	1.49	3.11	3.97
Licensing	4.62	4.07	4.30	1.99	2.07	0.00
Total	100	100	100	100	100	100

Source: ZEW, University of Exeter, own calculation.

In contrast, UK exporters, who tended to pro-actively exploit the foreign market, more often began their international business activities based on a contractual agreement with a foreign partner (push-strategy). UK firms' relative preference for using an intermediary probably also reflects that UK firms' three most important foreign markets were relatively often remote, non-European countries, where a cooperation with a foreign partner might be particularly advantageous. Besides foreign distributors, foreign agents that sell ad hoc on a commission basis might also act as this kind of foreign partner. In a good 10 % of the most important foreign markets, both German and UK firms used foreign agents as their first entry mode. The literature on entry modes generally does not distinguish between agents and distributors. Both export intermediaries are assumed to possess local-market knowledge and crucial contacts with foreign customers. Moreover, finding good distributors or agents demands considerable efforts (see, e.g., Root 1987). Although it might be argued that firms have to choose efficiently between agents and distributors and that their choice might be affected by transaction-specific assets and production-cost economies (Bello and Lohtia 1995), this section follows most other studies and regards the two export intermediaries as one sales mode.[92]

Sales joint ventures and wholly owned sales subsidiaries were rarely chosen as the entry mode. These two entry modes constitute more resource-intensive modes than direct exporting or export intermediaries. Most of our sample's exporters probably did not possess enough resources to enter the foreign market via a sales subsidiary. This is true not only for the firms' entry modes but also for the sales modes used in 1997 and 2003. Although a slight increase in the share of markets

[92] Adding up the percentages of agents and distributors reveals that for German exporters, as for their British counterparts, export intermediaries comprise the most frequently used entry mode. However, direct exporting remains more prominent among German firms than among UK firms.

where the firms used a sales subsidiary could be observed, these resource-intensive sales modes continued to be of minor importance. Therefore, they are neglected in the following.

Licensing as a foreign market entry mode is commonly defined as a contractual agreement where the domestic firm (licensor) provides a foreign company (licensee) with intangible assets or property rights in return for payment (Root 1987, p. 85). In general, licensing is discussed in the context of foreign production of manufacturing firms as opposed to foreign direct investment (FDI). This sales mode, however, is almost irrelevant for our sample. Only one manufacturing firm indicated licensing as its sales mode. The firms that indicated licensing as displayed in Table 4-12 were software firms that sold licenses for the use of their software programmes to foreign companies and end-users. In the following, licensing will be neglected as well, since the firms in our sample again rarely chose it as their dominant sales mode in their foreign markets.

In 1997, exporting via an intermediary (agents and distributors) was used in more than 50 % of the firms' most important foreign markets as the dominant sales mode. In comparison, the share of foreign countries that were served via direct exporting decreased for both German and UK firms. Some firms that had first entered a foreign market with direct exports changed their sales mode to exports via an intermediary before 1997.[93] If the initial stimulus to start an international engagement on a foreign market was an unsolicited order, firms might have first supplied their new foreign customer on that market by a direct export. Later, firms might have raised their commitment on that market by making a contractual agreement with a foreign distributor or agent. Thus, changing from direct exports to an intermediary can be regarded as an increased commitment of resources as predicted by the internationalisation process model (Johanson and Vahlne 1977, 1990). However, exporting via an intermediary is not necessarily more resource-intensive than direct exporting. If direct exporting means selling standardised products or pre-packaged software via the Internet (business-to-business or business-to-consumers e-commerce) transaction costs will fall below those of selling via a foreign distributor or agent (e.g., costs for finding and controlling the foreign intermediary). In fact, the share of firms that used direct exporting is significantly higher for our sample's software firms than for manufacturing firms. If, however, the firm sells a product that requires close contact with end-users (because of individual client customisation or intense technical consultation prior to sales, for instance), direct exporting will turn out to be highly resource-intensive. In this case, transaction costs could well be reduced by a foreign inter-

93 The number of observations in the two columns "entry mode" and "sales mode in 1997" are almost identical, since the information for both was given in the first survey conducted in 1997. The minor deviation in the number of observations is only due to some item non-responses. Changes in the share of entry modes in the two columns, therefore, result from firms changing their sales mode in one market or another.

mediary.[94] Thus, whether exporting via an intermediary comprises a more resource-intensive sales mode than direct exporting or vice versa depends on a firm's product characteristics. Similarly, a change of sales mode from direct exporting to an intermediary may or may not mean a more resource-intensive commitment to the foreign market. However, young and small technology-oriented firms might still be forced to use a foreign distributor or agent as their sales mode in order to overcome what Bürgel et al. (2004) called the "liability of alienness". Customers might not trust an unknown foreign supplier which is, as in the case of a born global, not even established in its own domestic market. Thus, using an intermediary might be the only way for a young high-tech firm to sell on a foreign market.

Taking this into account, it is rather surprising that between 1997 and 2003 some firms changed their dominant sales mode from using an intermediary to direct exporting.[95] German firms in particular increased the share of foreign markets where they used direct exports so that in 2003 this sales mode was more prevalent than exporting via an intermediary. The share of foreign markets where UK firms sold their products via direct exporting also rose between the two surveys, although intermediaries remained their most frequently used sales mode. The regained importance of direct exporting might have several reasons. Generally speaking, firms decide on a change of their sales mode based on a cost-benefit analysis. Thus, they will change to direct exporting if they can reach a given benefit (e.g., a desired foreign market penetration) with lower (transaction) costs, or if direct exporting results in a higher benefit at given costs.[96]

The cost-benefit trade-off might have altered between 1997 and 2003 for a number of reasons. Firstly, the sample's exporters might have become established suppliers on their foreign markets, reducing the liability of alienness and thus the necessity of using an intermediary. Secondly, the

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94 Note that this argumentation contradicts the propositions of Anderson and Gatignon (1986) as reviewed in section 4.1. The latter assumed that transaction costs of selling a technically sophisticated product via an intermediary (low-control sales mode) exceed those of direct exporting (high-control entry mode), in particular because of the high costs of controlling a potential intermediary. In contrast, I argue that in the presence of transaction-specific assets the costs of controlling a foreign distributor rise as proposed by Anderson and Gatignon, but that the costs of direct exporting also increase tremendously. Thus, the costs of exporting via an intermediary may or may not exceed the costs of direct exporting.

95 The number of observations in the column "sales mode in 2003" is smaller than in the first two columns of Table 4-12. German firms left a good 18 % of their three most important markets of 1997 between the two surveys, UK firms left a good 9 %. Thus, the shares of sales modes used in 2003 differ from the 1997 column because firms left certain markets and because they changed the sales modes used on the foreign markets where they still had international sales in 2003.

96 During the time period we observe, the majority of the firms in our sample switched their sales mode just once. There are a few markets where the sales mode was changed twice. Whenever this was the case, the sales mode first changed from direct exporting at the time of market entry to exporting via an intermediary in 1997, and then back to direct exporting in 2003.

investigated market might no longer belong to the firm's most important markets in 2003. Assuming that exporting via an intermediary is the more resource-intensive sales mode, a small firm might have reallocated its limited resources to its currently most important markets in order to build up new relationships with local distributors or agents. On the remaining, currently less important markets an exporter might restrict itself to serving its occasional customers by direct exports. Further, an exporter might have altered the innovativeness of its products. In fact, the share of exporters of which the product incorporated novel, self-developed technology had increased from 34 % in 1997 to 48 % in 2003. In return, the share of exporters that used a "tried and tested" technology decreased from 40 % to 21 % during that period. According to the theories reviewed, a higher degree of innovativeness should increase the firms' inclination to use a sales mode with a higher level of control, i.e. in our case, direct exports. Finally, firms might also have changed to direct exporting because the (relative) transaction costs of this sales mode decreased between 1997 and 2003. For example, electronic commerce (e-commerce), by which the costs of cross-border transactions can be reduced, became more and more widespread in both Germany and the UK.[97] [98] If direct exporting became relatively cheaper than exporting via an intermediary, this should have made a change more likely.[99]

Table 4-13 shows in how many markets firms chose a particular sales mode, given the sales mode they had used in the previous period. Although switching is relevant, we observe high persistence in the sales mode utilised. In more than 80 % of the firms' export destinations, the selected sales mode remained unchanged in the following period (observations on the main diagonal). This might be explained by the existence of sunk costs (e.g., the costs of finding a good intermediary) similar to the model of export market participation developed by Roberts and Tybout (1997) and in

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97 There are only a few reliable and internationally comparable figures for the application of e-commerce. OECD (2003) uses the number of SSL-servers (secure socket layer) as an indicator for the potential of e-commerce, because SSL-servers are needed for business transactions via the Internet that require the transmission of confidential data, in particular in the case of electronic payment. The number of SSL-servers per 100,000 inhabitants increased remarkably during the last years: Whereas in 1998 there were 0.6 (1.2) SSL-servers per 100,000 inhabitants in Germany (in the UK), the number rose to 9.7 (17.2) in 2002. According to a ZEW survey, 39 % of all German companies with at least 5 employees utilised the Internet for e-commerce activities in 2002 (Hempell 2004).

98 Fritz (2000) analysed how international market entry strategies will change if the possibilities of the Internet economy are taken into account.

99 Nakamura and Xie (1998) derived a Nash bargaining solution for the bargaining process between a multinational firm and its local partner. The Nash bargaining ownership share in a joint venture (i.e., the level of control) depends on the bargaining power of the two partners. In accordance with this model, it might be argued that our sample's high-tech firms have only relatively little bargaining power, since they are small and, at least in 1997, were forced to make a contractual agreement with a foreign intermediary due to the liability of alienness. Thus, contractual agreements our sample's firms made in 1997 might have been unfavourable for them, causing them to be interested in changing to direct exporting if possible.

accordance with the theoretical considerations in section 4.4.1. In just under 16 % of foreign markets where direct exporting was used as the dominant sales mode in the previous period, firms changed to exporting via an intermediary in the following period. As described above, this transition (not exclusively but) primarily occurred in the period between the foreign market entry and the 1997 survey. A transition from exporting via an intermediary to direct exporting was observed in just under 10 % of export destinations that were supplied via an intermediary in the previous period. Such a transition took place primarily in the period between the two surveys. Changes from and to other sales modes were numerically unimportant and will therefore be neglected. The econometric analysis thus concentrates on the upper-left four-field transition matrix in order to find out what factors influence the probabilities of a transition from direct exporting to exporting via an intermediary and vice versa.

Table 4-13: Changes of Sales Modes in Firms' Most Important Foreign Markets of 1997

		Sales modes *t*			
	n %	Direct exporting	Intermediary	Other sales modes	Total
Sales modes *t*-1	Direct exporting	146 81.11	28 15.56	6 3.33	180 100
	Exporting via an intermediary	30 9.74	266 86.36	12 3.90	308 100
	Other sales modes	8 22.86	4 11.43	23 65.71	35 100
	Total	184 35.18	298 56.98	41 7.84	523 100

Other sales modes: sales joint venture, wholly owned subsidiary, licensing.
Source: ZEW, University of Exeter, own calculation.

4.4.3 Econometric Implementation

Examining the probability of a transition from one sales mode to another or the same sales mode in the next period, I apply the same model used for estimating foreign market entry and exit (i.e., the transition probability between different states of export market participation) in section 4.2 (cf. Gouriéroux 2000 and Van et al. 2004). Since our sample's exporters were asked to indicate the sales mode used in their three most important foreign destination countries of 1997, the individual observation *i* is not the exporter but the sales mode used by the exporting firm in one particular foreign market.

Let Y_{it} denote the sales mode j used in a particular market in time t, with $Y_{it} = 1$ if the exporter has chosen direct exports and $Y_{it} = 0$ otherwise. As before, the transition probabilities are modelled with the logistic formulation and depend on a set of explanatory variables. The probability of transition from sales mode j in t-1 to sales mode j' at time t is then given by

$$(4.22) \quad P_{ijj'}(t) \equiv P\left(Y_{it} = j' \middle| Y_{it-1} = j\right) = \frac{\exp\left(x_{it}\beta_{jj'}\right)}{\sum_{j'=0}^{1} \exp\left(x_{it}\beta_{jj'}\right)},$$

$i = 1, \ldots, N$, $t = 0, 1, 2$, and $j, j' = 0, 1$. Thus, a logit model is specified for each row of the transition matrix (for more details see section 4.2.3).[100]

As Johanson and Vahlne (1990) proposed, large firms are able to use a more resource-intensive sales mode, assuming that size is a proxy for the firm-specific assets a company has at its disposal. Further, Johanson and Vahlne argued that uncertainty prevalent on a foreign market can be reduced by hiring an internationally experienced manager. The econometric model operationalises firm size as the logarithm of the number of employees at time t. International experience is measured by a dummy variable taking the value 1 if the firm's representatives indicated that a member of the firm's management team had work experience abroad, had previous work experience in the domestic country for an international company, or if a manager was educated abroad before joining the company. According to Johanson and Vahlne, these two variables should be positively correlated with a change to a more resource-intensive sales mode. However, as discussed in the previous subsection it is not clear, a priori, whether direct exporting is more resource-intensive than exporting via an intermediary or vice versa. Thus, it is not possible to hypothesise which sign these two variables are expected to take based on the internationalisation process model. It might, however, be argued that a higher amount of physical resources, approximated by firm size, enables the firm to bear the high switching costs of a sales mode change. This argument speaks in favour of a positive sign of firm size in each of the two transition equations.

The firm managers' international experience can also be regarded as constituting an intangible asset decisive in determining firms' internationalisation behaviour from a resource-based view of the firm, or as an ownership advantage in Dunning's eclectic framework. Finally, international experience can reduce internal uncertainty and thereby increase the probability of switching to a

[100] Since the transition from a distributor to direct exports can be regarded as a rare event in our data set, I also estimated the respective transition probability using a rare event logit, as also used when estimating the probability of an exit from foreign market in section 4.2. The results, however, do not change, so in the following I will restrict myself to using a conventional logit model.

high level of control, i.e., a more integrated sales mode like direct exporting as predicted by Anderson and Gatignon's (1986) transaction cost analysis theory.

According to the resource-based view, a firm distinguishes itself from its competitors by its intangible and inimitable assets. Those assets are generated by conducting R&D activities and are reflected by the innovativeness of the firm's products and services. Instead of considering R&D intensity in the econometric model, I will include a dummy variable in the regression equation that indicates whether a firm carried out permanent R&D activities at the time of the surveys. This variable better describes the firms' long-term R&D activities and is therefore probably more suitable for explaining the probabilities of a sales mode change, since there is a six-year interval between the two surveys.[101] Further, the firm's innovativeness is approximated by the dummy variable reflecting novel and self-developed technology incorporated into the firm's best-selling product or service. Both the organisational capability perspective and the transaction cost theory propose that a high-control sales mode (e.g., direct exporting) will be selected if the firm possesses intangible, inimitable assets, or if the firm's product is technically sophisticated. Hence, the two variables are both hypothesised to lower the probability of switching from direct exporting to exporting via an intermediary, and to increase the probability of a change from using a foreign distributor or agent to direct exports.

A high level of R&D activities is typical of technology-oriented firms like those examined by this study. Moreover, today's high-tech markets are characterised by shrinking product life cycles. The time span during which a high-tech firm can exploit its technological advantage is therefore limited (cf. Sampler 1998). Interviewing the firms in our sample, we asked firm representatives to estimate the time a competitor would need to launch either a similar product with superior performance or a product with similar performance at a lower price. Bürgel et al. (2004) called this competition-free time period when firms can realise temporary monopolistic rents the "window of opportunity". I will include a dummy variable in the estimation equation taking the value 1 if the estimated window of opportunity is one year or shorter. Malhotra et al. (2003) proposed that a short window should increase the probability of selecting a low-control sales mode in order to exploit the technology in the shortest time (see also Bürgel and Murray 2000). However, if a firm has to replace its product line at least once a year, the sales personnel of the foreign partner will have to be trained annually. Especially in the case of a technically sophisticated product where the transfer of knowledge to an intermediary is difficult, the costs of exporting via a distributor or

[101] Replacing the firm's R&D intensity by the dummy variable indicating permanent R&D activities already proved to be appropriate when estimating the firm's degree of internationalisation in the previous section.

agent will rise. It is questionable whether these costs can be amortised within the time span of a very short window. Therefore, I hypothesise that in the case of a short window of opportunity a firm is more likely to remain a direct exporter. Similarly, a firm is more likely to change to direct exports if it used an intermediary in the previous period. The econometric analyses will decide which of the two conflicting hypotheses, by Malhotra et al. (2003) and myself, better describes the sales mode selection of high-tech firms.

In addition to the technology incorporated into a firm's product or service, the transaction costs and thus the desired level of control might also be influenced by the necessity for close contact with key customers. According to Anderson and Gatignon (1986), a higher level of control will be preferred if intense product customisation is prevalent. For the econometric estimations, a dummy variable will be used taking the value 1 if the firm classified the requirement of customisation as "important" or "very important". If customisation is important, the probability of changing to an intermediary should decrease, while switching to direct exporting should be more likely. Moreover, the logit regressions contain a dummy variable that indicates if the product or service is directly sold to end-users, and a further dummy variable if the firm sells business services to other companies. The base category is a firm selling manufactured goods to other companies (either as a component or as an investment good). Selling a product or service directly to a probably large number of end-users is personnel-intensive, but is often a matter of routine business that can easily be handled by an intermediary (e.g., a foreign retailer). In contrast, selling to other companies is often practised via personal contact to the other firm's purchasing department so that direct exporting will be preferred, in particular, if the exporter only has a limited number of key customers.[102]

The role of target country-specific factors is underlined by the transaction cost theory and by the locational advantages of Dunning's eclectic paradigm. Moreover, the internationalisation process model emphasises the importance of experiential knowledge acquired in one particular target market for the selection of the appropriate sales mode. Our model measures the country-specific experience by the (logarithm of) years a firm has had international business activities in the particular country since market entry.[103] According to the transaction cost model of Anderson and

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[102] Anderson and Gatignon (1986) further proposed that the probability of using a high-control sales mode will increase if the firm sells an immature product. I estimated a specification that included (the logarithm of) the age of the firm's best-selling product, but this variable turned out to be insignificant in both transition equations and was therefore excluded from the final specification.

[103] Since we observe the firms in our sample only at the time of the two surveys, i.e. in 1997 and 2003, it cannot be excluded that a firm may have left and re-entered a particular foreign market between the two surveys. Thus, the number of years used in the regression models is, strictly speaking, only correct in the case of a continuous engagement in a foreign country.

Gatignon (1986), a lack of international experience leads to a low-control sales mode, i.e. to exporting via an intermediary. Furthermore, the model includes the target country's market potential, approximated by (the logarithm of) the target country's GDP and the rank of country risk.[104] It is difficult to predict how sales mode selection is affected by target market size. On the one hand, establishing one's own distribution network for direct exporting in a large country is rather resource-intensive. On the other hand, a country with a large market potential is attractive and firms might invest in that country in order to pro-actively exploit its market potential. Therefore, I will follow Barkema and Vermeulen (1998) and Bürgel and Murray (2000) and include the absolute size of target country as a control variable without formulating any hypothesis regarding the expected sign. Hence, the effect of market size, if any, will be determined econometrically.

The transaction cost theory argues that country risk increases the probability of choosing a high-control sales mode only in *combination* with transaction-specific assets. Hence, I calculated two interaction variables by multiplying the country risk variable with the two dummy variables that represent the intangible assets incorporated into the firm's best-selling product or service. The first interaction term is thus the product of country risk and the dummy variable that indicates whether a firm carries out permanent R&D activities; the second interaction variable is the product of country risk and the dummy denoting that novel and self-developed technology is incorporated into the firm's product or service. To control for an independent effect of country risk on the probabilities of sales mode change, i.e., without an interaction with transaction-specific assets, the rank of country risk is included individually in the regression equations.

The sales mode used in a foreign market might also depend on the importance of that market, measured in terms of the country's contribution to total sales. If a firm generates only a relatively small share of total sales in a particular foreign country, for example, due to some occasional orders from that country, the firm might not be willing to commit a high amount of resources to finding and training a foreign distributor or agent. In this case, occasional direct exports might be optimal. Conversely, in a target market that makes important contributions to the firm's total sales, a resource-intensive sales mode might be selected.[105] Unfortunately, the share of total sales generated by each target country is only available in the data set for the first survey and not for the second survey. In the second survey, firms were asked instead to indicate the percentage of total

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104 The data sources of target countries' GDP and risk are described in detail in appendix A.1. Country risks were ranked and then entered into the model. Rank "1" was attributed to the lowest risk level.

105 As already argued above, it is difficult to decide whether direct exporting or exporting via an intermediary is the more resource-intensive sales mode. Thus, it is not possible to hypothesise which sign is expected in the regression equations.

sales generated in the regions given by Table 4-11. Hence, I used the share of total sales generated in the region the target country belongs to in order to approximate the importance of the particular market for the firm.[106]

Finally, I will include three dummies as control variables in the regression equations. The first dummy variable takes the value 1 if the exporter is sited in Germany. As the descriptive analysis in Table 4-12 shows, distributors and agents were more frequently used by UK-based firms in their three most important target countries of 1997. Moreover, given that at time *t*-1 direct exporting was used, UK-based firms more often switched to exporting via an intermediary at time *t* than German firms. On the other hand, German and UK firms changed from an intermediary to direct exports in a comparably high share of foreign markets. The econometric analysis will show whether these disparities in the descriptive statistics can be explained by our model, or whether there are unobservable differences between German and UK-based exporters. In contrast to the analyses of both foreign market entry and exit and the firms' degree of internationalisation, this section's model will not contain an additional dummy variable indicating firms that are located in Eastern Germany, because the absolute number of sales mode changes is very small in the sub-sample of Eastern German exporters (only three changes from direct exports to exporting via an intermediary and three changes in the opposite direction). Thus, a dummy variable indicating Eastern German exporters would almost perfectly predict "failure" (read: non-change) and will therefore be neglected in this section's econometric model.[107]

The descriptive analysis in section 4.4.2 further showed that service firms more often used direct exporting as their dominant sales mode than manufacturing firms. Therefore, two industry dummy variables will be added. The first industry dummy variable characterises firms that belong to an engineering industry; the second dummy variable indicates firms from other manufacturing sectors, including ICT-hardware and health and life sciences. Thus, service firms are used as the base category.

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106 Data from the first survey were appropriately aggregated in order to obtain comparable data for both periods examined.

107 The main reason for the small number of changes observed is the significantly lower probability of Eastern German firms having international sales, reducing the number of Eastern German exporters. The number of foreign markets entered by Eastern German exporters is also smaller than the respective number for Western German firms, however not significantly so (2003: Western German exporters: 12 countries, Eastern German exporters: 10 countries). After entering into the foreign market, the export behaviour of Eastern German firms is similar to that of their Western German counterparts. This interpretation is supported by the econometric result that Eastern German firms do not have a significantly higher probability of leaving the foreign market and by the descriptive result that in 2003 the average degree of internationalisation of Eastern German exporters is no longer significantly smaller than that of exporting Western German firms (see Table 4-5).

4.4.4 Empirical Results

The results of the empirical model are given in Table 4-14. The second column shows the vector of coefficients $\hat{\beta}_{10}$, explaining the sales mode change from direct exporting at time *t*-1 to exporting via an intermediary at time *t*. The third column includes the vector $\hat{\beta}_{01}$ for a change in the opposite direction, i.e., from an intermediary to direct exports.

The country-specific dummy variable is insignificant in both transition equations. Thus, the fact that UK-based firms more often changed to exporting via an intermediary when they had used direct exporting in the previous period can be explained by our model. Manufacturing firms are more likely to change from direct exporting to exporting via an intermediary than service firms. Moreover, the probability that an engineering firm will keep on selling its products via a foreign distributor or agent if it had already used this sales mode in the previous period is higher than for other manufacturing and service firms. These results coincide with the findings of the descriptive analysis that service firms more often use direct exports as their dominant sales mode. For our sample's service firms (mainly software firms) direct exporting probably constitutes a relatively cheap sales mode since they can distribute their digital services directly via the Internet. Surprisingly, engineering firms differ from other manufacturing firms in their lower probability of switching to direct exports. There are possibly additional industry-specific costs that have to be borne by engineering firms, costs that are not captured by the variables of our model. If establishing business relations with a foreign intermediary is more expensive for an engineering firm than for other manufacturing firms, i.e., if the sunk costs an engineering firm has to pay exceed those of other firms, the engineering firm will more likely continue to sell its product via an intermediary. In the presence of sunk costs an engineering firm will keep on exporting via an intermediary in order to avoid (possible) costs of switching back, even if the use of an intermediary is currently not optimal. Interestingly, when analysing export market participation of our sample's firms in section 4.2.4, arguments were likewise found that foreign market entry of engineering firms is linked to higher industry-specific sunk costs in comparison to other manufacturing firms. Engineering firms showed a lower probability of entering the international market, but a higher probability of staying in the foreign market once they had entered. These differences can be explained by the existence of high industry-specific sunk costs. If there are sunk entry costs, engineering firms tend to avoid (possible) re-entry costs by staying in the international market, even if this is currently not optimal.

Firm size, measured by the number of employees, does not affect the probability of a change from direct exports to exporting via an intermediary. Interpreting size as representing the firms' finan-

Table 4-14: Propensities of Sales Mode Changes – Results of Logit Models

	Sales mode change direct exports → intermediary			**Sales mode change intermediary → direct exports**		
	Number of observations = 130 LL = -41.033 $\chi^2(17) = 29.71$ Prob > $\chi^2(17) = 0.029$ McFadden's $R^2 = 0.355$			Number of observations = 242 LL = -46.699 $\chi^2(17) = 40.28$ Prob > $\chi^2(17) = 0.001$ McFadden's $R^2 = 0.419$		
	Coeff.	*Robust stand. error*		*Coeff.*	*Robust stand. error*	
Country	-0.272	0.771		0.907	0.698	
Engineering	4.000	1.492	***	-2.206	1.072	**
Other manufacturing industries	3.238	1.316	**	-0.235	0.891	
Log (number of employees)	0.090	0.255		1.043	0.426	**
International experience of management	1.026	1.000		2.354	1.315	*
Permanent R&D activities	0.857	0.813		-0.797	0.621	
Interaction (country risk * perm. R&D)	-0.096	0.040	**	-0.023	0.043	
Novel, self-developed technology	-0.232	1.426		2.016	0.859	**
Interaction (country risk * novel tech.)	-0.006	0.064		-0.055	0.045	
Window of opportunity ≤ 12 months	-2.175	0.793	***	1.077	0.535	**
Intense product customisation	-1.171	0.593	**	0.860	0.695	
Consumer good	2.212	0.730	***	-1.211	0.690	*
Business service	1.303	0.866		3.272	0.977	***
Log (years since entry into target country)	1.233	0.590	**	3.802	1.120	***
Log (GDP of target country)	-0.043	0.310		-0.305	0.247	
Rank of country risk 1998	0.053	0.049		0.040	0.023	
Share of total sales generated in the target country's region	-0.016	0.020		-0.008	0.041	
Constant	-6.548	2.223	***	-14.565	4.412	***

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

Base category: entry of a UK-based software/service firm.

Source: own estimation.

cial or physical resources, this is an interesting result. It corresponds to the findings of Bürgel et al. (2004) who estimated a probit model for the exporters' decision on entry mode (the first sales mode used in a particular target country), using the cross-sectional data set of the first survey. They found that (the logarithm of) start-up size has no effect on choosing a distributor as the first sales mode.[108] As pointed out in section 4.4.2, a change from direct exporting to exporting via an intermediary was (not exclusively but) primarily observed in the period between foreign market entry and the 1997 survey. Thus, identifying and forming commercial relationships with a foreign partner requires so few additional resources that they can be raised even by the small, high-tech

[108] For the subsample of UK-based firms, Bürgel et al. (2004) found a positive effect of start-up size on the probability of selecting a distributor, however only at the 10 % level of significance.

firms of our sample during their start-up period and the early stage of their international engagement. On the contrary, replacing exporting via an intermediary by direct exports is facilitated if the firm has large financial or physical resources at its disposal. The coefficient of firm size is positive and significant in the transition equation. Finishing the cooperation with a foreign partner and establishing one's own distribution network for direct exporting can thus be interpreted as a more resource-intensive commitment to a particular market – at least for manufacturing firms.

The influence of the management's international experience goes in the same direction as that of firm size. While it does not have any effect on switching to an intermediary, it supports a change to direct exports. Internationally experienced managers are less reliant on a foreign partner. However, the managers' international experience does not prevent a firm from being forced to use an intermediary during an early stage of its international engagement. Regardless of any international experience, firms that have entered the foreign market by direct exports have the same probability of changing to an intermediary, possibly in order to overcome the liability of alienness.[109]

Two dummy variables were intended to measure the firms' intangible and inimitable assets: a dummy variable indicating permanent R&D activities and another dummy indicating whether novel and self-developed technology was incorporated into the firm's best selling product or service. These two variables were hypothesised to increase the probability of using a high-control sales mode, i.e. direct exports. Permanent R&D activities do not have any individual influence on the transition probabilities. There is only a slightly significant negative effect of the interaction term with the country risk variable. Moreover, the prevalence of novel and self-developed technology only raises the probability of switching from an intermediary to direct exports, having no effect on the transition in the other direction. The signs of the significant variables thus correspond to the predictions of the transaction cost theory and the organisational capability perspective. Nevertheless, the transition probability from exporting directly to exports via an intermediary seems to be rather independent of the firm's intangible and inimitable assets. In fact, the marginal effect of the interaction term is relatively small. Setting all variables to their means, the interaction term decreases the probability of a change from direct exports to an intermediary by less than one percentage point.[110] Similarly to the firm managers' international experience, it might be argued that during an early stage of the firm's international engagement, intermediaries are a prerequisite

[109] According to Bürgel et al. (2004), international experience of the management team increases the probability of choosing direct exports as foreign market entry mode. My results show that even if a firm entered the target country by direct exports it is sometimes compelled to change to an intermediary, e.g., because of the liability of alienness. If this is the case, international experience cannot prevent an exporter from taking this step.

[110] The marginal effects of the logit regressions will be discussed in greater detail below.

for selling abroad in order to cope with the liability of alienness. Firms that had entered the foreign market by exporting directly were forced to find a foreign partner, regardless of the technology and the degree of innovativeness incorporated into their product and even if the choice of an indirect sales mode was not optimal from a transaction cost point of view.

After becoming established in the foreign market, firms are able to select the sales mode that minimises transaction costs or that is best suited to the firms' intangible resources. Thus, the technology incorporated into the firms' products is more important for explaining a change from an intermediary to direct exports.[111] However, switching from exporting via an intermediary to direct exports cannot exclusively be interpreted as a change from a formerly suboptimal sales mode (from a transaction costs point of view) to an optimal one during a later stage of the firm's international engagement. This interpretation is only one possible scenario. Alternatively, choosing an intermediary during an early stage of the firm's export activities might have been perfectly optimal, because at the time of the first survey the exporter was producing its product using a "tried and tested" technology. The transaction cost theory and the organisational capability perspective suggest that in this case a low-control sales mode (i.e., an intermediary) is preferred. However, 40 % of the exporters that were using a "tried and tested" technology at the time of the first survey changed to a novel and self-developed technology in the period between the two surveys. Thus, switching from an intermediary to direct exports was necessary because the exporter increased the degree of innovativeness of its product.

Interestingly, the dummy variable representing permanent R&D activities is not correlated with the probability of such a transition. This might be due to the fact that R&D constitutes an input variable and may not necessarily reflect the product's transaction-specific assets. It may be that firms carry out R&D not to realise product innovations, but rather to make process innovations. The latter may lead to cost reductions and, as a consequence, to lower prices and improved competitiveness of the firm's product. Therefore, R&D activities may be able to explain the decision to internationalise, but may not have an impact on the sales mode chosen. In fact, analysing foreign market participation of the firms in section 4.2, R&D activities proved able to discriminate between exporters and non-exporters. However, as we have seen, they cannot explain changes of sales modes.[112] More suitable for measuring transaction-specific assets is the dummy variable

111 Recall that a change from an intermediary to direct exports primarily occurred between the surveys conducted in 1997 and 2003, that is, during a later stage of the firms' export activities.

112 Estimating the determinants of entry mode choice for the firms in our sample, Bürgel et al. (2004) found a significantly negative effect of R&D intensity on the probability of choosing a distributor. However, the reported marginal effect is very small: A marginal increase in R&D intensity reduces the probability of using a distributor as the first sales mode by only 0.3 percentage points.

indicating novel and self-developed technology incorporated into the firms' products. This variable is presumably closely related to the technological characteristics of the products, since it directly reflects what firm managers said about their products.

As I hypothesised, a short window of opportunity decreases the probability of changing from direct exports to an intermediary and, conversely, increases the chance of switching in the reverse direction. Contrary to the hypothesis of Malhotra et al. (2003), high-tech firms that have to exploit their technological advantages in a very short period of time favour direct exports. If technically sophisticated products are replaced or upgraded at least once a year, this will require, among other things, expensive training of foreign distributors or agents which raises the costs of exporting via a distributor or an agent. In this case, exporting directly is preferred by a technology-oriented firm, even though it has to relinquish its foreign partners' knowledge of the local markets and their close contact with potential foreign customers. The impact of a short window of opportunity might also be interpreted from Madhok's organisational capability perspective (cf. Madhok 1997). The notion of the OC perspective is that a firm exploits its competitive advantage in order to generate revenues in a foreign market. The empirical results show that if the time period for exploiting a competitive advantage is limited, an integrated sales mode will be optimal.

The requirement for intense product customisation acts as a barrier to initiating exports via an intermediary. Customisation demands close contact with individual customers. Thus, the costs of selling abroad could, on the one hand, be reduced by a foreign distributor who is assumed to already have close contact with potential customers. On the other hand, customisation increases the costs of controlling the foreign partner. Moreover, Anderson and Gatignon (1986) argued that in the presence of substantial product customisation, exporters rely heavily on their relationships with probably only a limited number of key customers, leading to their interest in controlling these important relationships. Our results are consistent with the latter interpretation. Changing from direct exports to an intermediary is less likely if individual client customisation is prevalent. However, the dummy variable indicating intense customisation is not significant in the second transition equation. Once an exporter has chosen a foreign intermediary, the probability of changing the distribution channel is unaffected by the degree of customisation. Finding a foreign distributor and making a contractual agreement with it might be regarded as a sunk investment. Especially if customisation is important, such an investment might be relatively high, implying that switching from an intermediary to direct exports is observed less frequently than in the absence of sunk costs. This could possibly explain the insignificant effect of product customisation on the transition probability from exporting via an intermediary to direct exports.

Consumer goods or services that are directly sold to end-users are generally distributed to the foreign market via an intermediary. Even if the firms have entered the foreign market by direct exports, for instance, because they received an unsolicited order from abroad, it is likely that they will try to find an appropriate intermediary – at least if they intend to expand their international engagement. Similarly, it is less likely that a firm producing a consumer good will switch to direct exports if it is currently using an intermediary. Distributing a consumer good to a large number of end-users is often a matter of routine business, making a foreign distributor preferable. Comparing companies that produce a consumer good with firms that sell their products and services to other firms (either as a business service, an intermediate or an investment good), our results show that for the latter firms, the probability of changing from direct exports to an intermediary is lower and that switching from an intermediary to direct exports is more likely. The probability of changing to direct exports during a later stage of the firm's international engagement is even higher for business service firms than for manufacturing firms selling intermediate or investment goods (the base category), perhaps because e-commerce became more widespread in the period between the two surveys, offering software firms a relatively cheap way of distributing their services abroad.

The number of years a firm exports its products to a particular target market is assumed to be positively correlated with the use of direct exports. The longer a firm is engaged in a particular market, the more experience it is able to gain, allowing its ability to export directly to increase. It is also no longer necessary for the exporter to rely on the knowledge of a foreign partner. In fact, the number of years the exporter is engaged in the target country has a positive effect on the probability of a transition from exporting via an intermediary to direct exports. However, the coefficient of this variable is also significantly positive in the second transition equation, which contradicts the theory and is inconsistent with the positive result in the other equation. The number of years a firm sells its products in a target country probably does not really measure the experiential knowledge acquired by the exporter. Instead, the two positive coefficients might be interpreted in the sense that changing the dominant sales mode in a country is more likely the longer the firm is engaged in that country. Or in other words, it takes time to make a change. Binding contracts a firm has entered into with a foreign customer or a foreign distributor can make an early replacement of the sales mode used impossible.

The remaining target country-specific variables that were included in the regression equations are neither individually nor jointly significant.[113] The target country's GDP was included as a control

[113] Wald tests of joint significance of the three remaining country-specific variables: transition from direct exports to exporting via an intermediary: $\chi^2(3) = 3.17$, (Prob > χ^2) = 0.366; transition from exporting via an intermediary to direct exports: $\chi^2(3) = 4.48$, (Prob > χ^2) = 0.215.

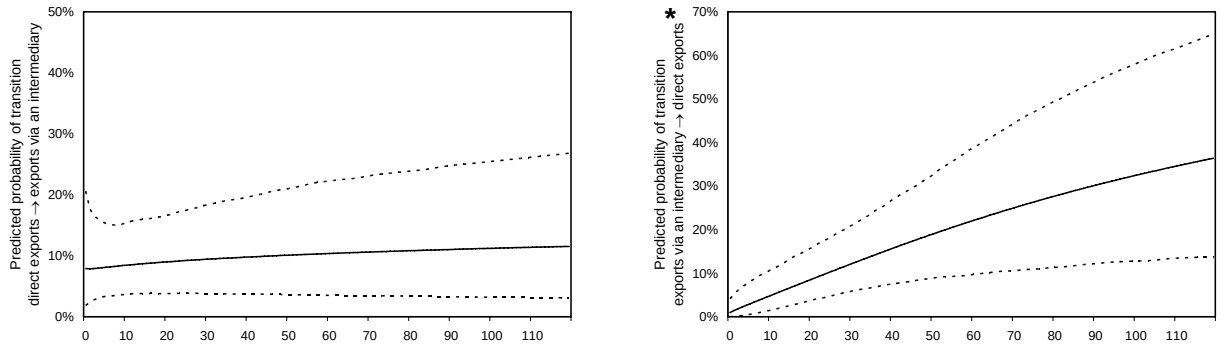
variable measuring the attractiveness of a foreign country. Although the descriptive analysis revealed that market potential is important for the selection of the exporter's target countries, in particular for UK-based firms that pro-actively exploit the potential of foreign markets, it is not relevant for changes in the sales modes used. According to Anderson and Gatignon (1986), country risk influences sales mode selection only in combination with transaction-specific assets. This proposition can be confirmed by our results. The rank of country risk has no significant effect in the two regression equations, but, as discussed above, the interaction term with permanent R&D activities decreases the probability of a transition from direct exports to exporting via an intermediary, although the effect is relatively small. Finally, the share of total sales generated in the region of the target market entered cannot explain why exporters change their sales modes either. The latter variable was intended to measure the importance of the particular target market for the exporting firm. Admittedly, this measure is rather vague, especially because the second survey contains only aggregated information about the share of total sales generated in several regions and none about the shares in the individual target markets. Moreover, the share of total sales might be endogenous since it can be regarded as a measure of the exporter's success in a country, which in turn might be influenced by the selected sales mode. Thus, it is impossible to say whether the variable proved to be insignificant because it is not suitable to measure the importance of a particular target country or whether a sales mode change is, in fact, independent of country-specific variables and can better be explained by firm-specific or transaction-specific assets.

In order to get further insights into how the individual variables affect the probability of switching to another sales mode, I calculated marginal effects. It is well known that the marginal effects vary with the values of x (see, e.g., Greene 2000), and it is thus common practice to evaluate the marginal effects at the means of the independent variables. The results of this specification are given in Tables 4-15 and 4-16, labelled as Model 1. Whereas the probability of a transition from direct exports to exporting via an intermediary changes significantly as discussed above, the probability of a transition in the reverse direction is not influenced significantly by any of the independent variables, given that all variables are set to their mean. At first glance, this outcome is somewhat surprising since we found some significant coefficients included in the vector $\hat{\beta}_{01}$. However, it was argued above that a change from exporting via an intermediary to direct exports was primarily observed in the period between the two surveys. Thus, a transition to direct exports generally takes place only in a later stage of a firm's engagement in the particular target market. The predicted probability of a transition from exporting via an intermediary to direct exports in dependence of the years since entry into the target country is depicted in the lower right graph in Figure 4-3, with

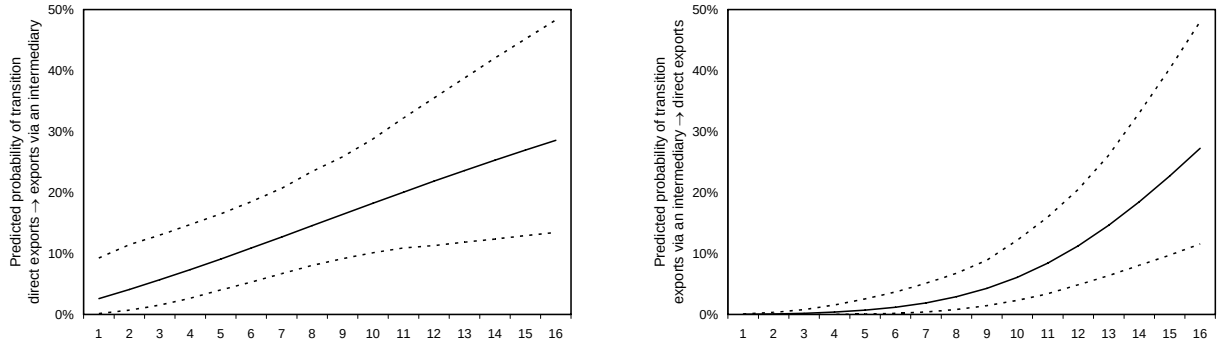
Figure 4-3: Predicted Probability of a Change of Sales Mode

Transition direct exports→ intermediary **Transition intermediary → direct exports**

Predicted probability in dependence of the number of employees



Predicted probability in dependence of years since entry into target country



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.

***** Years since target market entry set to the mean of 2003.

Source: own calculation.

all other independent variables set to their mean. The graph reflects the positive correlation between the time period of the exporter's engagement in the target country and the probability of a change to direct exports. In the early years a firm generates international sales in the target country, a change to direct exports is very unlikely. Only after a twelve-year engagement does the probability of a change exceed the ten-percent level. However, not only the probability of a change to direct exports rises with the number of years since market entry. The uncertainty of predicting a transition also increases. Thus, the time period in which the exporter is engaged in the target market is less appropriate for predicting changes in sales modes during a later stage of the firms' international activities. In this case, firm-specific or transaction costs-specific variables are probably more suitable to predict a transition from one sales mode to another. This argument is also true for a change from direct exports to exports via an intermediary as shown by the lower left graph in Figure 4-3.

Table 4-15: Marginal Effects of Logit Model – Sales Mode Change from Direct Exports to Exporting via an Intermediary

	Model 1	Model 2	Model 3
	Prob. of change = 0.080	Prob. of change = 0.050	Prob. of change = 0.177
	Marginal effect (robust stand. error)	*Marginal effect (robust stand. error)*	*Marginal effect (robust stand. error)*
Country	-0.020 (0.057)	-0.013 (0.036)	-0.039 (0.113)
Engineering	0.537 (0.203)***	0.419 (0.178)**	0.703 (0.210)***
Other manufacturing industries	0.371 (0.150)**	0.268 (0.113)**	0.558 (0.216)**
Log (number of employees)	0.007 (0.020)	0.004 (0.013)	0.013 (0.037)
International experience of management	0.059 (0.045)	0.037 (0.034)	0.120 (0.080)
Permanent R&D activities	0.054 (0.051)	0.034 (0.036)	0.109 (0.098)
Interaction (country risk * perm. R&D)	-0.007 (0.004)*	-0.005 (0.003)	-0.014 (0.006)**
Novel, self-developed technology	-0.016 (0.095)	-0.011 (0.059)	-0.033 (0.195)
Interaction (country risk * novel tech.)	-0.000 (0.005)	-0.000 (0.003)	-0.001 (0.009)
Window of opportunity ≤ 12 months	-0.206 (0.086)**	-0.139 (0.072)*	-0.356 (0.140)**
Intense product customisation	-0.094 (0.055)*	-0.061 (0.044)	-0.178 (0.088)**
Consumer good	0.234 (0.086)***	0.161 (0.075)**	0.389 (0.136)***
Business service	0.141 (0.109)	0.095 (0.075)	0.242 (0.187)
Log (years since entry into target country)	0.091 (0.036)**	0.058 (0.020)***	0.179 (0.111)
Log (GDP of target country)	-0.003 (0.023)	-0.002 (0.014)	-0.006 (0.046)
Rank of country risk 1998	0.004 (0.004)	0.003 (0.003)	0.008 (0.007)
Share of total sales generated in the target country's region	-0.001 (0.002)	-0.001 (0.001)	-0.002 (0.003)

Model 1: All variables set to their overall mean.

Model 2: Like Model 1, but log (employees) and log (years since entry into target country) set to their mean of 1997.

Model 3: Like Model 1, but log (employees) and log (years since entry into target country) set to their mean of 2003.

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

Base category: entry of a UK-based software/service firm.

Source: own estimation.

Table 4-16: Marginal Effects of Logit Model – Sales Mode Change from Exporting via an Intermediary to Direct Exports

	Model 1	**Model 2**	**Model 3**
	Prob. of change = 0.006	Prob. of change = 0.077	Prob. of change = 0.200
	Marginal effect (robust stand. error)	*Marginal effect (robust stand. error)*	*Marginal effect (robust stand. error)*
Country	0.006 (0.006)	0.071 (0.056)	0.153 (0.125)
Engineering	-0.012 (0.012)	-0.131 (0.069)*	-0.292 (0.127)**
Other manufacturing industries	-0.001 (0.006)	-0.017 (0.066)	-0.038 (0.144)
Log (number of employees)	0.007 (0.005)	0.074 (0.034)**	0.167 (0.071)**
International experience of management	0.008 (0.007)	0.097 (0.036)***	0.234 (0.082)***
Permanent R&D activities	-0.006 (0.007)	-0.066 (0.061)	-0.140 (0.129)
Interaction (country risk * perm. R&D)	-0.000 (0.000)	-0.002 (0.003)	-0.004 (0.007)
Novel, self-developed technology	0.016 (0.017)	0.167 (0.081)**	0.167 (0.081)**
Interaction (country risk * novel tech.)	-0.000 (0.000)	-0.004 (0.004)	-0.009 (0.009)
Window of opportunity ≤ 12 months	0.008 (0.008)	0.083 (0.050)*	0.180 (0.095)*
Intense product customisation	0.006 (0.008)	0.067 (0.060)	0.144 (0.119)
Consumer good	-0.008 (0.008)	-0.087 (0.047)*	-0.192 (0.116)*
Business service	0.109 (0.077)	0.568 (0.197)***	0.674 (0.134)***
Log (years since entry into target country)	0.024 (0.017)	0.269 (0.120)**	0.607 (0.210)***
Log (GDP of target country)	-0.002 (0.002)	-0.022 (0.020)	-0.049 (0.041)
Rank of country risk 1998	0.000 (0.000)	0.003 (0.003)	0.006 (0.007)
Share of total sales generated in the target country's region	-0.000 (0.000)	-0.001 (0.002)	-0.001 (0.004)

Model 1: All variables set to their overall mean.

Model 2: Like Model 1, but log (employees) and log (years since entry into target country) set to their mean of 2003.

Model 3: Like Model 2, but dummy variable indicating novel, self-developed technology set to "1".

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

Base category: entry of a UK-based software/service firm.

Source: own estimation.

Since a transition from exporting via an intermediary to direct exports is only probable during a later stage of an exporter's engagement in the target country, I took the mean number of years between target market entry and the year of the second survey, 2003, for calculating marginal effects. Moreover, the results of the logit regression have shown that switching to direct exports is also positively correlated with firm size. The relationship between the number of employees and the probability of a sales mode change is also depicted in Figure 4-3. Since the firms in our sample grew in the period between the two surveys[114], I further used the mean number of employees at the time of the second survey when calculating marginal effects. This specification is given in Table 4-16 as Model 2. For the third specification in Table 4-16, I further set the dummy variable indicating a novel, self-developed technology to the value 1. As discussed above, the percentage of exporters that used a novel technology at the time of the second survey had increased significantly compared with the first survey. Hence, it is useful to examine the marginal effects given a high degree of innovativeness incorporated into the firm's product.

In Table 4-15, which reflects the marginal effects on the transition probability from direct exports to exporting via an intermediary, I varied the two continuous variables (number of employees and years since target market entry) in a similar manner. Specification 2 shows the marginal effects, setting the two continuous variables to their mean at the time of the first survey, whereas in Model 3, these variables take the value of the mean at the time of the second survey. All other independent variables were set to their overall mean.

The two industry dummy variables have the highest marginal effects on the probability of a change from direct exports to exporting via an intermediary.[115] The second most important marginal effect comes from the dummy variable indicating a consumer good, followed by the dummy reflecting a short window of opportunity and the dummy indicating intense product customisation. As already mentioned, the marginal effect of the interaction term between the rank of country risk and permanent R&D activities is rather small. It only increases the transition probability by about one percentage point. The order of the marginal effects on the probability of switching from exporting via an intermediary to direct exports is similar. Neglecting the influence of the years since target market entry, the highest marginal effect is attributed to the dummy variable indicating that the firm's service is primarily sold to other companies as a business service, followed by the dummy reflecting the firm managers' international experience and the dummy for the engineering sector

114 The annualised employment growth rate in the period from 1997 to 2002 of our sample's exporters amounts to 7.7 percent (see section 5.3).

115 The marginal effect for a dummy variable is the discrete change of the dummy variable from 0 to 1.

(see Model 2 in Table 4-16).[116] The marginal effects of the remaining independent variables that had a significant coefficient increase the probability of a transition to direct exports by between seven and ten percentages points in Specification 2.

The strongest predictors in the transition equations are the dummy variables controlling for unobserved industry-specific factors and those indicating a typical customer of the firms' products or services. Thus, the choice of sales modes is, to a relatively large degree, determined by strategic and structural influences that are not observed by the two surveys this study is based on. Moreover, traditional distribution channels exist for certain kinds of products. For example, a consumer good is traditionally sold via an intermediary, regardless of the context. Hence, the high explanatory power of the dummy indicating a typical customer might reflect embedded routines and experiences the firm has in supplying such a typical customer, e.g., when distributing its product in the domestic market.[117] On the other hand, variables that are intended to measure transaction cost-specific assets (e.g., product customisation) or the firm's (intangible) resources are of minor importance. Nevertheless, the variables derived from the theoretical literature must not be neglected when explaining changes of sales modes – at least not for a transition from exporting via an intermediary to direct exports during a later stage of a firm's international engagement. When a young high-tech firm starts exporting to a foreign target market, it might suffer from the liability of alienness and might therefore make the strategic choice to sell its product via an intermediary, even if this is not optimal from the organisational capability perspective or from a transaction cost point of view. After becoming established in the foreign country, the exporter is no longer forced to use an intermediary. In this case, transaction cost-specific assets or the firm's (intangible) resources gain in importance so that the dummy variable indicating a novel, self-developed technology becomes a good predictor for a transition from an intermediary to direct exports.

In the logit model explaining the determinants of a transition from direct exports to exporting via an intermediary, McFadden's R^2 reaches a value of 0.355; in the logit model examining a reverse transition, McFadden's R^2 is 0.419. Hence, the empirical model fits well with the data. It should be noted, however, that in the logit model for a transition from exporting directly to exports via an

116 In Table 4-16, the marginal effects for Model 3 are generally higher than for Model 2. Of course, the marginal effect of the dummy variable indicating novel and self-developed technology is the same in the two specifications since the only difference between the two models is that the latter dummy variable is set to 1 in Model 3.

117 The first survey also contains information about the dominant sales mode used in the domestic market, i.e., whether the firm's product is primarily sold via distributors or by direct sales from headquarters. Bürgel and Murray (2000) included this information when estimating a probit model of the choice on mode of entry into a foreign market made by the UK-based firms in our sample. They found out that the domestic sales mode is the strongest predictor of the chosen foreign entry mode. This finding stresses the importance of firm-specific routines.

intermediary the independent variables are jointly significant only at the 5 % level according to a Wald test against the constant-only model. Although this result should not cause any concern from a statistical point of view, it shows that the influence of random effects on the probability of a transition from direct exports to exports via an intermediary is still relatively important. This might be due to the fact that for some firms, entering the foreign market by direct exports was a result of an unsolicited, i.e. random, order from abroad. For these firms the sales modes used in period *t*-1 are not a consequence of the firms' strategic decisions but of random events. Under these circumstances, it is difficult to predict a transition from direct exports to another sales mode based on the (changing) independent variables included in the regression equation.

4.4.5 Conclusion

As the third dimension of our sample's firms' international engagement, the objective of this section is to investigate the change of sales modes in foreign markets on the part of German and UK exporters. The two most frequently used sales modes were direct exports and exporting via an intermediary. Even in 2003, when our sample's exporters had been engaged in their most important target markets for an average of 9 years, more resource-intensive sales modes like sales subsidiaries or even FDI were still of minor importance. Therefore, I decided to examine changes between the two distinct modes of exporting. Descriptive analyses reveal that just under 16 % of exporters that sold their products directly to their foreign customers in the previous period switched to exporting via an intermediary. A sales mode change in this direction was observed (not exclusively but) primarily in the period between target market entry and the first survey, i.e., during an early stage of the firms' export activities. On the other hand, a change in the reverse direction took place primarily in a later stage of the firms' international engagement. Just under 10 % of those firms that exported via an intermediary in the previous period changed to direct exports. Thus, we observe a high persistence in the sales modes used over time, probably because of the existence of sunk costs or because of binding contracts an exporter made with its foreign distributors or customers.

The only theory that derived a time-dependent order of sales modes, the internationalisation process model, is not suitable for explaining the behaviour of young firms in high-tech sectors. The descriptive result that firms change from direct exports to exporting via an intermediary during an early stage of their international engagement and that a transition in the other direction is observed during a later stage already contradicts the notion of the process model that an exporter gradually increases its commitment in a foreign market, regardless of which sales mode is considered as the more resource-intensive commitment. Further, the percentage of firms that use resource-intensive

sales modes like sales subsidiaries is still relatively small, leaving almost no evidence that firms incrementally raise their commitment of resources.

Instead, the econometric analysis confirms that the transaction-cost theory and the resource-based view of the firm (and the organisational capability perspective which is based on the latter theory) are both relevant for explaining the probability of switching from one sales mode to another. Alternatively, Dunning's eclectic paradigm turned out to be a useful framework for investigating sales mode changes – apart from the fact that we do not find evidence for the relevance of locational advantages. Nevertheless, ownership advantages (e.g., the firm's physical, financial, and intangible assets) and internalisation advantages (e.g., transaction-specific assets like the requirement of intense product customisation) are decisive for selecting the optimal sales mode, especially for predicting a sales mode change from exporting via an intermediary to direct exports. This is an important result since most existing empirical studies examine either the choice of entry mode (i.e., the first sales mode used in a foreign market) or the selection of the sales mode used by a firm at a particular point in time. This study proves that those theories, which are already known to be able to account for the choice of entry modes, are also appropriate for explaining changes of sales modes, or in other words, a sequence of sales modes observed over a longer time period. The main managerial implication of this section's analyses is that from a transaction-cost reasoning and an organisational capability perspective, an exporter of a high-tech product which incorporates highly sophisticated technologies should use an integrated sales mode, that is, in the case of a young and small high-tech firm, direct exporting.

However, especially during an early stage of a high-tech firm's international engagement there are strategic and structural influences that might dominate the impact of the exporter's (intangible) resources or its transaction-specific assets. Due to the liability of alienness, an exporter might be forced to use an intermediary to sell its products abroad since foreign customers might not trust a young and small firm that is even not established in its domestic market. In this case, the reputation of an established foreign distributor or agent might be a way of gaining indirect legitimacy. After becoming established in the foreign market, the domestic high-tech firm might be able to refrain from using a foreign distributor and decide on its sales mode based on its intangible and transaction-specific assets.[118] Moreover, the transaction-cost reasoning and the OC perspective

[118] Bürgel and Murray (2000) further argued that accepting the product of a young innovative firm might not be attractive from the foreign distributor's point of view either. The distributor also has to invest, for instance, in specialised training of his sales personnel, although the return of this investment is highly uncertain. Thus, the distributor has to be paid to bear this risk, which makes exporting via an intermediary quite expensive for a small high-tech firm. If it is nonetheless forced to use an intermediary in the foreign market due to the liability of alienness, it will be interested in switching to direct exports as early as possible.

might be dominated by the existence of traditional distribution channels. Consumer goods, for example, are traditionally distributed via intermediaries. Of course, these traditional sales modes might change over time. The growing importance of e-commerce for distributing software and other digital products might induce software firms to change to direct exports via the Internet. Our results are consistent with this interpretation. Finally, this section's empirical results show that there are unobserved industry-specific effects which are actually the best predictors in our model. Therefore, in order to explain the selection of sales modes by young high-tech firms, the theories usually applied are useful but not sufficient. Firms might deviate from the sales mode choice predicted by existing theories. Future research should pay more attention to these strategic constraints a young high-tech firm has to consider in order to better understand a chosen sequence of sales modes.