

Bürgel, Oliver; Fier, Andreas; Licht, Georg; Murray, Gordon; Nerlinger, Eric A.

## Working Paper

# The internationalisation of British and German start-up companies in high-technology industries

ZEW Discussion Papers, No. 98-34

## Provided in Cooperation with:

ZEW - Leibniz Centre for European Economic Research

*Suggested Citation:* Bürgel, Oliver; Fier, Andreas; Licht, Georg; Murray, Gordon; Nerlinger, Eric A. (1998) : The internationalisation of British and German start-up companies in high-technology industries, ZEW Discussion Papers, No. 98-34, Zentrum für Europäische Wirtschaftsforschung (ZEW), Mannheim

This Version is available at:

<https://hdl.handle.net/10419/24279>

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Discussion Paper No. 98-34

**The Internationalisation of British and  
German Start-Up Companies  
in High-Technology Industries**

Oliver Bürgel, Andreas Fier, Georg Licht,  
Gordon Murray, Eric Nerlinger



## **Non-technical Summary**

During recent years, analyses of new technology-based firms (NTBFs) attracted growing interest from academics and politicians. NTBFs are regarded as an important source for new employment and important promoter of technological change and innovation in almost all European countries. However, only a minority of these firms fulfil the expectations and hopes. Only few NTBFs grow to large firms and the majority of them stays small.

Due to the limited size of the national markets, fast international activities are often the only way to pay off the cost-intensive investments for new technologies and innovations. The paper at hand is part of a joint research project carried out by the ZEW and Warwick Business School (UK), aiming to give new insights in the process of internationalisation of NTBFs in UK and Germany.

The results show that the majority of UK and German NTBFs are already active on international markets shortly after start-up. These international activities range from exporting and co-operative arrangements like joint-ventures and licensing to foreign direct investment. Hereby, comparisons between the firms and the two countries indicate significant differences. For some firms it seems to be easy to enter new markets abroad rapidly whereas others either have no international orientation or are gradually beginning to enter international markets. The comparison of firms with international activities and firms that are limited to their national markets show significant differences with respect to firm-, founder as well as product-specific characteristics. Firms with activities abroad are in average older, carry out R&D in a more regular way and achieve comparative advantages by technology-based product or process differentiation. Moreover, founders of internationalised firms can be characterised by above average work experience abroad or in multinational large firms. Products and/or processes which are only sold on national markets are more client-specific and involve higher adjustment costs compared to internationally distributed products/processes.

## **Zusammenfassung**

Technologieorientierte Unternehmensgründungen zählen vielfach zu den Hoffnungsträgern bei der Bewältigung des Strukturwandels und besitzen in fast allen europäischen Ländern eine wachsende Bedeutung. Einige wenige dieser Firmen sind zu großen, etablierten Unternehmen herangewachsen. Aufgrund der - im Vergleich zu den USA - kleinen nationalen Heimatmärkte ist die schnelle internationale Expansion häufig die einzige Möglichkeit, die hohen Investitionen in neue Technologien kurzfristig zu amortisieren. Da aber selbst nach der Europäischen Währungsunion von einheitlichen europäischen Gütermärkten nicht gesprochen werden kann, ist der Schritt auf Exportmärkte – selbst ins europäische Ausland – mit besonderen Risiken verbunden. Die vorliegende Analyse ist Teil einer in Zusammenarbeit mit der Warwick Business School (Großbritannien) durchgeführten Untersuchung, die zu einem besseren Verständnis des Internationalisierungsprozesses technologieorientierter Unternehmensgründungen in Großbritannien und Deutschland beitragen soll.

Die Ergebnisse zeigen, daß sowohl in Großbritannien als auch in Deutschland die Mehrheit der analysierten jungen Unternehmen bereits in den ersten Lebensjahren auf Auslandsmärkten aktiv sind, angefangen vom Verkauf über Zwischenhändler bis hin zu eigenen Auslandsniederlassungen. Vergleiche zwischen den Unternehmen und Ländern lassen dabei allerdings erhebliche Unterschiede erkennen. Einigen Unternehmen scheint es weitaus leichter zu gelingen, schnell auf internationalen Märkten Fuß zu fassen während andere Unternehmen entweder gar nicht oder erst allmählich beginnen, Märkte im Ausland mit ihren Produkten und/oder Prozessen zu bedienen. Der Vergleich zwischen Unternehmen, die auf den nationalen Markt beschränkt sind, und international tätigen Unternehmen läßt deutliche Unterschiede hinsichtlich unternehmens-, gründer- sowie produktspezifischer Merkmale erkennen. Unternehmen mit Auslandsaktivitäten sind im Durchschnitt älter, führen regelmäßig Forschungs- und Entwicklungsaktivitäten durch und suchen Marktvorteile durch technologiegestützte Produktdifferenzierungen. Gleichzeitig verfügen die Gründer international tätiger Unternehmen weitaus häufiger über Arbeitserfahrungen im Ausland oder in international tätigen Großunternehmen. In Bezug auf die Produkte und Prozesse ist zu erkennen, daß diese bei auf die nationalen Märkte ausgerichteten technologieorientierten Unternehmensgründungen kundenspezifischer sind und mit einem höheren individuellen Anpassungsaufwand verbunden sind als dies bei international vertriebenen Produkte der Fall ist.

# The Internationalisation of British and German Start-Up Companies in High-Technology Industries

**Oliver Bürgel, Gordon Murray**  
University of Warwick

**Andreas Fier, Georg Licht, Eric Nerlinger**  
Centre for European Economic Research

**Abstract:** Established theories in international business come to different conclusions when specifically applied to the analysis of the international activities of start-up companies in high-technology industries. Using a new dataset of 495 British and German start-ups operating in high-technology industries, we analyse the differences between those companies that have built up international activities and those which only compete in their home country. Our findings suggest that the key discriminatory variables are: age, the extent to which the product requires customisation, regularity of R&D activities, and the international professional experience of the founders. These findings suggest that internationalisation of New Technology Based Firms is best explained by adopting elements from a number of different theoretical frameworks.

**Keywords:** start-ups, high-technology industries, internationalisation

**JEL Class:** L 21, L60, F 23

**Acknowledgements** Financial support from the Anglo-German Foundation for the Study of Industrial Society, Apax Partners & Co. Ventures Ltd. and the Department of Trade & Industry (UK government) is gratefully acknowledged. The authors would also like to recognise the valuable contribution of Ralph Buntrock, Susanne Herrmann and Claudia Müller in preparing the data for the analysis and the critical comments from Matthias Almus on the econometric method. All errors of fact and/or omission remain solely the responsibility of the named authors.



# **1 Introduction**

In recent years, researchers have started to investigate the processes by which young, high-technology companies have internationalised. Observations that these firms engage in cross-border activities from a very early stage of their existence represent an interesting challenge for the established body of theory in the area of international business. Research activity in the latter area has historically been strongly oriented towards large firms or 'traditional' smaller firms. Previous enquiries that focused explicitly on start-up companies have largely been of an exploratory nature (MacDougall, Shane and Oviatt, 1994; Murray, 1996; Boter and Holmqvist, 1996). Furthermore, on the theoretical side, one can observe the conflicting prescriptions for young, high technology companies from behavioural and economic theories which have been based on the observations of either large or traditional small firms. Therefore, it is open to debate whether existing theories on internationalisation allow robust descriptions of high tech start-ups in their early years.

The primary purpose of this paper is to test these theoretical underpinnings with data from a fairly large sample of New Technology Based Firms (NTBFs) in Germany and UK. This paper will present the first preliminary findings of an Anglo-German research project, currently still in progress, which aims at a detailed investigation into the determinants of cross-border activities of technology-based start-ups. In the next section, we review the existing theoretical literature on the internationalisation of small firms. A summary is provided of existing empirical studies. Section 3 presents our testable hypotheses which are derived from the literature. We introduce our methodology, the survey and the analytical tools in section 4. Section 5 presents the empirical results. We demonstrate that our contemporary sample of 495 British and German start-ups operating in technology intensive industries is comparable between countries. Furthermore, we present and discuss statistical tests in order to highlight significant differences between firms with international activities and firms that have a purely domestic focus. Finally, section 6 contains our conclusions and indicates an agenda for further research.

## **2 Literature Review**

### **2.1 Theories of International Business**

The dominant theories in the field of international business can be divided into: i) behavioural theories and ii) theories that use concepts in the field of economics (see Welch and Luostarinen, 1988; Cantwell, 1991; Oviatt and McDougall, 1994 for a review of theories relevant to international entrepreneurship). Behavioural theories of international business embrace internationalisation process models including stage models (Johanson and Vahlne, 1977; Cavusgil, 1980) and network theories



(Johanson and Mattson, 1990). Economics-based theories include monopolistic advantage theory (Hymer, 1976), internalisation/transaction cost theory (Buckley and Casson, 1976) and oligopolistic behaviour theories (Knickerbocker, 1973). In addition, there are summary frameworks of broader relevance such as Dunning's OLI framework (Dunning, 1980) and the export management literature (see Leonidou and Katsikeas, 1996 for an overview). For the purpose of explaining the case of international entrepreneurship, monopolistic advantage, transaction cost and internationalisation process models will be observed more closely in this paper.<sup>1</sup>

Internationalisation process models concentrate on the managerial aspects of internationalisation. Timing of market entry, the structural forms of foreign operations and their evolution over time are seen as functions of the increasing commitment of managers to foreign markets. The mechanism behind this growing commitment involves a learning process. Monopolistic advantage and internalisation theories, conversely, originally tries to explain why multinational corporations exist as institutional forms for organising international production. As these separate theories look at different aspects of internationalisation and try to answer different questions, it is difficult to make direct comparisons. However, by arguing that different entry modes are substitutes, with each having a commercialisation objective, elements of both theories can be employed to make prescriptions concerning the structural forms of international activities. By comparing the implications of these behavioural and economic theories, an interesting (and contradictory) picture emerges when the firms in question are *both young and* operate in high-technology sectors.

*Internationalisation process models* see internationalisation as an incremental process. The commitment of resources grows over time as experience and knowledge of foreign markets increase (Johanson and Vahlne, 1990). According to this school of thought, the degree of internationalisation is a function of the age of the firm, its experience of international activities, and the size of the firm. The latter is seen as a proxy for available resources. A firm which is small and young is initially not expected to compete abroad because of the higher costs of cross-border activities relative to exclusively domestic sales.

In *internalisation theory*, the decision to internationalise is taken as given. Because its core, transaction cost theory, explicitly aims to compare the efficiency of

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<sup>1</sup> Oligopolistic behaviour looks at industries which are dominated by a few large firms and tries to explain internationalisation as a result of the competitive moves of rivals that are aware of each others' actions. The normative contribution of network theories is uncertain as they fail to explain why firms that are not part of a network also internationalise. Dunning's OLI framework incorporates elements of monopolistic advantage, internalisation and international trade theory. According to the author, it should not be considered as a theory, but rather framework or paradigm for explanation.

particular governance modes (Williamson 1985), its main application to the field of international business is concerned with the choice of the optimal market entry modes and not with the decision to compete abroad *per se*. According to this perspective, firms build up facilities abroad when the costs associated with arms-length transactions in the market place, for example exporting, are higher than the costs associated with internal transactions (Buckley and Casson; 1976; Hennart, 1989). It has been argued that this situation occurs in the case of high-technology industries. In these industries, significant information asymmetries can exist between buyers and sellers. Other peculiar characteristics of firms in high technology industries can include: the performance of a product may only be appraisable once it has been used; substantial costs in training and monitoring sales intermediaries may exist; and firms often have to build up a more permanent presence abroad in order to gain legitimacy among their customers (Teece, 1986; Meldrum, 1995). If these conditions apply, firms that have decided to compete in foreign markets are consequentially expected to carry out international activities using resource-intensive entry modes. This applies to all firms, irrespectively of age and size.

*Monopolistic advantage* theory might represent a useful platform to reconcile process models and internalisation theory. This theory holds that a firm can generate higher rents from the utilisation of firm specific assets which cannot be replicated by other firms (Hymer, 1976). The rents that stem from this quasi-monopoly can then be used to offset the higher costs of competing abroad. However, one can argue that this theory has been misnamed. The term "monopolistic rents" suggests that multinational firms achieve above-average returns by restricting their output and creating an exploitable scarcity. This may not be an adequate picture of reality as international firms frequently create and supply new product markets in target countries where none existed before (Buckley, 1989). Given that Hymer did not associate any social costs with the increase of choice brought about by multinationals, these rents are probably best described as "Ricardian rents" which are defined as returns in excess of their opportunity costs. That interpretation would make monopolistic advantage a predecessor of the resource-based view of the firm (Wernerfelt, 1984; Dierickx and Cool, 1989; Peteraf, 1993). International activities would then be determined by the resources and capabilities that a firm possesses and that allow it to overcome the initial costs of competing in foreign environments. Internationalisation would then be a function of resources, knowledge and capabilities and *not* primarily determined by age, size or transaction costs.

One can conclude that different theories lead to conflicting prescriptions when the firms in question are simultaneously young and operating in high-technology industries. On the one hand, according to internationalisation process theory, start-ups are not expected to engage in international activities. Yet, if they do so, they are expected to chose entry modes which require few resources. Conversely, internationalisation theory takes the decision to internationalise as given and expects

that firms operating in high-tech industries would choose more resource intensive entry modes. A resource-based perspective could provide a bridge between these two arguments and link the decision to internationalise and the chosen entry modes to the resource endowments of firms. A comparison between internationalisers and non-internationalisers could therefore help uncover which of these perspectives contribute most to the internationalisation decision.

## **2.2 Empirical Evidence on International Entrepreneurship**

Empirical studies in the field of entrepreneurship have been both exploratory and explanatory in nature. While some have an explicit focus on international business theories, others have focused on more general performance issues. Qualitative studies highlighted the phenomenon and reported behaviour different from other firms. The emphasis here has been on product characteristics (Jolly, Alahuhta and Jeannet, 1992; Murray, 1996; Roberts and Senturia, 1996), market entry forms (Jolly, Alahuhta and Jeannet, 1993; McDougall, Shane and Oviatt, 1994; Roberts and Senturia, 1996), characteristics of founders and key employees (McDougall, Shane and Oviatt, 1994; Boter and Holmquist, 1996; Murray, 1996; Roberts and Senturia, 1996). The quantitative studies surveyed by the authors analyse structural characteristics of the firms, such as age, size and technology intensity (Lindqvist, 1991; Lindell and Karagozoglou, 1997), market entry forms (Lindqvist, 1991; Bell, 1995; Shrader, Oviatt and McDougall, 1997), geographical spread of foreign sales (Bell, 1995; Shrader, Oviatt and McDougall, 1997), the relation between strategic orientation and growth or profitability (McDougall, 1989; McDougall and Oviatt, 1996; Bloodgood, Sapienza and Almeida, 1996; Shrader, Oviatt and McDougall, 1997), product characteristics (Lindell and Karagozoglou, 1997), characteristics of founders and key employees (Bloodgood, Sapienza and Almeida, 1996), and the role of risk in internationalisation decisions (Shrader, Oviatt and McDougall, 1997).

These studies demonstrate a number of common elements. The firms included in the samples of the different studies were predominantly operating in high-technology industries. This suggests that international entrepreneurship is particularly pertinent in high-technology sectors. In addition, the majority of the studies had an explicit focus on young firms.<sup>2</sup> All studies included firms that made bold commitments to international operations during their early years and rapid, resource-intensive market entries into different countries did occur. This is in contrast to previous research looking at the international activities of more traditional SMEs (see Leonidou and Katsikeas, 1996 for a review; Bank of England, 1998).

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<sup>2</sup> Note that some studies, while claiming to analyse young firms, also included SMEs that were up to 25 years old (Lindqvist, 1991; Lindell and Karagozoglou, 1997; Boter and Holmquist, 1996).

However, with the exception of McDougall (1989) and McDougall and Oviatt (1996), none of the studies used a control group of firms which had not undertaken international sales activity. To advance research on internationalisation and to improve the prescriptive ability of its findings to date, it is necessary to test if those variables which were reported to influence successful internationalisation can also effectively discriminate between non-internationalisers and internationalisers. Without this discriminant effect, the legitimacy and impact of the identified variables affecting internationalisation remains problematic. Using a control group of firms that did not venture abroad therefore provides a more stable empirical foundation to the findings of the studies above.

Our research project will attempt to address this critical issue and test whether or not variables which have been reported to influence rapid internationalisation, choice of market entry modes and share of non-domestic revenues can discriminate between internationalisers and non-internationalisers among small high-tech companies in their early years.

### **3 Research Objective and Hypotheses**

For the purpose of this paper, we will exclude both the analysis of choice of entry modes and related performance issues such as the growth and share of non-domestic revenues. Accordingly, this paper is confined to an analysis of the logical first step, ie. the decision whether or not to internationalise. To this end, firms without international activities and firms that already engage in international activities will be compared. We will test whether or not proxies that represent process models, resource-based approaches or transaction cost arguments can account for the differences between firms with international and purely domestic operations.

The effects of size and age on internationalisation have benefited from much attention by researchers. In accordance with the logic of internationalisation process models, one would expect older and larger firms to be more likely to internationalise because they possess the cumulative resources to overcome the cost and operational barriers of competing abroad (Johanson and Vahlne, 1977, 1990). A number of studies, frequently grouped under the rubric of "stage models", have reported a relationship between age and size on the one hand and the probability to internationalise and allocate increasing resource commitments to foreign markets on the other (Bilkey, 1978; Bilkey and Tesar, 1977; Cavusgil, 1980; Czinkota, 1982). Yet, these studies are frequently criticised for their weak methodological foundations (see Andersen, 1993 for an overview). More recent analyses which looked at large populations of firms merely seem to agree that there is no *negative* relation between internationalisation and firm size (Bonaccorsi, 1992; Calof, 1994). However, at least one author has argued that the variance in the degree of internationalisation which can be explained by size is so small that it can be ignored

for predictive purposes (Calof, 1994). In the specific context of technology-based start-ups, only one study is known to the authors which tried to assess the effects of size and age on internationalisation (Lindqvist, 1991). The fact that neither size nor age of the firm appeared significantly related to the degree of internationalisation performance in this Swedish study suggests that internationalisation may be best understood as 'jumping a threshold'. Once the threshold is overcome, the marginal effects of these variables on internationalisation may well decrease. However, the absence of a control group in Lindqvist's study weakens her findings. Accordingly, in the present study, size and age variables will be tested as a first step in order to ascertain whether or not they allow any discrimination between internationalisers and non-internationalisers.

H1: Start-ups with international activities are larger than start-ups without international activities.

H2: Start-ups with international activities are older than start-ups without international activities.

A key variable associated with international start-up companies has been the experience of top managers. Yet, while being intuitively convincing, empirical findings have remained inconclusive. In the case of multinational firms, Kogut (1989) argues that competitive advantage stems from the efficient organisation of the transfer of knowledge and resource between dispersed country operations. Following this argument, Roth (1995) reported that the experience of managers living abroad had a significant effect on performance in firms with a high degree of international interdependence. However, another finding of the same study was that experience in managing international activities did not have a significant influence on firm performance. Studies that looked at international entrepreneurship more specifically also reported similar findings. McDougall, Shane and Oviatt (1994) observe that the founders of the firms in their sample of international new ventures were characterised by first-hand experience of foreign factor and product markets. Accordingly, they concluded that 'alertness' to business opportunities abroad was a vital precondition for the formation of international new ventures. In contrast, Roberts and Senturia (1996) report that none of the top managers of the firms in their sample had direct international experience from having lived abroad. Still, a majority in their sample had previous work experience in US companies with international activities. Bloodgood, Sapienza and Almeida (1996) found that international work experience was positively related to internationalisation activity whereas international schooling was not. In the light of these several findings, the following hypotheses were constructed:

H3: Start-ups are more likely to have international activities, if their founders have

- a) worked abroad
- b) worked in the UK/Germany for companies with international activities
- c) been educated abroad

It has become popular to argue that, because of spiralling costs for research and development, competitive rivalry and shortening life cycles for high-technology products, firms operating in high-technology sectors cannot exclusively rely on domestic markets (Oakey, Rothwell and Cooper, 1988; Ohmae, 1990). Empirical investigations has provided confirmatory evidence for this trend. Kobrin (1991) found that technological intensity (expressed as a ratio of R&D expenditures to sales revenue) was the most important structural determinant of globalisation in the industries which he studied. At the firm level, several authors reported that, higher R&D intensity lead to higher propensity to export (Cooper and Kleinschmidt, 1985). Contrasting these findings, Lindqvist reported that, in her study of Swedish new technology based firms, higher R&D intensity was not related to higher degrees of internationalisation in terms of speed of first market entry, resource-intensity of entry modes, geographical sequence, or degree of international sales (Lindqvist, 1991). Furthermore, Fujita (1995) provides evidence that many small high-tech firms did not internationalise due to competitive pressures in their domestic market. However, we agree with those authors (see for example Roberts, 1991; McDougall and Oviatt, 1996) who argue that, in the case of high-technology start-ups frequently operating in specialised niches, sales to a domestic market may not generate the cash-flows required to recover the initial expenditures or to finance the development of next generation products or upgrades. In summary, we formulate our forth hypothesis as follows:

H4: Internationalisers will be characterised by higher intensities in research and development activity than non-internationalisers.

Besides firm-specific factors, we argue that the characteristics of their products are also believed to influence whether or not firms will engage in international sales. Yet, there appears to be little empirical evidence in the field of international business regarding the impact of product characteristics on internationalisation performance (Douglas and Craig, 1992; Cavusgil and Kirpalani, 1993). We will first look at the innovativeness of the products in question and then at characteristics that impact on the transaction costs associated with the internationalisation of these products.

Firms which introduced technological innovations internationalised later but were subsequently quicker at entering overseas markets (Lindqvist, 1991). This finding contradicts other research which argues that a majority of firms which internationalised had based their strategies on the development of incrementally new products, and that only a minority of internationalisers developed new technologies (Lindell and Karagozolu, 1997).

H5: The technology embedded in the products and services of internationalisers will be more innovative than the products and services of non-internationalisers.

An important impediment to internationalisation can lie in the scale of transaction costs associated with cross-border commercialisation. Transaction costs which

impact on the commercialisation of high-technology products can arise for many reasons including detailed consultations prior to sale, installation costs, maintenance and after sales activity, and training of sales and front-end personnel (Moriarty and Kosnik, 1989; Beard and Easingwood, 1996; Meldrum, 1995). For a small firm, these costs can represent an important barrier to internationalisation (Morgan and Katsikeas, 1997).

H6: The commercialisation of internationalisers' products will be less transaction cost-intensive than the commercialisation of non-internationalisers' products.

We would also expect that expenses for marketing and commercialisation will represent a higher proportion of a product's value if the product in question is a consumer good or a product that is sold directly to the end-user.

H7: Compared to non-internationalisers, the products of internationalisers are more likely to be investment goods or components rather than consumer goods or products sold to end-users.

In summary, we can provide a broad categorisation of the hypotheses presented here to establish a link to the international business theories mentioned above. Both size and age are variables that have been used previously in empirical studies to operationalise the propositions of internationalisation process and stage theories (see Welch and Luostarinen, 1988 for a review). A resource-based perspective can be associated with variables describing top management team's international experiences (Roth, 1995; McDougall, Shane and Oviatt, 1994), and R&D intensity (Dierickx and Cool, 1989; Mahoney, 1992). Sustained investment in research and development can result in the building up of heterogeneous resources (eg. specialised human resources) and capabilities embodied in a firm's end-products which are able to generating rents to offset the additional costs arising from cross-border operations. Product characteristics that impact on commercialisation can be linked with transaction cost arguments.<sup>3</sup> We will now test which, if any, of these variables can effectively discriminate between internationalisers and non-internationalisers.

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<sup>3</sup> However, we would like to make clear that a test concerned with the ability of these cost variables to discriminate between internationalisers and non-internationalisers is not a test of transaction cost theory. The latter is explicitly aims at comparing the efficiency of particular governance modes, or market entry modes in an international setting, but treats the decision to internationalise as given.

## 4 Method

The majority of existing analyses on the internationalisation of firms are based on case studies and/or surveys employing samples with only a small number of firms. One important aim of this study is to analyse the determinants of internationalisation with a relatively large sample of firms utilising a comparable basis of selection in both Germany and the UK. Moreover, tests of the hypotheses presented above are arguably more reliable when we use data of firms with different national backgrounds. Given the existing differences in the trade patterns of the UK and Germany as well as differences in their technological infrastructures and educational systems, combining data from both countries will offer the opportunity to partial out the effects which are probably correlated with firm's behaviour towards international high-tech markets. By using a multivariate approach, we can address the question of whether the theoretical approaches are complementary or competing in nature.

For the purpose of this study, a high-tech start-up is defined as being a legally independent company which is no older than ten years and which operates in one or more high-technology sectors. An operationalised definition of high-technology sectors in the UK has been established by Butchart (1987). He provides a definition of high-tech industries based on the two ratios of i) R&D expenses to sales and ii) employees working in R&D to total employees. We acknowledge that this method can not consider high-tech firms in industries that are not included by the Butchart definition. Yet, as opposed to targeting low-technology sectors in the search for high-technology start-ups, the proposed approach results in an increased likelihood of obtaining responses from firms that fulfil the specified sampling criteria.

### 4.1 Some observations on the survey process

#### „UK“

On the basis of the above definition of high-technology industries, 17 four-digit NACE codes were identified as having above average expenditures for research and development. Using a database obtained from Dun and Bradstreet, firms operating in those industries, which had at least three employees in 1997, and that had been founded between, 1987 and, 1996 were identified. This resulted in a gross sample of 7,788 firms. All identified company records were subsequently screened to exclude those firms whose business activities suggested that they were not carrying out any research and development activities (eg. retailers, wholesalers and assemblers). As a result, 2,671 firms were retained as eligible for inclusion in the research sample.<sup>4</sup>

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<sup>4</sup> This sharp reduction of the number of eligible firms can be attributed to the service sector. This is because of the fact that the chosen service NACE codes (telecommunications services and software) only allow for a crude classification of relatively new industries such as software.



2,000 firms were then chosen using a stratified random sampling process (ie. stratified by size class and service/manufacturing categorisation).

Based on a review of the specialised literature, a four page questionnaire was developed. Six pilot case studies were carried out to test whether or not the questions in the survey instrument were valid, easy to understand and unambiguous to the target respondents. As a result, the questionnaire was modified to take into account any expressed concerns. An introductory letter and questionnaire, followed by three reminders where appropriate, was sent to the managing directors of these 2,000 firms. 134 envelopes came back unopened from companies which could no longer be located at their address in the database. 9 companies wrote back saying they were in the process of receivership. 61 firms contacted the researchers and indicated that they wished not to participate in the survey. This resulted in 416 firms sending back completed questionnaires. After consistency checks to confirm that the firms each fulfilled all the criteria for eligibility (ie. less than ten years old and founded as independent new firms), 308 firms could be retained in the dataset (see Table 1).

### *„Germany“*

The German data originates from „CREDITREFORM e.V.“, the largest German credit rating agency. Since the beginning of 1989, CREDITREFORM has been supplying data on start-ups in West Germany and all firms established in East Germany to the Centre for European Economic Research (ZEW), in order to build up the ZEW-Foundation Panel (East/West). In this study, we use a source data set which contains company-level information on about 500,000 firms founded in West-Germany and 600,000 firms founded in East-Germany between January 1987 and December 1996. Using the Butchart definition, 31 five-digit branches of industry codes ("WZ-Codes") have been identified which correspond to the 17 four-digit NACE codes of the UK dataset. In these industries, 26,433 firms (West Germany: 19,125; East Germany: 7,308) have been identified. The company records have then been screened according to the identical procedure used on the UK data set in order to exclude companies that are exclusively involved in retail, wholesale and assembly. In addition, firms identified as being former East-German establishments were also excluded from the dataset. As a result, 5,045 firms were retained as eligible for inclusion in the research sample.

From these 5,045 firms, we choose 2,000 firms again using the same stratified random sampling procedure as for the UK. A questionnaire and two reminders were sent to the selected firms. In Germany, 19 envelopes came back unopened, 16 companies could not be located at their address. 8 firms contacted the researchers indicating that they did not wish to participate in the survey and 5 envelopes came back without any information. This resulted in 236 firms sending back completed questionnaires. After several consistency checks performed on the data, 187 German firms could be retained in the dataset (see Table 1).

**Table 1: Description of Range of UK and German Questionnaire Responses**

Description	UK		Germany	
	Number of cases		Number of cases	
	Abs.	rel. (%)	Abs.	rel. (%)
Usable Questionnaires	308	15.4	187	10.4
Answering only the first questions and then breaking-off	25	1.3	15	0.7
Refusal, questionnaire sent back	27	1.3	9	0.4
Refusal by mail or telephone	34	1.7	5	0.2
Firm does not belong to the target population	83	4.2	32	0.1
Firm not known at the address or Firm moved, address unknown	134	6.7	19	0.9
Firm failed, does not longer exist or is in receivership	9	0.4	2	0.1
No response at all	1380	69.0	1,803	87.1
Total	2,000	100	2,074*	100

\* 74 firms in the second mailing were not involved in the first mailing.

## 4.2 Choice of Analysis Methods

Our empirical analysis consists of three steps. We first analyse whether or not our sample of respondents is comparable between the UK and Germany. Secondly, we present some bivariate, descriptive statistics comparing firms with and without cross border activities. We argue that our sample accurately represents a population of high-tech start-ups. Finally, if one adopts the view that the hypotheses presented in the previous sections are representative of theories which are not competitive in explaining internationalisation decision but are complementary in nature, it seems to be a more appropriate approach to evaluate these effects within a unifying empirical framework. This approach is believed to be preferable to appraising a series of bivariate measures of association between various factors and the degree of internationalisation or the decision to go for international markets. The selected multivariate method is discussed in more detail in the following paragraphs.

The decision to, or not to, internationalise can be modelled using a binary choice model (see e.g. Greene 1993, pp. 635) where international sales ( $y$ ) corresponds to 1 and no international sales corresponds to 0. There is a set of factors, such as age, size of the firm, R&D intensity, product characteristics, and so on, which summarised in a vector  $x$  explain this decision. We are interested in estimating the parameter vector  $\beta$  which reflects the impact of  $x$  on  $y$ . The binary choice model we will examine is therefore given by:

$$\text{Prob}(y = 1|x) = \int_0^{\beta'x} \phi(t)dt = \Phi(\beta'x)$$

where  $\phi$  is density function of the standard normal distribution and  $\Phi$  represents the cumulated density function. This is the so called ‘probit model’. Estimation of the model is based on the maximum likelihood method. We treat all firms as a single draw from a Bernoulli distribution. We assume that all  $n$  observations in our sample are independent of each other which leads to the likelihood function ( $L$ ) of the probit model being given by:

$$L = \prod_i^n [F(\beta'x_i)]^{y_i} [F(\beta'x_i)]^{1-y_i}$$

The estimated asymptotic covariance matrix of  $\beta$  can be used to infer whether the estimated values of  $\beta$  are significantly different from zero. This corresponds to the usual t-tests. To test for the effect whether or not a subset of coefficients are zero, we can use either use likelihood ratio tests or Wald tests (see e.g. Greene 1993).

The interpretation of our results is based on the marginal effects of a change in an element of the vector  $x$  on the probability of internationalising. In case of the continuous variables (for example age), the marginal effect is given as

$$\frac{\partial E[y|x]}{\partial x} = \phi(\beta'x_i)\beta$$

It is obvious from this formula that the values of the marginal change in the expected probability depend on the values of  $x$ . We follow the usual procedure and evaluate  $x$  at the mean of the exogenous variables. In those cases where the element of  $x$  we are interested in is a dummy variable (e.g. international experience), we report the change in the expected probability of internationalisation when we change this variable from 0 to 1, vice versa.

### 4.3 Operationalisation of Variables

We used the number of employees during the first financial year to operationalise ‘size’. We did not use current size, because it could be an endogenous variable, ie. a result of the internationalisation activity and therefore likely to be influenced by the explanatory variables below. We then grouped companies into five different size classes ranging from 1-2 employees, 3-5 employees, 6-9 employees, 10-19 employees, and 20 and more employees. International experience was operationalised by asking respondents to indicate whether or not they had lived abroad, worked for an internationally operating company in the UK and/or were educated abroad.

In accordance with widespread practice (Butchart, 1987; see Koberg, Rosse and Bergh, 1994 for a review; OECD 1997) we operationalised R&D intensity using two measures. First, we asked respondents to indicate the expenditures for research and

development during their last financial year expressed as a percentage of total annual sales. Due to the problems associated with obtaining accurate company information from the owner/managers of small firms (Brush and Vanderwerf, 1992), we decided to use a second measure of R&D intensity. Respondents were asked to indicate in man-years the totality of employees who worked for at least 50% of their time on the development of new or existing products. We then calculated the ratio of these development employees to the total workforce. Due to the methodological difficulties associated with measuring R&D intensity in small firms (Kleinknecht and Reijnen, 1991; OECD, 1997), we also included a third measure by asking respondents if they carried out research and development activities permanently, occasionally or never.

We chose five dimensions to capture the extent to which the commercialisation of the firms' products is transaction cost intensive (Teece, 1986; Meldrum, 1995). We asked respondents to measure the extent to which a product requires significant technical consultation prior to sales, individual client customisation, installation resources, regular updates and maintenance, and training for sales and front line personnel. In addition, we asked respondents to classify their products as consumer goods, investment goods, components for other goods or products ready to use by end-users. Multiple responses to these questions were possible. Innovativeness of the technology was operationalised using a four-item scale, ranging from „tried and tested combinations of existing technology“, „new combinations of existing technology“, „product incorporates novel technology developed elsewhere“ and „incorporating novel technology specifically developed for this product or service“.

## **5 Results**

### **5.1 Inter-country comparison of the data**

A comparison between German and British start-ups reveals that there are only a few significant differences. The main difference is that the German sample firms had roughly twice as many employees in their first year of operation as their British counterparts. In addition, the British firms in the sample were slightly older than the German firms. On average, the firms in the sample show high levels of expenditure for research and development. R&D expenditures amount to 12% of turnover in Germany and 13% of turnover in the UK. These relatively high values of R&D intensity receive additional confirmation from our alternative measure, the percentage of employees working on the development of new or existing products. In Germany, 22% (UK 23%) of the labour (in man-years) was devoted to development-related activities.

In our sample, the same percentage of British and German firms were engaged in some form of international activity. This percentage is very high. In both countries,

two thirds of the start-ups had some level of international activities. This suggests that international activities are of considerable relevance for NTBFs. However, we should be carefully in relating this large share of firms with cross-border activities to the population of firms. It may well be the case that firms with international activities responded more readily to our survey thereby generating an upward biased estimate of the true share of internationalisers in the NTBF population in the UK and Germany.<sup>5</sup>

**Table 2: Comparison between German and British Start-ups**

Variable	Country		t-Test	
	Germany	UK	Result	No.
Size today (No. of Employees)	19.51	18.95		492
Start-Up Size (No. of Employees)	8.07	4.17	**	482
No. Of Founder	2.34	2.15		487
Age (Years)	5.16	5.73	*	491
Employees working on the development of existing or new products (%)	21.90	23.24		484
R&D-Expenditures (in % of total sales)	12.35	13.19		481
Firms with international activities (%)	66.29	66.20		495

\*\* 1 % Significance Level

\* 5 % Significance Level

For the remainder of this paper we will treat the firms from the two countries as a sample from one population but include a dummy variable for country in the analysis.

## 5.2 Comparisons between Internationalisers and Non-Internationalisers

Table 4 (see Appendix) ignores nationality and shows the differences between the internationalisers and non-internationalisers in our sample. Significant differences in the mean values exist for the variables size, age, R&D expenditure, regularity of R&D activities, customisation, and international experience of the founders. In all cases which were statistically significant, the direction of the differences appears to support the our initial hypotheses. Looking at the bivariate statistics, we find that internationalising firms are larger today as well as in the their first year. More surprisingly, sample firms on average seem to have fairly high growth rates. This is particularly the case for non-internationalising firms. But, as we will show later, the correlation between size and internationalisation is spurious. As can be seen from our correlation table (Table 5), age is correlated with several other relevant variables. Thus, the bivariate correlation between age and internationalisation picks

<sup>5</sup> We will address this issue more carefully in future research.

up the effects of these other variables. Not surprisingly, we find large technological difference between international and non international firms. R&D intensity is higher in international NTBFs. These firms also engage in R&D on a more permanent rather than an irregular basis. Differences between international and non-international firms are also reflected in the innovation process. We find a large share of international firms use in-house capabilities to generate new product and processes. Finally, founder managers' work experience abroad or in an international firm seems to be strongly associated with subsequent internationalisation activity. In contrast, it turns out not to be true that founders' experience of education in foreign countries stimulates international activities.

### 5.3 Estimation and results of the econometric models

To investigate the hypotheses stated above, we examine three different probit models. Model I only considers country, industry, and firm size. In Model II, we include the additional firm characteristics of R&D activities, age of the firm, and characteristics of the founding team. Start-up size drops out of the model as it turns out to be insignificant. Finally, in Model III we add product characteristics to Model II.

Results are illustrated in Table 4. We report marginal effects and test whether each is different from zero. We find R&D, international experience of founders, and industry and product customisation all have a fairly strong impact on the probability of internationalisation. In all three models, this probability is far smaller for firms in the service sector (about 20% less). Given the data from traditional export statistics, this is in line with our *a priori* expectations. Surprisingly, start-up size does not seem to be a significant factor for internationalisation of NTBFs. In none of the models examined do we find significant effects for the firm size dummies. Moreover, the Wald Test confirms that start-up size is not a crucial factor for post entry success in international markets. We therefore reject hypothesis H1. Given that our sample seemed to be comparable between the UK and Germany, we were surprised to find that UK start-ups had a 10% lower probability of engaging in international activities than German start-ups (Model III). As this effect is only uncovered after controlling for firm and firm/product characteristics, this suggests that, in general, British NTBFs are not necessarily less likely to internationalise. Rather, they have initially or develop characteristics which facilitate internationalisation. Still, by taking these characteristics into account, the multivariate approach shows that UK firms *per se* have a higher propensity to stay in their home market.

Both process models and the resource-based approach to international business receive support from our results. The age of the companies (H2) as well as permanent or occasional involvement in R&D activities had a positive impact on internationalisation in all three models. A firm with regular R&D activities had a

33% higher probability of internationalising than a firm which does not carry out any research and development activities (Model III). As R&D activities, R&D expenditures and the number of highly qualified personnel in a company are positively correlated (see Appendix, Table 5), this supports the idea that internationalisation is related to the capabilities and resource-endowments of firms. Moreover, work experience abroad or previous work experience in the UK for an international company by members of the founding team also had a strong impact on internationalisation, and lead to a 20% higher chance of venturing abroad. Education abroad, however, turned out not to be significant. H3 and H4 were therefore both partially supported.

The innovativeness of the technology embedded in the product or service of the firm in question did not have a significant impact on the decision to internationalise in any of the models.<sup>6</sup> This leads us to reject hypothesis H5. Among the five proxies for transaction cost intensity, only substantial product customisation had a significant impact on internationalisation, albeit a strong one.<sup>7</sup> This leads us to reject H6 in its present form. A good that requires substantial client specific customisation results in a 18% lower probability for international sales in our model. Furthermore, internationalisation seems to be more difficult with final goods and consumer products than with investment or intermediate goods. Although the effect of the latter is only significant at the 10%-level, this suggests that the specific marketing activities required by these products represent an additional barrier to international commercialisation. Accordingly, H7 is also rejected in its present form. However, the findings clearly indicate that a number of identified transaction costs have a non-trivial effect on the internationalisation processes of NTBFs. This is an area worthy of further exploration.

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<sup>6</sup> The results are not reported here but are available upon request.

<sup>7</sup> The Wald-Test also rejects the joint influence of the four measures for the extent to which a product requires significant consultation prior to sales, customer specific adaptation, installation resources, regular updates and maintenance, and training for sales and front line personnel on every statistically significant level.

**Table 3: Marginal effects and changes of expected probabilities of exogenous variables on the probability to internationalise (Probit Model)**

	Model I	Model II	Model III
Industry (0 = Manufacturing; 1 = Services)	-0.182 <sup>***</sup> (-3.757)	-0.207 <sup>***</sup> (-3.954)	-0.209 <sup>***</sup> (-3.843)
Country (0 = Germany; 1 = UK)	0.007 (0.148)	-0.113 <sup>**</sup> (-2.280)	-0.099 <sup>**</sup> (-1.963)
Start-Up Size:			
1-2 Employees (0/1)	-0.117 (-1.200)		
3-5 Employees (0/1)	-0.109 (-1.132)		
6-9 Employees (0/1)	-0.051 (-0.464)		
10-19 Employees (0/1)	0.147 (1.097)		
Ln(Age)		0.141 <sup>***</sup> (3.686)	0.150 <sup>***</sup> (3.719)
R&D Activities:			
No R&D-Activities (0/1)		-0.370 <sup>***</sup> (-5.564)	-0.331 <sup>***</sup> (-5.020)
Occasional R&D-Activities (0/1)		-0.157 <sup>***</sup> (-3.295)	-0.157 <sup>***</sup> (-2.632)
Founder with:			
Work Experience abroad or in an international Firm (0/1)		0.217 <sup>***</sup> (4.416)	0.182 <sup>***</sup> (3.626)
Education abroad (0/1)		0.036 (0.484)	0.064 (0.855)
Product Characteristics:			
Investment or Intermediate Good (0/1)			-0.051 (-0.861)
Consumer Good/'Ready to Use' Product (0/1)			-0.119 <sup>*</sup> (-1.951)
Substantial Client Customisation (0/1)			-0.180 <sup>***</sup> (-3.432)
Wald-Tests:			
Start-Up Size (4)	6.28		
R&D-Activities (2)		34.03 <sup>***</sup>	26.52 <sup>***</sup>
Experience of the Founder (2)		21.46 <sup>***</sup>	15.94 <sup>***</sup>
Product Characteristics (2)			3.93
No. of Observations	486	468	446
Log Likelihood	-299.86	-250.17	-232.04

**Note:** The reference category is a German manufacturing firm with more than 20 employees and permanent R&D-activities. The t-values for the test of the underlying coefficient being different from 0 are given in parenthesis. Except for ln(age) the reported values refer to the discrete change in the probability when a variable changes its value from 0 to 1. The coefficient for ln(age) represents the marginal change in the probability when ln(age) is changed by one unit.

\*\*\* 1 % Significance Level; \*\* 5 % Significance Level; \* 10 % Significance Level



## 6 Summary and Conclusion

Before discussing the findings of our research, an important caveat should be noted. As the survey's data analysis phase had not been completed at the time of writing this paper, we have not yet carried out non-response analyses. Our results, therefore, can only strictly relate to the 495 firms in our sample. A systematic bias between respondents and non-respondents would invalidate our findings. This paper should therefore be read in the light of this (hopefully temporary) limitation.

Regarding our sample, a number of important findings emerge from this study. First, it is worth pointing out that, in both countries, the majority of firms had internationalised. Two thirds of German and British NTBFs were engaged in some form of international activities ranging from simple exporting via entry modes using intermediaries (agents and distributors) to the building up of significant foreign assets and production facilities. This suggests that international activities are of critical strategic concern for firms in high-technology industries in Germany and the UK. This observation is, of course, nothing new when looking at established large firms. However, the reality that many start-ups, including some of these industries' youngest and often smallest players, engage rapidly and so pro-actively in international activities surprised the research team. An important message for investors and entrepreneurs in these technology based industries is, therefore, that international activities have to be a key area of attention when putting together a business plan.

Yet, internationalisation appears to be more difficult for some firms than for others. Our second finding is concerned with the theoretical problem described at the beginning of this paper. We argued that different theories of international business come to different conclusions when applied to the prediction of international activities by start-up companies in high-technology industries. As we pointed out, this suggests that internationalisers and non-internationalisers should be directly compared, a task that has not been attempted systematically in the field of international entrepreneurship to date. In addition, a research design that makes use of a control group of non-internationalisers also puts the results of earlier studies on a more stable empirical foundation, and improves the ability of academic research to inform practitioners.

Indeed, we discover a number of significant differences between internationalisers and non-internationalisers. Our findings suggests that the key discriminatory variables are age, the extent to which a product requires customisation, regularity of R&D activities and the international professional experience of the founders. This lends strong support to those studies that identified international experience of the founders as key characteristics of the management team (McDougall, Shane and Oviatt, 1994; Bloodgood, Sapienza and Almeida, 1996; Boter and Holmquist, 1996; Murray, 1996; Roberts and Senturia, 1996) and those that examined product characteristics of international start-ups (Murray, 1996; Roberts and Senturia, 1996;

Lindell and Karagozoglou, 1997). In addition, there is also some support for process models as internationalisers in our sample turned out to be significantly older than non-internationalisers.

Yet, the results are not as clear cut as we expected when formulating our hypotheses. All three theories of international business receive some support, but we also come up with some unexpected results. For example, we do not yet understand the nature of the latent effects among our variables which lead to the result that *regularity* of R&D activities is a strong discriminator whereas the direct *intensity* measured as ratio of R&D expenditures to sales is not. This finding suggests that it matters more that firms carry out R&D permanently as part of their business model than how much of their resources they devote to it. Furthermore, it is unclear, why product customisation does represent a barrier to international sales whereas substantial technical consultation, installation, maintenance and training requirements all appear to have no effect. As this suggests that products whose commercialisation is transaction cost intensive and products which require little efforts of this kind are both sold abroad, an investigation into the relation between product characteristics and the chosen market entry mode will be our next area of enquiry. Hopefully, this will lead to further insights into the different ways by which start-up and young technology intensive firms organise in order to sell complex products abroad.

Finally, given that it is hard to tell from our initial findings which of the theories delivers the more convincing arguments to explain internationalisation, we conclude that the hypotheses presented in the previous sections are not alternatives in explaining the internationalisation decision but are essentially complementary in nature. Process models highlight managerial aspects such as experience and knowledge of foreign markets. Transaction cost-based arguments focus on the costs of internationalisation and their particular relevance for small and young firms. Finally, a resource-based perspective can show how market entry barriers such as high costs and lack of experience and/or information may be overcome through the exploitation of firm-specific idiosyncrasies.

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**Table 4: Comparison between internationalisers and non-internationalisers**

Description	International Sales		Test-Statistics	No. of Obs.
	Yes	No		
<i>Firm Characteristics</i>				
Start-Up Size (No. of Employees)	6.18	4.27	** a)	475
Size today (No. of Employees)	20.70	16.35	** a)	484
Age (Years)	5.80	4.94	*** a)	484
No. of Founder	2.27	2.12		479
<i>R&amp;D-Activities</i>				
R&D-Expenditures (in % of total sales)	14.32	9.68	*** a)	474
Employees working on the Development of existing or new products (in % of Employment)	24.22	20.11	* a)	477
None R&D-Activities (0/1)	0.11	0.33	*** b)	471
Occasional R&D-Activities (0/1)	0.21	0.29		471
Permanent R&D-Activities (0/1)	0.67	0.38	*** b)	471
<i>Technology and Product Characteristics</i>				
„Tried and Tested,, Combinations of existing Technology (0 = No; 1 = Yes)	0.31	0.47		457
New Combinations of existing Technology (0 = No; 1 = Yes)	0.35	0.35		457
New Technologies developed external (0 = No; 1 = Yes)	0.17	0.20		457
New Technologies developed internal (0 = No; 1 = Yes)	0.42	0.26	*** b)	457
Investment Good or Service (0 = No; 1 = Yes)	0.42	0.33		462
Component for other Goods (0 = No; 1 = Yes)	0.28	0.32		432
Consumer Good or Service (0 = No; 1 = Yes)	0.11	0.16		462
Product ready for use by End-User (0 = No; 1 = Yes)	0.51	0.58		462
Product Characteristic: Substantial Client Customisation (0 = No; 1 = Yes)	0.25	0.43	*** b)	486
<i>Founder Characteristics</i>				
Founder with working experience abroad or in an international firm (0 = No; 1 = Yes)	0.72	0.44	*** b)	486
Founder with an international Education (0 = No; 1 = Yes)	0.17	0.91	* b)	486
<i>Industry-Dummy (0 = Manufacturing; 1 = Service Sector)</i>	0.23	0.41	*** b)	486
<i>Country-Dummy (0 = Germany; 1 = UK)</i>	0.63	0.64	*** b)	486

\*\*\* 1 % Significance Level; \*\* 5 % Significance Level; \* 10 % Significance Level

a) t-Test

b)  $\chi^2$ -Test

**Table 5: Correlation Table**

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]
[1] Intsales	1.000													
[2] Emp_t0	0.096 <sup>*</sup>	1.000												
[3] Age	0.198 <sup>**</sup>	-0.071	1.000											
[4] Tectried	-0.158 <sup>**</sup>	0.127 <sup>**</sup>	-0.063	1.000										
[5] Teccomb	-0.004	-0.089	0.034	-0.276 <sup>**</sup>	1.000									
[6] Tecext	-0.041	0.061	-0.103 <sup>*</sup>	-0.139 <sup>**</sup>	0.006	1.000								
[7] Tecint	0.157 <sup>**</sup>	0.074	0.047	-0.350 <sup>**</sup>	-0.202 <sup>**</sup>	-0.127 <sup>**</sup>	1.000							
[8] Empd_sh	0.081	-0.145 <sup>**</sup>	-0.063	-0.214 <sup>**</sup>	0.004	-0.031	0.297 <sup>**</sup>	1.000						
[9] Rd_sh	0.091 <sup>*</sup>	-0.087	-0.095 <sup>*</sup>	-0.206 <sup>**</sup>	0.033	-0.060	0.254 <sup>**</sup>	0.526 <sup>**</sup>	1.000					
[10] Rd_1	-0.261 <sup>**</sup>	0.161 <sup>**</sup>	-0.045	0.319 <sup>**</sup>	-0.150 <sup>**</sup>	0.057	-0.297 <sup>**</sup>	-0.281 <sup>**</sup>	-0.327 <sup>**</sup>	1.000				
[11] Rd_2	-0.089	-0.085	-0.030	0.029	0.023	0.065	-0.157 <sup>**</sup>	-0.204 <sup>**</sup>	-0.123 <sup>**</sup>	-0.271 <sup>**</sup>	1.000			
[12] Rd_3	0.282 <sup>**</sup>	-0.054	0.061	-0.274 <sup>**</sup>	0.097 <sup>*</sup>	-0.101 <sup>*</sup>	0.369 <sup>**</sup>	0.395 <sup>**</sup>	0.367 <sup>**</sup>	-0.560 <sup>**</sup>	-0.646 <sup>**</sup>	1.000		
[13] Exp_abr	0.280 <sup>**</sup>	-0.022	0.080	-0.168 <sup>**</sup>	0.056	0.002	0.092 <sup>*</sup>	0.118 <sup>**</sup>	0.058	-0.200 <sup>**</sup>	-0.035	0.188 <sup>**</sup>	1.000	
[14] Exp_edu	0.101 <sup>*</sup>	0.050	-0.021	-0.120 <sup>**</sup>	-0.029	-0.004	0.122 <sup>**</sup>	0.185 <sup>**</sup>	0.182 <sup>**</sup>	-0.070	-0.095 <sup>*</sup>	0.138 <sup>**</sup>	0.229 <sup>**</sup>	1.000
[15] D_cust	-0.182 <sup>**</sup>	0.050	-0.045	0.139 <sup>**</sup>	0.000	0.097 <sup>*</sup>	-0.044	-0.140 <sup>**</sup>	-0.104 <sup>*</sup>	0.065	0.101 <sup>*</sup>	-0.139 <sup>**</sup>	-0.101 <sup>*</sup>	0.021

<sup>\*\*</sup> 1 % Significance Level; <sup>\*</sup> 5 % Significance Level

A description of the variables used is given in Table 6.

**Table 6: Description of Variables**

Variable	Description
Intsales	Dummy for International Sales (0 = No; 1 = Yes)
Emp_t0	Number of Employees at start-up
Age	Age (in Years)
Tectried	„Tried and Tested,, Combinations of existing Technology (0 = No; 1 = Yes)
Teccomb	New Combinations of existing Technology (0 = No; 1 = Yes)
Tecext	New Technologies developed external (0 = No; 1 = Yes)
Tecint	New Technologies developed internal (0 = No; 1 = Yes)
Empd_sh	Employees working on Development of existing or new products (%)
Rd_sh	R&D-Expenditures (in % of total sales)
Rd_1	None R&D-Activities (0/1)
Rd_2	Occasional R&D-Activities (0/1)
Rd_3	Permanent R&D-Activities (0/1)
Exp_abr	Founder with working experience abroad or in an international firm (0 = No; 1 = Yes)
Exp_edu	Founder with an international Education (0 = No; 1 = Yes)
D_cust	Product Characteristic: Substantial Client Customisation (0 = No; 1 = Yes)