Young, Open and International: The Impact of Search Strategies on the Internationalization of New Ventures

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Non-technical summary

Entrepreneurial firms with the ability to internationalize early and decisively have received much attention in recent academic discussion, for example under the heading of "international new ventures" or "born globals". While substantial parts of the research examining firms' internationalization activities have been based on behaviourally oriented models – most prominently the Uppsala model focusing on a gradual internationalization process – relatively little is known about the underlying processes that enable young firms to skip several stages of the internationalization process to become an INV from the outset. In this paper we aim at shifting the focus on innovation as a key entrepreneurial component that allows INVs to achieve considerable foreign market success early in their evolution. More precisely, we establish theoretical links with the emerging open innovation paradigm of firms optimizing their research and development (R&D) activities by interconnecting them with external partners such as leading customers, universities or specialized suppliers.

Compared to established and mature firms, young firms typically share characteristics that might influence their ability to identify relevant external knowledge, to integrate it into the innovation process and to exploit it subsequently on international markets. These characteristics have frequently been described as organizational flexibility and inherent resource constraints. Both should moderate the absorptive capacity of young firms and push and pull them to benefit from open innovation potentials and translate them into superior success on foreign markets. Research in innovation management has narrowed down open innovation activities towards a firm's search strategies that provide direction and priorities to open innovation initiatives. On the one hand, higher organizational flexibility and better opportunity recognition implies that young firms may benefit more from search breadth than established firms. On the other hand, resource constraints suggest that young firms may encounter difficulties in following a deep search strategy compared with established firms.

Using a comprehensive sample of more than 2,500 firms in Germany our results show that both the breadth and depth of search strategies help young firms to enter international markets. Once they have entered these markets, though, the drivers for success seem to shift from general knowledge sourcing to targeted and specific ones. These findings have important implications for the management of internationalization processes in young and established firms.

Das Wichtigste in Kürze

Neu gegründete Unternehmen, die die Fähigkeit besitzen, ihre Geschäftsaktivitäten früh und zielgerichtet zu internationalisieren, haben in der neueren akademischen Diskussion einen hohen Stellenwert, beispielsweise unter der Überschrift „international new ventures (INV)" oder „born globals". In diesem Kontext legen die weitaus meisten Beiträge zum Internationalisierungsprozess von Unternehmen verhaltensorientierte Modelle und hier an vorderster Stelle das Uppsala-Modell zu Grunde. Vergleichsweise wenig ist über die Prozesse bekannt, die junge Unternehmen in die Lage versetzen, mehrere Stufen des Internationalisierungsprozesses zu überspringen und von Beginn an international tätig zu sein. In diesem Beitrag legen wir daher einen besonderen Schwerpunkt auf die Bedeutung von Innovation als wesentliche unternehmerische Komponente, die es INVs erlaubt, früh einen substanziellen Internationalisierungserfolg zu erzielen. Wir legen unserer theoretischen Diskussion dabei das „Open Innovation"-Modell zu Grunde, das die Einbeziehung unternehmensexterner Innovationsquellen in den Innovationsprozess fordert, um dadurch einen höheren Innovationserfolg zu erzielen. Solche externen Innovationsquellen können beispielsweise Kunden, Universitäten oder spezialisierte Zulieferer sein.

Verglichen mit etablierten Unternehmen sind junge Unternehmen typischerweise durch eine höhere Flexibilität, aber auch durch Beschränkungen ihrer verfügbaren Ressourcen gekennzeichnet. Beide Charakteristiken besitzen vermutlich einen Effekt auf die Fähigkeit, relevantes externes Wissen in den Innovationsprozess zu integrieren und auf internationalen Märkten zu nutzen. „Open Innovation"-Aktivitäten sind dabei in der Literatur mit dem Begriff der Suchstrategie verbunden, die Richtung und Prioritäten für solche Aktivitäten vorgibt. So kann vermutet werden, dass eine höhere Flexibilität dazu führt, dass junge Unternehmen eher als etablierte von einer höheren Suchbreite profitieren, während Ressourcenbeschränkungen dazu führen, dass etablierte Unternehmen eher als junge mit einer höheren Suchtiefe erfolgreich sind.

Basierend auf einem Datensatz mit mehr als 2 500 Unternehmen aus Deutschland zeigen die Ergebnisse, dass sowohl die Breite als auch die Tiefe der Suchstrategien jungen Unternehmen zum internationalen Markteintritt verhelfen. Ist der Marktzutritt geschafft, scheint es jedoch nicht mehr primär auf Innovationsaktivitäten anzukommen, sondern auf andere Firmeneigenschaften, die den Grad des Internationalisierungserfolges bestimmen.

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Abstract

Young firms with the ability to internationalize early and decisively have received much attention in recent academic discussion. However, relatively little is known about the underlying processes that enable them to skip several stages of the internationalization process. We contribute to this research stream by establishing theoretical links with the emerging open innovation paradigm of firms optimizing their R&D activities by interconnecting them with external partners such as leading customers, universities or specialized suppliers. Based on a sample of more than 2,500 firms in Germany we contrast young and mature firms with regard to the effect of open innovation strategies on internationalization performance. Our results show that both the breadth and depth of search strategies for external knowledge help young firms to enter international markets. Once they have entered these markets, though, the drivers for success seem to shift from general knowledge sourcing to targeted and specific ones.

Keywords: new ventures, internationalization, innovation, search strategies, entrepreneurship

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1 Introduction

Entrepreneurial firms with the ability to internationalize early and decisively have received much attention in recent academic discussion, for example under the heading of "international new ventures" (INVs) or "born globals" (McDougall and Oviatt, 2000; McDougall et al., 1994; Oviatt and McDougall, 1994). While substantial parts of the research examining firms' internationalization activities have been based on behaviorally oriented models – most prominently the Uppsala model (Johanson and Wiedersheim-Paul, 1975; Johanson and Vahlne, 1977) focusing on a gradual internationalization process – relatively little is known about the underlying processes that enable young firms to skip several stages of the internationalization process to become an INV from the outset. This general lack of theoretical advancement was echoed by Jones and Coviello (2005) pointing to the relevance of an entrepreneurial component in firm internationalization activities. In this paper we aim at shifting the focus on innovation as a key entrepreneurial component that allows INVs to achieve considerable foreign market success early in their evolution. More precisely, we establish theoretical links with the emerging open innovation paradigm (Chesbrough, 2003) of firms optimizing their research and development (R&D) activities by interconnecting them with external partners such as leading customers, universities or specialized suppliers. In this respect, existing research has shown that firms may benefit considerably from integrating external knowledge into their innovation processes (Katila, 2002; Katila and Ahuja, 2002; Laursen and Salter, 2006).

In fact, it has almost become conventional wisdom that knowledge serves as a cornerstone in the evolution of the multinational company (e.g., Kogut and Zander, 1993; Knight and Cavusgil, 2004). However, compared to established and mature firms, young firms typically share characteristics that might influence their ability to identify relevant external knowledge, to integrate it into their own innovation processes and to exploit it subsequently on international markets. First, Stevenson and Jarillo (1990) argued that entrepreneurial firms succeed in discovering as well as creating entrepreneurial opportunities (Brown et al., 2001; Zahra, 2008) which implies that young firms generally benefit from higher organizational flexibility in order to exploit opportunities as they arise (Autio et al., 2000). Second, young firms may face at the same time considerable resource constraints as the resource base from which the entrepreneurial team may draw from is limited (Brush et al., 2001). Both aspects suggest that young firms differ from established firms in the way they make use of external

knowledge. In other words, organizational flexibility as well as inherent resource constraints moderate the absorptive capacity (Cohen and Levinthal, 1989, 1990) of young firms and push and pull them to benefit from open innovation potentials and translate them into superior success on foreign markets.

Research in innovation management has narrowed open innovation activities down towards a firm's search strategies that provide direction and priorities to open innovation initiatives. A search strategy can be defined as an "organization's problem-solving activities that involve the creation and recombination of technological ideas" (Katila and Ahuja, 2002: 1184). In this respect, Laursen and Salter (2006) identified search breadth and search depth as the two central dimensions of a firm's openness to external knowledge. On the one hand, higher organizational flexibility and better opportunity recognition implies that young firms may benefit more from search breadth than established firms. On the other hand, resource constraints suggest that young firms may encounter difficulties in following a deep search strategy compared with established firms.

Using a comprehensive sample of more than 2,500 firms in Germany we test these arguments empirically. The empirical setup allows us to contrast young and mature firms with regard to the effect of open innovation strategies on internationalization performance. In this respect, we contribute to the literature by joining the research paths of international entrepreneurship and open innovation. We show that the adoption of a certain search strategy affects the internationalization performance of young firms and that substantial differences exist compared to established firms' search activities. These findings have important implications for the management of internationalization processes in young and established firms.

The remainder of this paper is hence organized as follows. The next section outlines our conceptual background leading to the hypotheses which we wish to test. Section 3 provides insights into our data and methods while the subsequent section describes the results. These are discussed in Section 5 after which we conclude with limitations of our study and suggestions for further research.

2   Conceptual background

Knowledge, be it internal or external, has been characterized as the most valuable asset of a firm for achieving competitive advantage (Grant, 1996; Liebeskind, 1996). Consequently,

knowledge enabling innovative activities can be assumed to provide particular advantages that facilitate foreign market entry and operations (Kogut and Zander, 1993; Knight and Cavusgil, 2004). In this section, we aim at clarifying the relationship between external knowledge acquisition and resulting innovation capacities as a major driver in the internationalization activities of entrepreneurial firms. We develop detailed hypotheses suggesting that more interconnected and "open" innovation models should be especially beneficial to young firms because of their inherent strengths and weaknesses.

2.1 Knowledge and innovation in international entrepreneurship

Knowledge can be considered crucial for a firm's success as it provides a platform for decisions on what resources and capabilities to deploy, develop or discard as the environment changes (Ndofor and Levitas, 2004). Especially knowledge acquisition appears highly relevant for research on entrepreneurial firms. The opportunity-based definition of entrepreneurship by Stevenson and Jarillo (1990) has become widely accepted in the literature (Brown *et al.*, 2001). In fact, this definition coincides with Schumpeter's (1975) and Kirzner's (1973) views of entrepreneurship as opportunity seeking, recognition and exploitation through novel resource commitments. Consequently, the way entrepreneurs discover, create and exploit these opportunities affects company development (Zahra, 2008). Psychologists have demonstrated, for example, that founders of new ventures have higher scores on risk-taking propensity and ambiguity tolerance (Begley and Boyd, 1987). These psychological attributes are related to an entrepreneurial orientation (Begley and Boyd, 1987; Miller and Droge, 1986; Miner, 2000) defined as a person's willingness to take the risks associated with creating new companies and exploit these opportunities. Entrepreneurs' schemas and mental models allow them to quickly and efficiently categorize and respond to events, as they show a stronger possession of self-efficacy (Chen et al., 1998) explaining the entrepreneurs belief in their capabilities and their decision making (Wood and Bandura, 1989).

These characteristics of entrepreneurs and entrepreneurial firms have received much attention in recent academic discussion because of their enabling effect on internationalizing early in the firm's lifecycle. In fact, McDougall and Oviatt (2000: 903) define international entrepreneurship as "… a combination of innovative, proactive and risk-seeking behavior that crosses national borders and is intended to create value in organizations". Important in this definition is the explicit integration of the generally accepted understanding of internationalization as a firm-level activity that crosses international borders (Wright and

Ricks, 1994), with the characteristics of an entrepreneurial orientation as defined by Covin and Slevin (1989): innovative, proactive and risk-seeking behavior.

The ability to internationalize has frequently been characterized as a function of the internal capabilities of a firm (Autio *et al.*, 2000; McDougall *et al.*, 1994; Zahra et al., 2000). The importance of internal capabilities is rooted in evolutionary economics (Nelson and Winter, 1982) which puts particular emphasis on the innovation process. This perspective implies that the superior ability of certain firms to sustain innovation and, as a result, create new knowledge leads to the development of organizational capabilities, consisting of critical competences and embedded routines. Most international entrepreneurship research appears to be in agreement that international new ventures gain competitive advantage by differentiating themselves from competitors by introducing innovative products. McDougall et al. (1994) indicate that international new ventures use innovative differentiation as a means of avoiding head-to-head competition with entrenched incumbents. Oviatt and McDougall (1994, 1995) stress the importance of using unique knowledge and technologies to provide innovative, differentiated products or services and thereby gain advantage over purely domestic firms. Jolly et al. (1992) identified a high quality innovative product that rides on a fundamental redefinition in an industry as one of the primary strategies employed by the INVs they studied. Brush (1993) found that young international firms emphasize innovation and product development significantly more than older firms. Ray (1989) asserts that INVs achieve competitive advantage by either reconfiguring products or redefining markets, and that technology and proprietary advantage were their core competitive advantages.

Knowledge production and acquisition can therefore be considered a primary driver in the internationalization of entrepreneurial firms. Knowledge is used here to refer not only to an existing stock but also to the capacity of the firm to apprehend and use relationships among informational factors to achieve intended ends (Autio *et al.*, 2000). In this regard, international entrepreneurship is about opportunity identification and exploitation in foreign markets (Zahra *et al.*, 2000). New opportunities for knowledge acquisition and management should therefore be of central importance for INVs.

2.2 Open innovation and internationalization

Building a competitive strategy around knowledge is challenging as knowledge is inherently a public good (Arrow, 1962; Jaffe, 1986) that could "spill over" to competitors and allow them

to free-ride on a firm's investments in knowledge production. Hence, firms have strong incentives to keep their knowledge proprietary (Liebeskind, 1997). It is therefore not surprising that the traditional approach of producing knowledge through investments in R&D has been dominated by secretive and self-contained in-house processes. However, this negative perception of knowledge spillovers between firms and their environment is fading as recent literature has pointed towards the merits of acquiring external knowledge (Tsang, 2000) and moving from "research and develop" towards "connect and develop" (Huston and Sakkab, 2006).

The "Open Innovation" model by Chesbrough (2003) conceptualizes this new perspective on how firms innovate. Closed innovation, i.e. firms rely solely on their own resources for the complete R&D process, appears to be an inferior innovation strategy as important changes in the competitive and economic environment have occurred. Shorter product life cycles and the growing complexity of technologies and markets push firms towards using external sources of knowledge. External sources have also become more readily available, for example, information and communication technologies have improved. Chesbrough (2003) identifies four interconnected factors that propel a more open innovation process: the increasing availability and mobility of skilled workers, a venture capital market that endows entrepreneurs with the necessary capital to compete, external options for previously shelved ideas and, finally, the increased capabilities of external suppliers. Hence, firms have to reach out to actors beyond firm boundaries to maximize the benefits from inventions and ideas (Rosenkopf and Nerkar, 2001). This openness materializes as a heightened demand for external knowledge and other external inputs in the innovation process (Fagerberg, 2005; Monjon and Waelbroeck, 2003; Peters, 2003). Several studies have identified positive performance effects from incorporating external knowledge at various levels. Such effects range from innovation success (Gemünden et al., 1992; Love and Roper, 2004) to an increased novelty of innovations (Landry and Amara, 2002) and higher returns on R&D investments (Nadiri, 1993).

As firms begin to open up their innovation processes, potentially relevant external sources of knowledge need to be identified, activated and managed for success (Gottfredson et al., 2005; Stock and Tatikonda, 2004). Firms need to identify the most promising external knowledge sources and align and optimize their innovation process accordingly. Hence, it entails a change in the way firms search for new ideas or technologies for innovation (Laursen and Salter, 2006). This can be especially challenging for mature firms with manifested structures

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and procedures. Mature companies may be bound by their past experiences or inertial forces, slowing down their decision making. Entrepreneurs instead are less prone to second guessing or counterfactual thinking (Baron, 2000). Established organizations have cognitive systems, exhibiting the shared beliefs and information of the members of their dominant coalitions (Daft and Weick, 1984). These cognitive systems relate to organizational identity (Fiol and O'Connor, 2002), schematic frameworks (McNamara et al., 2002), top management beliefs (Guth and Ginsberg, 1990), and dominant logic (Prahalad and Bettis, 1986). The systems influence the decision-making process to seek, for example, certain types of knowledge, give greater weight to particular pieces of knowledge or interpret them in specific ways. In this respect, the decision making process is already predetermined, making it less affordable to try new ways and new opportunities as cognitive systems influence also decision rules, decision horizons, and risk preferences. Hence, we conclude:

Hypothesis 1: Young firms benefit more from open innovation strategies in their internationalization success than mature firms.

2.3 Dimensions of open innovation strategies and internationalization success

Several studies have identified characteristic search strategies as ways to open the innovation process for external knowledge (Katila, 2002; Katila and Ahuja, 2002; Laursen and Salter, 2006). The search strategy should reflect the environment and the availability of external knowledge sources. Cohen and Levinthal (1990) have discussed the availability of technological opportunities, the turbulence of the environment as well as other firm's search activities in the industry. This means that investments into problem solving activities should result in a favorable combination and linkage of users, suppliers and other relevant actors in the innovation system (Laursen and Salter, 2006).

Laursen and Salter (2006) have developed the concepts of breadth and depth as the dimensions of a firm's search strategy. On the one hand, a broader set of external inputs reduces the risk of unforeseen developments. On the other hand, it has to be considered that a company's information processing capacities are limited. There is hence a need to focus, as a vast amount of impulses would impede selection and in-depth exploitation processes (Koput, 1997). In contrast to breadth, search depth is defined as the extent to which firms draw deeply from the various external sources for innovation impulses (Laursen and Salter, 2006). Both breadth and depth can then be characterized as dimensions of a firm's openness for external

knowledge (Chesbrough, 2003). In their study on the UK manufacturing sector, Laursen and Salter (2006) find that the relationship between searching widely and deeply and innovation performance takes on an inverted U-shape, i.e. although search efforts initially increase performance, firms may also "over-search" their environment, which in turn impedes performance.

Katila and Ahuja (2002) apply a related approach to examine how firms search and solve problems by focusing on search depth, which they define as the extent to which a firm reuses existing knowledge, and on search scope, which is how widely a firm explores external knowledge. While the latter concept largely corresponds to search breadth, the former exhibits a different focus that is more centered on exploiting the established knowledge base. They also find an inverted U-shaped relationship between a firm's search behavior and innovation performance, indicating the negative effects of overly extensive search activities (Katila and Ahuja, 2002). Moreover, they provide evidence that the interaction of search scope and depth is positively related with innovation performance as it increases the uniqueness of recombination: A deep understanding of firm-specific knowledge assets that is extended towards a new application (scope) creates a unique combination that serves as a basis for commercializing inventions.

As a consequence, search efforts of firms can be regarded as attempts to identify opportunities. Following Stevenson and Jarillo's (1990) opportunity-based definition of entrepreneurship, searching for external knowledge can be assumed to be of particular importance for INVs (Zahra, 1995, 2008). Indeed, Ghoshal (1987) observes that innovation, learning and adaptation are important strategic objectives for companies that expand internationally. He argues that firms learn from societal differences in organizational and managerial processes and systems. In this regard, Autio et al. (2000) suggest that new ventures enjoy learning advantages that established multinational companies do not have. Learning thrives on the effective integration of newly acquired external knowledge and and its transformation it into new products, systems and processes (Zahra and George, 2002). When firms age, they develop learning barriers that hamper their ability to grow successfully in new environments. Older firms become increasingly resistant to change over time (Hannan, 1989), which hampers quick adaptation to new environmental conditions, an attribute especially relevant for foreign market success.

Hence, we suggest that INVs possess higher flexibility in exploiting external knowledge sources. They should be in a much better position to use multiple sources than mature firms. As they are less constrained by past experience and related predetermined cognitive maps, and better at coping with equivocality associated with the uncertainty of new opportunities than mature firms, they should be more likely to benefit from activities helpful to identify and adopt new market opportunities. In other words, search breadth will provide INVs with better opportunities than mature firms to exploit knowledge impulses which they can incorporate into their innovation process and subsequently use to internationalize. Thus, our second hypothesis reads:

Hypothesis 2: Search breadth is more beneficial to the internationalization success of young firms compared to established firms.

Identifying, integrating and exploiting knowledge gained by interacting with external sources requires resource commitments and management (Brush, 1993). Decisions on the scale and scope of international operations are made based on expected market definition, competition in foreign markets, current and potential resource availabilities, networks of alliances and collaborators, and requirements for success in the markets to be entered.

As outlined before, international entrepreneurs enjoy on the one hand certain advantages for recognizing new opportunities (Zahra, 2008). On the other hand, they also face constraints based on resource availabilities, foreignness and newness. When firms age, the negative implications from liability of newness can be expected to diminish as firms become more accepted, they accumulate the required experience and the necessary resources (Stinchcombe, 1965). In other words, firms achieve legitimacy (Rao et al., 2008). While INVs need resources to grow, the founding entrepreneurial team typically only has a given resource pool from which to draw (Brush *et al.*, 2001). Unlike established firms, there are no resources to fall back upon. A search strategy based on experience and resources, as it would be the case for search depth, relies heavily on an intensive long-term exchange of knowledge with strong resource commitments. Search depth requires the establishment of stable channels for communication with leading customers, specialized suppliers or top university researchers. Establishing shared language and procedures requires continuous interaction in practice over time (Laursen and Salter, 2006). At the same time, success is highly uncertain. Developing deep search strategies therefore bears the inherent risk of neglecting other opportunities.

These strategies should be more affordable for firms with more experience and resources and less affordable for new and rather inexperienced INVs. We propose:

Hypothesis 3: Search depth is more beneficial to the internationalization success of mature firms compared to young firms.

3 Empirical study

3.1 Data

For the empirical part of this analysis we use data from a survey on the innovation activities of German enterprises called the "Mannheim Innovation Panel" (MIP). It is the German contribution to the Community Innovation Survey (CIS) of the European Union. Thus, the methodology and questionnaire used fully comply with CIS standards and follow the OECD Oslo manual. For our analysis we use surveys conducted in 2001 and 2005 in which data was collected on the innovation activities of enterprises during the preceding three-year periods. The vast majority of the firms in our dataset has only responded in one of the two surveys. A panel approach is therefore not feasible. We opt for a pooled sample instead. The survey targets general managers or the heads of R&D departments of firms with at least five employees. Non-innovating firms were excluded from our analysis because most variables can only be constructed for firms with innovation activities. Besides, we restrict our sample to domestic firms only by excluding multinational groups. This allows for clarity in interpretation when using exports as a measure for internationalization success. However, this restriction should be kept in mind when interpreting the results.

CIS surveys are self-reported and represent subjective assessments which raise quality issues with regard to administration, non-response and response accuracy (for a recent discussion see Criscuolo et al., 2005). First, our CIS survey was administered via mail which prevents certain shortcomings and biases of telephone interviews (for a discussion see Bertrand and Mullainathan, 2001). The multinational application of CIS surveys adds extra layers of quality management and assurance. CIS surveys are subject to extensive pre-testing and piloting in various countries, industries and firms with regards to interpretability, reliability and validity (Laursen and Salter, 2006). Second, a comprehensive non-response analysis of more than 4,000 firms per survey showed no systematic distortions between responding and non-

responding firms with respect to their innovation activities. Third, the questionnaire contains detailed definitions and examples to increase response accuracy.

In conclusion, the major advantage of CIS surveys is that they provide direct, importance-weighted measures from the heads of R&D departments or innovation management for innovation inputs, processes and outputs (Criscuolo *et al.*, 2005). On the downside, this information is self-reported. This immediate information on processes and outputs has been used in the literature to complement traditional measures of innovation such as patents (e.g., Laursen and Salter, 2006; Sofka, 2008).

We complement this dataset with additional information from the European Patent Office (EPO) and business R&D expenditures at the industry level provided by the OECD ANBERD dataset. Our final sample consists of 2,316 firm observations.

3.2 Measures

We measure internationalization performance through the share of exports in total sales. We are confident that this is an appropriate measure as all firms within our sample are domestic (i.e. there are no multinational firms included). However, only 58 percent of the firms are actively exporting. Export success would therefore only be observable for this subgroup. We will address this issue methodologically by estimating selection models (see methods section for details).

The primary focus of our investigation is the effect of a firm's open innovation search strategy on internationalization performance. We define the breadth and depth of this search strategy in accordance with Laursen and Salter (2006). We rely on a survey question to identify the sources of external knowledge for each firm. General managers or heads of R&D departments provide importance-weighted answers on the value of the contribution of various sources. More precisely, respondents are asked to evaluate the importance of the main sources for their innovation activities on a 4-point Likert scale ranging from "not used" to "high". These sources include: suppliers, customers, competitors, universities, research institutes, professional conferences (meetings, trade fairs) as well as professional journals. We construct two index variables to measure the breadth and the depth of a search strategy. The search breadth of firm i is defined as the number m of external sources for information x that are used by the firm i, divided by the maximum number of external sources M that can be used by firms in the sample:

$$\text{breadth}_i = \frac{\sum_{m=1}^{M} x_m}{M} \qquad (1)$$

The search depth of firm *i* is defined as the number *m* of external sources for information *z* which are highly important for the firm, normalized by the number of sources it uses (breadth):

$$\text{depth}_i = \left(\frac{\sum_{m=1}^{M} z_m}{M} \right) \Big/ \text{breadth}_i \qquad (2)$$

Hence, both indices range between zero and one.

We include several control variables to achieve unbiased results. First, we include a firm's age since foundation (years, standardized in logs) and its size measured by the number of employees (in logs). What is more, a firm's degree of innovativeness may crucially depend upon other input factors in the innovation process. These include most importantly the firm's own investment in R&D (as a share of sales) and the qualification level of their employees (measured as the share of employees with college education). Besides, several authors have highlighted the importance of accumulated knowledge for successful innovation activities (e.g. Cohen and Levinthal, 1990). We reflect this distinguishing feature between firms by calculating a patent stock per employee at the beginning of each observation period. To construct the patent stock for each firm we use information on all patents granted by the EPO to a given firm and employ a perpetual inventory method with the standard depreciation rate of 15 percent (Griliches and Jaques, 1984).

Firms may also differ in their opportunities to internationalize their activities. This may be easier if the domestic industry it is operating in is on the technological forefront. Hence, we introduce a measure on the technological leadership status of German industries. We calculate the R&D index on the basis of the OECD ANBERD data developed by Salomon and Byungchae (2008). The index is constructed by comparing the R&D expenditures of German industries with those of the other OECD countries. It allows the identification of industries in which Germany is a technological leader or laggard. The following formula is applied:

$$RDI_{jt} = \frac{R_{jt}^{Germany}}{GDP_t^{Germany}} - \left[\sum_{k=1}^{n} \left(\frac{R_{kjt}}{GDP_{kt}} \right) \right] \bullet \frac{1}{n}$$

where *R* is R&D expenditure in industry *j* at time *t* in country *k* or in Germany and *GDP* is the gross domestic product of country *k* or Germany at time *t*. Positive values indicate a leadership status of the German industry compared to all other OECD countries. Negative values indicate a lagging status. Data for the start of the survey observation period is utilized so that the effects can be considered predetermined.

Besides, we control for other potentially influential factors like whether the firm is part of a domestic group and may draw from the group's resources and whether it is located in East Germany which is still economically challenged following reunification. We include a dummy variable for whether the observation was part of the 2005 survey. This is supposed to capture remaining time-based differences in firm performance. We also add dummy variables for remaining industry differences. These include other manufacturing (and will serve as a comparison group), medium high-tech manufacturing, high-tech manufacturing, distributive services, knowledge-intensive services and technological services. See Appendix A for the detailed industry classification.

3.3   Method

Our central dependent variable, share of exports on sales (export intensity), is only observable for firms with exports activities. All other firms would automatically have zero export shares. The sample is therefore censored. Heckman (1979) shows that estimating a simple regression model would generate biased results. Including the export status (i.e. exporting yes/no) as an exogenous variable would ignore the endogeneity between export intensity and export status. This selection would bias the estimated standard errors downwards and therefore increase the probability for significant results (see for example Cantwell and Mudambi, 2005, for a recent application and Greene, 1993, for a full discussion).

We address this issue by estimating a Heckman two-stage selection model. Put simply, it consists of estimating two equations. In the selection equation stage the probability for exporting is estimated (export status = 1) through a probit model. Based on this estimation a correction factor can be calculated ("inverse Mills ratio") and added as a regressor to the

second stage regression model (dependent variable: export intensity). The goal is to correct for the selection bias.

The Heckman selection model is driven by the basic idea that at least one factor can be identified that influences the selection (i.e. export status) but not the dependent variable of the second stage regression model (i.e. export intensity). We argue that the R&D index on the technological leadership status of a German industry compared to all other OECD countries fulfills this criterion. On the one hand, firms in industries on the technological forefront may benefit from access to a specialized infrastructure and knowledge spillovers which are often times geographically confined (see for example Audretsch and Feldman, 1996). Hence, they should be more likely to develop superior productivity levels and expand these advantages into foreign markets. On the other hand, these advantages are in principle available to all firms in the industry of the country. Differences in firm's success in international markets may therefore be much more driven by firm-specific assets and capabilities. In conclusion, we argue that a positive R&D index (RDI), indicating the technological leadership status of an industry, should influence the likelihood to export (export status) positively, but should not make a significant difference with regards to export success (export intensity). We test this assumption empirically by including the R&D index variable in both the selection and regression equation of a Heckman two-stage selection model. As predicted, the R&D index has a positive and significant effect on export status and no significant effect on export intensity (see Appendix C for the full estimation results). Our estimation model can therefore be considered as suitable.

Besides, we will split the sample into age quantiles to investigate differences in effects between different age groups. This approach has the advantage that we do not have to assume a certain functional relationship (e.g. linear, curvilinear) for this relation. Additionally, we conduct an analysis of the correlations between exogenous variables. Individual correlations, variance inflation factors as well as the condition index provide no evidence for any relevant degree of multicollinearity within our dataset. Appendix B provides full details.

4 Results

4.1 Descriptive statistics

Table 1 provides an overview through descriptive statistics for all variables introduced before. Firms in the sample are on average 16 years old and have 155 employees. They use on average 5.6 different knowledge sources (breadth: 71 percent of the eight sources available) but only 21 percent of those are highly important (depth). They spend an average of 4 percent of sales on R&D and are mostly located in West Germany (38 percent in East Germany). 15 percent of sales stem from exporting. However, only 58 percent of firms in the sample are active exporters. Hence, we extend the descriptive analysis and conduct t-tests on significant differences in means between exporting and non-exporting firms and find great differences (Table 1).

Table 1:   Descriptive statistics full sample

Variable	All firms		No export activity		Export activity		
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	T-test
Export status (d)	0.58	0.49	0.00	0.00	1.00	0.00	
Export share of sales (ratio)	0.15	0.22	0.00	0.00	0.26	0.24	***
Breadth of search strategy (index)	0.71	0.22	0.66	0.23	0.74	0.21	***
Depth of search strategy (index)	0.21	0.22	0.19	0.22	0.22	0.22	***
Company age since found. (years)	16.16	12.49	15.27	12.78	16.79	12.24	***
No of employees (log)	3.96	1.40	3.71	1.43	4.15	1.35	***
No of employees	154.55	348.45	138.79	340.11	165.97	354.05	*
Share R&D exp. of sales (ratio)	0.04	0.10	0.02	0.09	0.05	0.10	***
Patent stock per empl. (ratio)	0.00	0.02	0.00	0.01	0.00	0.02	***
Share empl. w/ college educ. (ratio)	0.23	0.24	0.24	0.26	0.21	0.23	***
Part of company group (d)	0.41	0.49	0.40	0.49	0.41	0.49	
Location East Germany (d)	0.38	0.49	0.46	0.50	0.33	0.47	***
Other manuf. (d)	0.35	0.48	0.29	0.45	0.40	0.49	***
Medium high-tech manuf. (d)	0.17	0.37	0.03	0.18	0.26	0.44	***
High-tech manuf. (d)	0.09	0.28	0.04	0.19	0.12	0.33	***
Distributive services (d)	0.14	0.34	0.23	0.42	0.07	0.25	***
Knowledge-intensive services (d)	0.10	0.29	0.19	0.39	0.03	0.16	***
Techn. oriented services (d)	0.16	0.37	0.22	0.42	0.12	0.32	***
Year: 2005 (d)	0.55	0.50	0.53	0.50	0.56	0.50	
RDI (index)	0.10	0.58	-0.09	0.33	0.24	0.67	***
Observations	2316		973		1343		

* significant at 10%; ** significant at 5%; *** significant at 1%;
(d) Dummy variable.

Exporting firms have both broader and deeper search strategies. They are on average slightly older (17 years) and larger (166 employees) than non-exporting firms. Interestingly, they

invest more in R&D (5 percent of sales compared to 2 percent), have a higher patent stock, but at the same time a lower share of employees with college education. This may have to do with the industries they are active in. Non-exporting firms are more active in service industries whereas exporters can be found much more often in all manufacturing sectors. On average, they are also more active in industries in which Germany has higher R&D expenditures than OECD average (RDI index). Non-exporting firms are also more frequently located in East Germany.

A primary focus of this article is the effect of age on internationalization. We therefore present a separate descriptive analysis for the youngest quartile of 576 firms in our sample. Their age ranges between one and nine years since foundation. Table 2 presents the analogous mean comparison between exporting and non-exporting firms in this age group.

Table 2: Descriptive statistics youngest quartile of firms (1-9 years)

Variable	No Export activity		Export activity		
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*T-test*
Export status (d)	0.00	0.00	1.00	0.00	
Export share of sales (ratio)	0.00	0.00	0.26	0.25	***
Breadth of search strategy (index)	0.67	0.23	0.75	0.21	***
Depth of search strategy (index)	0.18	0.21	0.24	0.22	***
Company age since found. (years)	5.14	2.10	5.26	2.07	
No of employees (log)	3.53	1.51	3.91	1.44	***
No of employees	150.25	412.57	165.90	432.32	
Share R&D exp. of sales (ratio)	0.04	0.13	0.06	0.10	
Patent stock per empl. (ratio)	0.00	0.01	0.00	0.02	**
Share empl. w/ college educ. (ratio)	0.26	0.28	0.26	0.26	
Part of company group (d)	0.40	0.49	0.42	0.49	
Location East Germany (d)	0.45	0.50	0.37	0.48	
Other manuf. (d)	0.27	0.44	0.35	0.48	**
Medium high-tech manuf. (d)	0.03	0.17	0.28	0.45	***
High-tech manuf. (d)	0.04	0.21	0.11	0.31	***
Distributive services (d)	0.21	0.41	0.07	0.26	***
Knowledge-intensive services (d)	0.19	0.39	0.02	0.13	***
Techn. oriented services (d)	0.27	0.44	0.17	0.38	***
Year: 2005 (d)	0.55	0.50	0.59	0.49	
RDI (index)	-0.12	0.26	0.25	0.79	***
Observations	267		309		

* significant at 10%; ** significant at 5%; *** significant at 1%;
(d) Dummy variable.

This group of young firms is more homogenous with regards to remaining differences between exporting and non-exporting firms. 53 percent of the young firms are active in exporting achieving 26 percent of their sales with it. These findings are fully in line with the

descriptive results of the full sample. This holds also for the finding that exporting firms have broader and deeper search strategies. Interestingly, exporting firms have a larger patent stock but all other R&D inputs (R&D expenditures, share of skilled employees) are similar. There is no remaining significant difference between East and West German firms. The industry composition, though, is different and follows the same patterns as identified in the overall sample. Firms in manufacturing sectors are more likely to be exporters compared to service firms. Plus, firms operating in industries in which Germany is on the technological forefront are more likely to export.

We draw several conclusions from this descriptive analysis. Firstly, exporting firms are distinctively different from non-exporting firms. These differences go beyond differences in the breadth and depth of their search strategy. All control variables appear relevant. Hence, a multivariate analysis is required. Secondly, we find differences and similarities between young and older firms when it comes to their internationalization patterns. Thirdly, a methodological approach is required that takes into account that the export status is a central determinant of export success.

4.2 Multivariate analysis

As the starting point of the empirical analysis we apply the Heckman two-stage selection model to the full dataset. Table 3 shows the results. The estimation procedure provides marginal effects for the selection equation in the first column of Table 3, i.e. the probability to export (export status). The second column shows marginal effects for the export share of sales (export intensity) given that a firm has become an exporter.

We find that breadth and depth have positive effects on a firm's internationalization performance. However, they differ with regard to export status versus export intensity. Both breadth and depth of a firm's search strategy increase its likelihood to become an exporter. An additional t-test reveals that the effects are not statistically different. Once a firm has become an exporter, though, it benefits solely from the depth of its search strategy.

Several control variables have identical effects on export status and intensity. Firm size probably associated with the availability of resources has a positive effect on both, as does the accumulated knowledge of a firm measured by the patent stock per employee. R&D investments in a particular year, though, increase only the likelihood to export. This supports other research stressing the importance of continuous learning activities and accumulated

stocks of knowledge for firm success (see for example Cohen and Levinthal, 1990). Employee skills, measured as the share of employees with college education, provide an additional facet to a firm's knowledge production activities and their effect on internationalization. They turn out to be a differentiating factor with regard to export intensity but not export status.

The marginal effects for regional (East Germany) and industry differences underline the findings of the descriptive data analysis. Firms in West Germany and manufacturing sectors are more likely to be successful exporters.

Table 3: Marginal effects of Heckman two-stage selection model estimation: full sample

Variable	Selection	Regression
	Export status	*Export intensity*
Breadth of search strategy (index)	0.18***	0.01
	(0.05)	(0.04)
Depth of search strategy (index)	0.14***	0.08**
	(0.05)	(0.03)
Company age since found. (years, log)	0.01	0.00
	(0.01)	(0.01)
No of employees (log)	0.05***	0.04***
	(0.01)	(0.01)
Share R&D exp. of sales (ratio)	0.72***	0.15
	(0.13)	(0.11)
Patent stock per empl. (ratio)	2.91***	1.86***
	(1.11)	(0.32)
Share empl. w/ college educ. (ratio)	0.05	0.17***
	(0.06)	(0.04)
Part of company group (d)	-0.04	-0.03**
	(0.03)	(0.01)
Location East Germany (d)	-0.16***	-0.09***
	(0.02)	(0.02)
Medium high-tech manuf. (d)	0.27***	0.12***
	(0.03)	(0.03)
High-tech manuf. (d)	0.14***	0.06**
	(0.04)	(0.03)
Distributive services (d)	-0.32***	-0.09
	(0.03)	(0.06)
Knowledge-intensive services (d)	-0.51***	-0.23**
	(0.03)	(0.10)
Techn. oriented services (d)	-0.26***	-0.11**
	(0.04)	(0.05)
Year: 2005 (d)	0.02	0.04***
	(0.03)	(0.01)
RDI (index)	0.06*	
	(0.03)	
Constant	-0.46***	-0.03
	(0.15)	(0.09)
Lambda		0.10
		(0.09)
R2	0.24	
N	2316	2316
LR Chi2	770.41	94.05
P-value	0.00	0.00

* significant at 10%; ** significant at 5%; *** significant at 1%;
(d) Dummy variable.

Table 4 and Table 5 provide the results to test our hypotheses. In these estimations, the sample was split by the median of firm age (Table 4) as well as into quartiles of firm age

(Table 5).[1] The median sample split yields a group of firms with a maximum age of 13 years. In the second quartile sample split, the youngest quartile comprises firms up to nine years while firms in the oldest quartile are between 22 and 81 years. The two different sample splits are employed to account for differences in the definition of INVs with Table 5 providing the most conservative definition as the youngest quartile. Starting with the median split, Table 4 shows interesting differences between selection and the performance equation. It turns out that both search breadth and depth are important for younger firms in order to internationalize, i.e. to become an exporter. No effects can be observed for the export performance. In contrast to this, search depth seems to be more important for older firms to achieve export performance while the export status remains unaffected by breadth and depth.

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[1] Groups are not equal in size because the median or quartile values were assigned to one group.

Table 4: **Marginal effects of Heckman two-stage selection model estimation: median sample split**

Variable	Below median age (1-13 years)		Above median age (14-81 years)	
	Selection	**Regression**	**Selection**	**Regression**
	Export status	*Export intensity*	*Export status*	*Export intensity*
Breadth of search strategy	0.25***	-0.03	0.08	0.02
(index)	(0.07)	(0.06)	(0.08)	(0.04)
Depth of search strategy	0.23***	0.02	0.03	0.12***
(index)	(0.07)	(0.05)	(0.07)	(0.04)
Company age since found.	0.01	-0.01	-0.07*	0.01
(years, log)	(0.02)	(0.01)	(0.04)	(0.02)
No of employees (log)	0.05***	0.03***	0.06***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Share R&D exp. of sales (ratio)	0.60***	0.11	1.20***	0.25
	(0.14)	(0.13)	(0.32)	(0.18)
Patent stock per empl. (ratio)	1.78*	1.51***	10.99***	2.48***
	(1.07)	(0.39)	(3.92)	(0.54)
Share empl. w/ college educ.	0.07	0.16***	0.01	0.17***
(ratio)	(0.08)	(0.05)	(0.10)	(0.06)
Part of company group (d)	0.00	-0.05***	-0.07**	-0.01
	(0.04)	(0.02)	(0.04)	(0.02)
Location East Germany (d)	-0.14***	-0.08***	-0.22***	-0.09**
	(0.03)	(0.03)	(0.05)	(0.04)
Medium high-tech manuf. (d)	0.29***	0.10*	0.25***	0.13***
	(0.05)	(0.05)	(0.05)	(0.03)
High-tech manuf. (d)	0.11**	0.06	0.19***	0.05
	(0.06)	(0.04)	(0.05)	(0.04)
Distributive services (d)	-0.32***	-0.15*	-0.32***	-0.02
	(0.05)	(0.09)	(0.05)	(0.06)
Knowledge-intens. services (d)	-0.48***	-0.21	-0.55***	-0.20**
	(0.04)	(0.14)	(0.05)	(0.10)
Techn. oriented services (d)	-0.23***	-0.11*	-0.36***	-0.08
	(0.05)	(0.06)	(0.07)	(0.06)
Year: 2005 (d)	0.00	0.02	0.05	0.06***
	(0.04)	(0.02)	(0.04)	(0.02)
RDI (index)	0.07*		0.00	
	(0.04)		(0.06)	
Constant	-0.66***	0.08	-0.13	-0.11
	(0.20)	(0.14)	(0.23)	(0.08)
Lambda		0.06		0.09
		(0.13)		(0.09)
R2	0.23		0.27	
N	1249	1249	1067	1067
LR Chi2	401.13	50.49	382.43	84.47
P-value	0.00	0.00	0.00	0.00

* significant at 10%; ** significant at 5%; *** significant at 1%;
(d) Dummy variable.

Moving on to the quartiles, Table 5 generally tends to support the findings from the median split. Here again, search breadth and depth are important for young firms to internationalize while there is no effect on the export performance. In contrast to this, export performance is affected by searching deeply for innovation sources in the case of the mature firms.

Our findings suggest that the relationship between open innovation search strategies and internationalization performance is not that straightforward once we control for the selection bias inherent to measuring internationalization performance. Apparently, internationalization performance has two facets which can be defined in a broader and a narrower sense. On the one hand, it can be regarded a success if a firm enters international markets in the first place, i.e. becomes an exporter. In this respect, INVs benefit most when they rely on search breadth as well as search depth. Hence, it is not only the search breadth that propels internationalization performance. This finding supports hypothesis 1 while 2 and 3 have to be rejected. On the other hand, internationalization performance depends on the extent to which firms are able to achieve international sales. Interestingly, both search strategies do not matter for INVs when it comes to export intensity, i.e. the scale of internationalization performance. Regarding the third hypothesis which focused on the importance of search depth for mature firms, interesting results can be observed again. Both search strategies appear to be irrelevant for mature firms when it comes to becoming an exporter. Instead, search depth is important for the scale of internationalization. Referring to a narrower definition of internationalization performance, our third hypothesis receives support.

Apart from these focus variables, Table 4 and Table 5 also provide insights into the age-specific effects of our control variables on the export status and intensity. Generally speaking, the different sample splits tend to confirm the findings from the full sample estimation. In this regard, particularly firm size, R&D intensity and the patent stock matter for achieving internationalization performance. The following section will focus on the discussion of our primary results.

Table 5: Marginal effects of Heckman two-stage selection model estimation: quartile sample split

Variable	Youngest 25% quart. (1-9 y.)		25%-50% age quart. (10-13 y.)		50%-75% age quart. (14-21 y.)		Oldest 75% quart. (22-81 y.)	
	Selection	Regression	Selection	Regression	Selection	Regression	Selection	Regression
	Export status	*Export intensity*	*Export status*	*Export intensity*	*Export status*	*Export intensity*	*Export status*	*Export intensity*
Breadth of search strategy	0.27***	0.05	0.21*	-0.17**	0.07	-0.04	0.10	0.07
(index)	(0.10)	(0.08)	(0.11)	(0.08)	(0.11)	(0.08)	(0.11)	(0.06)
Depth of search strategy	0.32***	0.07	0.11	-0.06	0.02	0.12	0.04	0.14**
(index)	(0.10)	(0.08)	(0.11)	(0.07)	(0.12)	(0.08)	(0.10)	(0.06)
Company age since found.	0.00	-0.03	-0.01	0.25*	0.13	0.02	-0.07	0.01
(years, log)	(0.03)	(0.02)	(0.26)	(0.15)	(0.17)	(0.11)	(0.06)	(0.03)
No of employees (log)	0.06***	0.03**	0.04*	0.02	0.05**	0.05***	0.06***	0.04***
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Share R&D exp. of sales	0.24	0.19	1.68***	-0.41	1.42***	0.63**	0.78	0.03
(ratio)	(0.18)	(0.13)	(0.34)	(0.33)	(0.42)	(0.30)	(0.52)	(0.31)
Patent stock per empl. (ratio)	3.86	1.48***	-0.08	2.47***	7.48	3.08***	14.12**	1.38*
	(2.61)	(0.49)	(1.66)	(0.86)	(4.77)	(0.91)	(5.63)	(0.80)
Share empl. w/ college educ.	0.11	0.18***	-0.03	0.13	0.17	0.21**	-0.31**	0.29***
(ratio)	(0.11)	(0.07)	(0.14)	(0.09)	(0.14)	(0.09)	(0.16)	(0.11)
Part of company group (d)	-0.02	-0.07**	0.02	-0.03	-0.02	0.02	-0.13***	-0.02
	(0.05)	(0.03)	(0.06)	(0.03)	(0.05)	(0.03)	(0.05)	(0.03)
Location East Germany (d)	-0.14***	-0.06**	-0.16***	-0.04	-0.15**	-0.13***	-0.44***	0.05
	(0.04)	(0.03)	(0.05)	(0.05)	(0.06)	(0.05)	(0.10)	(0.10)
Medium high-tech manuf. (d)	0.30***	0.10	0.27***	0.01	0.23***	0.14***	0.27***	0.09**
	(0.06)	(0.06)	(0.08)	(0.08)	(0.07)	(0.05)	(0.06)	(0.05)
High-tech manuf. (d)	0.12	0.07	0.07	0.02	0.11	0.04	0.26***	-0.01
	(0.08)	(0.05)	(0.09)	(0.05)	(0.09)	(0.06)	(0.04)	(0.06)
Distributive services (d)	-0.27***	-0.20**	-0.38***	0.14	-0.29***	-0.12	-0.35***	0.10
	(0.06)	(0.08)	(0.07)	(0.15)	(0.07)	(0.09)	(0.07)	(0.08)
Knowledge-intens. services	-0.51***	-0.24	-0.44***	0.08	-0.61***	-0.46**	-0.43***	-0.03
(d)	(0.05)	(0.17)	(0.07)	(0.17)	(0.05)	(0.20)	(0.09)	(0.10)

Variable	Youngest 25% quart. (1-9 y.)		25%-50% age quart. (10-13 y.)		50%-75% age quart. (14-21 y.)		Oldest 75% quart. (22-81 y.)	
	Selection	Regression	Selection	Regression	Selection	Regression	Selection	Regression
	Export status	*Export intensity*	*Export status*	*Export intensity*	*Export status*	*Export intensity*	*Export status*	*Export intensity*
Techn. oriented services (d)	-0.18**	-0.16***	-0.31***	0.11	-0.46***	-0.25**	-0.24*	0.09
	(0.07)	(0.06)	(0.08)	(0.10)	(0.08)	(0.11)	(0.13)	(0.08)
Year: 2005 (d)	0.06	0.03	-0.06	0.00	-0.02	0.01	0.09*	0.07***
	(0.05)	(0.03)	(0.06)	(0.04)	(0.06)	(0.04)	(0.05)	(0.03)
RDI (index)	0.11*		0.04		-0.03		0.03	
	(0.07)		(0.05)		(0.09)		(0.10)	
Constant	-0.96***	-0.02	-0.26	0.45**	-0.14	-0.14	-0.20	-0.08
	(0.28)	(0.17)	(0.35)	(0.18)	(0.35)	(0.15)	(0.35)	(0.11)
Lambda		0.09		-0.25		0.30*		-0.09
		(0.13)		(0.18)		(0.16)		(0.10)
R2	0.24		0.26		0.25		0.33	
N	728	728	521	521	523	523	544	544
LR Chi2	242.78	29.19	185.51	37.39	176.59	28.44	232.51	60.96
P-value	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00

* significant at 10%; ** significant at 5%; *** significant at 1%;
(d) Dummy variable.

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5 Discussion

We have started our analysis with the assertion that knowledge, be it internal or external, can be regarded as the most valuable asset of a firm for achieving competitive advantage (Grant, 1996; Liebeskind, 1996). The way in which firms make use of knowledge to achieve internationalization performance, however, was described as being contingent upon firm age. In this respect, we have concentrated on the internationalization process of young firms and contrasted them with mature firms. In fact, our results support the essence of our theoretical reasoning. Nevertheless, our empirical analysis has shown that the assumed relationships are more complex than hypothesized.

Our analysis draws an important distinction between the export status as the first step of the internationalization process and the export intensity as the scale of this internationalization performance. Search breadth and depth have been shown to be of varying relevance, depending on which performance facet we are looking at and on firm age. First of all, our results substantiate the benefits of following an open innovation strategy (Chesbrough, 2003; Laursen and Salter, 2006). These positive effects appear on various levels for almost all groups of firms. In fact, search breadth and depth are particularly important for young firms for entering foreign markets. Obviously, external knowledge impulses enable these firms to develop internationally competitive products, processes or services. In other words, external knowledge contributes towards creating a unique advantage that motivates young firms to seek sales from abroad (Dunning, 1973). Hence, open innovation can be assumed to lead to higher product quality and product uniqueness in that they open up the way for firm internationalization (Kayak et al., 1987; Lecraw, 1989).

Another finding supporting this reasoning is the high importance of a firm's own R&D expenditure for achieving the export status for middle-aged firms. As a consequence, superior product quality and uniqueness seem to be driven by openness (breadth and depth) for externally available knowledge combined with internal technological capabilities, leading to a notion of an "interconnected technology-push" in the internationalization process. However, open innovation does not, i.e. neither search breadth nor depth, contribute to the level of export sales in international entrepreneurship. The export intensity appears to be much more dependent on other firm level factors like the stock of knowledge, measured by patents, or the educational level of the employees. Moreover, an INV's R&D intensity does not influence

export intensity, suggesting that the actual level of foreign sales of INVs is not so much technology-driven. We conclude that open innovation strategies enable young firms to differentiate themselves from non-exporting firms through superior products, processes and services. Once they have entered international markets, though, this general access to external knowledge is not a distinguishing factor. We suspect that export success may no longer depend upon a general stock of knowledge but rather specific interactions with leading customers, competitors or suppliers abroad. In that sense, the focus shifts from general knowledge acquisition to specific, often times experimental learning.

Our findings tell a very different story when it comes to the mature firms in our sample. The results suggest that important differences exist between the way young and mature firms make use of external innovation impulses. Apparently, both search strategies do not matter for mature firms to attain the exporter status. Rather, they reap benefits from searching deeply to increase the share of foreign sales, i.e. to increase internationalization performance in a more narrow sense. Although search depth has been shown to be relevant for both young and mature firms, the effects of such a search strategy are distinctively different. As young firms typically have only a given pool of resources from which to draw they search deeply in order to recognize opportunities (Brush *et al.*, 2001). Once the assumes the export status, i.e. has moved on in its internationalization process, search strategies become less important. Particularly a high search depth incurs considerable costs as the channels of interaction need to be developed and intensified. Hence, young firms use both search strategies to jump over a hurdle, but they need to realign their search activities in the second stage when it comes to the level of international sales. In contrast to this, mature firms can "afford" to follow a different objective when employing a particular search strategy. In other words, they may use a deep search strategy deliberately to increase their export intensity given that they have become an exporting firm in the first place. This result also hints at higher levels of legitimacy that mature firms may have achieved compared with new ventures (Rao *et al.*, 2008). They should be able to benefit from a reduced liability of newness as they become more established, accumulate the required experience and the necessary resources (Stinchcombe, 1965).

These findings have important implications. While INVs conceive search strategies primarily as a way to identify and exploit opportunities in foreign markets (Zahra, 2008), mature firms deliberately use intensive interactions with external knowledge sources to extend their international engagement. There appears to be a special challenge for INVs to refine and readjust their search strategies once they have entered foreign markets. This supports existing

literature on the need to reconfigure absorptive capacities when searching for knowledge outside the firm's national and cultural environment (Sofka, 2008). In this respect, a lack of legitimacy seems to be a major barrier for INVs to actually increase the benefits that they can reap from their search activities. As legitimacy can not only be built through an extended resource base, INVs should consider other means to compensate for this. In this respect, Rao et al. (2008) have suggested that alliances can be used to build legitimacy. We argue that these efforts should also translate into enhanced opportunities for identifying and exploiting external knowledge sources which can in turn be used to foster internationalization performance of young firms.

6   Conclusion and further research

Our research has explored the links between open innovation search strategies and internationalization performance while considering the moderating effects of firm age. To date, the effect of search strategies on firm performance has only been analyzed in the context of innovation (Katila and Ahuja, 2002; Laursen and Salter, 2006). Both, search breadth and depth, have been characterized as being conducive to higher innovation performance. While these search strategies have also proven to be relevant in the internationalization process of the firm, our theoretical reasoning and empirical findings have outlined several trajectories through which internationalization performance is affected. By conceptually differentiating between the decision to export and the subsequent extent of international sales we contribute to the literature on the driving forces of internationalization in young firms. We show that entrepreneurs use external knowledge as a door opener to internationalization. However, there appear to be limits on how these general open innovation knowledge assets can subsequently be exploited to achieve higher sales abroad. In contrast to this, mature firms draw deeply from external knowledge to increase their sales. We argue that the build-up of legitimacy could be a viable strategy for young firms to increase the pace of the internationalization process.

While our research provides insights into effectiveness of search strategies in young firms, it would be desirable to study the evolution of INVs and their use of external innovation impulses which would require a longitudinal setup. We cannot track the geographical dispersion of valuable knowledge sources in the firm's environment at this point. However, we consider this a very fruitful path for future research to track and analyze shifting search strategies of internationalizing firms. Moreover, further research should explore the

opportunities for young firms to build legitimacy and to establish linkages with external actors whose knowledge provides valuable inputs to the innovation process more deeply.

Appendix

Appendix A: Industry breakdown

Industry	NACE Code	Industry Group
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewelry, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.3	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

Appendix B: Correlation matrix and variance inflation factors

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Breadth of search strategy (index)	1.00								
(2)	Depth of search strategy (index)	-0.04	1.00							
(3)	Company age since found. (years, log)	-0.01	-0.02	1.00						
(4)	No of employees (log)	0.18	-0.05	0.18	1.00					
(5)	Share R&D exp. of sales (ratio)	0.15	0.09	-0.09	-0-17	1.00				
(6)	Patent stock per empl. (ratio)	0.04	0.01	0.01	0.00	0.11	1.00			
(7)	Share empl. w/ college educ. (ratio)	0.13	0.06	-0.17	-0.28	0.37	0.08	1.00		
(8)	Part of company group (d)	0.11	-0.09	0.03	0.24	-0.03	-0.02	-0.03	1.00	
(9)	Location East Germany (d)	0.01	0.04	-0.25	-0.13	0.11	-0.03	0.19	-0.01	1.00
(10)	Medium high-tech manuf. (d)	0.06	0.03	0.04	0.09	0.03	0.07	-0.04	0.00	-0.05
(11)	High-tech manuf. (d)	0.08	-0.03	-0.00	-0.06	0.13	0.05	0.76	-0.02	0.02
(12)	Distributive services (d)	-0.13	-0.04	0.03	-0.03	-0.14	-0.06	-0.14	-0.02	0.02
(13)	Knowledge-intensive services (d)	-0.010	-0.02	0.01	0.06	-0.09	-0.04	0.01	0.00	-0.04
(14)	Techn. oriented services (d)	0.07	0.01	-0.15	-0.23	0.29	0.04	0.57	-0.01	0.08
(15)	Year: 2005	0.12	-0.14	0.06	-0.09	0.01	0.03	-0.07	0.29	-0.04
(16)	RDI (index)	0.05	0.04	0.02	0.12	0.01	0.07	-0.10	0.03	-0.02
	Variance Inflation Factors (VIF)	1.15	1.04	1.12	1.34	1.25	1.03	1.85	1.19	1.12

	Variable	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(10)	Medium high-tech manuf. (d)	1.00						
(11)	High-tech manuf. (d)	-0.14	1.00					
(12)	Distributive services (d)	-0.18	-0.12	1.00				
(13)	Knowledge-intensive services (d)	-0.15	-0.01	-0.13	1.00			
(14)	Techn. oriented services (d)	-0.20	-0.14	-0.17	-0.14	1.00		
(15)	Year: 2005	-0.01	0.03	-0.09	-0.03	-0.03	1.00	
(16)	RDI (index)	0.60	0.03	-0.20	-0.15	-0.25	0.01	1.00
	VIF	1.75	1.24	1.27	1.24	2.06	1.20	1.69
	Mean VIF	1.35						
	Condition Number	14.46						

Appendix C: Marginal effects of Heckman two-stage selection model estimation (test of Heckman model specification)

Variable	Selection	Regression
	Export status	*Export intensity*
Breadth of search strategy (index)	0.18***	0.02
	(0.05)	(0.04)
Depth of search strategy (index)	0.14***	0.09**
	(0.05)	(0.03)
Company age since found. (years, log)	0.01	0.00
	(0.01)	(0.01)
No of employees (log)	0.05***	0.04***
	(0.01)	(0.01)
Share R&D exp. of sales (ratio)	0.72***	0.19*
	(0.13)	(0.11)
Patent stock per empl. (ratio)	2.91***	1.94***
	(1.11)	(0.34)
Share empl. w/ college educ. (ratio)	0.05	0.18***
	(0.06)	(0.04)
Part of company group (d)	-0.04	-0.04**
	(0.03)	(0.02)
Location East Germany (d)	-0.16***	-0.10***
	(0.02)	(0.02)
Medium high-tech manuf. (d)	0.27***	0.12***
	(0.03)	(0.04)
High-tech manuf. (d)	0.14***	0.06**
	(0.04)	(0.03)
Distributive services (d)	-0.32***	-0.11*
	(0.03)	(0.06)
Knowledge-intensive services (d)	-0.51***	-0.27***
	(0.03)	(0.10)
Techn. oriented services (d)	-0.26***	-0.12**
	(0.04)	(0.05)
Year: 2005 (d)	0.02	0.04***
	(0.03)	(0.01)
RDI (index)	0.06*	0.02
	(0.03)	(0.01)
Constant	-0.46***	-0.08
	(0.15)	(0.10)
Lambda		0.15
		(0.10)
R2	0.24	
N	2316	2316
LR Chi2	770.41	91.22
P-value	0.00	0.00

* significant at 10%; ** significant at 5%; *** significant at 1%;
(d) Dummy variable.

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