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ESSAYS ON THE DETERMINANTS OF FIRM INNOVATIVENESS, PERFORMANCE, AND INTERNATIONALIZATION

eingereicht von

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To my family –

especially my Parents,

Siblings, and Husband

Contents

Abstract

This dissertation investigates the forces driving firm innovativeness, performance, and internationalization, focusing on the effects of firm location by employing survey data from approximately 6,200 East German firms. The impact of firm environment is captured through three aspects: locational conditions, collaboration activities, and competition situation. What makes this thesis unique is that it uses firms' perceptions of the importance and quality of 15 different locational factors to assess the influence of locational characteristics. This approach takes into consideration that not all locational factors affect the performance and operations of all firms equally. The analysis also includes firm-related factors that allow consideration of firm heterogeneity in terms of size, age, and industry affiliation.

Keywords: Locational Conditions, Cooperation, Firm Innovativeness, Performance, Competitive Advantage, Internationalization, Spin-Offs, Partial Least Squares, Bivariate Probit Model

Zusammenfassung

In der vorliegenden Dissertation werden die Determinanten der Innovativität, Performance und Internationalisierung von Unternehmen untersucht, mit Schwerpunktlegung auf die Wirkung von Unternehmensstandortbedingungen. Die Daten aus der Befragung von etwa 6.200 ostdeutschen Unternehmen bilden die Grundlage der Analyse. Der Einfluss der Unternehmensumwelt wird durch drei Aspekte erfasst: Standortfaktoren, Kooperationsaktivitäten und Wettbewerbsituation. Die Besonderheit dieser Untersuchung liegt darin, dass die Unternehmenseinschätzungen der Wichtigkeit und Qualität von 15 unterschiedlichen Standortfaktoren verwendet werden. Diese Vorgehensweise berücksichtigt, dass nicht alle Standortfaktoren die Performance und die Aktivitäten aller Unternehmen im gleichen Maße beeinflussen. Weiterhin werden auch unternehmensspezifische Faktoren, welche die Heterogenität von Unternehmen bezüglich der Größe, des Alters und der Branche erfassen, in Betracht gezogen.

Schlüsselwörter: Standortfaktoren, Kooperation, Unternehmensinnovativität, Performance, Wettbewerbsvorteil, Internationalisierung, Spin-Offs, Partial Least Squares, Bivariate Probit Model

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Chapter 1 Introduction

There is a large and growing body of theoretical and empirical research on the spatial allocation of economic activity. In its early stages, the theory of location (see, e.g., Lösch 1938; Weber 1929) explained regional performance differences as due to natural factor endowment and transport costs. More recent strands of this research—the new economic geography and regional economic performance and growth—shift toward analyzing how various locational attributes impact regional development and competitiveness (e.g., Asheim and Gertler 2005; Cooke and Morgan 1998; Gordon 1991). The focal point of this research is on the locational characteristics that incubate and foster innovation and technology transfer, such as the presence of a university, regional human capital availability, and regional networking systems (e.g., Beise and Stahl 1999; Feldman 1999; Jensen and Thusby 2001; Mowery and Ziedonis 2001; Zucker, Darby and Amstrong 1998).

Since regional performance is the cumulative outcome of individual economic units, some scholars have explored the locational antecedents of performance at the micro-level in their efforts to explain regional variation. Though various theoretical approaches—e.g., the general theory of location, the cluster approach, or regional innovation systems—generally emphasize the pivotal role of firm location in its performance and development, the extant empirical research on this topic is, to date, limited, providing only fragmentary evidence about these relationships. Most econometric studies concentrate on the impact of one or a few particular locational factors, without considering larger sets of locational conditions (Babtista and Swann 1998; Brouwer, Budin-Nadvornikova and Kleinknecht 1999; Ronde and Hussler 2005). This dissertation starts filling this gap by providing empirical evidence on the relationship between locational conditions and firm performance and activity.

1.1 Basic Ideas

The main objective of this thesis is to investigate the antecedents of firm innovativeness, performance, and internationalization, focusing on locational effects. The impact of a firm's environment on its performance and activity is captured via the following aspects: (1) locational conditions, (2) collaboration and networking, and (3) competition situation.

With respect to locational conditions, the literature highlights the role of several factors that facilitate the generation and accumulation of knowledge within a firm and/or an industry, including most particularly, the presence of a university or other research facility, support from government and other institutions, and the availability of skilled labor influence (e.g., Beise and Stahl 1999; Feldman 1999; Longhi 1999; Meyer 2003; Rees and Stafford 1986; Stöhr 1986; Zucker et al. 1998). However, it is also argued that due to a high heterogeneity among individual firms, their needs and requirements as to locational conditions are heterogeneous, too (Diller 1991; Funk 1995; Grabow et al. 1995; Dziembowska-Kowalska and Funk 2000). In other words, different locational factors influence and/or favor performance and activities of different firms. Accordingly, the main proposition of this dissertation is that favorable locational factors, that is, those factors that are favorable to a certain firm, enhance its innovativeness, performance, and foreign activities.

Furthermore, many studies find that a firm's operation and performance depend on its ability to form strategic alliances and its integration into diverse exchange networks (e.g., Best 2001; Blankenburg and Johanson 1992; Campagni 1991; Cunningham and Cullingan; Johanson and Vahlne 1990, 1992; Porter 2000). By exploiting the complementary potential of their members' capabilities, competencies, and resources, networks facilitate accomplishment of members' mutually beneficial, although not necessarily identical, goals. Thus, collaboration and networking should enhance firm innovativeness, performance, and internationalization.

As suggested by the literature on regional innovation systems and the cluster approach, the competition environment is of special importance to firm innovation and foreign activity, as well as performance. Geographically proximate strong rivals exert constant pressure on firms to innovate, improve product and quality standards, and increase efficiency (Beise-Zee and Rammer 2006; Porter 1990, 2000).

In addition to the impact of specific external environmental factors, a firm is also influenced by a wide range of firm-related characteristics and capabilities, including size, age, and industry or affiliation with a firm group (see, e.g., Acs and Audretsch 1990; Agell 2004; Cantwell 1992; Davies and Geroski 1997; Feldman and Audretsch 1999; Johansson, Lööf and Olsson 2005; Keppler 1997; Mansfield 1963; Patel and Pavitt 1995). Thus, the analysis considers firm-specific attributes.

Finally, this thesis aims to assess the influence of innovativeness on firm performance and internationalization. Figure 1 illustrates the expected relationships between a firm's

environment, its characteristics, innovation and R&D activities, performance, and internationalization.

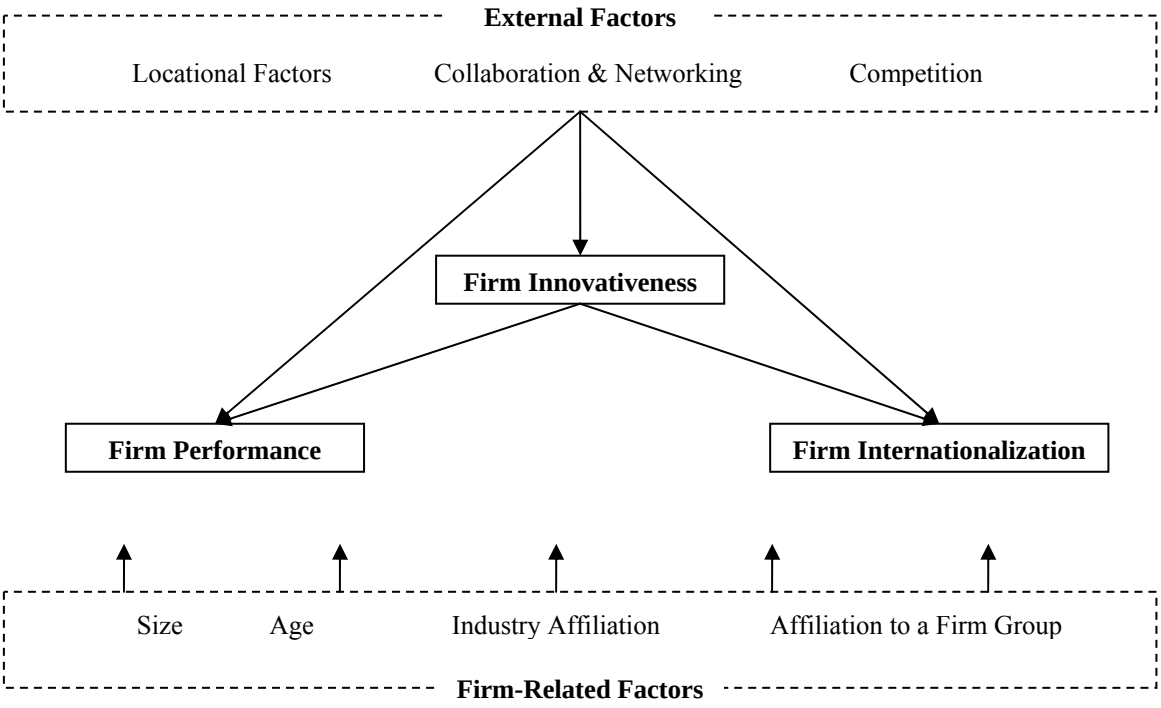

Figure 1: Outline of dissertation analysis

1.2 Contribution of This Dissertation

The determinants of firm innovativeness, performance, and internationalization are analyzed by employing micro-level data collected by the German Institute for Economic Research (DIW Berlin) in a large survey entitled "Current Situation and Outlook of East German Firms." [1] The survey was sent to about 30,000 firms in the year 2004, garnering a response rate of approximately 20 percent. The questionnaire consists of 49 questions about the firm generally, its business operations, the economic and competition situation, and R&D and innovation activities, as well as collaboration and networking. The firms were also asked to assess the importance and quality of 15 different locational conditions, such as regional availability of skilled labor, proximity to universities, transportation links, and various types of support provided by regional authorities and institutions.

These unique data allow us to discover what firms themselves consider attractive and desirable in regard to location. Hence, applying the importance filter specific to an individual firm for each locational factor, the analysis considers the fact that not all locational attributes influence the performance and operations of firms equally. On the other hand,

[1] The survey was carried out on behalf of the German Ministry of Education and Science.

taking the firm's assessment at face value raises certain concerns as to accuracy of facts and bias. Indeed, a firm's assessment of locational conditions may not be accurate objectively speaking (e.g., perceived vs. actual distance from an airport or university). However, these perceptions, objectively true or not, do influence firm decisionmaking and behavior (Britton 2004; Oerlemans et al. 2001; Rees and Stafford 1986). Moreover, Czarnitzki and Hottenrott (2009) investigates the impact of firm location on the share of total sales due to new products using both actual regional characteristics and firm perceptions of the importance of six locational factors. Their results show that firm perceptions are far better at explaining innovation performance than are the objective conditions. Hence, we claim that our data are well-suited to testing for locational effects.

Firm innovation and performance are not simple, unidimensional phenomena, and so to better understand these complex issues we take a multi-measure approach. Innovativeness is assessed in terms of introducing novel products and new processes, applying for patents, or R&D deployment share. Firm performance is measured by productivity (total turnover over number of employees), export intensity (export share in total turnover), expectations about market volume development, and firm assessment of competition situation.

This dissertation is comprised of three essays; each of which is outlined below.

1.2.1 Locational and Internal Sources of Firm Competitive Advantage: Applying Porter's Diamond Model

In Chapter 2, we examine the relationships between a firm's locational environment, its innovation capabilities, and competitive advantage assessed in terms of various performance indicators. The study is based on Porter's diamond model, which lists four (hence the diamond analogy) external sources of firm competitive advantage: (1) factor conditions, (2) demand conditions, (3) related and supporting industries, and (4) firm strategy and rivalry. The diamond model also takes into consideration the influence of government and chance play on each of its four facets. Moreover, Porter views the internal (firm-specific) determinants—particularly firm innovativeness—as major sources of achieving and sustaining competitiveness and performance.

In the empirical analysis, we develop a structural equation model using Porter's diamond model as a theoretical framework and estimate the model using the partial least squares (PLS) method. The analysis takes into consideration the heterogeneity among firms and the impact of different (settlement) types of firm location. This study distinguishes between high-innovative and less-innovative firms in order to investigate whether

the competitive advantage of high-innovative firms is more locally embedded than that of their less-innovative counterparts, or vice-versa.

The results reveal that a high frequency of cooperation spurs firm innovativeness and performance but that a strong focus on local demand impedes both. The investigation confirms that firm innovativeness positively affects competitive advantage. Furthermore, the findings show important differences between high-innovative and less-innovative firms. The innovativeness and performance of less-innovative firms appear to be more locally embedded than is the case for high-innovative firms. Various types of governmental support, as well as the quality of locational factors, tend to be more important for less-innovative companies compared to the more innovative ones. Surprisingly, the results indicate that strong local competition is an impediment to firm innovativeness and performance.

1.2.2 Locational Conditions, Cooperation, and Innovativeness: Evidence from Research and Company Spin-Offs

In Chapter 3, we analyze the relationships between locational factors, cooperation activities, and innovativeness, focusing this time on spin-off companies. Spin-offs have a unique role in the economy, being viewed as one of the most effective and efficient ways of transferring and commercializing the knowledge and technology that arises out of research facilities into marketable products. This study extends the literature, which mostly concentrates on research spin-offs (also termed university or academic spin-offs), by taking a look at spin-offs from companies and, in the process, investigates the following issues:

(1) The extent to which spin-off innovativeness is influenced by locational conditions. We disentangle the effect of locational factors on innovativeness by taking into account the possibility of an indirect effect via collaboration activities.

(2) How important geographical proximity to cooperation partners is to the innovation development process, especially considering that a great deal of firm collaboration occurs with nonlocal partners.

(3) The sustainability of innovation throughout a spin-off's lifespan, that is, being born of innovation, in a manner of speaking, do they continue to be more or less innovative than firms created in other ways?

These questions are answered by employing a methodology similar to that described in Chapter 2. We develop an appropriate structural equation model that is estimated with the

partial least squares method. In addition, we control for the effect of firm-related characteristics and the impact firm location settlement type.

The findings show that certain locational conditions—in particular, close proximity to research institutes and various types of support—significantly strengthen the intensity of cooperation activities, mainly with local partners, for spin-offs. These locational conditions appear to play a very important role in the innovativeness of research spin-offs (captured as a direct effect).

This research confirms the positive relationship between cooperation intensity and firm innovativeness. However, it appears that it is not local but, rather, nonlocal cooperation ties that are more conducive to innovativeness of research spin-offs. The findings also highlight that the innovativeness of research spin-offs having solely local links is strongly dependent on support from various authorities and institutions.

Finally, even though the descriptive analysis confirms that firms that begin as research spin-offs tend to be more innovative than the other groups of firms, our econometric analysis implies that type of firm creation is not decisive for innovativeness in later phases of a firm's development.

1.2.3 Determinants of Internationalization: Differences Between Service and Manufacturing SMEs

In Chapter 4, I investigate the antecedents of internationalization of SMEs, focusing on differences between the manufacturing and service sectors. Specifically, I examine the factors determining firm choice of two internationalization strategies—exporting or relocating production or other operations abroad—and whether the particular antecedents are substantively different between service and manufacturing SMEs. To this end, I employ a bivariate probit model that can account for the correlation between the two internalization strategies. The model includes both internal and external factors. Internal factors are firm-related variables, such as size, age, sector, or innovation capabilities. External factors, such as quality of firm location, competition situation, and collaboration and networking activity, are designed to discover the impact of the firm environment on its foreign activity.

The results reveal that three factors are especially important in the internationalization of SMEs. First, firm size—assessed in terms of number of employees—relates significantly positively both to exports and relocations abroad. The second crucial factor is the competition situation: having main rivals abroad influences an SME to also engage in the foreign market; however, having main competitors co-located has a dampening effect on

international activities. Third, firm innovativeness—particularly the introduction of novel products and patent applications—enhances internationalization.

With respect to whether internationalization behavior varies between SMEs in the manufacturing and service sectors, I find that manufacturing firms, particularly in high-tech industries, do more exporting than their service counterparts. In fact, it appears that it is only the introduction of a novel product, on either the domestic or foreign market, that leads to export activity by service SMEs. For the manufacturing sector, two innovation output variables—patent applications and novel products—are conducive to exporting. Interestingly, however, manufacturing firms with a high deployment share in R&D and/or that assess proximity to research facilities as an important and good locational condition, are less likely to relocate. Finally, locational conditions and cooperation activities are generally less important for internationalization of service firms compared to their manufacturing counterparts.

1.2.4 Summary

Table 1 is a brief summary of the three chapters and their publication status, and also details author contributions.

1.3 Concluding remarks

The findings of this thesis are of relevance to both practicing managers and public policy-makers. Managers can significantly improve a firm's chances of success in terms of innovativeness and, in turn, performance, by networking and engaging in more frequent collaboration with a variety of partners, including research institutes and other firms. Policy-makers will find the results useful in designing policies to sustain firm innovativeness by encouraging cooperations and improving locational conditions, in particular, by facilitating access to the knowledge available from universities and research institutes. Finally, the strategic provision of various forms of support will encourage exporting, but keep the actual production facilities and, even more important, the jobs at home.

Table 1: Summary of chapters

Chapter	Publication status	Author's contribution	Main findings
2	Updated version of working paper by Eickelpasch, Lejpras, and Stephan (2007); submitted to the *Journal of Business Research*	Author was responsible for developing and estimating the model, interpreting the results, and writing the bulk of the analyses/text	Collaboration spurs firm innovativeness and performance; governmental support and quality of locational factors more important for less-innovative firms; strong local competition and focus on local demand impedes firm innovativeness and performance
3	Updated version of working paper by Lejpras and Stephan (2008); accepted for publication in the *Annals of Regional Science*	Author was responsible for estimating the model, interpreting the results, and writing the bulk of the analysis/text; model development was collaborative	Proximity to research facilities most influential factor for intensity of cooperation; collaboration spurs firm innovativeness; nonlocal (vs. local) collaboration more conducive to innovativeness of research spin-offs; how firm created not decisive of later innovativeness
4	In preparation for submission to *Small Business Economics*	Author's independent research	Size, competition, and innovativeness generally of most importance to SME internationalization; for manufacturing sector, but not for services, being in a high-tech industry conducive to internationalization; also locational conditions and collaboration less important for service firms than for their manufacturing counterparts

Chapter 2 Locational and Internal Sources of Firm Competitive Advantage: Applying Porter's Diamond Model

2.1 Introduction

Porter (1990) posits that national competitive advantage finds its source in a combination of strategic management and international economics. Porter's framework influences and stimulates a large and growing body of theoretical and empirical research. The diamond model has been applied at the country and/or industry level (e.g., Bellak and Weiss 1993; Cartwright 1993; Crouch and Ritchie 1999; Jin and Moon 2006; Hodgetts 1993; Moon, Rugman and Verbeke 1998; Öz 2002; Porter 1990), and has also been employed to explore the sources of competitive advantage in particular regions or even cities (e.g., Nail and Ahlstrom 2007; Windsberger 2006).

Despite the fact that Porter himself mentions extension of the diamond model to the firm level, use of the model to investigate the locational antecedents of firm competitiveness and performance are rare and, moreover, limited to qualitative analyses based on interviews with managers or consist of case studies of firms mainly located in certain clusters and well-known, advantaged regions (e.g., Britton 2004; Tavoletti and te Velde 2007; Windsberger 2006).

Using Porter's diamond model as a framework, this paper estimates to what extent locational resources impact firm innovativeness and performance. The analysis uses data on 2,345 East German firms collected in a survey conducted in 2004. The questionnaire included many aspects of innovation activities, performance indicators as well as frequency of cooperation activities in various fields, and, additionally, had a special focus on the assessment of locational conditions with respect to 15 different locational factors, ranging from qualified labor, proximity to customers, research facilities, and transportation infrastructure to support by local authorities. Taking into consideration that locational conditions improved significantly over the last 15 years in many East German regions and, on the other hand, that a strong heterogeneity still exists among its regions (Fritsch, Hennig, Slavtchev and Steigenberger 2007), these data are ideally suited for testing the influence on locational effects on firm performance.

To examine the sources of firm competitive advantage, the present study develops a structural equation model and estimates the model using the partial least squares (PLS) method. This method appears infrequently in business research, but the approach is useful for estimating complex cause-effect relationship models and allows both for reflective and formative specifications of the latent variables (e.g., Gudergan, Ringle, Wende and Will 2008; Lohmöller 1989; Wilcox, Howell and Breivik 2008). To account for the multidimensionality, that is, various aspects of the latent variables included in the structural equation model, they are operationalized as formative measurement models and represent indexes—combinations of their various indicators (see Coltman, Devinney, Midgley and Venaik 2008 for an overview on theoretical and empirical considerations in model specification).

The paper is structured as follows. Section 2 describes Porter's diamond model and key criticisms of it. Section 3 provides details about the data. Section 4 contains a brief overview of methodological issues, followed by a presentation of the model design. The estimation results appear in Section 5. Conclusions and limitations of the study as well as suggestions for future research are in Sections 6 and 7.

2.2 Theoretical Background: Porter's Diamond Model

Porter's diamond model stresses the significance of both internal and external sources in creating firm competitive advantage (Porter 1998b): "Untangling the paradox of location in a global economy reveals a number of key insights about how companies continually create competitive advantage. What happens inside companies is important, but clusters reveal that immediate business environment outside companies plays a vital role as well." Porter views firm innovation activities as a major internal source of achieving and sustaining competitiveness and performance. Thus, he defines innovation very broadly as something with a novel feature, including not only new technologies embodied in a new product design or a new production process, but even including new ways of doing things, for example, a new marketing approach or a new training method (Porter 1998a). Innovation is conducive to enabling companies to break into entirely new markets or discover an overlooked market segment or niche. Moreover, to achieve international leadership, it is necessary that consistent innovation, defined as a process of constant improvement and upgrading, is part and parcel of a firm's strategy (Porter 2000).

However, Porter finds that firm competitive advantage and ability to persistently innovate are also embedded in external sources, that is, national and/or locational attributes—knowledge, relationships, motivation—that distant competitors cannot match (Porter

1998a; 1998b). In the diamond model (see Figure 2), Porter presents the environmental antecedents of national competitive advantage, namely, factor conditions, demand conditions, and related and supporting industries as well as firm strategy and rivalry. Moreover, Porter includes the effect of government and chance on these four major external factors of competitive advantage.

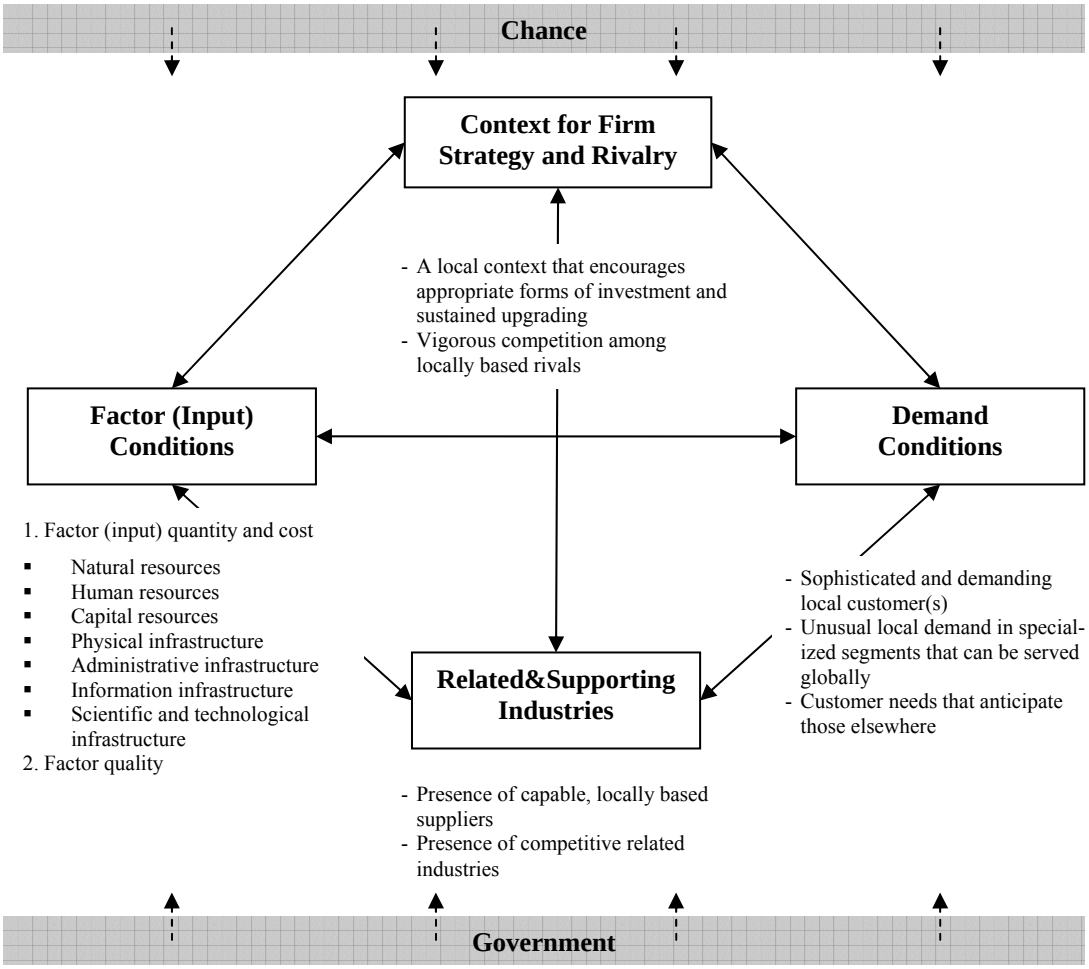

Figure 2: Porter's diamond model

Source: Porter (2000)

With respect to factor conditions, Porter argues that access to specialized and advanced input factors (such as highly skilled human resources or scientific and technological infrastructure) leads to competitive advantage in knowledge-intensive industries. These production factors are scarce, expensive, and more difficult for foreign rivals to imitate than generalized and/or basic factors are. On the other hand, however, selective disadvantages in more basic factors may have also a stimulating effect by exerting pressure on firms to innovate and upgrade so as to overcome these factor shortages.

According to Porter, demand conditions in the home base influence industry competitiveness through three mechanisms. First, an industry will have an advantage when a particular market segment is larger and more important at home than elsewhere. Second, sophisticated, demanding buyers in the home base pressure firms to meet high standards, to innovate, and to upgrade into more advanced market segments. Third, the demands of domestic buyers should anticipate the needs of customers from other countries. Porter argues that a large home market that meets all three conditions will be highly supportive of international competitiveness.

Related and supporting industries make up the third corner of the diamond model. The relationships between firms and suppliers play a decisive role in the value chain that is crucial for innovation and improvement. In close collaboration, local suppliers assist firms in establishing new methods and technologies. Productivity enhancement also occurs when cluster participants recognize their complementarities and facilitate them.

The fourth antecedent of national competitive advantage is firm strategy and rivalry. Porter stresses the decisive role of geographically proximate, strong rivals: such a situation results in a constant pressure on each firm to offer competitive products, quality improvements, and strategic differences.

In addition, Porter's model captures the roles that government and chance play (e.g., unpredictable technological discontinuities, wars, and other chance events) as factors influencing the functioning of these four environmental antecedents (Porter 1990).

Porter's diamond model is not without its critics (e.g., Davies and Ellis 2000; Gray 1991; Martin and Sunley 2003; Reich 1990; 1991). One of the most fundamental criticisms has to do with the model's high level of abstraction and the ambiguity of the manifestation of proposed relations, that is, Porter's shifts in explaining the competitive advantage or competitiveness at a variety of conceptual scales: the nation, the industry, the individual firm or the regional and locational levels. Moreover, Porter claims that all aspects in the diamond model interact and reinforce each other but, in fact, the model does not explicitly include independent variables: every variable is related to the other variables, thus each variable is dependent. These mutual relationships between the environmental antecedents permit a wide range of causal relations and interpretations and are therefore quite problematic. Finally, the diamond model has not yet been operationalized for empirical testing at the micro-level. This study intends to fill this gap.

2.3 Data

The analysis uses firm-level data collected by the German Institute for Economic Research (DIW Berlin) in 2004. About 30,000 companies from East Germany were surveyed; the response rate was approximately 20 percent. The questionnaire included 49 questions pertaining to general information about the firm and its activities, business and competition situation, innovation and R&D activities, and collaboration and networking, as well as questions about locational conditions.

After deleting observations with missing values, the data set consists of 2,345 firms. The study distinguishes between high-innovative firms (541 firms) and those that are less so (1,804 firms). A company is considered a high-innovative firm if it either developed and brought a completely novel product to the market or applied for a patent in 2003/2004.

Table 2: NACE codes for high-innovative and less-innovative firms

NACE code	Description	**High-innovative firms**		**Less-innovative firms**	
		Number	*% in H*	*Number*	*% in L*
15	Manufacture of food products and beverages	27	5.0	121	6.7
17	Manufacture of textiles	8	1.5	27	1.5
18	Manufacture of wearing apparel	2	0.4	16	0.9
19	Tanning and dressing of leather	1	0.2	8	0.4
20	Manufacture of wood and of products of wood and cork, except furniture	8	1.5	64	3.6
21	Manufacture of pulp, paper and paper products	5	0.9	18	1.0
22	Publishing, printing and reproduction of recorded media	12	2.2	124	6.9
24	Manufacture of chemicals and chemical products	22	4.1	30	1.7
25	Manufacture of rubber and plastic products	26	4.8	78	4.3
26	Manufacture of other non-metallic mineral products	23	4.3	81	4.5
27	Manufacture of basic metals	4	0.7	27	1.5
28	Manufacture of fabricated metal products, except machinery and equipment	51	9.4	334	18.5
29	Manufacture of machinery and equipment n.e.c.	78	14.4	158	8.8
30	Manufacture of office machinery and computers	6	1.1	6	0.3
31	Manufacture of electrical machinery and apparatus n.e.c.	24	4.4	54	3.0
32	Manufacture of radio, television and communication equipment and apparatus	21	3.9	21	1.2
33	Manufacture of medical, precision and optical instruments, watches and clocks	63	11.7	79	4.4
34	Manufacture of motor vehicles, trailers and semi-trailers	8	1.5	19	1.1
35	Manufacture of other transport equipment	5	0.9	19	1.1
36	Manufacture of furniture; manufacturing n.e.c.	17	3.1	65	3.6
37	Recycling	2	0.4	41	2.3
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	1	0.2	3	0.2
52	Retail trade, except of motor vehicles and motorcycles	1	0.2	3	0.2
71	Renting of machinery and equipment without operator and of personal and household goods	-	-	32	1.8
72	Computer and related activities	41	7.6	110	6.1
73	Research and development	27	5.0	6	0.3
74	Other business activities	58	10.7	260	14.4
Total		**541**	**100%**	**1,804**	**100%**

NOTE: H refers to high-innovative firms, L are less-innovative firms.

This distinction is important because this study aims to explore whether the competitive advantage of high-innovative firms is more locally embedded than that of less-innovative firms, or vice versa. In other words, the goal is to investigate how important a firm's close environment is to its innovation capabilities and competitive advantage taking degree of innovativeness into consideration.

Table 2 shows the distribution of firms within economic sectors at the NACE 2 level;[2] about 75 percent of the firms in both groups (high- or less-innovative) are manufacturing firms. However, but not surprisingly, the high-innovative firms in the sample appear more frequently than the less-innovative firms in manufacturing branches generally regarded as innovative (see Götzfried 2004), for example, chemicals and chemical products (NACE 2: 24), machinery and equipment (NACE 2: 29), or medical, precision, and optical instruments, watches, and clocks (NACE 2: 33).

Figure 3 presents the geographical distribution of the two subsamples of firms: 13.6 percent of the high-innovative firms (H) and 15.9 percent of the less-innovative firms (L) are located in Berlin, 11.7 (H) and 11.6 (L) percent in Brandenburg, 8.2 (H) and 6.1 (L) percent in Mecklenburg-Vorpommern, 11.4 (H) and 10.7 (L) percent in Saxony-Anhalt, 19.1 (H) and 22.7 (L) percent in Thuringia, and 36 (H) and 33 (L) percent in Saxony.

2.4 Methodology

To investigate the complex relationships between firm environment, innovativeness, and performance, this study employs a structural equation model which is presented in detail in Section 4.2. For estimation, this model implements the partial least squares (PLS) approach, which is briefly described below.

2.4.1 Estimation Approach: PLS

The PLS method interplays between data analysis and traditional modeling based on the distribution assumptions of observables (Wold 1982a). Contrary to the parameter-oriented covariance structure analysis (e.g., LISREL), PLS is variance based, distribution free, and prediction oriented (Fornell and Cha 1994). This approach explicitly estimates the scores of the (directly unobserved) latent variables (LV) as weighted aggregates of their observed, manifest variables (MV) (Wold 1980). Table 3 sets out the main features of the PLS and LISREL approaches.

[2] NACE stands for Nomenclature générale des activités économiques, or, in English, Nomenclature of economic activities.

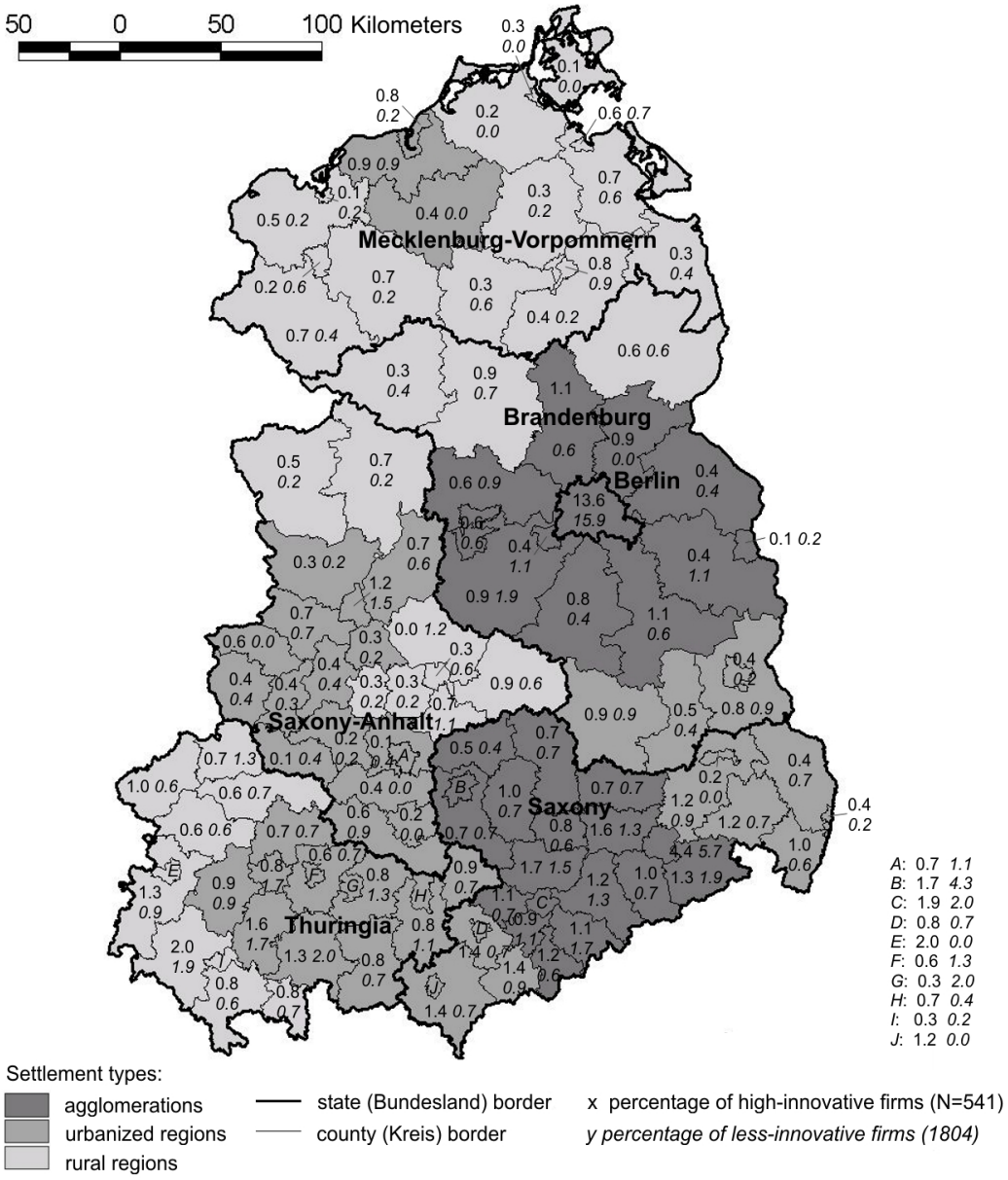

Figure 3: The geographical distribution of high-innovative (x) and less-innovative (*y*) firms

Table 3: Main features of PLS and LISREL approaches

PLS	**LISREL**
variance-based	covariance-based
OLS	maximum likelihood
soft-modeling (distribution free)	distribution assumption of observables
explicit estimation of LV scores	-
small-sized samples sufficient	200 and more observables required
reflective and formative LV	reflective LV; formative LV <u>only</u> for exogenous LV

PLS modeling (such as LISREL) starts with a conceptual arrow scheme representing hypothetical relationships—sometimes including the expected correlation signs between LV and between MV and their LV (Wold 1982b). The latent constructs can be operational-

ized as reflective or formative measurement models. The reflective manifest variables (also called effect indicators) are reflected by the LV and should be highly correlated. The formative manifest variables (cause indicators) are assumed to determine the LV and need not be correlated (Bagozzi 1994; Bollen and Lennox 1991; Coltman et al. 2008).

PLS estimation occurs in three stages. In the first iterative stage, the values of latent variables are estimated; in the second stage, the inner and outer weights are calculated; and in the third stage, the location parameters (means of latent variables and intercepts of linear regression functions) are determined (Lohmöller 1989).

In this paper, all measurement models are operationalized as formative blocks, in which case multicollinearity among MVs should be avoided (Diamantopoulos and Winklhofer 2001).[3] Evaluation of the estimation results in the structural model occurs by determining the coefficient R^2 of the endogenous latent constructs. Chin (1998a) classifies R^2 values of 0.19, 0.33, or 0.67 as weak, moderate, or substantial, respectively. On the basis of changes in R^2 values, the effect size f^2 of a particular exogenous LV on an endogenous LV can be calculated.[4] f^2 values of 0.02, 0.15, or 0.35 indicate a small, medium, or large effect, respectively. To check the significance of the inner and outer weights, t-statistics are produced via the bootstrap technique by resampling with replacements from the original data (Tenenhaus, Vinzi, Chatelin and Lauro 2005).[5]

2.4.2 Model Design

Using Porter's diamond model as a starting point for the analysis, the study attempts to identify significant sources of firm competitive advantage. In other words, the goal of this paper is to investigate what antecedents of the firm's locational environment play a pivotal role in creating and sustaining its innovativeness and competitive advantage. To this end, the analysis employs a structural equation model, which is described in detail below.

2.4.2.1 Outer (Measurement) Models

Detecting and measuring firm innovativeness, competitive advantage, or local demand conditions is generally viewed as a multidimensional problem. Accordingly, in this study, the environmental (locational) antecedents hypothesized to be important by Porter, and a

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[3] See Diamantopoulos, Riefler and Roth (2008) on formative measurement modeling. Examples of applications are, among others, Lee (1994) and Okazaki and Taylor (2008).

[4] Chin (1998): $f^2 = (R^2_{included} - R^2_{excluded})/(1 - R^2_{included})$.

[5] We chose options for the bootstrapping procedure as suggested by Tenenhaus et al. (2005); namely, 500 resamples with the number of cases equal to the original sample size, and for sign changes, the option construct level changes.

firm's internal capabilities assessed by the firm's innovativeness, as well as the firm's competitive advantage as measured by the firm's performance, are considered to be latent constructs related to various indicators. The analysis uses these indicators to capture various aspects of the constructs. In the following, the section presents the assignment of the MVs to their LVs. All outer relations (i.e., relationships between MVs and their LVs) should be positive.

Factor Conditions: This LV is measured by firm assessment of seven various locational factors: supply of skilled labor (FC1), supply of additional education (FC2), supra-regional transportation links (FC3), intra-regional transportation links (FC4), proximity to universities (FC5), proximity to research institutes (FC6), and support of local financial institutions (FC7). These variables are measured on a six-point Likert scale, ranging from unimportant (0), important and very bad quality (1) to important and very good quality (5).

Local Demand: Local demand conditions are measured by two indicators—local turnover share in total firm turnover in 2004 as a percentage (LD1) and firm assessment of proximity to customers (LD2). More specifically, LD1 is turnover share achieved by a company within a 30-km radius of its location and LD2 is measured on a six-point Likert scale, ranging from unimportant (0), important and very bad quality (1) to important and very good quality (5).

R&S Industries:[6] This LV is measured by the frequency of cooperation with research facilities or other firms in the following areas: basic research (RS1), product development (RS2), process development (RS3), equipment usage (RS4), and sales (RS5). The indicators RS1 to RS5 are measured on a five-point Likert scale, ranging from we do not cooperate (1), we cooperate sometimes (3) to we often cooperate (5).

Rivalry: This LV is measured by three indicators—a dummy variable for main competitors' headquarters being located within a 30-km radius from the company location (R1), firm assessment of main competitors' size (R2), and firm assessment of number of competitors (R3). R2 and R3 are measured on a three-point Likert scale: small (1), medium (2), and large (3).

Government: This LV is measured by firm assessment of four locational factors capturing the impact of government at various levels—support of job centers (G1), support from local authorities (G2), support from business development corporations (G3),[7] and state (Bundesland) government support (G4). These indicators are measured on a six-point

[6] "R&S Industries" is an abbreviation for "Related and Supporting Industries."
[7] Business development corporations are separate corporate bodies; however, public authorities establish and administrate them (often together with, for example, chambers or financial institutions).

Likert scale, ranging from unimportant (0), important and very bad quality (1) to important and very good quality (5).

Innovativeness: This LV is measured by dummy variables for new products in 2003/2004 (I1), new processes in 2003/2004 (I2), and fundamental organizational changes in 2003/2004 (I3), as well as by number of patent applications in 2003/2003 (I4) and deployment share in R&D in 2003/2004 as a percentage (I5).

Performance: This LV is assessed in terms of export share in total turnover in 2004 (P1), firm productivity (total turnover over number of employees in 2004) (P2), turnover growth in 2004 compared to 2003 (P3), firm assessment of profit situation in 2003/2004 (P4), firm assessment of expected competition in 2005/2006 (P5), and firm assessment of the development of market volume for a medium term (P6). P1 and P3 are percentages. P4 is measured on a five-point Likert scale—large losses (1), small losses (2), approximately balanced (3), small profit (4), and large profit (5). P5 is measured on a five-point Likert scale—"The competition situation is expected to be …": much worse (1) to much better (5). P6 is also measured on a five-point Likert scale—"The market volume is expected to …": shrink clearly (1) to grow clearly (5).

2.4.2.2 Inner (Structural) Model

Considering Porter's cluster theory and given the fact that this study cannot take into consideration all aspects and features of, for example, demand conditions or related and supporting industries as discussed by Porter, Figure 4 presents the corresponding structural model.

The paths between the LVs in Figure 4 correspond to the hypotheses that this study intends to test:

H1: Favorable factor conditions enhance both firm innovativeness (1a) and performance (1b).

H2: Local demand should positively affect both firm innovativeness (2a) and performance (2b).

H3: R&S industries enhance both firm innovativeness (3a) and performance (3b).

H4: Rivalry should positively influence both firm innovativeness (4a) and performance (4b).

H5: Government should exert a positive impact on factor conditions (5a), and R&D industries (5b), as well as on firm innovativeness (5c).

H6: Firm innovativeness should enhance performance.

The model as specified will allow for the identification and also the disentanglement of both direct and indirect effects exerted by the explaining variables on the dependent constructs. For instance, government support is assumed to directly influence firm innovativeness ($H5c$) as well as have an indirect impact on innovativeness through factor conditions ($H5a * H1a$) and related and supporting industries ($H5b * H3a$). Thus, the total effect of the LV government on the LV innovativeness is:

$$TotalEffect\left(Government \rightarrow Innovativeness\right) = H5a * H1a + H5b * H3a + H5c.$$

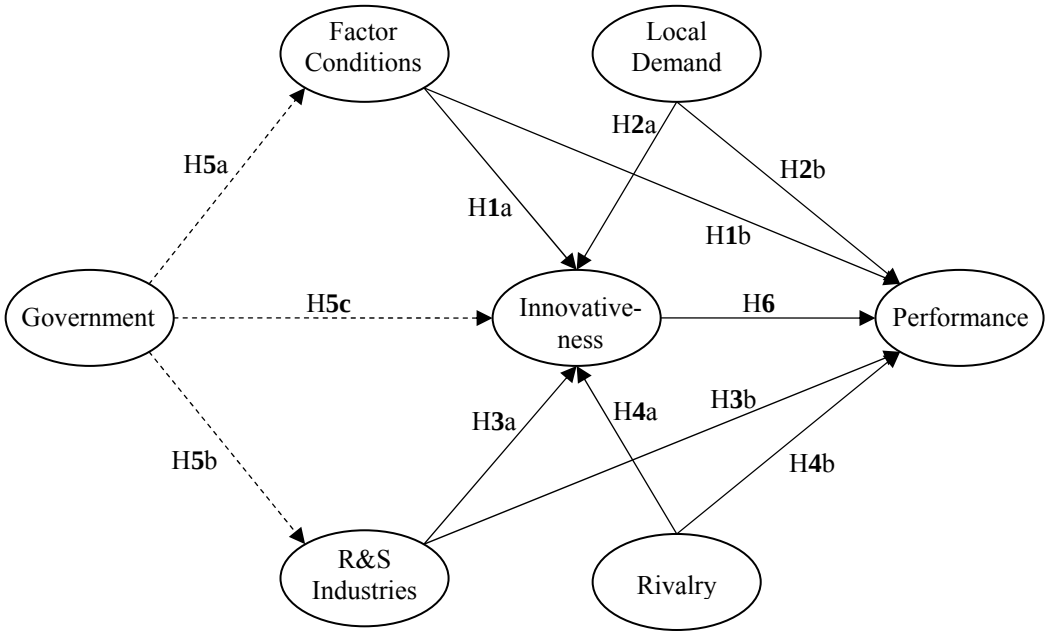

Figure 4: The concept of the structural model

2.4.3 Control Variables

This study controls for several variables that, according to the literature, might influence a firm's ability to innovate or the way it responds to particular locational conditions (e.g., Acs and Audretsch 1990; Agell 2004; Cantwell 1992; Davies and Geroski 1997; Feldman and Audretsch 1999; Johansson, Lööf and Olsson 2005; Keppler 1997; Mansfield 1963; Patel and Pavitt 1995; Schumpeter 1934). These control variables should capture, on the one hand, the heterogeneity among firms (i.e., various firm characteristics) and, on the other hand, the impact of different (settlement) types of firm location (i.e., urbanization economies). To avoid the potential bias resulting from this heterogeneity, in the first stage of the analysis, these potential effects are excluded by regressing the manifest variables on control variables separately for both groups of firms (high- and less-innovative) and then

use the residuals from these analyses in the subsequent step of analysis. The first-stage regression models are as follows:

$$MV_{ij} = D_i^{group} + \sum_{a=1}^{3} D_i^{age_a} + \sum_{s=1}^{5} D_i^{size_s} + \sum_{b=1}^{B} D_i^{branch_b} + \sum_{t=1}^{3} D_i^{settlement_t} + u_{ij},$$

where

MV_{ij} = (original) value of manifest variable j for firm i,

D_i^{group} = dummy variable for affiliation with a firm group,

$D_i^{age_a}$ = dummy variable for firm age in category a (a = 1 if age < 3; a = 2 if 3 ≤ age < 10; a = 3 if age ≥ 10),

$D_i^{size_s}$ = dummy variable for firm size in category s (s = 1 if size < 10; s = 2 if 10 ≤ size < 50; s = 3 if 50 ≤ size < 100; s = 4 if 100 ≤ size < 250; s = 5 if size ≥ 250),

$D_i^{branch_b}$ = dummy variable for branch b (b = NACE codes at the two-digit-level),

$D_i^{settlement_t}$ = dummy variable for settlement type in category t (t = 1 if firm located in an agglomeration; t = 2 if firm located in urbanized region; t = 3 if firm located in rural region), and

u_{ij} = disturbance term.

In the second step of the analysis, the residuals from each regression are used to define the corresponding manifest variable ($MV_{ij} = \hat{u}_{ij}$). Note that due to the bootstrapping technique employed in the second step, all statistical tests will remain appropriate even if estimates from a first-step regression are used as input in the second step.

2.5 Results

2.5.1 Descriptive Analysis

Table 4 provides means and standard deviations (SD) of the MVs included in this model, along with other descriptive statistics. Moreover, Table 4 presents the results of t-tests on mean differences for high-innovative firms compared to less-innovative ones. 78 and 48 percent of high-innovative firms established novel products and applied for patents in2003/2004, respectively. Compared to less-innovative companies, high-innovative ones appear to be on average significantly bigger (in terms of number of employees). High-innovative firms have better assessments of some locational factors (i.e., local supply of skilled labor, supra-regional transportation links, proximity to universities and research

Table 4: Descriptive statistics of indicators and t-tests on mean differences

		High-innovative firms		Less-innovative firms	
Variables		*Mean*	*SD*	*Mean*	*SD*
Dummy for bringing novel products on the market in 2003/2004		0.78 +	0.41	0.00	0.00
Dummy for patent applications in 2003/2004		0.48 +	0.50	0.00	0.00
Founding year		1990	16.32	1989	18.39
Dummy for affiliation to a firm group		0.21 +	0.41	0.12	0.32
Number of employees		38.38 +	54.11	27.06	55.88
Factor Conditions					
Firm assessment of locational factor:					
FC1	supply of skilled labor	2.49 +	1.48	2.02	1.48
FC2	supply of additional education	1.65	1.76	1.52	1.72
FC3	supra-regional transportation links	2.01 +	1.82	1.62	1.81
FC4	intra-regional transportation links	1.60 -	1.85	1.79	1.80
FC5	proximity to universities	1.50 +	2.02	0.59	1.42
FC6	proximity to research institutes	1.31 +	1.93	0.39	1.18
FC7	support of local financial institutions	1.55	1.59	1.56	1.55
Local Demand					
LD1	local turnover share	18.93 -	27.11	43.11	37.43
LD2	firm assessment of proximity to customers	1.50 -	1.84	2.48	1.86
R&S Industries					
Cooperation frequency in:					
RS1	basic research	1.62 +	1.11	1.19	0.63
RS2	product development	2.86 +	1.45	1.74	1.15
RS3	process development	2.15 +	1.33	1.53	0.97
RS4	equipment usage	1.75 +	1.16	1.52	1.03
RS5	sales	2.05 +	1.36	1.83	1.28
Rivalry					
R1	main competitors' headquarters in firm's proximity	0.21 -	0.41	0.48	0.50
R2	competitors' size	2.23 +	0.64	2.08	0.67
R3	number of competitors	1.79 -	0.79	2.02	0.77
Government					
Firm assessment of:					
G1	support from job centers	0.66 -	1.26	0.85	1.39
G2	support from local authorities	0.84 -	1.40	1.04	1.46
G3	support from business development corporations	1.38 +	1.71	1.09	1.53
G4	support from state government	1.43 +	1.70	1.02	1.42
Innovativeness					
I1	new products in 2003/2004	0.98 +	0.13	0.62	0.49
I2	new processes in 2003/2004	0.51 +	0.50	0.32	0.47
I3	fundamental organizational changes in 2003/2004	0.48 +	0.50	0.38	0.49
I4	number of patent applications	1.31 +	2.81	0.00	0.00
I5	deployment share in R&D	19.87 +	24.03	3.81	11.33
Performance					
P1	export share in total turnover in 2004	18.49 +	24.49	6.21	15.14
P2	productivity in 2004	0.13	0.58	0.11	0.20
P3	turnover growth in 2004 compared to 2003	0.19 +	0.47	0.08	0.35
Firm assessment of					
P4	profit situation in 2003/2004	3.52 +	1.08	3.37	1.03
P5	competition situation in 2005/2006	3.48 +	0.83	3.13	0.78
P6	development of market volume for a medium term	3.45 +	1.09	2.82	1.05
Number of firms		***541***		***1,804***	

NOTE: t-tests on differences of means, + significantly larger, - significantly smaller than comparison group of less-innovative firms at 5% level. SD refers to standard deviation.

institutes) and tend to cooperate more frequently in various areas than do the less-innovative firms. However, the high-innovative companies have a smaller share of local

turnover and rate the locational factor proximity to customers worse than do the less-innovative firms. One interesting result regarding the average values of indicators of rivalry is that less-innovative firms appear to have a larger number of smaller competitors, which are more frequently located in their proximity, than is the case for high-innovative firms. Not surprisingly, less-innovative firms show a smaller degree of innovativeness than high-innovative companies. Finally, high-innovative firms appear to achieve better performance than the less-innovative firms—the means of export share, turnover growth, current profit situation, and expected competition situation, as well as development of market volume, are significantly above the means of less-innovative firms.

2.5.2 Model Estimation Results

2.5.2.1 Results for High-Innovative Firms

Figure 5 and Table 5 present the PLS estimation results of structural and measurement models for high-innovative firms, respectively.[8] In this model, six of the twelve hypothesized inner relations are significant. As expected, high frequency of cooperation in process development (RS2) and basic research (RS1), as well as in equipment usage (RS4), positively influences firm innovativeness ($H3a$) and, thus, exerts an indirect positive effect on performance ($H3a*H6$); the direct impact of related and supporting industries on performance ($H3b$) could not be confirmed. Further, the postulated positive relationship between firm innovativeness and performance turns out to be significant ($H6$). The innovativeness of high-innovative firms is determined by deployment share in R&D (I5), establishing new processes (I2), and number of patent applications (I5); these firms' performance—by export share in total turnover (P1), the expected development of market volume (P6), and turnover growth in 2004 compared to 2003 (P3). In addition, governmental support positively influences the quality of locational factor conditions ($H5a$); however, the LV governmental support and locational conditions) have a nonsignificant impact on the innovativeness and performance of high-innovative firms.

Nevertheless, contrary to the previously mentioned hypotheses, three significant paths in the structural model appear to be negative. First, local demand conditions as measured by turnover share achieved in proximity to the firm (within a 30-km radius from firm location; LD1) turn out to have a significantly negative influence on both firm innovativeness

[8] Comparing the correlations between the MVs according to Diamantoloulos and Winklhofer (2001), the results reveal no indication of a multicollinearity problem.

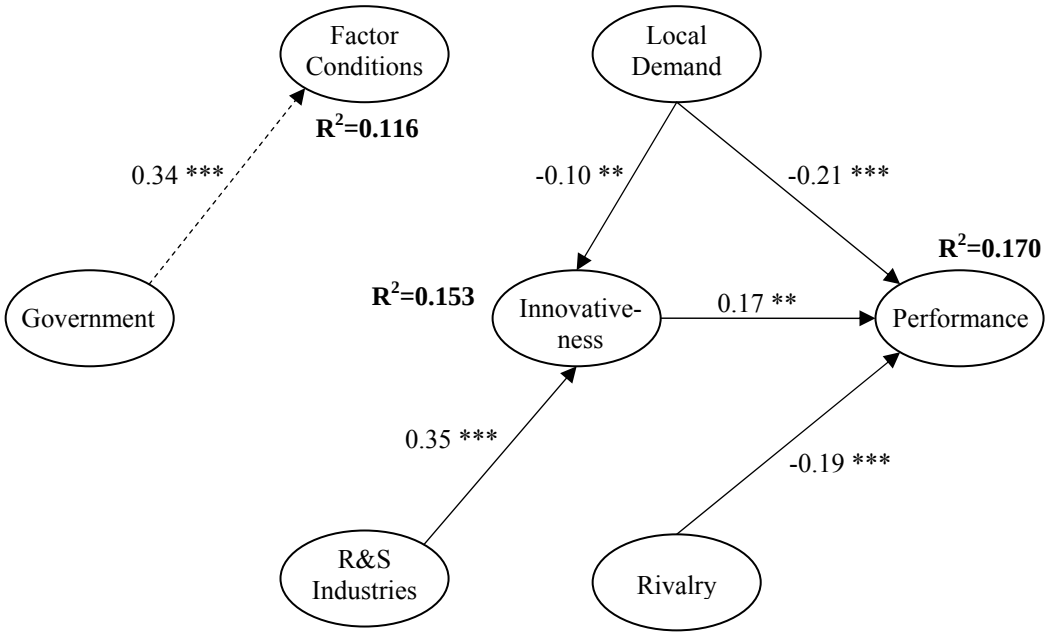

Figure 5: PLS estimation results for high-innovative firms—Structural model

NOTE: Bootstrapped t-values (not reported) based on 500 resamples: ***, **, and * refer to significance at the 1%, 5%, and 10% levels, respectively.

($H2a$) and performance ($H2b$). Furthermore, rivalry—as measured by firm assessment of number of competitors (R3), the presence of main competitors in proximity to the firm (R1), and the assessment of competitor size (R2; with an estimated negative weight)—negatively affects firm performance ($H4b$).

2.5.2.2 Results for Less-Innovative Firms

Figure 6 and Table 5 set out the PLS estimation results of inner and outer relations for less-innovative companies, respectively. Here, the vast majority of the postulated relationships in the structural model turn out to be significant. As expected, the following locational factors, assessed as good by less-innovative firms, positively influence their innovativeness (a direct impact; $H1a$) and performance (an indirect effect; $H1a * H6$): support of local financial institutions (FC7), proximity to research institutes (FC6), supra-regional transportation links (FC3), regional supply of skilled labor (FC1), and supply of additional education (FC2). The LV related and supporting industries, that is, a high frequency of cooperation in product (RS2) and process development (RS3) and in basic research (RS1), has a positive effect on the endogenous LVs innovativeness ($H3a$) and performance ($H3b + H3a * H6$). The findings support the hypothesizes of the positive influence of governmental support—support from business development corporations (G3), state govern-

Table 5: PLS estimation results for high-innovative and less-innovative firms—Measurement models

Variable	High-innovative firms Weight		Less-innovative firms Weight	
Factor Conditions				
FC1	0.21		0.25	***
FC2	0.24		0.23	**
FC3	0.03		0.28	***
FC4	0.24		0.06	
FC5	0.19		0.11	
FC6	0.25		0.39	***
FC7	0.60	*	0.52	***
Local Demand				
LD1	0.85	***	0.78	***
LD2	0.25		0.35	***
R&S Industries				
RS1	0.38	**	0.13	*
RS2	0.22		0.61	***
RS3	0.51	***	0.45	***
RS4	0.30	*	0.05	
RS5	0.04		0.07	
Rivalry				
R1	0.41	***	0.70	***
R2	-0.31	**	-0.20	***
R3	0.79	***	0.57	***
Government				
G1	0.26		0.17	*
G2	0.39		0.33	**
G3	0.43		0.47	***
G4	0.42		0.42	***
Innovativeness				
I1	0.10		0.43	***
I2	0.54	***	0.30	***
I3	0.15		0.20	**
I4	0.41	**	-	-
I5	0.61	***	0.70	***
Performance				
P1	0.63	***	0.77	***
P2	0.09		0.12	**
P3	0.25	**	0.04	
P4	0.13		0.12	**
P5	0.15		0.18	***
P6	0.51	***	0.39	***

NOTE: Bootstrapped t-values (not reported) based on 500 resamples: ***, **, and * refer to significance at the 1%, 5%, and 10% levels, respectively.

ments (G4), local authorities (G2), and job centers (G1)—on innovativeness and performance; these various forms of support seem to have both direct and indirect effects through LVs factors conditions and related and supporting industries. Further, firm innovativeness appears to have a positive impact on performance. The weights of all indicators of innovativeness (except for the omitted MV I4, i.e., number of patent applications) are signifi-

cantly positive. Exports (P1), expected development of market volume (P6), the competition situation (P5), productivity as measured by total turnover over number of employees in 2004 (P2), and firm assessment of current profit situation (P4) determine performance.

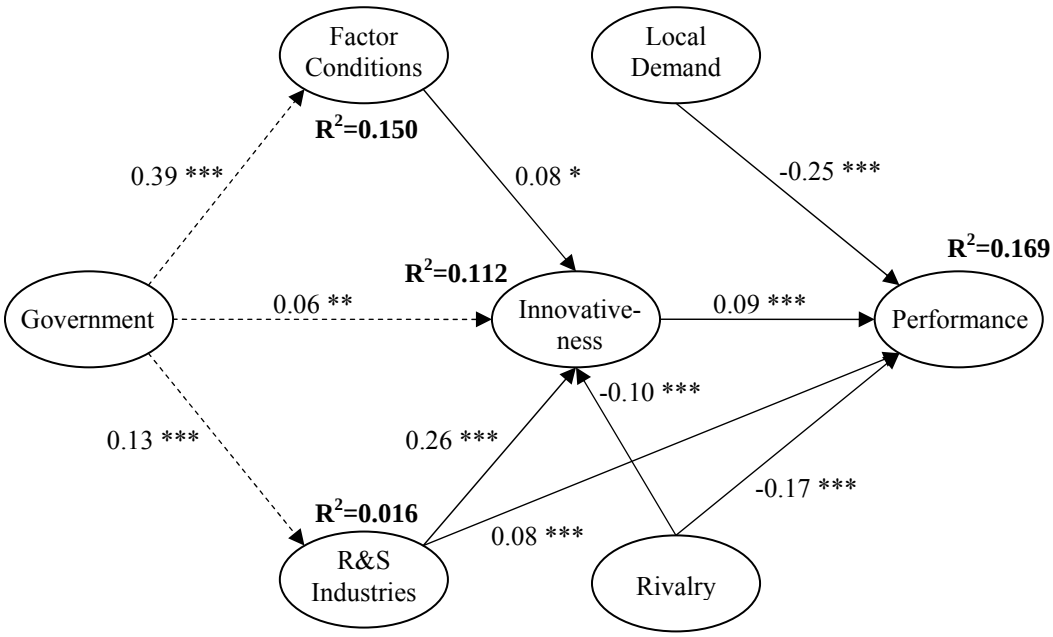

Figure 6: PLS estimation results for less-innovative firms—Structural model

NOTE: Bootstrapped t-values (not reported) based on 500 resamples: ***, **, and * refer to significance at the 1%, 5%, and 10% levels, respectively.

Contrary to expectations, in this model three of nine significant inner paths have a negative sign. Local demand conditions assessed in terms of local turnover share (LD1) and proximity to customers (LD2) seem to negatively affect firm performance ($H2b$). Finally, proximity to main competitors (R1) and a high number of competitors (R3), as well as their size (R2; a negative weight), negatively influence both firm innovativeness ($H4a$) and performance ($H4b + H4a * H6$).

2.5.2.3 Comparison and Discussion of Results for Firm Groups

The results reveal that frequent collaboration with a variety of partners is a driving force behind firm performance regardless of the firm's degree of innovativeness (see Table 6 which presents the R^2 as well as f^2 effect size values). Furthermore, the study provides empirical evidence for the positive relationship between firm-internal innovation capabilities and competitive advantage as measured by several firm performance indicators.

Regarding the other environmental antecedents of firm innovativeness and competitive advantage, the analysis shows bigger differences between high-innovative and less-innovative companies. First, local demand assessed in terms of percentage of local turn-

over share appears to have a negative effect on the innovativeness of high-innovative firms only, a result that seems to contradict Porter's prediction. However, it is important to note that the model could not capture any demand characteristics (e.g., degree of sophistication of local customers). This fact poses a problem because the quality of local demand arguably plays a pivotal role in a successful user-producer interaction (e.g., Beise-Zee and Rammer 2006; Hippel 1988; Porter 1990). On the other hand, the outcome of the analysis is in line with the well-documented problem in international management that the more locally embedded an innovation, the less successful it will be in a foreign market. In fact, the very definition of high-innovative firms as used in this study—companies that established novel products on the market and/or applied for patents—creates a type of selection bias favoring firms oriented to national and/or foreign demand, instead of the local.

Second, in the case of less-innovative firms, support from public authorities at different levels appears to spur innovativeness and performance. This support occurs, on the one hand, through direct assistance, for example, R&D grants, and, on the other hand, indirectly by improving various factor conditions and promoting cooperation activities and networking in various areas of business activity.

The quality of several locational factors appears to be significant for less-innovative firms; in particular, support of local financial institutions, proximity to research institutes, supra-regional transportation links, and a regional supply of skilled labor are crucial for the innovativeness of less-innovative firms. For high-innovative companies, neither governmental support nor factor conditions are important.

Not surprisingly, the relationship between rivalry and innovativeness is insignificant for the high-innovative companies in this sample. Recent innovations (e.g., products or technologies) established by these firms are a novelty on domestic and/or foreign markets and, therefore, competitors cannot easily and/or quickly imitate them. In the case of less-innovative firms, a large number of proximate rivals hampers innovativeness. Although these firms show some degree of innovativeness, their "new" products tend to be either of a type already on the market or enhancements of existing products. Thus, less-innovative firms appear to innovate in an attempt to edge out strong rivals and secure their market share and economic situation. Finally, in the case of both types of firms, the results reveal that firms that face strong competition and are chiefly oriented to local markets are less likely to achieve good performance.

Table 6: Estimation results for high-innovative and less-innovative firms—R^2 determination coefficient values and f^2 effect size values

	High-innovative firms				**Less-innovative firms**			
f^2	*Factor Conditions*	*R&S Industries*	*Innovativeness*	*Performance*	*Factor Conditions*	*R&S Industries*	*Innovativeness*	*Performance*
Factor Conditions			0.00	0.00			0.00	0.00
Local Demand			0.00	0.03			0.00	0.06
R&S Industries			0.15	0.00			0.07	0.01
Rivalry			0.00	0.03			0.01	0.02
Government	0.13	0.01	0.00	-0.01	0.18	0.02	-0.01	0.00
Innovativeness				0.03				0.01
R^2	*0.116*	*0.011*	*0.153*	*0.170*	*0.150*	*0.016*	*0.112*	*0.169*

2.6 Conclusions

This paper provides novel empirical evidence on the links between locational environment, firm innovation capabilities, and competitive advantage. The study uses Porter's diamond model as a theoretical framework as it highlights the external sources of competitive advantage, that is, factor conditions, demand conditions, related and supporting industries, rivalry, and government; furthermore, the model encompasses internal sources embedded in firm innovation capabilities. To model the complex relationships between the variables, for example, firm innovativeness or competitive advantage, this analysis implements a structural equation system and employs the partial least squares approach in the estimation.

The results show that frequent cooperation activities play a pivotal role in firm innovativeness. In turn, firm innovativeness positively affects competitive advantage as assessed by several firm performance indicators. Thus, the findings confirm several important aspects of Porter's model. However, the results reveal important differences between high-innovative and less-innovative firms. The innovativeness and performance of less-innovative firms appear to be more locally embedded than is the case for high-innovative firms. In fact, for the less-innovative companies, this study shows that locational factor conditions as well as governmental assistance enhance their innovation capabilities. In contrast, high-innovative firms (defined as companies that developed and brought a completely novel product to the market and/or applied for patents) show stronger orientation toward nonlocal (domestic and/or foreign) markets and local demand negatively influences both their innovativeness and performance. Another noteworthy result of this study is the lack of empirical support for Porter's theory that the presence of local competitors results in higher performance.

The research also provides valuable insights for practicing managers as to the antecedents of innovative performance and competitiveness. First, the findings indicate that, re-

gardless of the degree of a firm's innovativeness, collaboration and networking in various areas have a positive impact on the firm's innovation and performance. Second, the innovativeness of less-innovative firms appears to depend to a larger extent on the quality of locational factors. Thus, these firms should carefully consider locational conditions when making location decisions.

2.7 Limitations of the Study and Directions for Further Research

Overall, the empirical analysis provides supporting evidence for the central predictions of Porter's framework. Some of the more surprising (i.e., less confirming of Porter) outcomes of this analysis may be due to the fact that the specifics of the available firm data do not allow for the operationalization of certain constructs, such as local demand or related and supporting industries, in exactly the way Porter intended. Added to this is the high degree of ambiguity inherent in Porter's concept, as discussed above. Therefore, it should be stressed that the aim of this study was not to verify or empirically test Porter's approach, but to use it as a guiding theoretical framework for analyzing the sources of firm competitive advantage. The surprising findings from the empirical analysis regarding the effects of the competition environment and local demand deserve more attention in future research.

Another potential concern might be whether East German firms are appropriate for testing Porter's theory, seeing that many of these firms are located in middle-ranked or disadvantaged regions with regard to locational conditions. On the other hand, quite a few of the firms in the sample are located in regions—for instance, Dresden, Jena, and Berlin—which are currently regarded as having quite favorable locational conditions for innovative firms.

Another limitation of this study is that, in addition to quantitative indicators (e.g., number of patent applications or turnover), the analysis uses the firms' own assessments of business situation and locational conditions, raising the potential for bias in the data. Indeed, it is possible that a firm's assessment of locational conditions may not reflect the objective reality of same (e.g., perceived vs. actual distance from university or airport). However, the perceptions, objectively true or not, of potential decisionmakers are crucial because these perceptions can affect decisions they may make about their economic activities. Thus, future research should explore the extent to which firm assessment of conditions corresponds to actual conditions.

Chapter 3 Locational Conditions, Cooperation, and Innovativeness: Evidence from Research and Company Spin-Offs

3.1 Introduction

The unique role of spin-off companies in the economy is much discussed in the literature. Spin-offs act not only as product innovators, but also as a means of transferring knowledge and technology from research facilities to companies. Thus, much work focuses on the creation and development of spin-offs, stressing the importance of proximity to knowledge source and the role of public authority and parent organization support, as well as potential benefits from the particular firm environment (Beise and Stahl 1999; Callan 2001; Garvin 1983; Klepper and Sleeper 2005; Koster 2006; Mustar 1998; Turner 2000). However, there is very little empirical evidence on the role of geography and locational patterns in the innovativeness of already established spin-offs. This paper intends to fill this gap.

Building on empirical research into the relationship between location and the innovativeness of firms in knowledge-intensive sectors (such as electronics, biotechnology, and IT), we intend to answer three questions. (1) To what extent do locational conditions (e.g., proximity to research facilities or support from regional authorities) influence the cooperation activities and innovativeness of spin-offs? (2) Does cooperation have an effect on spin-off innovativeness and, if so, which is more conducive—local or nonlocal? (3) How important is spin-off origin (research vs. company) to innovativeness and performance?

We disentangle the effect of locational conditions on innovativeness by taking into account the possibility of an indirect effect via the cooperation activities of spin-offs. Many authors have argued that proximity to cooperation partners is crucial to the innovation process (for example, Audretsch and Feldman 1996; Jensen and Thursby 2001; Keeble et al. 1998a; Longhi 1999; Mowery and Ziedonis 2001; Porter 2000). On the other hand, others have found that a great deal of collaboration takes place between knowledge-intensive firms and nonlocal partners (Audretsch and Stephan 1996; Egeln et al. 2004). Our study will shed some light on this conflict.

Scholars argue that spin-offs exhibit higher innovation capabilities and performance, at least in the early stages of their development, compared to firms created in other ways. However, to our knowledge, the extant literature does not empirically investigate whether already established and/or mature spin-offs outperform firms whose genesis was of another type. Thus, the paper aims to fill this gap also.

Furthermore, the vast majority of previous studies on spin-offs concentrates either on research spin-offs (also known as university, academic, or public spin-offs) only or company spin-offs (sometimes termed corporate spin-offs) only. Our paper looks at both types and provides results for each. We also analyze other forms of firm creation to investigate whether the kind of firm entry influences innovativeness and performance at later stages of development.

The basis for our study is a sample of East German firms collected in a large survey in the year 2004. In this survey, firms provided information about, inter alia, their innovativeness (e.g., new products, number of patent applications, or amount spent on R&D) and about their cooperation activities (e.g., collaboration frequency or geographical proximity to their partners). The firms also assessed the importance and quality of several locational conditions, such as availability of skilled labor, transportation links, and support from local authorities. Indeed, it is true that a firm's assessment of locational conditions may not reflect the objective reality of same (e.g., perceived vs. actual distance from an airport or university). However, the perceptions, objectively true or not, of potential decisionmakers are crucial because these perceptions can influence decisions they may make about the spatial scope of their economic activities. Since regional systems can be regarded as a cumulative outcome derived from decisions of various individual economic actors, it is necessary to take the firms' viewpoint into consideration when performing a spatial analysis (Britton 2004; Oerlemans et al. 2001; Rees and Stafford 1986).

Much of the research on spin-offs deals with famous clusters, such as Silicon Valley, Boston Route 128, or Cambridge (Massachusetts) (Clayton, Bradley and Harned 1999; Keeble et al. 1998a; Saxenian 1994; Shane 2004). Our analysis is unique in that we study firms located in a more disadvantaged region—East Germany (e.g., Kronthaler 2005; Niefert et al. 2006). Locational conditions have improved significantly in many East German regions over the last 15 years, but there is still a strong heterogeneity among regions (Fritsch et al. 2007). Given this variation of locational conditions for firms in our sample, these data are very suitable for testing locational effects.

The next section sets out the theoretical background of our study, including our definition of a "spin-off company," a literature review, the hypotheses included in our structural equation model, and an outline our methodology. Section 3 provides a description of the data. Section 4 presents and discusses the estimation results. We conclude in Section 5 by discussing implications of our study.

3.2 Theoretical Background

3.3.1 Research Spin-Off vs. Company Spin-Off

Despite a growing body of research into spin-offs in recent years, there is, as yet, no commonly accepted definition of a spin-off. The vast majority of studies define a spin-off as a firm whose intellectual capital somehow originates from its parent institution, which may be a university, a research institute, or another company. However, the definitions used by different authors cover a wide variety of affiliations between the spin-off company and its parent organization, including everything from knowledge transfer (occurring by, e.g., personnel links, provision of technology, and/or existing products) to equity financing (Callan 2001; Klepper and Sleeper 2005; Meyer 2003).

In this paper, we distinguish between research spin-offs and company spin-offs. Research spin-offs are defined as firms originating from a university or research institute that have a former or present employee of that facility as one of the founders. Company spin-offs are firms created by splitting off from a preexisting company. We distinguish between these two types because of their different characteristics, which may be rooted in the vast dissimilarity of their parent organizations. Lindholm Dahlstrand (1997) argues that universities are interested in having their research published and used outside the university, whereas private companies often try to keep knowledge and technology within the firm. Universities may assist research spin-offs, particularly during the research and product development phases, by allowing access to laboratories or through part-time employment of the future spin-off founders (see, e.g., Egeln et al. 2002; Mustar 1997; Shane 2004). In contrast, company spin-offs may receive more support from their parent companies during the production and commercialization phases by, e.g., providing supplier and customer contacts or already established marketing channels (e.g., Clayton et al. 1999; Garvin 1983).

We realize that our rather vague specification of the relationship between a spin-off and its parent organization might raise some concern about the usefulness of our definition; however, analysis of this specific connection is not the focus of our study. In fact, we ex-

tend the literature (e.g., Egeln et al. 2004; Jensen and Thursby 2001; Zucker et al. 1998) by consideration of a variety of cooperation partners, not just parent institutions. Moreover, the data employed in this study allow us to avoid the potential selection bias inherent in many previous spin-off studies based on survey data derived from the parent institutions (see Callan 2001 for a summary of the data sources used in many studies on spin-offs in OECD countries).

3.3.2 Recent Literature on Spin-Offs: Innovativeness and Location Pattern

3.2.3.1 Innovativeness

Although the literature often discusses the high innovation potential of (particularly research) spin-offs in their preliminary development phase (for a literature overview on spin-offs, see Helm and Mauroner 2007), there is to date very little empirical evidence on how the innovativeness of established spin-offs compares to that of firms established by other forms of market entry.

Lindholm Dahlstrand (1997) compares the background and performance (in terms of growth and innovativeness) of spin-offs and non-spin-off firms. Data from 60 small Swedish technology-based established firms are used; among these firms, there are 30 spin-offs. Two-thirds of the spin-offs emerged from private firms (i.e., company spin-offs) and one-sixth were related to universities (i.e., research spin-offs). In the analysis, no distinction is made between research and company spin-offs. It is found that the spin-offs enjoy a higher degree of technology transfer and sales growth than the non-spin-offs. However, the difference between the two groups regarding innovativeness appears to be insignificant, possibly because firm innovativeness is measured by only one indicator, i.e., the number of patents. Other relevant indicators of innovativeness, such as introducing new products on the market or developing new processes, are not considered.

3.2.3.2 Location Pattern

Existing literature makes it clear that geographic location has a significant influence on spin-off activity across countries and regions.[9] In the OECD STI Review (2001) on re-

[9] For example, Pressman (2002) and Wright et al. (2002), in their comparisons of national rates of spin-off activities per license and per dollar of R&D expenditure, respectively, show that university spin-off activity varies significantly across countries. Shane (2004) suggests that this variation at the national level might originate in differences in access to capital, locus of property rights and licensing policy, rigidity of the academic labor market, and the industrial composition of the area.

search spin-offs, Mustar (2001) highlights a local dimension of spin-offs that is embodied in the spatial proximity between spin-offs and their parent institutions (primarily universities) as well as local innovation networks.

For example, Zucker et al. (1998) investigate the location determinants of nearly 700 biotechnology firms in the United States. Both new firms (entrants) and new subunits of existing firms (incumbents) are included in the analysis. It is found that intellectual human capital, measured separately in terms of the presence of star scientists and top-quality universities, has a strong positive impact on the location of the biotechnology industry. Moreover, birth of new firms is positively influenced by federal research grants. In addition, using data on licensed patents from three U.S. universities (University of California, Stanford University, and Columbia University), Mowery and Ziedonis (2001) show that knowledge flows from university inventions appear to be more geographically localized if they occur through market channels (licenses) than if they are due to nonmarket spillovers (patent citations). Moreover, Jensen and Thursby's (2001) study of the licensing practices of U.S. universities makes clear that most university inventions cannot be made by either the inventor or the firm. Because the majority of licensed inventions are in an embryonic phase, university technology managers consider inventor cooperation crucial to commercial success.

However, on the other hand, Egeln et al. (2004) come to a somewhat different conclusion regarding the issue of geographic proximity between spin-offs and their parent organizations. In their paper, the authors investigate the location pattern and the determinants of location decisions of spin-offs from public research institutions in Germany. They find that a significant percentage of spin-offs do not, in fact, locate near the parent institution (more than 30 percent locate outside a 50-kilometer radius); however, about 55 percent of the spin-offs are located closer (e.g., within 25 kilometers) to their parent institutions. Moreover, spin-offs tend to move away from the parent's region when urbanization economies are less pronounced and as the time span between leaving employment with a public research facility and starting an own business increases. Finally, the authors report that although a concentration of highly qualified personnel positively influences how many spin-offs stay in the same region as the parent, the need for highly trained staff does not significantly determine a spin-off's decision to move from the parent's region.

Thus, although most empirical studies argue that geographical proximity to parent institutions is crucial to the establishment, and success, of spin-offs, the findings of Egeln et al. (2004) suggest that the significance of spatial closeness diminishes over time.

3.3.3 Theoretical Concept: Hypotheses, Methodological Issues, and Model Specification

With its chief focus on proximity to research facilities, the literature on location patterns of spin-offs neglects investigating the role of other spatial variables that may be crucial to firm innovativeness, such as the regional factor endowment or the geography of connections between cooperation partners (not only universities). Thus, our goal is to examine the relative importance of various locational conditions and spatial scope of collaboration to spin-off innovativeness. Below, we present our hypotheses, explain the estimation method, and develop the structural equation model.

3.2.3.1 Hypotheses

One thing that is common across the spin-off literature, regardless of differences in data and methodologies, is that access to knowledge is assumed to be a very important locational determinant for firms in knowledge-intensive sectors (see, e.g., Beise and Stahl 1999; Feldman 1999; Rees and Stafford 1986; Stöhr 1986). This knowledge can be obtained from various sources, including skilled labor, research institutions, collaboration, and networking. The literature also stresses the role of public authorities and financial institutions in firm innovativeness (e.g., Longhi 1999; Meyer 2003), a role that covers a wide range of support—financial (e.g., seed capital, R&D grants, network-building grants), incubation programs, commercial advice, and consultancy. The traditional friction-of-distance considerations involving transportation are of little relevance to knowledge-intensive firms; indeed, transportation costs comprise a rather small proportion of their costs. However, transportation may be an important locational condition in terms of the general availability of the infrastructure (Rees and Stafford 1986). In fact, good-quality transportation infrastructure enables easier access to cooperation partners, suppliers, and customers.

According to Gordon (1991: 178): "Geographic areas are championed as autonomous reservoirs of 'regional innovation potential' derived from specific locational attributes (research institutions, high levels of scientific and technical expertise, venture capital operations, 'quality of life' amenities, and non-unionized economic environment) that literally incubate small-firm, high technology growth." Hence, the potential and quality of the firm's location can be viewed as the sum of potential inherent in a variety of locational conditions. Moreover, the impact of the location on firm economic activity can be resolved into the separate effects of various locational conditions, such as regional availability of

skilled labor or local government support. However, note that different locational factors do not influence and/or favor business operations for all firms equally. In other words, depending on own capabilities, requirements and goals, particular firms take an advantage of varying sets of locational factors (Diller 1991; Funk 1995; Grabow et al. 1995; Dziembowska-Kowalska and Funk 2000). Thus, our main hypothesis:

H1: Favorable locational conditions enhance cooperation intensity, particularly with local partners, and innovativeness of firms.

Furthermore, many studies emphasize that key to the success of a firm's innovativeness is its ability to create strategic alliances and its integration into diverse networks of interactive relationships and partnerships (see, e.g., Best 2001; Campagni 1991; Porter 2000). Moreover, collaboration and networking enable firms to expand their capacities and complement the resources required for their specialized activities (Richardson 1972). This leads to the following hypothesis:

H2a: High cooperation intensity enhances firm innovativeness.

The evidence is inconclusive as to the importance of geographic proximity to cooperation partners. On the one hand, most research claims that local and/or intra-regional collaboration links play a crucial role in firm development and innovativeness (e.g., Audretsch and Feldman 1996; Keeble et al. 1998a; Longhi 1999; Mustar 2001; Zucker et al. 1998). However, these analyses often concentrate on the networking systems of well-known clusters and locations and, therefore, the generalizability of their results is in doubt (Britton 2004; Egeln et al. 2004). Indeed, firms located in lower-rated regions may be compelled to collaborate with external partners to overcome locational disadvantages. Gordon argues that local relationships driven by largely informal mechanisms "are insufficient either to initiate or sustain creative activity as techno-economic complementarities force firms to incorporate extra-regional sources of innovation" (Gordon 1991: 190). Moreover, Mustar (1998) points out that the dependence of firms' success on local and/or nonlocal partnerships is related to their stage of development. Local ties appear to be crucial for the creation and early development of spin-offs, but national and international alliances are important at later stages of development. To capture the spatial scope of cooperation for established firms, we propose the following hypothesis:

H2b: Nonlocal collaboration ties enhance the innovativeness of established spin-offs to a greater extent than do purely local links.

Furthermore, many researchers argue that there is a positive relationship between a firm's innovation activities and performance (e.g., Ahn 2002; Eickelpasch et al. 2007; Harris 1988; Geroski et al. 1993; Klomp and Leeuwen 2001; Lööf and Heshmati 2006). In developing innovative products and processes, firms facilitate productivity growth, increase their market shares, as well as, improve their competitive position. Thus, we expect the following to hold:

H3: Firm performance is positively affected by innovativeness.

Regardless of the personal motivation and goals of the founder, spin-offs have their beginnings in the knowledge and/or technology transfer from the parent organization. Therefore, spin-offs, at least in their early development phase, appear to have higher innovation potential and capabilities than do firms that have entered the market via a different path (e.g., Callan 2001; Helm and Mauroner 2007; Klepper and Sleeper 2005; Mustar 1998). Nevertheless, the extant literature provides no evidence on whether spin-offs sustain this higher innovativeness, compared to non-spin-offs, in later stages of development.

As far as innovation generally, however, scholars do argue that it appears to be persistent over time. Using data on the patent applications of 577 U.K. manufacturing firms, Cefis (2003) finds that the probability of a firm applying for a patent is much higher when the firm already has patents, compared to the probability of going from no patents to one. Moreover, Peters (2006) confirms the persistence of firm-level innovation activity assessed in terms of innovation expenditure, as well as in terms of introducing new products or processes, especially for the manufacturing sector. Hence, we arrive at our next hypothesis:

H4a: Firms that have been established as spin-offs are more innovative in their further development than are firms created in other ways.

The literature on spin-offs uses several aspects of firm success to measure performance (see Helm and Mauroner 2007). First, scholars find that spin-offs have a higher survival rate than firms created in other ways (Callan 2001; Egeln et al. 2003; Mustar 1997). Moreover, spin-offs, in general, grow more rapidly than firm created otherwise. In particular, spin-offs more than 10 years old start to outperform non-spin-offs of the same age (Callan 2001; Lindholm Dahlstrand 1997). On the other hand, Egeln et al. (2003) find that, particularly in the initial years, the sales growth of spin-offs falls behind employment growth. As a result, spin-offs tend to show lower productivity in the early stages of their development than do firms founded in other ways.

Hence, previous work only partially supports the superiority of spin-offs in terms of performance. However, the last two mentioned indicators (i.e., sales growth rate and productivity), revealing the lower performance of spin-offs compared to firms created in other ways, appear to hold particularly for a spin-off's initial years, but not necessarily for later stages of development. In fact, because of the assistance spin-offs receive from parent organizations in the early stage of their development, e.g., access to laboratories, funds, and/or materials, it appears likely that spin-offs achieve higher performance compared to their non-spin-off peers in subsequent periods. Thus, we propose:

H4b: Firms that have been established as spin-offs show better firm performance in their further development than do firms created in other ways.

3.2.3.2 Methodological Issues

To test our hypotheses on the relationships between locational conditions, cooperation intensity, innovativeness, and firm performance, we employ a structural equation model—for two reasons. First, such a model allows taking into consideration the multidimensionality (i.e., various aspects) of latent (directly unobserved) variables (LV). Second, its high flexibility in modeling various relationships enables us to disentangle the direct and indirect impacts of locational conditions on firm innovativeness.

We use the partial least squares (PLS) method to estimate our structural equation model. The flexible PLS method permits interplay between data analysis and traditional modeling based on the distribution assumptions of observables (Wold 1982a). In contrast to parameter-oriented covariance structure analysis (e.g., LISREL), PLS is variance-based, distribution-free, and prediction-oriented (Fornell and Cha 1994). The scores of the LVs are estimated explicitly as weighted aggregates of their observed, manifest variables (MV) (Wold 1980).

PLS modeling (such as LISREL) starts with the design of a conceptual arrow scheme representing hypothetical relationships, sometimes including the expected correlation signs between LVs and between MVs and their LVs (Wold 1982b). The latent constructs can be operationalized as reflective or formative measurement models. The reflective MVs (also called effect indicators) are reflected by the LV and should be highly correlated. The formative manifest variables (called cause indicators) are assumed to determine the LV and need not be correlated (Bagozzi 1994; Bollen and Lennox 1991; Coltman et al. 2008).

PLS estimation occurs in three stages: in the first iterative stage, the values of latent variables are estimated; in the second stage, the inner and outer weights are calculated; and

in the third stage, the location parameters (means of LVs and intercepts of linear regression functions) are determined (Lohmöller 1989).

Since all our LVs are operationalized as formative measurement models (MVs represent different features of their LV), only the approach for evaluating the estimation results is briefly described. In the first instance, before model estimation, strong multicollinearity among the MVs should be tested for and, if found, avoided (Diamantopoulos and Winklhofer 2001). Accordingly, estimation results are evaluated by using the determination coefficient R^2 calculated for the endogenous latent constructs. Chin (1998a) classifies R^2 values of 0.19, 0.33, or 0.67 as weak, moderate, or substantial, respectively. Moreover, on the basis of changes in R^2 values, the effect size f^2 of a particular exogenous LV on an endogenous LV can be calculated.[10] f^2 values of 0.02, 0.15, or 0.35 indicate a small, medium, or large effect. Finally, to check the significance of the inner and outer weights, t-statistics are produced via bootstrap technique by resampling with replacements from the original data (Tenenhaus et al. 2005).

3.2.3.3 Model Design

The complete structural model is shown in Figure 7. Various locational conditions, as assessed by the firms in our sample, are grouped into four exogenous LVs; namely, skilled labor, transportation, research facilities, and support. Furthermore, three endogenous LVs—cooperation, innovativeness, and performance—are formulated. The paths between the LVs represent our hypotheses. We use the basic model to test hypotheses H1, H2, and H3; to test H4, the basic model is extended by two additional exogenous LVs (RSO and CSO)[11] that should capture the influence of kind of firm entry (research or company spin-off) on firm innovativeness and performance.

The latent constructs are operationalized as follows:

LV: Skilled labor

L1: Firm assessment of locational condition: skilled labor supply

L2: Firm assessment of locational condition: additional education supply

LV: Transportation

T1: Firm assessment of locational condition: supra-regional transportation links

T2: Firm assessment of locational condition: intra-regional transportation links

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[10] Chin (1998a): $f^2 = (R^2_{included} - R^2_{excluded}) / (1 - R^2_{included})$.

[11] Both LVs are measured by only one indicator: a dummy variable that takes the value 1 if a firm is a research spin-off or a company spin-off, and 0 if it was created in another way.

LV: Research facilities

R1: Firm assessment of locational condition: proximity to universities

R2: Firm assessment of locational condition: proximity to research institutes

LV: Support

S1: Firm assessment of locational condition: local financial institution support

S2: Firm assessment of locational condition: job center support

S3: Firm assessment of locational condition: local government support

S4: Firm assessment of locational condition: business development corporation support

S5: Firm assessment of locational condition: state government support

S6: Firm assessment of locational condition: chambers' support

The particular locational conditions—that is, the variables L1, L2, T1, T2, R1, R2, and S1 to S6—are assessed by firms on a six-point Likert scale, ranging from unimportant (0), important and very bad quality (1), to important and very good quality (5).

LV: Cooperation

C1: Cooperation frequency: basic research

C2: Cooperation frequency: product development

C3: Cooperation frequency: process development

C4: Cooperation frequency: additional education

C5: Cooperation frequency: sales

The variables C1 to C5 are measured on a five-point Likert scale, ranging from we do not cooperate (1), we cooperate sometimes (3), to we often cooperate (5).

LV: Innovativeness

I1: New products in 2003/2004

I2: New processes in 2003/2004

I3: Number of patent applications in 2003/2004

I4: Deployment share of R&D in 2003

The first two indicators of the LV innovativeness (i.e., I1 and I2) are dummy variables; the last two (I3 and I4) are measured on a metric scale.

LV: Performance

P1: Firm assessment of competition in 2005/2006

P2: Firm assessment of medium-term market volume development

The indicators of LV performance are measured on a five-point Likert scale: P1—"The competition situation in 2005/2006 is expected to be …" considerably worse (1) to consid-

erably better (5); P2—"The market volume is expected to …" shrink clearly (1) to grow clearly (5).

We expect that all indicators will be positively related to their LVs.

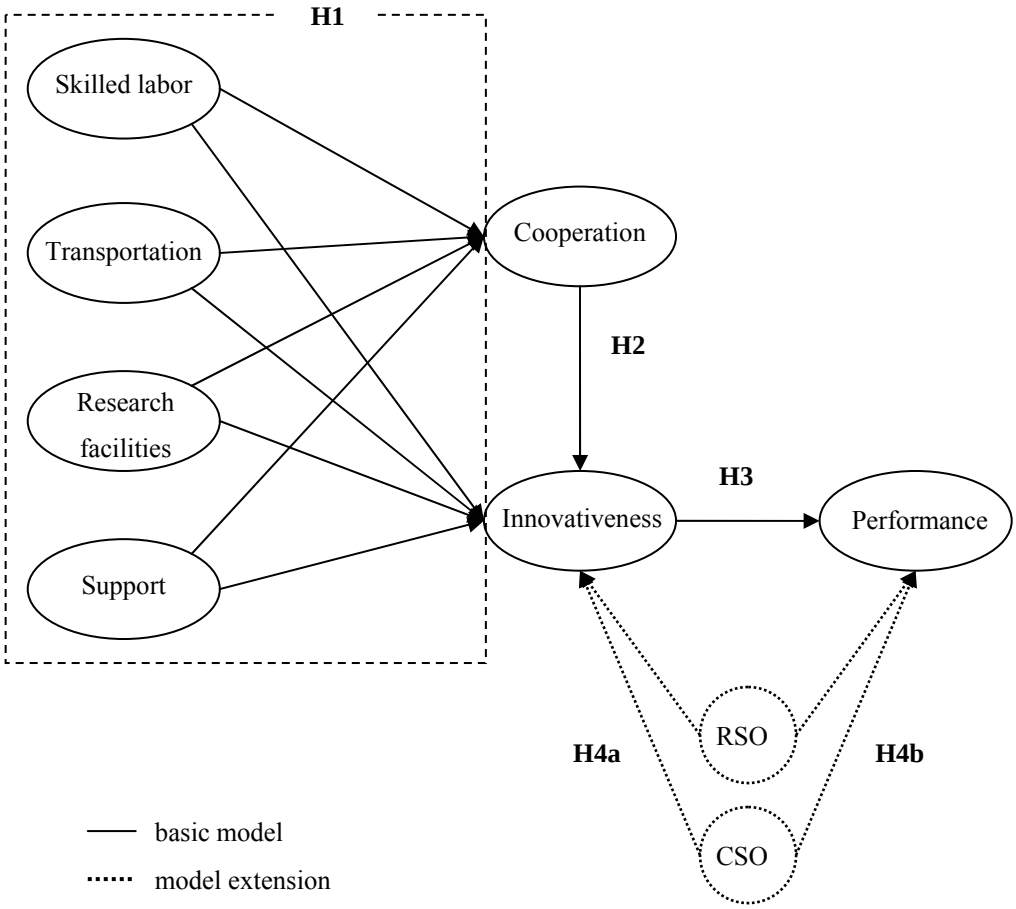

Figure 7: The structural equation model

3.3 Data and Descriptive Analysis

3.3.1 Samples Description

Our analysis employs micro-level data collected via survey by the German Institute for Economic Research (DIW Berlin). This survey, entitled "Current Situation and Outlook of East German Firms," was sent to 30,000 firms in East Germany in 2004 (the response rate was approximately 20 percent).

From the dataset of about 6,200 surveyed firms, we select 1,517 firms from knowledge-intensive sectors, using as selection criteria the OECD classifications of high and medium-high technology manufacturers and knowledge-intensive services (KIS) (see

Götzfried 2004). The NACE[12] codes for these sectors are set out in Table 7. We distinguish between three groups of firms, namely, research spin-offs (79 firms),[13] company spin-offs (410 firms), and firms otherwise created (1,028 firms). About 30 percent of all research spin-offs are manufacturing firms; the remaining 70 percent are services. For company spin-offs, this ratio is approximately 60 percent to 40 percent.

Table 7: NACE codes for high and medium-high technology manufacturing and KIS

		Research spin-offs		**Company spin-offs**		**Otherwise created firms**	
		Number	*% in spin-offs*	*Number*	*% in spin-offs*	*Number*	*% in other firms*
High and medium-high technology manufacturing							
	Manufacture of						
24	chemicals and chemical products	4	5.1	21	5.1	46	4.5
29	machinery and equipment	-	-	100	24.4	232	22.6
30	electrical and optical equipment	2	2.5	3	0.7	9	0.9
31	electrical machinery and apparatus	3	3.8	32	7.8	81	7.9
32	radio, television, and communication equipment and apparatus	-	-	-	-	-	-
33	medical, precision, and optical instruments, watches, and clocks	16	20.2	61	14.9	113	11.0
34	transport equipment	-	-	14	3.4	26	2.5
35	other transport equipment	-	-	12	2.9	10	1.00
Knowledge-intensive services							
61	water transport	-	-	-	-	-	-
62	air transport	-	-	-	-	-	-
64	post and telecommunications	-	-	-	-	-	-
65	financial intermediation	-	-	-	-	-	-
66	insurance and pension funding	-	-	-	-	1	0.1
67	activities auxiliary to financial intermediation	-	-	-	-	-	-
70	real estate activities	-	-	3	0.7	-	-
71	renting of machinery and equipment	-	-	10	2.4	31	3.0
72	computer and related activities	19	24.0	39	9.5	131	12.7
73	research and development	15	19.0	9	2.2	21	2.0
74	other business activities	20	25.3	104	25.4	322	31.3
80	education	-	-	1	0.2	1	0.1
85	health and social work	-	-	-	-	-	-
92	recreational, cultural, and sporting activities	-	-	1	0.2	4	0.4
Total		**79**	**100%**	**410**	**100%**	**1,028**	**100%**

Figure 8 shows the geographical distribution of the (a) research spin-offs and (b) company spin-offs in our dataset. There are 25 research spin-offs in Saxony (most of them in Dresden and Leipzig), 19 in the eastern part of Berlin, 16 in Thuringia (mainly in Jena and Erfurt), 9 in Mecklenburg-Vorpommern, and 5 each in Brandenburg (4 of them in Potsdam) and Saxony-Anhalt. About 25 percent of these companies are headquartered in the

[12] NACE stands for Nomenclature générale des activités économiques, or, in English, Nomenclature of economic activities.

[13] About 54 percent of the research spin-offs in our dataset are "descendants" of universities, the other 46 percent originated in other types of research institutes.

East German state capitals. The Figure 8 shows that the company spin-offs are rather unequally distributed across the states; approximately 50 percent of them are located in the southern part of East Germany (28 percent in Saxony and 20 percent in Thuringia).

As mentioned before, the East German regions are highly heterogeneous with respect to locational conditions and, of course, not all of them are lower-rated regions. Hence, a concern could arise as to how suitable the underlying data are for testing Hypothesis 2b, which is based on an underlying assumption of being located in a lower-ranked region. However, only a small share of our sample is made up of firms located in regions with good-quality conditions, such as Dresden or Jena, and we thus believe that these data are indeed suitable for our analysis.

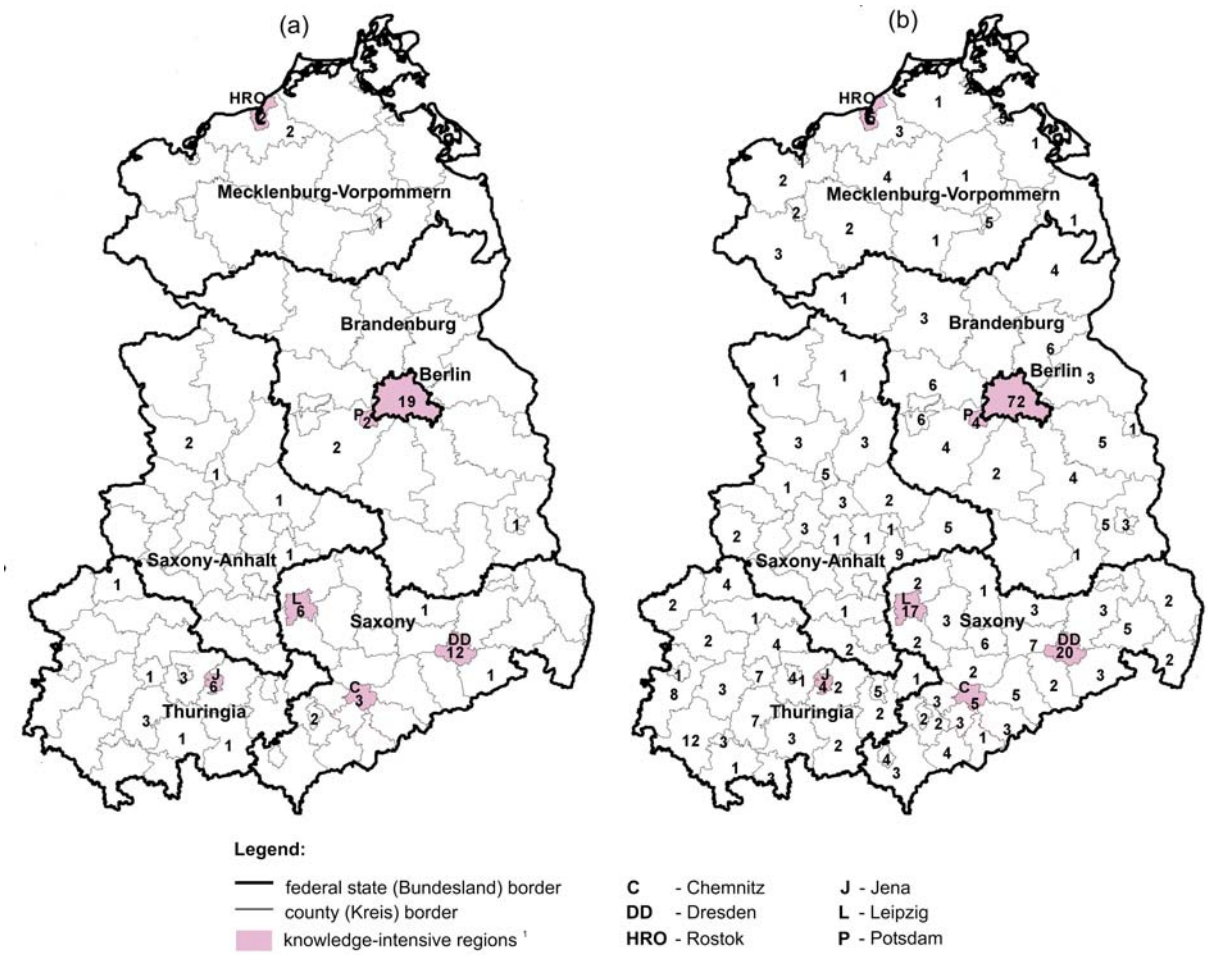

Figure 8: The geographical distribution of (a) research and (b) company spin-offs

SOURCE: [1] Federal Office for Building and Regional Planning

Table 8 shows how the three groups of firms are spread across three settlement types—agglomerations, urbanized regions, and rural regions (each county's assignment to a settlement type is illustrated on the map in the Appendix). The majority of research spin-offs are located in agglomerations and urbanized regions (58 and 32 percent, respectively).

Company spin-offs and otherwise created firms are more often located in rural regions than are research spin-offs.

Table 8: Distribution of firms across various settlement types

Settlement type	Research spin-offs		Company spin-offs		Otherwise created firms	
	Number	*% in spin-offs*	*Number*	*% in spin-offs*	*Number*	*% in other firms*
1 agglomerations	46	58.2	201	49.3	539	52.6
2 urbanized regions	25	31.6	114	27.9	303	29.6
3 rural regions	8	10.1	93	22.8	182	17.8
Total	**79**	**100%**	**408**	**100%**	**1,024**	**100%**

NOTE: Number of missing values = 6

3.3.2 Firm Characteristics: Research and Company Spin-Offs vs. Otherwise Created Firms

Table 9 presents the means and standard deviations of the indicators included in our model, as well as other firm characteristics.[14] The median value of the founding year is comparable for all firm groups. Employing on average about 14 persons, research spin-offs are smaller than the otherwise created firms (26 employees). However, company spin-offs are significantly bigger (about 38 employees). Research spin-offs employ more highly skilled workers than do the other two groups; about 60 percent for research spin-offs compared to 36 percent for each of the other types. Approximately one-third of all research spin-offs are integrated into innovation networks. Furthermore, research spin-offs have, on average, higher cooperation frequency in the areas of basic research and product and process development; company spin-offs more frequently cooperate in process development and additional education.

On average, research spin-offs have higher innovativeness than firms in the other groups; 90 percent of these firms brought new products to the market in 2003 or 2004 and 44 percent of them established new processes. The number of patent applications and deployment shares in R&D are three times larger than those of the other types of firms. Similarly, in general, research spin-offs have better expectation-based performance than other wise created firms, which may be because the vast majority of the research spin-offs (71 percent) received governmental aid for R&D. Finally, both types of spin-off show, on average, higher export rates than otherwise created firms.

[14] Our findings are similar to the results reported by Hemer, Schleinkofer and Göthner (2007) on academic spin-offs in Germany, e.g., the average turnover and number of employees (after outlier exclusion) were about 1,000,000 EUR and 14, respectively, in 2004.

Table 9: Descriptive statistics

	Research spin-offs			Company spin-offs			Otherwise created firms		
Variables	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*
Founding year	79	1995*	9.35	410	1994*	14.65	1024	1994*	19.49
Affiliation to a firm group	79	0.06	0.25	410	0.20+	0.43	1028	0.10	0.30
Number of employees in 2003/2004	78	14.10-	17.41	395	38.02+	73.25	1012	26.24	124.07
Number of employees with university degree in 2003/2004	77	7.68	8.31	373	8.43+	17.37	991	5.73	15.40
Relative frequency of employees with university degree in 2003/2004	77	0.61+	0.28	373	0.36	0.32	992	0.36	0.33
Turnover (EUR) in 2003/2004	74	1.00-	1.25	384	4.82	12.68	973	3.68	32.78
Export share (%) in 2003/2004	73	15.09+	22.58	363	12.43+	21.27	946	9.63	20.08
Investment intensity (%) in 2003/2004	69	0.09	0.16	365	0.06	0.09	939	0.07	0.12
Obtaining government aid for R&D	72	0.71+	0.46	269	0.38	0.49	637	0.38	0.49
Partner in innovation networks	79	0.30+	0.46	407	0.11	0.31	1020	0.10	0.29
LV: Skilled labor									
Assessment of the locational condition:									
L1: supply of skilled workers	79	2.80+	1.52	410	2.22	1.47	1028	2.13	1.51
L2: additional education supply	79	1.70	1.89	410	1.84	1.76	1028	1.67	1.75
LV: Transportation									
Assessment of the locational condition:									
T1: supra-regional transportation links	79	2.00	1.89	410	1.78	1.85	1028	1.63	1.79
T2: regional transportation links	79	1.68	1.86	410	1.55	1.83	1028	1.62	1.79
LV: Research facilities									
Assessment of the locational condition:									
R1: proximity to universities	79	2.58+	2.19	410	1.17	1.86	1028	1.06	1.80
R2: proximity to research institutes	79	2.49+	2.22	410	0.96	1.72	1028	0.77	1.58
LV: Support									
Assessment of the locational condition:									
S1: local financial institution support	79	1.16	1.38	410	1.40	1.54	1028	1.45	1.54
S2: job center support	79	0.43-	1.11	410	0.69	1.28	1028	0.71	1.31
S3: local government support	79	0.67	1.30	410	0.92	1.46	1028	0.86	1.36
S4: business development corporation support	79	1.03	1.63	410	1.35+	1.70	1028	1.07	1.52
S5: state government support	79	1.56+	1.79	410	1.16	1.59	1028	1.04	1.44
S6: chambers' support	79	1.10	1.71	410	1.15	1.60	1028	1.09	1.53
LV: Cooperation									
Cooperation frequency in:									
C1: basic research	79	2.20+	1.51	410	1.42	0.93	1028	1.33	0.84
C2: product development	79	3.03+	1.41	410	2.15	1.34	1028	2.09	1.35
C3: process development	79	2.37+	1.46	410	1.80+	1.15	1028	1.65	1.12
C4: additional education	79	2.20	1.41	410	2.21+	1.36	1028	1.99	1.25
C5: sales	79	2.09	1.26	410	1.83	1.27	1028	1.95	1.35
LV: Innovativeness									
I1: new products in 2003/2004	79	0.90+	0.30	410	0.74	0.44	1028	0.71	0.45
I2: new processes in 2003/2004	79	0.44+	0.50	410	0.35	0.48	1028	0.32	0.47
I3: number of patent applications in 2003/2004	79	1.14+	2.34	410	0.41	1.41	1028	0.39	1.98
I4: deployment share in R&D in 2003	79	35.04+	31.84	410	10.60	19.92	1028	10.93	20.38
LV: Performance									
Assessment of the development of:									
P1: competition situation in 2005/2006	79	3.52+	0.86	410	3.31	0.79	1028	3.27	0.78
P2: market volume in the medium term	79	3.58+	1.10	410	3.10	1.11	1028	3.09	1.12

NOTE: In the case of * mean = median; t-tests on differences of means, + significantly larger, - significantly smaller than comparison group at 5% level.

3.3.3 Cooperation Activities of Research Spin-Offs

Table 10 sets out descriptive statistics for the cooperation activities of research spin-offs.[15] The average share of these firms that cooperate in five various fields is about 55 percent, ranging from 47 percent of firms cooperating in basic research to 78 percent cooperating in product development.

On average, approximately 30 percent of research spin-offs cooperate with other companies in various areas, most frequently this cooperation involves product development and sales. Only 11 percent of the research spin-offs collaborate with other firms in additional education. About 30 percent of the research spin-offs are in partnership with research facilities such as universities or research institutes, ranging from only 5 percent for sales to about 40 percent for basic research and product development.

Moreover, 35 percent of the research spin-offs collaborate with local (within 30-km radius from the company headquarter) partners; 30 percent collaborate with nonlocal (outside a 30-km radius from the firm location) partners. Thirteen percent of the research spin-offs cooperate with both local and nonlocal partners.

Table 10: Cooperation activities of research spin-offs: Partners and their headquarters

			Cooperation									
			Partners are				Partners' headquarters are					
	No cooperation		other firms		research facilities		local		external		both local and external	
Cooperation field	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
basic research	0.53	0.50	0.11	0.32	0.42	0.50	0.32	0.47	0.25	0.44	0.13	0.33
product development	0.22	0.41	0.49	0.50	0.43	0.50	0.57	0.50	0.43	0.50	0.23	0.42
process development	0.44	0.50	0.33	0.47	0.32	0.47	0.32	0.47	0.30	0.46	0.10	0.30
additional education	0.49	0.50	0.16	0.37	0.33	0.47	0.23	0.42	0.20	0.40	0.13	0.33
sales	0.49	0.50	0.39	0.49	0.05	0.22	0.33	0.47	0.32	0.47	0.08	0.27
Relative frequency	**0.44**		**0.30**		**0.31**		**0.35**		**0.30**		**0.13**	

3.4 Estimation Results and Discussion[16]

As discussed in the previous section, there is considerable heterogeneity among firms and firm subsamples in terms of, e.g., firm size and affiliation with a firm group or economic sector. To avoid the potential bias resulting from this heterogeneity, in the first stage of the

[15] Note that shares do not add up to 100 percent. Firms can be included in more than one category because, e.g., they can cooperate with both research facilities and other firms.

[16] Before performing the estimation, we tested for multicollinearity between the MVs and found that it would not be a problem. The estimations were carried out using the following software: PLSGraph 3.0 and SmartPLS 2.0 with PLS algorithm settings, path weighting scheme, and standardization of manifest variables. Furthermore, we chose options for the bootstrapping procedure as suggested by Tenenhaus et al. (2005), namely, 500 resamples with the number of cases equal to the original sample size and, for sign changes, the option-construct level changes.

analysis we eliminate these potential effects by regressing the manifest variables on control variables and using the residuals from these analyses in the subsequent step of analysis. The first-stage regression models are as follows:

$$MV_{ij} = D_i^{group} + \sum_{a=1}^{3} D_i^{age_a} + \sum_{s=1}^{5} D_i^{size_s} + \sum_{b=1}^{B} D_i^{branch_b} + \sum_{t=1}^{3} D_i^{settlement_t} + u_{ij} ,$$

where

MV_{ij} = (original) value of manifest variable j for firm i,

D_i^{group} = dummy variable for affiliation with a firm group,

$D_i^{age_a}$ = dummy variable for firm age in category a (a = 1 if age < 3; a = 2 if age is > 3 but < 10; a = 3 if age ≥ 10),

$D_i^{size_s}$ = dummy variable for firm size in category s (s = 1 if size < 10; s = 2 if size is > 10 but < 50; s = 3 if size is > 50 but < 100; s = 4 if size is > 100 but < 250; s = 5 if size ≥ 250),

$D_i^{branch_b}$ = dummy variable for branch b (b = NACE codes at the two-digit-level),

$D_i^{settlement_t}$ = dummy variable for settlement type in category t (t = 1 if firm located in an agglomerations; t = 2 if firm located in urbanized region; t = 3 if firm located in rural region),

u_{ij} = disturbance term.

In the second step, the residuals from each regression are used to define the corresponding manifest variable ($MV_{ij} = \hat{u}_{ij}$; see Table A in the Appendix for an outline of the regression results).[17] Note that due to the bootstrapping technique employed in the second step, all statistical tests will remain appropriate even if estimates from a first-step regression are used as input in the second step.

The empirical strategy for testing our hypotheses (second stage of the analysis) consists of three steps. First, we aim to discover the determinants of innovativeness for research and company spin-offs, as well as for otherwise created firms, i.e., to test H1, H2a, and H3. To this end, the basic model is estimated separately for each subsample—research spin-offs, company spin-offs, and otherwise created firms. Furthermore, the LV cooperation includes all cooperation linkages, i.e., both local and nonlocal ties.

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[17] The regression models including the control variables exhibit the highest explanatory power for two indicators of the LV innovativeness: deployment share in R&D (I4; R^2=0.322) and number of patent applications (I3; R^2=0.192). The deployment share in R&D is significantly influenced by industry dummies and firm age. Affiliating to a firm group and to several branches, as well as firm size, exert a significantly positive impact on the number of patent applications. On the other hand, the model for regional transportation links (T2) has the smallest value for the determination coefficient (R^2=0.004). None of the control variables appear to significantly affect this locational factor.

Second, the impact of proximity to cooperation partners on firm innovativeness is investigated (H2b). Here, because proximity appears to be of particular significance for research spin-offs, we take only these firms into consideration. We use the basic model again, but LV cooperation is replaced by the frequency of local (set A), only local ($A \setminus B$), and nonlocal (set B) cooperation (see Figure 9).

In the third step, we analyze the extent to which innovativeness and firm performance depend on how the firm was created (H4a and H4b). To this end, the extended model is estimated for all firms together.

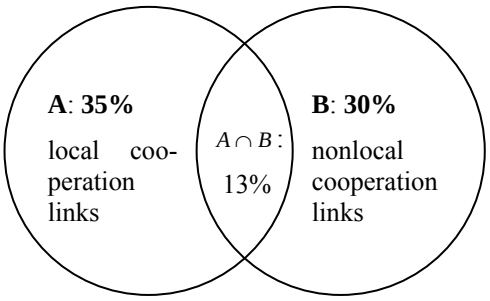

Figure 9: The location-orientated focus of cooperation links for research spin-offs

3.4.1 Determinants of Innovativeness: A Comparison of Research Spin-Offs, Company Spin-Offs, and Otherwise Created Firms

Estimation results for the firm subsamples are presented in Tables 11 through 13. Table 11 contains the relationships between the LVs (inner relations); Table 12 the R^2 determinant coefficients and f^2 effect size values. The relationships between the MVs and their LVs are shown in Table 13. Furthermore, in the model for the otherwise created firms, we are able to indicate the highest number of significant inner and outer relations, possibly because this subsample contains the largest number of cases. As a result, several paths are significant even though the coefficients and their effect size values are very low. Thus, in our discussion of results, we look at only those relationships between the LVs that have values higher than 0.10.[18]

In the research spin-offs model, two of four LVs capturing the assessment of locational conditions, namely, research facilities and support, appear to have a significantly positive impact on cooperation activities, innovativeness, and/or performance. The proximity to research institutes and universities directly strengthens cooperation activities and has a

[18] Lohmöller (1989) finds to be significant only those standardized inner coefficients with a value higher than 0.10; further, Chin (1998b) suggests that standardized paths should be at least 0.20 to be considered meaningful and theoretically interesting.

medium effect on explaining this LV (the value of the determination coefficient for the LV cooperation is moderate). These locational conditions also have a moderate effect on explaining research spin-off innovativeness. However, this impact tends to occur indirectly via cooperation intensity. Furthermore, both the collaboration activities and the locational conditions capturing various types of support are driving forces behind innovativeness for research spin-offs (both have a very large, direct effect on explaining innovativeness). The innovativeness of these firms shows a substantial value for the determination coefficient. However, firm performance (expected market volume development) is only weakly explained by innovativeness (direct effect).

The estimation results for company spin-offs and otherwise created firms are quite similar to each other. In both models, proximity to research facilities (particularly to research institutes, which is not surprising) positively influences cooperation intensity as well as innovativeness and firm performance. Additionally, for otherwise created firms, the relationship between the LVs support and innovativeness appears to be significantly positive. The R^2 value of cooperation intensity for company spin-offs is nearly twice as high as it is for otherwise created firms, but is still weak. As well, the LV innovativeness in both models is explained rather weakly. Cooperation intensity shows the highest effect size on innovation activities for both groups. Finally, in both cases, the positive relationship between innovativeness and expected firm performance is confirmed; however, the values of the determination coefficients for performance are very low.

Table 11: Estimation results for research spin-offs, company spin-offs, and otherwise created firms—Inner relations

	Research spin-offs			**Company spin-offs**			**Otherwise created firms**		
	Cooperation	*Innovativeness*	*Performance*	*Cooperation*	*Innovativeness*	*Performance*	*Cooperation*	*Innovativeness*	*Performance*
Skilled labor	0.057	-0.151		0.086	0.055		0.036	0.005	
Transportation	0.152	-0.017		0.012	-0.065	-	0.000	0.095***	
Research facilities	0.375**	0.157		0.423***	0.181***		0.289***	0.112***	
Support	-0.208	- 0.489* +		0.061	0.113		0.124***	0.077***	
Cooperation		0.602**			0.340***			0.391***	
Innovativeness			0.279**			0.264***			0.251***

NOTES: Bootstrapped t-values (not reported) based on 500 resamples: ***, **, and * refer to significance at the 1%, 5%, and 10% levels, respectively. t-tests on differences of means, + significantly larger, - significantly smaller than comparison group at 5% level.

Surprisingly, the relationship between the locational condition skilled labor and cooperation activities, innovativeness, and firm performance was not confirmed for any of the groups. Nevertheless, all firm groups, particularly the research spin-offs, have a relatively

high share of employees with a university degree. This could imply that the nonlocal, or extra-regional, labor markets are more important sources of acquiring skilled workers for firms in knowledge-intensive sectors.[19]

Not all relationships between the LVs and their indicators (outer models) have the expected sign. This is especially the case for various types of support. These findings might be a result of depending on support from these institutions by firms with shrinking market volume and/or a declining competitive position, which may tend to make this type of locational condition be negatively assessed.

Finally, in addition to analyzing the significant relationships between variables in the models for the three firm groups, we perform a direct comparison of the particular coefficients of the research and company spin-offs with the coefficients in the model for the otherwise created firms. The significance of the differences between the coefficients is calculated using the methodology proposed by Chin (2000).[20] The results can be found in Table 12 and 13. The LV support has significantly greater influence on innovativeness for the research spin-offs than for otherwise created firms. On the other hand, the impact of support on the intensity of cooperation activities is significantly smaller for research spin- offs. In the model for company spin-offs, transportation infrastructure has significantly smaller influence on innovation than it does for otherwise created firms; however, this relationship is insignificant in the case of company spin-offs.

Table 12: Estimation results for research spin-offs, company spin-offs, and otherwise created firms—R^2 determination coefficient values and f^2 effect size values

	Research spin-offs			**Company spin-offs**			**Otherwise created firms**		
f^2 values	*Cooperation*	*Innovativeness*	*Performance*	*Cooperation*	*Innovativeness*	*Performance*	*Cooperation*	*Innovativeness*	*Performance*
Skilled labor	0.01	0.03	-0.01	0.01	0.01	0.00	0.00	0.00	0.00
Transportation	0.03	0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.00
Research facilities	0.05	**0.20**	-0.03	**0.18**	0.03	0.00	**0.09**	0.01	0.00
Support	**0.08**	**0.38**	-0.04	0.00	0.02	0.00	0.02	0.01	0.00
Cooperation	-	**0.44**	0.00	-	**0.11**	0.00	-	**0.16**	0.00
R^2 values	*0.283*	*0.498*	*0.067*	*0.222*	*0.244*	*0.070*	*0.119*	*0.232*	*0.063*

NOTE: Bold values show the largest f^2 effect of the respective LVs on explaining the dependent LV.

[19] Using data from Finish high-technology firms, Simonen and McCann (2007) also do not find any positive effect of local labor acquisition on the firms' innovation behavior.

[20] Chin (2000) suggests executing the multi-group comparison on the basis of the standard errors for the structural paths provided in the resampling procedure and by treating these estimates in a parametric sense via t-tests. The complete formula for calculating the t-statistics for the difference in paths between groups is as follows:

$$t = \frac{Path_1 - Path_2}{\sqrt{\frac{(n_1-1)^2}{(n_1+n_2-2)} \times S.E._1^2 + \frac{(n_2-1)^2}{(n_1+n_2-2)} \times S.E._2^2} \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}},$$

where n_i represents the number of observations in sample i and $S.E._i$ is the standard error of the $Path_i$ calculated in the resampling procedure.

Table 13: Estimation results for research spin-offs, company spin-offs, and otherwise created firms—Outer relations

MV	Research spin-offs	Company spin-offs	Otherwise created firms
LV: Skilled labor			
L1: supply of skilled workers	0.563	0.672***	1.012***
L2: additional education supply	0.725	0.571**	-0.042
LV: Transportation			
T1: supra-regional transportation links	0.985	1.076***	1.149***
T2: regional transportation links	0.03	-0.233	-0.412
LV: Research facilities			
R1: proximity to universities	0.593	0.135	0.449***
R2: proximity to research institutes	0.571	0.904***	0.633***
LV: Support			
S1: local financial institution support	-0.017	-0.053	-0.105
S2: job center support	0.501	-0.032	-0.259**
S3: local government support	0.251	-0.113	-0.363***
S4: business development corporation support	-0.722*** -	0.596**	0.546***
S5: state government support	0.577*	0.726***	0.747***
S6: chambers' support	-0.357	-0.156	-0.183
LV: Cooperation			
C1: basic research	0.33	0.632***	0.405***
C2: product development	0.65*	0.376***	0.573***
C3: process development	0.316	0.382***	0.379***
C4: additional education	0.048	0.056	-0.1
C5: sales	0.345	-0.09	-0.026
LV: Innovativeness			
I1: new products in 2003/2004	0.277	0.204**	0.328***
I2: new processes in 2003/2004	0.18	0.412***	0.202***
I3: number of patent applications in 2003/2004	0.674**	0.211**	0.221***
I4: deployment share in R&D in 2003	0.411	0.723***	0.77***
LV: Performance			
P1: competition situation in 2005/2006	0.539	0.356*	0.448***
P2: market volume in the medium term	0.694*	0.812***	0.731***

NOTES: Bootstrapped t-values (not reported) based on 500 resamples: ***, **, and * refer to significance at the 1%, 5%, and 10% level, respectively. t-tests on differences of means, + significantly larger, - significantly smaller than comparison group at 5% level.

3.4.2 Local vs. Nonlocal Cooperation Links and Innovativeness of Research Spin-Offs

In the second step of our analysis, we test H2b, i.e., whether local or nonlocal cooperation links are more conducive to research spin-off innovativeness. Here, we focus on the effect size values f^2 and the values of the determination coefficient R^2 for the respective LVs, which are presented in Table 14.

In the model of cooperation intensity with local partners, innovativeness is determined in the first instance by the LVs support and cooperation—both variables show an equally high, and thus large, effect on explaining innovativeness—as well as by the proximity to

research facilities (medium effect size value). In the case of the model with only local cooperation ties, support has a great deal of influence on innovativeness. However, here, purely local cooperation connections appear to have a rather small effect on stimulating innovation activities. Finally, for the model including nonlocal links, both cooperation intensity and support have a large impact on explaining innovativeness, but the effect size value of (nonlocal) cooperation is higher than that of support. Not surprisingly, nonlocal cooperation intensity is explained only very weakly by locational conditions.

Table 14: Estimation results for research spin-offs with various levels of cooperation intensity—R^2 determination coefficient values and f^2 effect size values

	Local cooperation [a]			**Only local cooperation** [b]			**Nonlocal cooperation** [c]		
f^2 values	*Cooperation*	*Innovativeness*	*Performance*	*Cooperation*	*Innovativeness*	*Performance*	*Cooperation*	*Innovativeness*	*Performance*
Skilled labor	0.00	0.02	0.00	0.00	0.01	0.00	0.02	0.00	0.00
Transportation	0.00	0.00	0.01	0.01	0.03	-0.01	0.02	0.02	0.01
Research facilities	**0.07**	**0.16**	-0.05	0.01	-0.01	-0.06	0.01	0.05	-0.01
Support	**0.05**	**0.28**	-0.02	**0.08**	**0.23**	-0.04	0.01	**0.23**	0.00
Cooperation	-	**0.28**	-0.01	-	0.06	-0.04	-	**0.33**	0.02
R^2 values	*0.254*	*0.436*	*0.058*	*0.184*	*0.320*	*0.029*	*0.073*	*0.459*	*0.082*

NOTES: Bold values show the largest f^2 effect of the respective LVs on explaining the dependent LV. [a] Model with local cooperation (local links coexistent with nonlocal ties not excluded). [b] Model with only local cooperation (local links coexistent with nonlocal ties excluded). [c] Model with nonlocal cooperation (nonlocal links coexistent with local ties not excluded).

Comparing the results from the models with local, only local, or nonlocal cooperation allows drawing interesting conclusions about the importance of proximity to collaboration partners for innovativeness and performance of established research spin-offs. First, our analysis shows that nonlocal collaboration connections are more conducive to innovativeness of established research spin-offs. Second, the innovativeness of research spin-offs that mainly cooperate with local partners is particularly tied to various types of support.

3.4.3 Impact of Type of Firm Entry on Firm Innovativeness and Performance

In the third and last step of our analysis, we investigate to what extent innovativeness and expected performance of established firms is influenced by how the firm was founded by estimating the extended version of our model for all firms simultaneously. None of the four postulated relationships between the two LVs RSO and CSO and the innovativeness and performance of established firms is significant. Moreover, RSO and CSO themselves appear to have no effect on explaining firm innovativeness and performance (Table 15 presents the calculated f^2 and R^2 values). Therefore, the higher innovativeness of established

research spin-offs is not related to how the firm was created. Moreover, our results make clear that high intensity of cooperation activities is a driving force behind innovativeness of firms in knowledge-intensive sectors.

Table 15: Estimation results for all firms (extended model)—R^2 determination coefficient values and f^2 effect size values

	All firms		
f^2 values	*Cooperation*	*Innovativeness*	*Performance*
Skilled labor	0.00	0.00	0.00
Transportation	0.00	0.00	0.00
Research facilities	**0.12**	0.01	0.00
Support	0.01	0.01	0.00
RSO	-	*0.00*	*0.00*
CSO	-	*0.00*	*0.00*
Cooperation	-	**0.14**	0.00
R^2 values	*0.157*	*0.224*	*0.070*

NOTE: Bold values show the largest f^2 effect of the respective LVs on explaining the dependent LV.

3.5 Conclusions

In this paper, based on a sample of established research and company spin-offs and otherwise created firms in knowledge-intensive sectors, we analyzed the importance of locational conditions to cooperation activities and firm innovativeness. To this end, we developed a structural equation model that was estimated by employing the partial least squares method. Because of the high flexibility of this modeling approach, we were able to disentangle the effect of locational conditions on innovativeness by teasing out an indirect effect via the firm's collaboration behavior. Furthermore, in our analysis, we controlled firms' heterogeneity in terms of age, size, and affiliation with a firm group and economic sector, as well as controlling for the effect of firm location settlement type.

Our results show that certain locational conditions, in particular, close proximity to research institutes and various types of support, significantly strengthen the intensity of cooperation activities, mainly with local partners, for spin-offs. Furthermore, these locational conditions appear to play a very important role in the innovativeness of research spin-offs (captured as a direct effect). However, we find no effect of the other locational conditions included in our model, i.e., regional availability of skilled workers or transportation infrastructure, on the cooperation intensity and innovativeness of spin-offs.

Nevertheless, our study confirms that cooperation activities are a crucial determinant of firm innovativeness. For company spin-offs, innovativeness can be moderately explained

by cooperation intensity in various areas; for research spin-offs, the effect size of collaboration intensity on innovativeness is large. Contrary to the widespread view about the relevance of geographic proximity to cooperation partners for firm innovativeness, we find that nonlocal collaboration links are more conducive to innovativeness than are local ones. Finally, though the established research spin-offs tend to show higher innovativeness than the other groups of firms, our findings imply that type of firm creation is, at the end of the day, not decisive for firm innovativeness in later phases of its development.

Our findings are of relevance to both practicing managers and public policymakers. Managers can significantly improve the prospects of firm success in terms of innovativeness by enhancing networking and engaging in more frequent collaboration with a variety of partners, such as research institutes or other firms. Furthermore, to sustain the innovativeness of established spin-offs, regional innovation policy should promote and provide incentives for firm cooperation activities, particularly with external or nonlocal partners. Finally, governmental R&D subsidies should be funneled toward research spin-offs, as the results show that the impact on innovativeness of such funding is largest for this group.

Chapter 4 Determinants of Internationalization: Differences Between Service and Manufacturing SMEs

4.1 Introduction

Globalization and rapid progress in information and communication technologies, as well as international services trade agreements (such as the General Agreement on Trade in Services and the European Union Service Directive), have improved the position of service industries in the world economy. Consequently, an ever-increasing number of service firms are engaging in foreign markets (e.g., Daniels 1993; OECD 2008; Roberts 1999). The literature on internationalization, however, does not pay much attention to this sector, tending to focus more on the manufacturing sector and multinational enterprises (MNEs). Moreover, the sparse literature that does exist on the topic concentrates on particular branches of the service industry, without much generalization of concepts or findings (Bryson 2001; Contractor, Kundu and Hsu 2003).

Scholars highlight four features that distinguish services from manufactured goods: (1) intangibility (services are not transportable or storable), (2) inseparability (production and consumption occur simultaneously), (3) perishability (services cannot be saved but must be consumed as they are produced), and (4) heterogeneity (services are unique and difficult to standardize) (e.g., Zeithaml, Parasuraman and Berry 1985). Of course, different services are characterized by varying degrees of these attributes. Researchers argue that it is the intensity of the respective characteristics that influences tradability and performance of particular service industries in foreign market operations and this also inevitably makes their internationalization pattern different from that of the manufacturing sector (Clark and Rajaratnam 1999; Clark, Rajaratnam and Smith 1996; Ekeledo and Sivakumar 1998; Erramilli 1990; Knight 1999).

The main objective of this study is to empirically investigate the driving forces behind internationalization of small and medium-sized enterprises (SMEs), focusing on differences between the service and manufacturing sectors. Specifically, I examine the factors determining firm choice of two internationalization strategies—exporting or relocating production or other operations abroad—and whether the particular antecedents are substan-

tively different between service and manufacturing SMEs. To this end, I estimate a bivariate probit model that can account for the correlation between the two internationalization strategies. The analysis uses survey data of about 3,900 East German SMEs engaged in various types service and manufacturing activity.

This paper is novel in that the analysis includes a wide range of exogenous variables that can be generally classified into two groups: firm-specific or external factors. The firm-related variables, such as size, age, sector, or innovation capabilities, incorporate the attributes and strategic orientation of a firm. The external factors, such as quality of firm location, competition situation, and collaboration and networking activity, are designed to discover the impact of a firm environment's on its foreign activity. Extant empirical studies, with their primary focus on the characteristics of host and/or home-country markets neglect explicitly modeling the effect of firm location on its internationalization (e.g., Dunning 1998; O'Farrell, Wood and Zheng 1998; Porter 2000), an oversight this paper intends to remedy.

One potential concern of this study refers to the general classification and definitional problems of service and manufacturing industries (e.g., Clark et al. 1996; Daniels 1993; OECD 2008, Pilat and Wölfl 2005), seeing as the distinction between the two sectors is increasingly blurred in today's world. Still and all, however, the two sectors do play different roles in the economy. For example, the manufacturing sector is much more strongly linked to other industries (e.g., suppliers, transport, etc.). Thus, it is expected that there is enough variation in the internationalization process of these two sectors to make a study of the differences worthwhile.

4.2 Theoretical Background

4.4.1 Theories of Internationalization

The literature reveals four main approaches to firm internationalization: (1) the internalization approach and the eclectic paradigm, (2) stage models, (3) the network perspective, and (4) a business-strategy approach. The first approach is based in the economic school of foreign direct investment (FDI) theory; the latter three are more behavioral approaches (Coviello and McAuley 1999; O'Farrell et al. 1998). Each of the four approaches is discussed below.

4.4.2.1 Internalization Approach and the Eclectic Paradigm

Based on transaction cost analysis (TCA), the internalization theory aims to explain factors influencing the modality choice of organizing cross-border activities by MNEs (Anderson and Gatignon 1986; Buckley and Casson 1976; Buckley 1988; Dunning 1981, 1988; Rugman 1981; Hennart 1988, 1991; Williamson 1975, 1979). The general axiom of the internalization approach is that firms choose a foreign market location, as well as the mode of market servicing, for which overall transaction costs are minimized. Markets are assumed to be competitive but characterized by various imperfections, including, for example, cost of knowledge, government regulations and tariffs, and quality control problems. Indeed, imperfections in goods and factor markets are seen as one of the chief reasons for internalization, especially of knowledge-intensive intermediate products. To reduce the risk of losing its knowledge advantage, a firm will favor high-control modes of foreign market entry—through the establishment of a hierarchically structured organization, that is, FDI. Conversely, standardized and unsophisticated products can be distributed more efficiently in lower-control modes—through nonequity or contractual agreements, for example, licensing or exporting.

In his eclectic (OLI) paradigm of international production, Dunning (1981, 1988, 1992) proposes a more general and comprehensive theory of FDI and MNE activity. In addition to internalizing (I) advantages elaborated within the scope of the transaction cost approach, the OLI paradigm highlights two other advantages that influence the international engagement of a firm, namely, ownership-specific (O) and location-specific (L) advantages. O-advantages are comprised of unique firm-related characteristics and capabilities that make a firm superior to local competitors, regardless of its location. O-advantages encompass not only tangible assets, such as workforce, capital, and property rights, but also intangible ones, such as managerial and entrepreneurial skills, organizational and marketing systems, noncodifiable knowledge embodied in human capital experience, and the technology or ability to reduce costs of intra and/or inter-firm transactions. L-advantages involve the competitive advantages of countries and the potential benefits of firm activity in a particular location. L-specific variables include country-related resource endowments and markets (availability, prices, and quality), transport and communication costs, infrastructure, barriers to trade, business and cultural environment, political and institutional framework, and so forth.

4.4.2.2 Stage Models

Another approach to firm internationalization examines foreign market expansion in terms of hypothetical development stages. This can take one of two paths: (1) the establishment chain (stage) model (also known as the Uppsala model or the U-model) introduced by Johanson and Wiedersheim-Paul (1975) and developed further by Johanson and Vahlne (1977, 1990), or (2) the diffusion of innovation theory (innovation-related models or I-models) derived from Rogers's (1962) stages of the adoption process (Young 1995). Both the U-model and the I-models are viewed as more dynamic than the internalization paradigm and focus firm exporting activities rather than FDI (Andersen 1993; Turnbull 1987; Young 1987).

The U-model[21] suggests that firm internationalization occurs incrementally and gradually due to lack of knowledge, especially experiential knowledge, and uncertainty. The model argues that firms initially engage in psychically close foreign markets (i.e., those that are not so very different from the home market) through low-risk, indirect exporting approaches. Over time and on the basis of experience gained in this way, the firm will expand into more distant markets through higher control modalities. Thus, a basic proposition of the U-model is that market knowledge and market affect both market commitment decisions and the way current decisions are made—and these, in turn, influence market knowledge and commitment (Johanson and Vahlne 1977, 1990; Johanson and Wiedersheim-Paul 1975).

The innovation-based approach sees the internationalization process as a learning sequence that occurs within the innovation adoption process. Various I-model adaptations, developed by Bilkey and Tesar (1977),[22] Cavusgil (1980, 1982),[23] Czinkota (1982),[24] and

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[21] Johanson and Wiedersheim-Paul (1975) distinguish between four subsequent modes of foreign market entry, which reflect increasing levels of international involvement: (1) no regular export activities, (2) export via independent representative (agents), (3) establishment of an overseas sales subsidiary, and (4) overseas production/manufacturing units.

[22] Bilkey and Tesar (1977) consider a six-stage process: (1) management is not interested in exporting, (2) management is willing to fill unsolicited orders, but makes no effort to explore the feasibility of active exporting, (3) management actively explores the feasibility of active exporting, (4) the firm exports on an experimental basis to some psychologically close country, (5) the firm becomes an experienced exporter to this country, and (6) management explores the feasibility of exporting to other more psychologically distant countries.

[23] Cavusgil (1980) suggests five stages: (1) domestic marketing, (2) pre-export stage, (3) experimental involvement, (4) active involvement, and (5) committed involvement.

[24] Czinkota (1982) introduces a six-stage model: (1) the completely uninterested firm, (2) the partially uninterested firm, (3) the exploring firm, (4) the experimental firm, (5) the experienced small exporter, and (6) the experienced large exporter.

Reid (1981),[25] generally posit that export development depends on external stimuli (e.g., unsolicited orders or inquires) and/or internal factors such as attitudinal and behavioral commitment of managers. The particular I-models vary with respect to the number and definitions of the development stages; however, Andersen (1993) suggests that these differences are more semantic than anything else.

4.4.2.3 Network Perspective

A third and more recent school of internationalization research, referred to as the network perspective, recognizes that foreign market development does not solely depend on firm-related advantage, but also relies on networking activities and strategic alliances (Blankenburg and Johanson 1992; Cunningham and Culligan 1991; Johanson and Mattsson 1988, 1992). Therefore, externalization rather than internalization of foreign markets and/or functions occurs. The portfolio of exchange relationships includes the firm's direct relationships (e.g., individuals, business units, public agencies, and noncommercial organizations) and its indirect connections to those individuals or entities with which firm personnel are directly linked (e.g., Firm X cooperates with Firms Y, which is linked also with Firm Z, thus Firm X and Z have an indirect relationship through Firm Y). Hence, networks can be limitless in extent and are viewed as unbounded and nontransparent (Blankenburg and Johanson 1992; Johanson and Vahlne 1990, 1992).

By exploiting the complementary and synergistic potential of their members' capabilities and competencies, networks facilitate joint accomplishment of mutually beneficial although not necessarily identical goals. A basic assumption of the network approach is that the individual firm is dependent on resources controlled by other firms and secures access to those resources via its network position. It follows logically from this idea that firm internationalization is also influenced by the network (Bell 1995; Cunningham and Culligan 1991; Johanson and Mattsson 1988, 1992; Johanson and Vahlne 1990, 1992; O'Farrel and Wood 1999).

4.4.2.4 Business Strategy

The business strategy framework is a pragmatic approach to firm internationalization. Under this approach, it is understood that firms take a wide range of variables into consideration when looking at the benefits and costs of various internationalization strategies, but at

[25] Reid (1981) defines the following five stages of internationalization: (1) export awareness, (2) export intention, (3) export trial, (4) export evaluation, and (5) export acceptance.

times do not have an entirely objectively rational way of choosing between the alternatives. However, by calculating the profit potential of each alternative, the options can be assessed more rationally to find the optimal solution and, thus, to find an appropriate mode of foreign market entry and/or to change the market servicing mode over time (Clark and Mallory 1997; Reid 1983; Welford and Prescott 1994). The business strategy approach emphasizes achieving success of the firm as a whole, not simply the efficiency maximization of individual subsidiary units. Accomplishing this goal requires actively managing interdependencies across firm divisions (Kim and Hwang 1992).

Generally, scholars distinguish between two groups of variables relevant to the internationalization decision: external and internal factors (Kim and Hwang 1992; Porter 1985; Reid 1983; Root 1987; Turnbull and Ellwood 1986). The external factors involve market characteristics and supply conditions of both the host country and home regions (e.g., workforce, market accessibility and attractiveness, cultural distance, ease of transportation, and degree of competition). The internal variables are comprised of firm-related factors, specifically the firm resources (such as size, branch, capital resources, managerial knowledge, export orientation and international trade experience) and firm product factors (particularly technology level and product differentiation).

4.4.2 Internationalization Theories and Diversity of Service and Manufacturing Firms

The research discussed above deals with various strands of the complex phenomenon of firm internationalization and they complement each other more than they compete (Coviello and McAuley 1999; Daniels 1991). However, each has its own specifics and/or drawbacks that disqualify it from being completely appropriate for this study (O'Farrell et al. 1998).

The main criticism of the FDI theory is that it attempts to explain the extent, form, and location of foreign investment of MNEs by focusing primarily on transaction-cost advantages (TCA), rather than on the pattern of firm internationalization (Johansson and Mattsson 1988). In fact, many service companies have lower capital needs than manufacturing firms and thus benefit from lower entry barriers into foreign markets in terms of financial constraints—establishing an office, for example, is much cheaper than setting up a manufacturing plant. Indeed, the internalization approach neglects a variety of non-TCA stimuli (e.g., following client's foreign market entry, securing product quality, enhancing firm prestige) that are important determinants of firm internationalization (Bell 1995; Erramilli

and Rao 1993; Roberts 1999). Furthermore, though Dunning claims that firm internationalization should be investigated in a wider strategic context, he does not consider it a managerial decision-making process (Coviello and McAuley 1999). Neither does Dunning make any distinction between beginners and advanced firms in foreign markets or between various forms of foreign investment (Forsgren 1989), all of which make the FDI approach inappropriate for this paper.

Reid (1983) argues that the stage model approach is too deterministic and that the internationalization process of individual firms is highly situational. Firms, regardless of industry sector, do not necessarily implement consistent and incremental steps toward internationalization (e.g., Bell 1995; Clark and Mallory 1997; Crick, Chaudhry and Batstone 2001; Lautanen 2000). Moreover, stage models appear to be too inflexible to account for firm strategic (re-)orientation (such as combining various modes of foreign market servicing in one country or withdrawing from a foreign market altogether) or foreign market specifics and requirements with respect to entry modes (McKiernan 1992; Turnbull and Valla 1986; Young, Hammill, Wheeler and Davies 1986). Further critique of the stage model involves that it neglects the conditions under which a firm might begin international engagement or shift from one stage to another (Cavusgil 1980). Thus, this research strand does not appear to be an effective theoretical framework for investigating strategic firm internationalization.

As to the network perspective, scholars emphasize the collaborative nature of the internationalization of knowledge-based services (e.g., Bell 1995; Knight 1999; O'Farrell et al. 1998; O'Farrell and Wood 1999). And, indeed, due to their very nature, services generally do require a more intense client-producer interaction than does manufacturing, where standardization of the product across countries is easier to achieve. On the other hand, by focusing solely on the interdependencies between actors, the network approach does not provide any explanation for certain foreign market development that is only partially the result of collaboration and even less for that which occurs without any cooperation. Thus, the network perspective provides only a partial explanation for internationalization and needs to be complemented by broader aspects of firm strategy.

Compared to the frameworks discussed above, the business strategy approach is more multilateral and appears flexible enough to handle the development, characteristics, and goals of individual firms, on the one hand, and to capture the influence of firm environment (e.g., competition situation or locational conditions) on the other (Clark and Mallory

1997; Kim and Hwan 1992; O'Farrell et al. 1998). Therefore, this study is primarily based on the business strategy approach, with some attention to the network perspective.

I expect that both internal and external factors play an important role in the internationalization of SMEs. Internal factors, e.g., firm size, age, and innovation capability, should incorporate the influence of the firm's characteristics, capacities, and strategic orientation. External factors, such as attractiveness of firm location or collaboration and networking, should capture the impact of the firm environment on its international activities. Due to the great diversity between the manufacturing and service sectors (discussed above), as well as large differences between specific industries, predictions about differences in the effects of the particular factors of firm internationalization between the two sectors have been, to date, highly ambiguous. This study intends to shed some light on this issue.

4.3 Data and Econometric Model

4.4.1 Data

I use firm-level data collected by the German Institute for Economic Research (DIW Berlin) in the course of a large survey entitled "Current Situation and Outlook of East German Firms." This survey was sent to 30,000 firms in East Germany in 2004; the response rate was approximately 20 percent. To avoid the potential bias of affiliation with a firm group, firms that were related to a firm group in 2002 and did not relocate their production or another unit abroad in 2003/2004 are excluded from the analysis. Observations with missing values are removed, too, leaving a final sample of 3,939 firms (3,063 manufacturing firms and 876 engaged in services).

The questionnaire consisted of 49 questions eliciting general information about a firm, its business operations, the economic and competition situation, and R&D activities, as well as cooperation and networking. Firms also provided information about their production capacity and the importance and quality of several different locational factors, including proximity to universities, regional availability of skilled labor, and different types of support provided by regional authorities and institutions. Because locational conditions have improved significantly in many East German regions over the last 15 years and yet there is still strong heterogeneity between regions (Fritsch, Hennig, Slavtchev and Steigenberger 2007), these data are highly appropriate for testing locational effects (Eickelpasch, Lejpras and Stephan 2007; Lejpras and Stephan 2008).

The use of qualitative firm assessments of business situation and locational conditions arguably raises the concern that the data will be biased as it is possible that a firm's assessment of locational conditions may not reflect the objective reality of same. For instance, a firm's perception of proximity to a university or an airport may vary somewhat from the actual distance. However, perceptions, regardless of their objective truth, still have an impact on decision making and thus can be crucial to economic activity.

4.4.2 Model and Hypotheses

4.4.2.1 Methodology and Dependent Variables

Each firm has two choices with respect to internationalization in 2003/2004: (1) to engage in exporting, and/or (2) to relocate production and/or other business operations abroad. Since it is possible that a firm employs both foreign strategies simultaneously, the empirical analysis uses a bivariate probit model approach that allows for two binary choice equations with correlated disturbances (e.g., Greene 2003). Let EX represent the exporting strategy choice, where $EX = 1$ if a firm sells on the foreign markets and $EX = 0$ if the firm has domestic sales only. Another binary choice dependent variable R takes the value 1 if the firm relocates abroad and 0 if the firm does not relocate abroad. The developed econometric model is given as follows:

$EX^* = x'\beta_{EX} + \varepsilon_{EX}$, where $EX = 1$ if $EX^* > 0$, 0 otherwise,

$R^* = x'\beta_R + \varepsilon_R$, where $R = 1$ if $R^* > 0$, 0 otherwise,

$E\left[\varepsilon_{EX} \mid x\right] = E\left[\varepsilon_R \mid x\right] = 0$,

$Var\left[\varepsilon_{EX} \mid x\right] = Var\left[\varepsilon_R \mid x\right] = 1$,

$Cov\left[\varepsilon_{EX}, \varepsilon_R \mid x\right] = \rho$.

Hence, the error terms ε_{EX} and ε_R are assumed to be jointly normally distributed with zero means, unit variances, and a correlation coefficient ρ. The vector x denotes a set of explanatory variables (described below) that are identical for the two equations in this model. Moreover, the empirical specification of the model entails four categories of observations, with their unconditional probabilities:

$\Pr\left(EX = 1, R = 1\right) = \Phi\left(x'\beta_{EX}, x'\beta_R, \rho\right)$,

$\Pr\left(EX = 1, R = 0\right) = \Phi\left(x'\beta_{EX}\right) - \Phi\left(x'\beta_{EX}, x'\beta_R, \rho\right)$,

$\Pr\left(EX = 0, R = 1\right) = \Phi\left(x'\beta_R\right) - \Phi\left(x'\beta_{EX}, x'\beta_R, \rho\right)$,

$$\Pr\left(EX=0,R=0\right)=1-\Phi\left(x'\beta_{EX}\right)-\Phi\left(x'\beta_{R}\right)+\Phi\left(x'\beta_{EX},x'\beta_{R},\rho\right),$$

where Φ refers to the bivariate standard normal cumulative distribution function. The corresponding log-likelihood function is:

$\ln L=\sum_{k}\ln\Pr\left(EX_{k},R_{k}\right)$, where $k=0,1$.

4.4.2.2 Independent Variables

Table 16 sets out the specification and measurement of the explanatory variables included in the model. Accordingly to the business strategy approach, the independent variables represent the firm-related characteristics and capabilities (firm size, age, innovativeness, industry), as well as attributes specific to the firm environment (locational conditions, competition situation, collaboration activities). A detailed description of the exogenous variables follows.

Size. Even though SMEs are more frequently internationalizing (Knight 2001; Lo, Hauser, Stiebale, Engel and Kohlberger 2007; OECD 2008), the literature generally finds that these firms are less likely to engage in foreign activity than are larger companies, chiefly due, it is argued, to their lower resource capacities in terms of finance, knowledge, or managerial experience. They are also more sensitive to external barriers, for example, market and/or product standard regulations, compared to larger companies (e.g., Acs, Morck, Shaver and Yeung 1997; Brunninge, Nordqvist and Winklund 2007; Hollenstein 2005; Kuo and Li 2003). Hence, I expect that firm size, measured by number of employees, positively relates to internationalization. To account for the possible nonlinear effects of firm size, the model includes four dummy variables for the following size categories: (1) size < 10, (2) size ≥ 10 but < 50, (3) size ≥ 50 but < 100, and (4) size ≥ 100.

Age. The business strategy approach views a firm's international behavior as dependent on its resources and capabilities, as well as external conditions. As a firm ages, it develops managerial and entrepreneurial competencies and accumulates knowledge and experience about the competitive environment. Thus, firm age should positively affect its involvement in foreign markets. Firm age is captured in the model through three dummy variables: (1) age < 3 years, (2) age ≥ 3 but < 15, and (3) age ≥ 15.

Innovativeness. Firm innovativeness is assessed by way of four variables: (1) deployment share in R&D in 2003 (as a percentage), (2) a dummy for introducing a novel product on the domestic and/or foreign market in 2003/2004, (3) a dummy for applying for a patent in 2003/2004, and (4) a dummy for issuing a license in 2003/2004. The internationalization

literature emphasizes that superior innovation capabilities play a decisive role in a firm's foreign engagement (e.g., Buckley and Casson 1976; Dunning 1988; Miesenbock 1988; Mutinelli and Piscitello 1998). Accordingly, I expect that firm innovativeness spurs its internationalization.

Industry. The last group of firm-specific explanatory variables includes a dummy for affiliation with the manufacturing sector, as well as dummies for affiliation with high-tech manufacturing and/or high-tech services.[26] Generally, the literature suggests that manufacturing firms, as well as firms servicing knowledge-intensive products, have a higher degree of internationalization than their counterparts from the service sector and/or low-tech firms.

Locational conditions. The existence of clusters and the spatial concentration of economic activity illustrate the crucial role of firm location (e.g., Dunning 1998; O'Farrell, Wood and Zheng 1998; Porter 2000). Indeed, a firm located in a region with good-quality factor endowment should enhance its internationalization. In the model, the influence of firm location is separated into the effects of four groups of locational conditions: availability of skilled labor, transportation infrastructure, proximity to research facilities, and various types of support from public authorities and other bodies. The particular locational factors are assessed by firms on a six-point Likert scale, ranging from unimportant (0), important and very bad quality (1), to important and very good quality (5). The variable "skilled labor" refers to the mean value of the firm's assessment of the regional availability of skilled workers and additional education supply. The variable "transportation" has to do with interregional transportation links. The variable "research facilities" is the mean value of the assessments of proximity to universities and research institutes. Finally, the variable "support" encompasses assessments of support from local financial institutions, job centers, local government, business development corporations, state government, and chambers.

Competitors. The competition situation is included via two dummy variables: (1) one for having main competitors located abroad, and (2) one for having main rivals in proximity to the firm (i.e., within 30-km radius from the company's headquarters). Porter

[26] Here, I use the industries classification according to Götzfried (2004). High-tech manufacturing industries include chemicals and chemical products (NACE 24), machinery and equipment (NACE 29), office machinery and computers (NACE 30), electrical machinery and apparatus (NACE 31), radio, television, and communication equipment and apparatus (NACE 32), medical, precision, and optical instruments, watches, and clocks (NACE 33), motor vehicles, trailers, and semi-trailers (NACE 34), and other transport equipment (NACE 35). High-tech services are computer and related activities (NACE 72) and research and development (NACE 73).

(1990) argues that strong local competition exerts constant pressure on a firm to innovate, improve product and quality standards, increase efficiency, and reduce prices. Indeed, co-location with strong rivals facilitates discovering and developing sources of competitive advantage and, thus, achieving success internationally. Furthermore, the literature suggests that organizations tend to exhibit mimetic isomorphism and/or "follow-the-leader behavior" (DiMaggio and Powell 1983; Ito and Rose 2002; Levitt and March 1988). Accordingly, to reduce uncertainty, a firm is likely to imitate its foreign rival's successful international practices. Hence, I expect the two variables to relate positively to firm internationalization.

Cooperation. The model includes three dummy variables for frequent cooperation with a variety of partners (e.g., universities, research institutes, or other firms) in three fields: product development, process development, and sales. Accordingly to the network approach, collaboration activities should facilitate internationalization by enabling firms to

Table 16: Specification of the exogenous variables

Variable	Description
FIRM-SPECIFIC FACTORS	
Size	dummies for (1) size < 10 employees, (2) size ≥ 10 but < 50, (3) size ≥ 50 but < 100, (4) size ≥ 100
Age	dummies for (1) age < 3 years, (2) age ≥ 3 but < 15, (3) age ≥ 15
Innovativeness	
R&D deployment	deployment share in R&D in 2003 as percentage
Novel products	a dummy for introducing novel products in 2003/2004
Patent applications	a dummy for applying for patents in 2003/2004
License issues	a dummy for issuing licenses in 2003/2004
Industry affiliation	
Manufacturing	a dummy for affiliation with the manufacturing sector
High-tech manufacturing	a dummy for affiliation with high-tech manufacturing
High-tech services	a dummy for affiliation with high-tech services
EXTERNAL FACTORS	
Locational conditions	
Skilled labor	firm assessment of the regional availability of skilled labor and additional education supply
Research facilities	firm assessment of proximity to research facilities
Transportation	firm assessment of interregional transportation links
Support	firm assessment of support from regional authorities and other organizations
Competitors	
Foreign competitors	a dummy for having main competitors located abroad
Local competitors	a dummy for having main competitors co-located (within 30-km radius from firm headquarters)
Cooperation	
Product development	a dummy for frequent cooperation in product development
Process development	a dummy for frequent cooperation in process development
Sales	a dummy for frequent cooperation in sales

gain access to the complementary resources, competencies, and capabilities of their cooperation partners.

First, I estimate the econometric model for all firms so as to identify the determinants of choosing different modes of foreign market entry by SMEs. I also estimate the model separately for the manufacturing firms and the service firms and thus am able to discover whether the significance and the magnitude of each explanatory variable differ between the two groups.

4.4 Results

4.4.1 Descriptive Analysis

The sample includes data for 3,939 firms—3,063 manufacturing firms and 876 from the service sector. About 70 percent of all firms neither exported nor relocated abroad; about 30 percent engaged in international activities in 2003/2004 (see Figure 10). Thus, 28.1 and 0.6 percent engaged in exporting only and relocated production and/or other operations

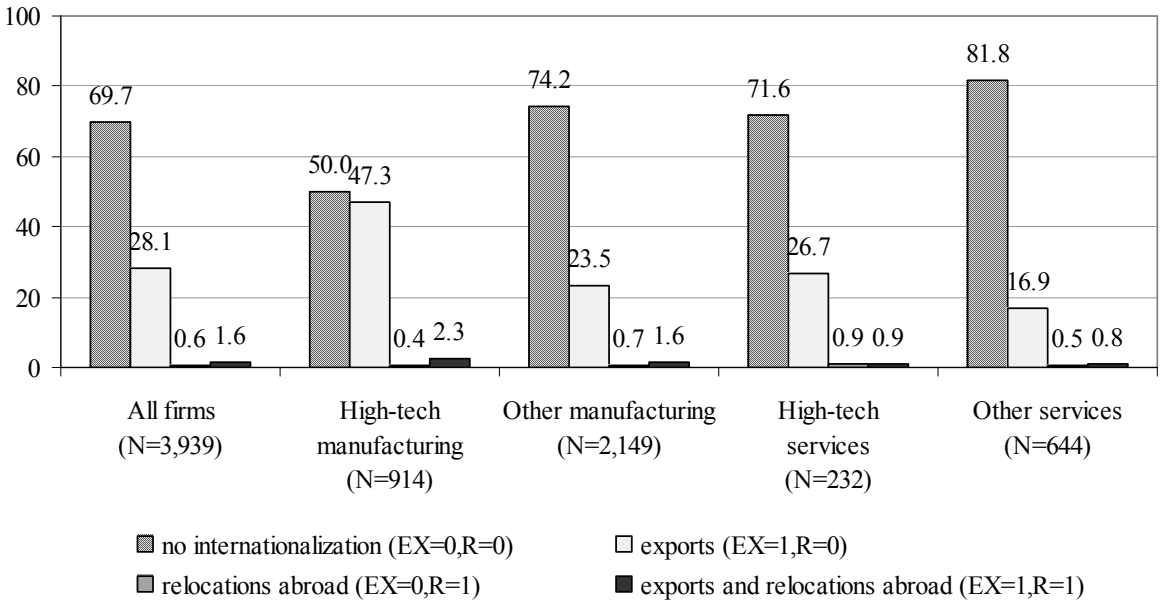

Figure 10: Firm distribution in internationalization strategies—Relative frequencies (in percentages)

Note: High-tech manufacturing industries include chemicals and chemical products (NACE 24), machinery and equipment (NACE 29), office machinery and computers (NACE 30), electrical machinery and apparatus (NACE 31), radio, television, and communication equipment and apparatus (NACE 32), medical, precision, and optical instruments, watches, and clocks (NACE 33), motor vehicles, trailers, and semi-trailers (NACE 34), and other transport equipment (NACE 35). High-tech services are computer and related activities (NACE 72) and research and development (NACE 73).

abroad only in 2003/2004, respectively. Moreover, 1.6 percent adopted both internationalization strategies simultaneously. On average, firms from high-tech manufacturing operate more frequently on foreign markets than other firms. Though high-tech services are more frequently engaged in international activity than are other types of services, the extent of this engagement is still only at about the level of that of low-tech manufacturing.

Table 17: Firm distribution in internationalization strategies and industries

	Internationalization strategy								
	EX=0,R=0		EX=1,R=0		EX=0,R=1		EX=1,R=1		
	N	*RRF*	N	*RRF*	N	*RRF*	N	*RRF*	Total
Food products and beverages	241	*88.9*	26	*9.6*	1	*0.4*	3	*1.1*	271
Textiles	44	*54.3*	34	*42.0*	0	*0.0*	3	*3.7*	81
Wearing apparel	28	*66.7*	11	*26.2*	2	*4.8*	1	*2.4*	42
Tanning and dressing of leather	18	*69.2*	6	*23.1*	0	*0.0*	2	*7.7*	26
Wood and products of wood and cork, except furniture	130	*82.8*	25	*15.9*	1	*0.6*	1	*0.6*	157
Pulp, paper, and paper products	12	*44.4*	15	*55.6*	0	*0.0*	0	*0.0*	27
Publishing, printing, and reproduction of recorded media	184	*79.0*	45	*19.3*	3	*1.3*	1	*0.4*	233
Chemicals and chemical products	24	*37.5*	37	*57.8*	1	*1.6*	2	*3.1*	64
Rubber and plastic products	82	*48.8*	81	*48.2*	0	*0.0*	5	*3.0*	168
Other nonmetallic mineral products	130	*81.3*	28	*17.5*	0	*0.0*	2	*1.3*	160
Basic metals	20	*50.0*	18	*45.0*	2	*5.0*	0	*0.0*	40
Fabricated metal products, except machinery and equipment	563	*77.1*	153	*21.0*	4	*0.5*	10	*1.4*	730
Machinery and equipment n.e.c.	185	*51.4*	168	*46.7*	0	*0.0*	7	*1.9*	360
Office machinery and computers	4	*33.3*	8	*66.7*	0	*0.0*	0	*0.0*	12
Electrical machinery and apparatus n.e.c.	80	*54.8*	60	*41.1*	1	*0.7*	5	*3.4*	146
Radio, television, and communication equipment and apparatus	19	*38.8*	27	*55.1*	0	*0.0*	3	*6.1*	49
Medical, precision, and optical instruments, watches, and clocks	107	*48.6*	111	*50.5*	0	*0.0*	2	*0.9*	220
Motor vehicles, trailers, and semi-trailers	15	*48.4*	14	*45.2*	1	*3.2*	1	*3.2*	31
Other transport equipment	23	*71.9*	7	*21.9*	1	*3.1*	1	*3.1*	32
Furniture; manufacturing n.e.c.	85	*59.9*	48	*33.8*	2	*1.4*	7	*4.9*	142
Recycling	57	*79.2*	15	*20.8*	0	*0.0*	0	*0.0*	72
Total manufacturing	*2,051*	*67.0*	*937*	*30.6*	*19*	*0.6*	*56*	*1.8*	*3,063*
Wholesale and retail sales	32	*80.0*	8	*20.0*	0	*0.0*	0	*0.0*	40
Transporting and storage	10	*83.3*	2	*16.7*	0	*0.0*	0	*0.0*	12
Real estate activities	5	*100.0*	0	*0.0*	0	*0.0*	0	*0.0*	5
Renting of machinery and equipment without operator and of personal and household goods	50	*94.3*	3	*5.7*	0	*0.0*	0	*0.0*	53
Computer and related activities	149	*77.2*	42	*21.8*	1	*0.5*	1	*0.5*	193
Research and development	17	*43.6*	20	*51.3*	1	*2.6*	1	*2.6*	39
Other business activities	425	*80.3*	96	*18.1*	3	*0.6*	5	*0.9*	529
Education	5	*100.0*	0	*0.0*	0	*0.0*	0	*0.0*	5
Total services	*693*	*79.1*	*171*	*19.5*	*5*	*0.6*	*7*	*0.8*	*876*
Total	2,744	*69.7*	1,108	*28.1*	24	*0.6*	63	*1.6*	3,939

NOTE: RRF refers to the relative row frequency (in percentages). Bold descriptions show high-tech manufacturing and service industries.

Table 17 presents the distribution of firms in industries (at the two-digit level of NACE) and internationalization strategies. Not surprisingly, manufacturing firms selling on domestic markets only are more often affiliated with lower technology manufacturing, such as food products and beverages, wood products, nonmetallic mineral products, and fabricated metal products. However, firms that choose to internationalize, in whatever form, are from both high-tech and low-tech industries. Regarding the service sector, the vast majority of those firms engaged in real estate activities and education (100 percent of firms from the two branches), as well as the renting of machinery and equipment (about 90 percent of these firms), are chiefly oriented to domestic markets. Only those firms engaged in research and development appear to show on average a considerably higher internationalization degree than other services.

Table 18 sets out the distribution of firms in five size categories. Approximately 90 percent of all firms have fewer than 50 employees and only about 3 percent have more than 100 employees. Manufacturing firms are significantly larger than service firms.

Table 18: Firm distribution in size (in number of employees) categories

	Manufacturing firms		Service firms		All firms	
	N	*RCF*	N	*RCF*	N	*RCF*
size < 10	1,422	*46.4*	587	*67.0*	2,009	*51.0*
10 ≤ size < 50	1,353	*44.2*	256	*29.2*	1,609	*40.8*
50 ≤ size < 100	188	*6.1*	21	*2.4*	209	*5.3*
100 ≤ size < 250	85	*2.8*	11	*1.3*	96	*2.4*
size ≥ 250	15	*0.5*	1	*0.1*	16	*0.4*
Total	3,063	*100.0*	876	*100.0*	3,939	*100.0*

NOTE: RCF refers to relative column frequency (in percentages).

Table 19 presents the means and standard deviations of the explanatory variables included in the econometric model, as well as the results of t-tests on mean differences for manufacturing and service firms compared to all firms. The two types are considerably different. First, the service firms engage in significantly less exporting (assessed in terms of share in total turnover in the year 2002 and in 2003/2004) compared to the all-firms group. Second, manufacturing firms are significantly older than all firms; service firms are younger: 77 and 94 percent of manufacturing and service firms are less than 15 years old, respectively. Regarding innovation activity, service firms have significantly higher deployment share in R&D and issue licenses more frequently than all firms; manufacturing firms employ on average fewer personnel in R&D and issue licenses less frequently. Furthermore, manufacturing firms gave significantly better assessments of support from regional authorities and other organizations, and worse assessments of the proximity to research facilities, than all firms. Service firms gave consistently higher ratings to the re-

gional supply of skilled labor and proximity to research facilities than did the all-firms group. Nevertheless, service firms, on average, provide worse assessments of the "support" locational condition.[27] Finally, the share of firms having main competitors located abroad is higher for the manufacturing sector and lower for services compared to the all-firms group. However, service firms have main rivals co-located more frequently than all firms; the manufacturing firms encounter this situation less frequently.

Table 19: Descriptive statistics

	Manufacturing firms			Service firms			All firms	
Variable	Mean		SD	Mean		SD	Mean	SD
Export intensity in 2002	6.30		15.72	3.51	-	13.13	5.68	15.23
Export intensity in 2003/2004	6.92		16.05	4.22	-	14.02	6.32	15.66
Age (in years)								
age < 3	0.11		0.31	0.10		0.30	0.11	0.31
3 ≤ age < 15	0.67	-	0.47	0.84	+	0.37	0.71	0.45
age ≥ 15	0.22	+	0.41	0.06		0.24	0.18	0.39
Innovativeness								
R&D deployment	4.65	-	12.32	10.00	+	22.48	5.84	15.34
Novel products	0.14		0.34	0.14		0.35	0.14	0.34
Patent applications	0.08		0.27	0.08		0.27	0.08	0.27
License issues	0.01	-	0.11	0.05	+	0.22	0.02	0.15
Locational conditions								
Skilled labor	1.56		1.33	1.79	+	1.43	1.61	1.35
Research facilities	0.39	-	1.10	0.89	+	1.56	0.50	1.23
Transportation	1.40		1.77	1.42		1.83	1.40	1.78
Support	1.08	+	0.99	0.83	-	0.87	1.02	0.97
Competitors								
Foreign competitors	0.22	+	0.42	0.07	-	0.25	0.19	0.39
Local competitors	0.46	-	0.50	0.58	+	0.49	0.49	0.50
Cooperation								
Product development	0.25		0.43	0.24		0.43	0.25	0.43
Process development	0.21		0.41	0.21		0.41	0.21	0.41
Sales	0.26		0.44	0.24		0.43	0.25	0.43
N	3,063			876			3,939	

Note: t-tests on differences of means: + significantly larger, - significantly smaller than comparison group (all firms) at 5 percent level.

4.4.2 Model Estimation Results

The next subsection presents the results of the model estimation using the data from all SMEs in the sample. In the Section 4.4.2.2, I discuss those findings that relate to differences between the manufacturing and service firms with respect to the determinants of their internationalization.

[27] Figure B in the Appendix presents the importance and assessment of specific locational conditions as rated by the firms.

4.4.2.1 Antecedents of SMEs' Internationalization

Table 20 sets out the estimates of the bivariate probit model for all firms. The correlation coefficient ρ is 0.288 and highly significant, suggesting that the bivariate choice approach is more appropriate than a two univariate probit one. A positive ρ value indicates that unobservable factors, such as managerial experience or motivation, that increase the probability of exporting are also associated with a higher likelihood to relocate abroad (after accounting for the impact of the included factors). In addition to estimated coefficients, I also present the corresponding marginal effect at means of the independent variables to simplify interpretation of results.[28]

Three variables are especially important determinants of SME internationalization. First, firm size—assessed in terms of number of employees—relates significantly positively both to exports and relocation abroad. The second crucial factor is the competition situation. The findings show that having main rivals abroad is conducive to internationalization, as expected. Thus, this result seems to confirm the mimetic behavior of firms. Contrary to expectations, however, is that having main competitors in proximity significantly impairs a firm's probability of international activity. Interestingly, the negative impact of co-location with main rivals is much stronger on exporting activity than it is on relocation abroad. Third, firm innovativeness enhances internationalization. Introducing novel products and applying for patents are driving forces behind exporting. Internationalization via relocation abroad is significantly facilitated by introducing novel products only.

I find that being a manufacturer significantly increases the probability of exporting. However, the strategy of relocation of production or other operations appears to be independent of industry sector. Surprisingly, I find a negative influence of firm age on exporting: firms older than 15 appear more likely to sell on domestic markets only than to export.[29]

Several explanatory variables specific to the firm environment significantly influence SME internationalization. I find that proximity to research facilities (universities and/or research institutes) fosters exporting. Surprisingly, the regional availability of skilled labor

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[28] The marginal effects shown in Table 20 refer to the marginal probabilities of engaging in exports and relocating abroad, respectively, which are given by: $\Pr(EX=1)=\Pr(EX=1,R=1)+\Pr(EX=1,R=0)$ and $\Pr(R=1)=\Pr(EX=1,R=1)+\Pr(EX=0,R=1)$.

[29] Empirical studies present inconsistent results on the relationship between firm age and internationalization. Some scholars find no correlation, while others detect a positive sign or even a negative relation, emphasizing the growing role of born-globals—firms that engage in foreign activity soon after founding—in the business world (e.g., Autio, Sapienza and Almeida 2000; Keeble, Lawson, Smith, Moore and Wilkinson 1998b; Kundu and Katz 2003; Lo et al. 2007; Miesenbock 1988).

Table 20: Bivariate probit model for all firms—Beta coefficients, marginal effects, and corresponding robust standard errors in parentheses

	Exports (EX=1)		Relocations abroad (R=1)	
	coeff./s.e.	marg. eff./s.e.	coeff./s.e.	marg. eff./s.e.
Constant	-0.884***		-2.149***	
	(0.104)		(0.214)	
FIRM-SPECIFIC FACTORS				
Size (size < 10 is the reference group)				
10 ≤ size < 50 [a]	0.335***	0.1101***	0.002	0.0001
	(0.051)	(0.017)	(0.117)	(0.004)
50 ≤ size < 100 [a]	0.742***	0.2757***	0.722***	0.0484***
	(0.101)	(0.040)	(0.159)	(0.018)
size ≥ 100 [a]	1.041***	0.3927***	0.970***	0.0854***
	(0.143)	(0.053)	(0.176)	(0.029)
Age (age < 3 is the reference group)				
3 ≤ age < 15 [a]	-0.005	-0.0016	0.046	0.0015
	(0.079)	(0.026)	(0.175)	(0.005)
age ≥ 15 [a]	-0.221**	-0.0679**	0.095	0.0033
	(0.094)	(0.028)	(0.196)	(0.007)
Innovativeness				
R&D deployment	0.002	0.0005	-0.006	-0.0002
	(0.002)	(0.001)	(0.005)	(0.000)
Novel products [a]	0.442***	0.1555***	0.291**	0.012*
	(0.072)	(0.027)	(0.135)	(0.007)
Patent applications [a]	0.416***	0.1474***	0.102	0.0036
	(0.090)	(0.034)	(0.158)	(0.006)
License issues [a]	0.218	0.0749	0.337	0.0157
	(0.160)	(0.058)	(0.268)	(0.017)
Industry affiliation				
Manufacturing [a]	0.209***	0.0647***	0.011	0.0004
	(0.065)	(0.019)	(0.132)	(0.004)
EXTERNAL FACTORS				
Locational conditions				
Skilled labor	-0.035*	-0.0113*	-0.017	-0.0005
	(0.020)	(0.006)	(0.039)	(0.001)
Research facilities	0.075***	0.0241***	-0.054	-0.0017
	(0.021)	(0.007)	(0.047)	(0.002)
Transportation	0.008	0.0027	0.050*	0.0016*
	(0.014)	(0.004)	(0.028)	(0.001)
Support	0.032	0.0104	-0.141**	-0.0046**
	(0.026)	(0.008)	(0.060)	(0.002)
Competitors				
Foreign competitors [a]	0.690***	0.2462***	0.393***	0.017***
	(0.059)	(0.022)	(0.108)	(0.006)
Local competitors [a]	-0.696***	-0.2211***	-0.268**	-0.0087**
	(0.051)	(0.016)	(0.114)	(0.004)
Cooperation				
Product development [a]	-0.019	-0.0061	-0.033	-0.0011
	(0.090)	(0.029)	(0.160)	(0.005)
Process development [a]	-0.137	-0.0429	0.294*	0.0117
	(0.093)	(0.028)	(0.172)	(0.008)
Sales [a]	0.073	0.024	-0.425**	-0.0112***
	(0.072)	(0.024)	(0.175)	(0.004)
N	3,939			
Log likelihood	-2,200.39			
Rho (ρ)	0.288***			

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. ([a]) dy/dx is for discrete change of dummy variable from 0 to 1.

appears to diminish the probability of exporting. Nevertheless, SMEs selling on the foreign market have a significantly higher share of employees with a university degree than their nonexporting counterparts.[30] This could imply that the nonlocal, or extra-regional, labor markets are more important sources of acquiring skilled workers for SMEs that export. Good-quality interregional transportation infrastructure is conducive to a decision to relocate abroad. Firms that give good assessments to the support provided by various regional bodies are less likely to relocate abroad, as are firms who engage in frequent collaborating in sales. Contrary to expectations, cooperation activities appear to have an insignificant effect on an SME's decision to sell on the foreign market.

In general, the estimated signs for the independent variables are in the expected direction. However, for the most part, the magnitudes of the corresponding marginal effects are lower for relocations abroad than they are for exports. Thus, to assess how well the model predicts the respective outcomes, I compute both the estimated mean and maximal probabilities. Table 21 shows the actual and predicted event probabilities from the joint and marginal distributions. Generally, the estimated mean probabilities are close to the observed ones. Hence, on average, the model's explanatory variables predict the SME internationalization behavior quite accurately.

Table 21: Bivariate probit model for all firms—Estimated probabilities for export (EX) and relocation abroad (R) choice

	Predicted probability	Observed probability
Joint distribution		
Pr(EX = 1, R = 1)	0.0068	0.0160
Pr(EX = 1, R = 0)	0.2510	0.2813
Pr(EX = 0, R = 1)	0.0058	0.0061
Pr(EX = 0, R = 0)	0.7364	0.6966
Marginal distribution		
Pr(EX = 1)	0.2578	0.2973
Pr(R = 1)	0.0125	0.0221

Table 22 provides a cross-tabulation of the predicted versus actual outcomes, where the predicted state is the one with the highest estimated probability. This approach enables examining the model's predictability at the individual-firm level. Surprisingly, when looking at maximal probabilities for relocation abroad, none are found. This could imply that some particularly important, but unobservable, factors—for instance, the attractiveness of foreign location or firm strategic orientation—are not included in the model.

[30] For the exporting and nonexporting firms, the share of employees with a university degree amounts on average to 24.4 and 19.7 percent, respectively. The difference of these mean values is significant at the 1 percent level (the calculated t-value is –4.73).

On the other hand, however, the model's ability to predict the mean probabilities for relocation abroad suggests that this strategy is also highly situation-specific. The significant factors behind the decision to relocate abroad appear to be unique and are thus difficult to capture for individual firms through modeling.

Table 22: Bivariate probit model for all firms—Joint frequencies and predictions for export (EX) and relocation abroad (R) choice

	R		
EX	0	1	Total
0	2,744	24	2,768
Fitted [a]	*3,136*	*0*	*3,136*
Correctly fitted [b]	*2,498*	*0*	*2,498*
1	1,108	63	1,171
Fitted [a]	*803*	*0*	*803*
Correctly fitted [b]	*509*	*0*	*509*
Total	3,852	87	3,939

Note: [a] Predicted cell is the one with the highest probability. [b] Predicted cell is cell with the highest probability predicted correctly.

4.4.2.2 Differences Between Service and Manufacturing SMEs

The model estimation results for the separate samples of manufacturing and service SMEs reveal that there are substantial differences between the two sectors as to internationalization (see Table 23). For manufacturing SMEs, being from a high-tech industries strengthens the probability of engaging in exporting, but has an insignificant impact on relocating abroad. For service firms, however, being high-tech has no significant impact on any type of internationalization, but having main competitors located abroad is quite important to the exporting decision. For manufacturing firms, having foreign and local competitors has about the same impact on the propensity to export, but in opposite directions.

Regarding firm innovation capabilities, I find that only one variable—introduction of a novel product on either the domestic or foreign market—significantly favors exporting by service SMEs. For the manufacturing sector, however, two innovation output variables—applying for a patent and introducing a novel product—significantly enhance exports. Introducing a novel product also has a significantly positive impact on the decision to relocate abroad. Interestingly, looking at the innovation input side, the results for manufacturing SMEs show that the higher the deployment share in R&D, the lower the probability of relocating abroad. In other words, manufacturing SMEs with a high degree of R&D appear less likely to separate production from other operating areas and relocate, than do their counterparts with low R&D intensity.

The findings show that certain locational conditions influence SME internationalization differently, depending on whether the SME is in manufacturing or in services. Only good-

Table 23: Bivariate probit model for manufacturing and service firms—Marginal effects from joint distributions

	Manufacturing			Services		
	EX=1,R=1	EX=1,R=0	EX=0,R=1	EX=1,R=1	EX=1,R=0	EX=0,R=1
FIRM-SPECIFIC FACTORS						
Size (size < 10 is the reference group)						
10 ≤ size < 50 [a]	0.0016	0.1087***	-0.0015	-0.0002	0.1070***	-0.0014
	(0.002)	(0.019)	(0.002)	(0.002)	(0.032)	(0.002)
50 ≤ size < 100 [a]	0.0345**	0.2698***	0.0050	0.0374	0.1064	0.0326
	(0.014)	(0.041)	(0.004)	(0.029)	(0.095)	(0.027)
size ≥ 100 [a]	0.0795***	0.3086***	0.0110	-0.0020**	0.3351**	-0.0023
	(0.026)	(0.062)	(0.008)	(0.001)	(0.162)	(0.002)
Age (age < 3 is the reference group)						
3 ≤ age < 15 [a]	0.0010	0.0038	0.0007	0.0006	0.0088	0.0007
	(0.003)	(0.029)	(0.003)	(0.001)	(0.048)	(0.002)
age ≥ 15 [a]	0.0010	-0.0510	0.0024	0.0000	-0.0544	0.0010
	(0.004)	(0.033)	(0.004)	(0.002)	(0.057)	(0.004)
Innovativeness						
R&D deployment	-0.0003**	0.0011	-0.0003***	0.0000	0.0000	0.0000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
Novel products [a]	0.0102*	0.1367***	0.0022	0.0063	0.1137**	0.0042
	(0.006)	(0.032)	(0.003)	(0.005)	(0.049)	(0.005)
Patent applications [a]	0.0049	0.1608***	-0.0009	0.0038	0.0783	0.0027
	(0.005)	(0.040)	(0.002)	(0.005)	(0.063)	(0.004)
License issues [a]	0.0226	0.1237	0.0080	0.0004	0.0696	-0.0004
	(0.023)	(0.079)	(0.011)	(0.002)	(0.074)	(0.002)
Industry affiliation						
High-tech ind. [a]	0.0010	0.1336***	-0.0023	-0.0003	-0.0035	-0.0003
EXTERNAL FACTORS						
Locational conditions						
Skilled labor	-0.0007	-0.0143*	-0.0002	0.0003	-0.0068	0.0004
	(0.001)	(0.008)	(0.001)	(0.000)	(0.010)	(0.001)
Research facilities	-0.0018	0.0266***	-0.0020**	0.0005	0.0072	0.0005
	(0.001)	(0.009)	(0.001)	(0.001)	(0.009)	(0.000)
Transportation	0.0010*	-0.0030	0.0008*	0.0002	0.0205***	-0.0001
	(0.001)	(0.005)	(0.000)	(0.002)	(0.007)	(0.000)
Support	-0.0017	0.0206**	-0.0018**	-0.0016	-0.0025	-0.0020
	(0.001)	(0.010)	(0.001)	(0.001)	(0.016)	(0.001)
Competitors						
Foreign competitors [a]	0.0149***	0.2077***	0.0025	0.0118	0.4460***	0.0004
	(0.005)	(0.023)	(0.002)	(0.008)	(0.074)	(0.002)
Local competitors [a]	-0.0107***	-0.2337***	-0.0017	0.0006	-0.1169***	0.0022
	(0.003)	(0.018)	(0.002)	(0.001)	(0.030)	(0.002)
Cooperation						
Product development [a]	-0.0032	0.0038	-0.0024	0.0016	-0.0495	0.0035
	(0.003)	(0.036)	(0.002)	(0.001)	(0.040)	(0.003)
Process development [a]	0.0121*	-0.0540	0.0132**	-0.0028**	-0.0129	-0.0033
	(0.006)	(0.035)	(0.007)	(0.001)	(0.045)	(0.002)
Sales [a]	-0.0063**	0.0285	-0.0050**	-0.0013	0.0163	-0.0017
	(0.003)	(0.028)	(0.002)	(0.001)	(0.043)	(0.002)
N = 3,063; LL = -1,739.12; Rho (ρ) = 0.321***				N = 876; LL = -407.8; Rho (ρ) = 0.303*		

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. ([a]) dy/dx is for discrete change of dummy variable from 0 to 1.

quality supra-regional transportation links are significantly positively related to engaging in exporting by service firms; however, several locational factors appear to affect the foreign activity of manufacturing firms. The presence of research facilities and various types of support from regional authorities and other bodies are conducive to exporting by manufacturing firms. However, firms that assess these locational factors as good are also less likely to relocate production or other operations abroad. Furthermore, good-quality transportation infrastructure slightly increases the probability of a manufacturer to relocate abroad.

Finally, the influence of cooperation activities on choice of internationalization strategy by manufacturing SMEs appears to differ from that it has on service sector SMEs. Frequent cooperation in process development favors relocating abroad for manufacturing firms, but this relationship is negative for service firms. Additionally, manufacturing firms that collaborate frequently in sales are less likely to relocate abroad.

4.5 Conclusions and Implications

Based on two approaches to firm internationalization—the business strategy approach and the network perspective—this paper investigates the driving forces behind international activity of SMEs, focusing on differences between the manufacturing and service sectors. Specifically, I analyze which factors influence firm choice between two alternative foreign strategies: engaging in exporting and/or relocating production or other operations abroad. To this end, I employ a bivariate probit model approach that can account for possible correlation between the two binary dependent variables. The model is based on survey data from approximately 3,900 SMEs from East Germany and includes various firm-related and external factors.

The results from both the descriptive and econometric analysis reveal that manufacturing SMEs, particularly in high-tech industries, engage in more exporting than do their service counterparts. Furthermore, findings from the model estimating for the manufacturing and service sectors separately show that there are considerable differences between the two with respect to the specific antecedents of internationalization. Regarding firm innovativeness, only introducing a novel product on the domestic and/or foreign market facilitates the decision to export for service firms. For the manufacturing sector, two innovation output variables—patent applications and novel products—foster engaging in exports. Interestingly, however, manufacturing firms with a high deployment share in R&D and/or that

assess proximity to research facilities as an important and good locational condition, are less likely to relocate.

Having main competitors located abroad, as well as firm size, significantly enhance the internationalization of all SMEs, regardless of industry affiliation. However, having main rivals in proximity to the firm has a significant negative impact on engaging in foreign market activity. This surprising finding deserves attention in future research.

Overall, it is more difficult to discern the significant determinants of firm internationalization for service SMEs than it is for manufacturing firms. One possible explanation for this outcome might involve the lower degree of standardization in service products compared to manufacturing goods, which also makes foreign activity by service firms more unique and highly situation-specific (e.g., Bell 1995; Clark and Mallory 1997). Moreover, scholars argue that the internationalization of service SMEs varies substantially between particular industries (e.g., Samiee 1999; Nachum 1999; OECD 2008). Thus, future investigation of SME internationalization patterns and processes, especially that focused on the service sector, should take inter-industries differences into consideration.

Appendix

Figures

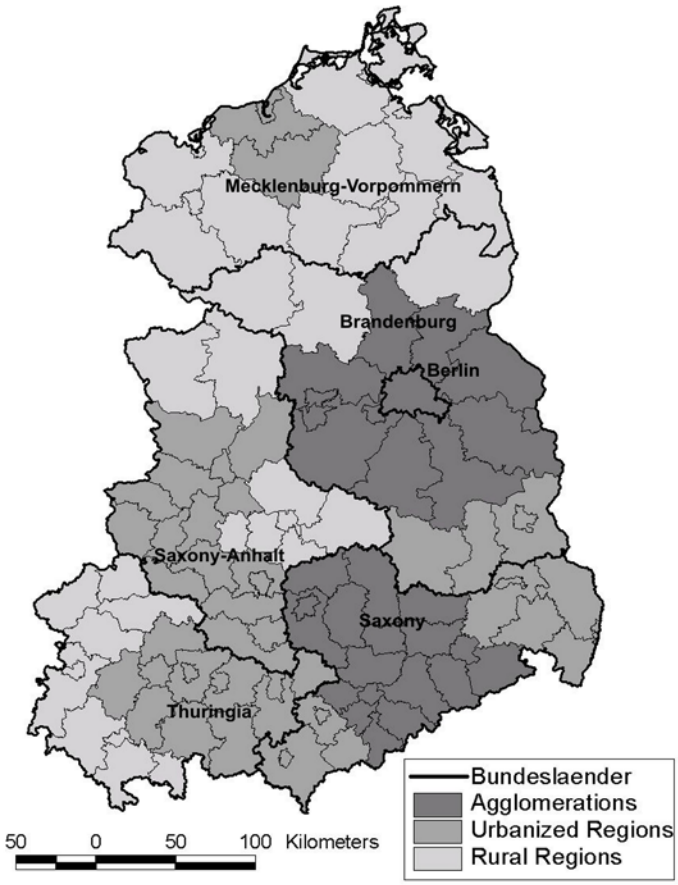

Figure A Assignment of counties (Kreise) to settlement types

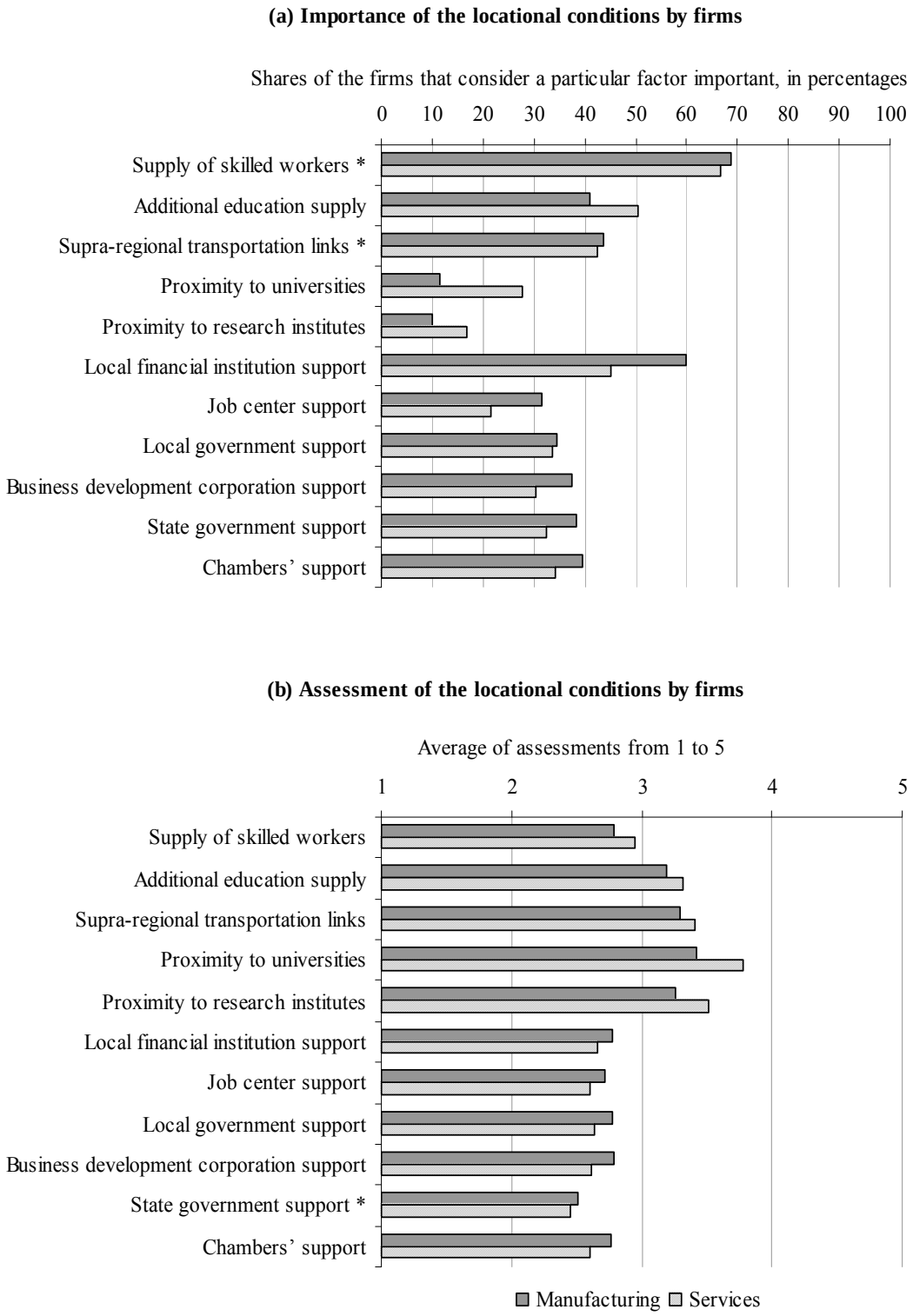

Figure B: Importance and assessment of locational conditions by firms

NOTE: * denotes insignificant mean differences at 5 percent level.

Tables

Table A Estimation results—regression of manifest variables on control variables

Control variables, dummies for: / Manifest variables:	NACE 24	NACE 30	NACE 31	NACE 33	NACE 34	NACE 35	NACE 71	NACE 72	NACE 73	NACE 74	affiliation to a firm group	age<3	3≤age<10	size<10	10≤size<50	50≤size<100	100≤size<250	agglomeration	urbanized region	**Adjusted R^2**
LV: Skilled labor; *assessment of the locational condition:*																				
L1: skilled workers supply							-					+		-						.037
L2: additional education supply										+				-	-					.024
LV: Transportation; *assessment of the locational condition:*																				
T1: supra-regional transportation links												+	+	-	-					.021
T2: regional transportation links																				.004
LV: Research facilities; *assessment of the locational condition:*																				
R1: proximity to universities	+	+		+				+	+	+		+	+	-	-	-				.088
R2: proximity to research institutes	+	+		+					+	+				-						.085
LV: Support; *assessment of the locational condition:*																				
S1: local financial institution support								-		-				+	+	+	+	-		.045
S2: job center support			-					-				+	+	-	-	-				.030
S3: local government support	+				+					+				-	-	-				.028
S4: business development corporation support					+							+	+							.035
S5: state government support	+		-				-	-	+			+	+	-						.099
S6: chambers' support							-			+										.028
LV: Cooperation; *cooperation frequency in:*																				
C1: basic research	+			+					+		+			-						.113
C2: product development	+	+		+			-	+	+					-						.100
C3: process development	+								+					-	-	-				.085
C4: additional education									+					-						.041
C5: sales	+				-			+		-		+								.024
LV: Innovativeness																				
I1: new products in 2003/2004	+	+		+				+	+					-						.077
I2: new processes in 2003/2004	+						-		+					-	-					.065
I3: number of patent applications in 2003/2004	+				+				+		+			-	-	-	-			.192
I4: deployment share in R&D in 2003	+	+		+			-	+	+				+							.322
LV: Performance; *assessment of the development of:*																				
P1: competition situation in 2005/2006											+	+	+							.033
P2: market volume in the medium term	+	+		+			-	+	+			+	+	-	-	-	-			.082

NOTE: + and - refer a significantly positive and negative coefficient at 5% level, respectively. Reference categories are age≥ 10, size ≥ 250, NACE 32, and rural regions.

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