10 DETERMINANTS OF INNOVATIVE ACTIVITY IN NEWLY FOUNDED KNOWLEDGE INTENSIVE BUSINESS SERVICE FIRMS*

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1. Introduction

The ability to innovate is an essential precondition for competitiveness in the knowledge economy both at the level of a single firm as well as at regional levels. Particularly, in sectors with a high rate of technological progress and where knowledge plays a major role, firms can achieve advantages by developing innovative products and services. Previous research has shown that small firms make a large contribution to innovation in developed economies and that innovation is an important means of entry for new firms (Acs and Audretsch, 1990).

During the last few decades, there have been fundamental changes and enhancements in the understanding of innovation processes. Since the advent of evolutionary concepts in economics, innovation is no longer conceived as a unidirectional and linear process starting with inputs from basic research and resulting in outputs of new technical products. Rather, innovation is viewed as an interactive process involving many different actors and characterized by large uncertainties which have to be overcome by different means, for instance cooperation, networking and spatial proximity (Dosi, 1988, Malerba and Torrisi, 1992; Nelson and Winter, 1982). In this context, researchers have emphasized the role of users and clients (Lundvall, 1988) as well as the role of systemic elements (e.g. Moulaert and Sekia, 2003).

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Despite of the growing awareness that innovation is not confined to technical processes and products, most contemporary research on the preconditions and consequences of innovative activity focuses on the manufacturing sector (for recent empirical studies see, for example, Becker and Dietz, 2004; Huergo and Jaumandreu, 2004; Lynskey, 2004; Rogers, 2004). Only recently have researchers explicitly accounted for the importance of innovative activities in the service sector (e.g. Drejer, 2004; Gallouj and Weinstein, 1997; Sirilli and Evangelista, 1998; Sundbo and Gallouj, 1998; Tether, 2003).

Considering the increasing importance of service activities in modern economies, this existing bias in innovation studies towards the manufacturing sector is surprising. It often results from a lack of suitable firm micro data. Today, the highly "industrialized" nations of the world are all characterized by an outstanding economic significance of the service sector. The most noticeable phenomenon within this process of structural change is perhaps the rapidly growing importance of the so-called Knowledge Intensive Business Service firms (KIBS). In Germany, for example, more than 14 percent of all new firms in 2002 have been founded in this sector (ZEW, 2004).[1] More and more KIBS are believed not to simply perform innovative activity in dependence on the demand of the manufacturing sector, but to be "knowledge bridges" or "bridges of innovation" between manufacturing, science, and clients (Czarnitzki and Spielkamp, 2003).

However, little is known about what determines innovative activity in the sector of knowledge intensive business services. This might be partially contributed to the difficulties in measuring innovative activities in a sector where patenting is unusual and formal R&D is the exception. Existing empirical studies on firm innovation in the service sector and the KIBS sector are mostly based on case study evidence, the analyses of small samples or highly aggregated sectoral or regional data. This study supplements this literature by examining the determinants of firm innovative activity in the KIBS sector using firm micro data, thereby focusing on newly-founded KIBS. On the basis of the KIBS Foundation Survey 2003, a new micro dataset of 547 start-up firms in three German agglomeration regions[2], we are able to analyze the role of possible determinants of innovation within a multivariate framework.

Section 2 gives a brief description of the central characteristics of the firms in the KIBS sector and the general nature of their innovative activities. Based on this description, we hypothesize amongst others that managerial characteristics and external linkages of a firm are crucial determinants of their innova-

1 However, the high foundation rates are simultaneously accompanied by above-average failure rates (Brixy and Grotz, 2004).

2 The KIBS Foundation Survey 2003 is the outcome of a project funded by the German Research Foundation (Grant No. RO 534/6), which has been carried out jointly by the Institute for Applied Economic Research (IAW) in Tübingen and the Fraunhofer Institute for Systems and Innovation Research (ISI) in Karlsruhe. We are indebted to our colleagues Knut Koschatzky and Thomas Stahlecker for the fruitful cooperation.

tive activity (section 3). Dataset and methodology are described in section 4, whereas section 5 outlines the main empirical results from ordered logit and multinomial logit regressions. Section 6 concludes.

2. Characteristics of the KIBS Sector

The central characteristics of firms in the KIBS sector are knowledge intensity and the orientation of their services to other firms or organizations (Haas and Lindemann, 2003).[3] KIBS provide non-material, intangible and highly customized services like software development, engineering services or business consultancy. On one hand, they act as external knowledge sources for their client firms, and, on the other , they are increasingly becoming independent innovation creators (Czarnitzki and Spielkamp, 2003; Gallouj and Weinstein, 1997). The provision of knowledge intensive business services requires specialized knowledge and cumulative learning processes, which can only be realized by intense interaction between service suppliers and clients (Johannisson, 1998; Strambach, 2002). As KIBS mostly provide highly application-oriented services, implicit knowledge plays an important role. For the acquisition of this type of knowledge, cooperation, trust, communication and face-to face contacts are very important (Howells, 2002). Thus, knowledge intensive business service firms locate mainly in close spatial proximity to their customers (Illeris, 1994).[4] As in most branches of the service sector, scale economies play a minor role in the KIBS sector and thus, most firms are small or medium sized and on the average smaller than in manufacturing (Audretsch et al., 1999).

Generally, three motives for the foundation of new firms in the KIBS sector can be identified: (1) Outsourcing processes in existing firms, (2) changes in the organization of innovation processes in the manufacturing sector, and (3) the creation of new user needs by independent innovation activities in the

3 The definition of the KIBS sector in the Standard Industry Classification is not consistent across different studies. However, the mainstream of existing research includes the following sectors: Computer and Related Activities (72), Research and Development (73) as well as the sub-sectors of Legal, Accounting, Book-keeping and Auditing Activities, Tax Consultancy, Market Research etc. (74.1), Architectural and Engineering Activities and related Technical Consultancy (74.2), Technical Testing and Analysis (74.3) and most parts of the Advertising Sector (74.4). Furthermore, it is usually differentiated between Technical KIBS (72, 73.1, 74.2, 74.3) and Professional KIBS (73.2, 74.1, 74.4). For an overview of this discussion see Koch and Stahlecker (2005). The knowledge intensity is measured by input factors like the qualification structure of the employees or the R&D expenditures, or by output factors like innovations or patents (Haas and Lindemann, 2003).

4 Indeed, at least in Germany, most firms and firm foundations in the KIBS-sector concentrate in the major urban agglomerations (Brixy and Grotz, 2004), where also important potential clients are located. However, the role of proximity may well vary not only from firm to firm, but also between different sub-sectors of the KIBS-sector (Czarnitzki and Spielkamp, 2003).

KIBS sector (Strambach, 2002; Koch and Stahlecker, 2005). Regardless of the motivation for a foundation, intense and close interaction with clients is a distinctive feature of KIBS, particularly in the early stages of a firm's development when services are least standardized. Thus, it is necessary to maintain a frequent exchange of information, communication, and trust in order to anticipate (or even to create) user needs and to meet the specific demands. For the purpose of performing innovative activity in the KIBS sector, it is crucial to gain access to relevant information and, subsequently, to adequate communication channels and networks.

3. Determinants of Innovative Activity in the KIBS Sector

In the following section, we will argue that the probability of a newly founded firm in the KIBS sector to innovate is essentially determined by its *internal (idiosyncratic) technological and organizational capabilities and by its external linkages* (for similar concepts see e.g. Lynskey, 2004; Malerba/Torrisi, 1992).[5] A series of uncertainties determines both the foundation of a new firm and the development of innovative, new-to-the-market products or services. It is, therefore, necessary to have access to information and knowledge in order to manage and reduce these uncertainties. The existing stock of experience and knowledge as well as the capacity to interact and cooperate may reduce uncertainties.

3.1 Internal Capabilities in New Firms: Managerial Characteristics

New products require new competencies or at least a new combination of competencies. In new firms, particularly in independent and originary start-ups – the internal, idiosyncratic capabilities are strongly linked to the founder (or founders). By adding his or her experiences, motivations, and networks, he or she is the creative mind and the central agent for strategic decisions and innovative activities (Johannisson, 1998). The small size of newly founded independent firms intensifies the important role of the founder in the early stages of a firm's development. Thus, the technological and organizational capabilities of the founder of a new firm might be considered as important elements that determine the innovative activity of the firm (Lynskey, 2004).[6]

5 Similarly, Cohen (1995, 203) identifies two sorts of capabilities analyzed in existing empirical studies: Whereas *organizational or procedural capabilities* condition the R&D productivity of firms, *substantive technological or related expertise* leads them to pursue different kind of innovative activity. It has to be noted that the results of Malerba and Torrisi (1992) are based on a sample of only 51 software companies and thus have to be handled with some caution.

6 This concept follows evolutionary thinking and is normally applied to established firms, as is also pointed out by Dosi (1988, 225): "What the firm can hope to do technologically in the future is heavily constrained by what it has been capable of doing in the past." Surely, it could

Malerba and Torrisi's (1992, 50) statement that firms "accumulate idiosyncratic capabilities over time" by learning has to be supplemented by the conclusion that capabilities are also "imported" into a new firm (Shane, 2000). These "imported" capabilities, like concrete and applied prior knowledge about services, products or technologies as well as experience-based organizational and managerial competencies may not only influence the type and sector of the start-up but also the direction and intensity of innovative activity.

The majority of economic activities in the KIBS sector show characteristics of high customization of the services towards the clients, because specialized, uncodified (tacit) knowledge is important to start a new firm and perform innovations. Formalized knowledge (university, patenting, etc.), on the other hand, is of minor importance in newly founded KIBS firms, mainly due to the dynamic development, the customer orientation and the short product life cycles of services.[7] We might expect, accordingly, a higher probability to innovate when the founders dispose of adequate specialized and applied knowledge and personal networks, routines, and experiences. A founder, for example, who transfers specialized knowledge or even ready-to-market services from another private firm (employee start-up) may be more likely to develop innovative services (Klepper, 2001). It is very likely that these founders had the opportunity to learn how to perform innovatively in a special field due to their former occupations. They might also be more likely to dispose of a set of relevant routines and experiences. Furthermore, they are supposed to be integrated in relevant networks (see section 3.2). Koch and Stahlecker (2004) figure out that it is most usual that the founders of newly founded firms in the KIBS sector apply their previous work experience in the same field of activity. Hence, the first hypothesis to be tested within the following empirical analyses is:

> *H1:* The professional capabilities of the founder(s) (e.g. work experience, access to ideas) influence the innovative activities of start-ups in the KIBS sector. Applied technological and organizational experiences enhance the probability to innovate.

Due to informational and subsequently arising technological and organizational advantages, we might expect that teams of founders have an advantage compared to start-ups by single founders. The stock of experiences and

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be argued that new firms are frequently rather controlled by e.g. venture capitalists or respective creditors. This might be true for capital-intensive start-ups; however, as most firms in the service sector are not capital intensive, venture capital is not a usual way of financing a new firm, at least in most sub-sectors.

7 Several studies (e.g. Sirili and Evangelista, 1998; Sundbo and Gallouj, 1998) confirm that formal protecting like patenting is of minor importance in the service sector. Without doubt, differences between sub-sectors can be expected. For example, for a service firm advising high-tech oriented manufacturing firms it is more important to dispose of profound technical and formalized knowledge than for a business consultant whose service is primarily based on the provision of experiences and network contacts.

knowledge and the resulting chances to develop innovative ideas and products should be positively (albeit not linearly) correlated with the number of individuals in the founding team. Moreover, the differences in the backgrounds of the members of the founding team may play an important role in determining the development of innovative activities in the new firms. We anticipate that founding teams combining competencies from different fields have advantages in this respect. Therefore, our second hypothesis concerns the role of founding teams:

H2: KIBS start-ups founded by a team are more probable to innovate, especially when the founders have different professional backgrounds.

There may be also factors limiting the influence of the founders capabilities to perform innovative activities in the KIBS sector. As Lynskey (2004, 173) states, it is not only crucial for a new firm to internally apply a stock of capacities for innovative activity, but also "to be aware of and associate with [external] sources of knowledge, together with its capacity to assimilate and apply such knowledge to R&D". An orientation that is too strong in regards to internal competencies, knowledge and experiences may cause lock-in effects.[8] Thus, a balance between the concentration on internal capabilities and the openness towards the environment is supposed to be most conducive to innovation (Deephouse, 1999; Oerlemans and Meeus, 2005). As internal capabilities are a necessary, but not a sufficient precondition for effectively performing innovation, firms "cannot rely only on internal capabilities; rather they establish formal and informal networks which allow them to obtain knowledge and expertise" (Malerba and Torrisi, 1992, 50).[9] At the same time, the "internal capabilities affect the extent and type of external network channels used by firms" (ibid., 51).

3.2 External Linkages, Interaction and Networking

As aforementioned, interaction with users plays an important role for innovation activities in the KIBS sector. We suggest three features of external linkages that might be of particular relevance: (1) the generic networks which influence the access and exchange of information as well as knowledge and thus impact on innovative activity, (2) the specific networks in the KIBS sector regarding the interaction and cooperation with clients and (3) spatial proximity which influences the exchange of knowledge and information.

The access to information and knowledge as well as the process of knowledge generation are pivotal elements of innovative activity (e.g. Arvanitis, 2002; Becker and Dietz, 2004; Rogers, 2004; for a recent overview see Pit-

8 These thoughts are also based upon Nelson and Winter's (1982) reasoning about entrepreneurial vs. routinized regimes in innovative activity.

9 This consideration is based on Granovetter's (1973) theory of weak and strong ties, stating that for an efficient flow of new information and knowledge, particularly weak ties are important.

taway et al., 2004) and firm foundation (e.g. Johannisson, 1998; Elfring and Hulsink, 2003, for an overview see Witt, 2004). The degree of absorption of extramural knowledge and the amount of knowledge which is available to the firm are supposedly of particular relevance. Know-how from both users and competitors is believed to be of high significance for R&D activities (Arvanitis, 2002). Therefore, we may conclude that it is essential to possess adequate channels in order to attain access to information and knowledge. Whereas, firms may be able to reduce costs, risks and uncertainties of the innovation process through cooperation, information sharing, acquisition of external knowledge, opening up new markets and so on. (Pittaway et al., 2004). Thus, our third hypothesis is:

H3: The access to information and knowledge is positively correlated with innovative activity in newly founded KIBS.

These processes of networking, however, are a somewhat ambiguous phenomenon, and research results are rather contradictory (Pittaway et al., 2004).[10] Love and Roper (2001), in a comparative study on Irish, British and German firms, find no significant relation between external linkages and innovation intensity. In contrast, Becker and Dietz (2004) observe that cooperation significantly enhances the innovative output of firms in a study of 2,200 German manufacturing firms; they also emphasize that a mix of heterogeneous actors in the innovative process raises the probability of product innovations. Rogers (2004) concludes, in a study of 4,500 Australian firms, that networking is particularly important in very small firms, whereas it does not matter in bigger firms.

Networks might be of particular importance in the KIBS sector because most of the current knowledge about products and services is uncodified and thus embodied in individuals. Innovations are frequently the outcome of interactive processes between user and producer in the KIBS sector ("ad-hoc innovation", as Tether, 2003, names it). This type of knowledge acquired via learning-by-using knowledge may be regarded as a central element of innovative activity (Lundvall, 1988). Due to the significance of uncodified knowledge, we expect that the relevance of access to applied knowledge and information exceeds the relevance of formalized knowledge from research institutions (this is analogously the case for the internal capabilities, cp. section 3.1):[11]

H4: Cooperation with partners (e.g. universities, firms) and integration into the customers' innovation processes enhances the probability of innovation in newly founded KIBS firms.

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10 The causes for that phenomenon may be manifold, but they can be expected to be predominantly of methodological nature as the samples and the methods and definitions of networking are defined differently throughout the studies.

11 For the manufacturing sector, however, Lynskey (2004) finds a high significance for joint projects with universities and the probability of a firm to innovate.

Last but not least, spatial proximity is often regarded as a factor influencing innovative activity because cooperation, knowledge exchange and networking frequently occur on informal levels and are based on reciprocity and trust (Tödtling and Kaufmann, 2001). Spatial proximity between different actors is believed to enhance frequent (face-to-face) contacts, a common understanding or culture and, thus, networking. Illeris (1994) provides case-study evidence that geographical proximity fosters different levels of cooperation in each sub-sector of the KIBS sector. In a comparative study of three European regions, Sternberg (1999) states that small firms have a higher probability to maintain intraregional linkages such as cooperation for innovation.

Contrarily, Freel (2000, 262) observes that innovators are more likely to have extra-regional linkages and collaborative arrangements: "innovators are marked not only by the frequency but also by the geographic reach of external linkages". The truth, though, may lie in the middle. A balanced mixture of intra-regional and extra-regional linkages could be important to perform innovative activity (Oerlemans and Meeus, 2005), resulting in the fifth hypothesis:[12]

H5: Spatial distance between actors matters for the probability to innovate. Particularly a balanced mixture of intra-regional and extra-regional linkages is conducive to innovative activity in the KIBS-sector.

3.3 Firm and Industry Characteristics

The previous sections discussed determinants of a firm's innovative activities in the KIBS sector, which result directly from the special characteristics of this sector and the properties of newly founded firms. Neither the impact of managerial characteristics nor external linkages, interaction, and networking have so far been tested empirically for the KIBS sector based on firm micro data. We conducted this for the first time and, therefore, put special emphasis on these determinants. However, it is well known from existing studies of innovative activities on a firm-level for other sectors, that firm-specific and industry-specific factors might also partly explain firm innovation. Even though they are not in the center of our analysis, we will briefly outline them below (for a detailed view and discussion see e.g. Cohen, 1995).

There is a large strand of literature discussing whether there is a link between firm size, firm age, and firm innovation. With respect to firm size, research results are somewhat ambiguous so far. Since the seminal contributions of Josef Schumpeter (1942), various arguments and empirical studies were presented to discuss the question whether large firms (Schumpeter's

12 Elsewhere, Koch and Strotmann (2005) show that a balance between regional and extra-regional linkages is most conducive to the post-entry performance of start-ups in the KIBS-sector.

originary view) or small firms have advantages in creating innovative products or services. Nelson and Winter (1982) argue that it might depend on the type of industry whether small or large firms tend to have an innovative advantage and distinguish two types of technological regimes, the 'routinized regime' and the 'entrepreneurial regime'. Though there is no ample concordance in the research results with respect to R&D input, the probability of a firm conducting R&D increases with its size, whereas smaller firms tend to account for a disproportionately large share of innovations (output) relative to their size. Thus, R&D productivity tends to decline with size (Cohen, 1995, 184-191).[13]

In a recent paper, Huergo and Jaumandreu (2004) examine the effects of firm age on the probability to innovate with a dataset of 2,300 Spanish firms. While with respect to firm size the data confirm that smaller firms are less innovative than their bigger counterparts, they find a negative non-linear relationship between innovation and firm age: innovative output is generally higher in younger firms than in older ones, however, it is lowest in the middle-aged firms (18-20 years) and then rises again for firms with an age over 25 years. Nevertheless, the impact of firm age on innovation activities is still an ambiguously discussed subject. It remains vague whether organizations loose their adaptability to their environment with an increasing age or whether organizational aging increases innovativeness due to learning processes (Shane and Katila, 2003).

Though we restrict our analysis to the KIBS sector, we still have to consider that this sector is very heterogeneous. Sectoral characteristics as e.g. market structure, expected demand or the degree of price and quality competition may influence the innovation behavior of the firms (see e.g. Arvanitis, 2002; or Huergo and Jaumandreu, 2004).

4. Data, Economic Model and Measurement Issues

4.1 Data

Section 3 showed that, from a theoretical point of view, different factors may explain a firm's capability to innovate. With respect to the typical characteristics of the KIBS sector, we expect that the founder, his educational and professional background, and his ability to draw back on external knowledge by interacting with universities, clients or suppliers are particularly important.

13 This is also in line with Nelson and Winter's (1982) reasoning about entrepreneurial and routinized regimes. Cohen and Levinthal (1989), in an empirical study of 1,719 firms, point out that a firm's investments in R&D affect not only directly the output of innovative products or processes, but also "the capacity to assimilate and exploit new knowledge" (absorptive capacity).

Due to the lack of suitable data, empirical micro data studies analyzing the role of access to knowledge, networking, and spatial proximity for innovative activities of KIBS are still missing. The aim of this study is to fill this gap by creating a new firm micro dataset. In autumn 2003, we conducted a telephone survey with founders of start-ups in the KIBS sector – the *KIBS Foundation Survey 2003* – in three German agglomeration regions (Bremen, Munich, Stuttgart).[14]

The KIBS sector is defined according to the mainstream of publications in this research area (for an overview and discussion of different definitions see Koch and Stahlecker, 2005). It includes firms classified under the NACE-Codes 72, 73 and 741-744[15] (see section 2). Furthermore, we restrict on the population of firms founded between 1996 and 2003 and focus the analysis on genuine foundations listed in the trade registers. Thus, subsidiaries, branch offices, firms arising from mergers and acquisitions, and firm reformations were excluded from our survey.

As a consequence of these definitions, the population size in our three regions is 7,714 firms. We then drew a random sample of 2,108 firms, stratified on the 3-digit sectoral level[16] and interviewed the founders of these firms. In cases where there were more than one founder, we interviewed only one of them. In total, we successfully conducted 547 interviews resulting in a rather satisfactory rate of return of 26 percent.

The interviews were based on a standardized questionnaire, which covered a large variety of detailed questions concerning individual attributes of the founder (e.g. context of business idea, former occupation and location of workplace, skills, etc.), start-up characteristics of the firm and its development over time.

Due to this new micro dataset, we are able to analyze a variety of possible determinants of innovative activities, which have not yet been examined empirically. Though, before we present the results of the empirical analyses, we will describe the economic model and the methods used in the following section.

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14 These three German metropolitan regions were chosen due to their comparability regarding political functions (all are Federal State capitals) and their differences regarding their industrial structure (for a detailed assessment see Koch and Stahlecker, 2005). The survey is based on address data provided by the Chambers of Industry and Commerce (IHK) in the respective regions.

15 Some sub-sectors of 74 have been excluded. For example, the firms classified as "Management Activities of Holding Companies" (74.15) – up to 40 percent of the total original sample in the regions – have not been considered as KIBS.

16 The sectoral distribution of the firms included in our dataset corresponds by and large with the data provided in the *"Mannheim Foundation Panel"* of the Centre for European Economic Research (ZEW) which can be regarded as the most reliable and detailed data source for firm foundations in Germany.

4.2 Economic Model and Measurement Issues

The first problem to be addressed in an empirical analysis of firm innovative activities is the adequate measurement of innovation. More than 40 years ago, Kuznets (1962) pointed out that the greatest obstacle to comprehend the role of innovation in economic processes is the lack of suitable measures for innovation inputs and outputs.

In empirical studies of firm innovation, it is a common strategy to measure innovation either by input or by output indicators, even though there are a series of problems in measuring (for details see e.g. Rogers, 2004 or Tether, 2003), which are well known. As an input indicator, a variable might e.g. be used reflecting whether a firm invests in R&D or not. The firm's share of R&D expenditures in turnover is a more informative alternative. In this paper, we will focus on output indicators, but we will also include the share of R&D expenditures as an explaining variable. Some studies (e.g. Lynskey, 2004) use a firm's number of patents as an output measure. In other studies (see e.g. Huergo and Jaumandreu, 2004; Rogers, 2004; Becker and Dietz, 2004), innovation is proxied by some categorical variables measuring whether a firm produced some type of innovation in the preceding year(s) or not. Due to the fact that patenting is not common in the service sector we follow the latter strategy in our paper. Thereby, we primarily explain the decision to innovate, not the decision to choose a certain level of innovation.[17] Though we can not address the problem of different "qualities" or "quantities" of innovation in a truly satisfactory manner[18], we at least consider an important aspect of the intensity of innovation by distinguishing between incremental and radical innovations. In the KIBS Foundation Survey firm founders were asked whether their firm produced innovation, and, if yes, whether it did so by (1) "improving existing own services", by (2) "newly integrating existing services from other firms into their own portfolio" or by (3) "developing totally new services". While option (3) is judged as "radical innovation" the first and the second form are interpreted as "incremental innovation".[19]

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17 See for example Arvanitis (2002) for an empirical analysis for the Swiss service sector that distinguishes both kinds of decisions.

18 When using the number of patents one might expect that this is a better indicator for the "quantity" of innovation activities. However, the underlying assumption that more patents imply always better innovation activities must not hold. Knowing that we cannot address this problem of "weighting" the relevance of innovation activities, we therefore decided to draw our conclusions upon simple categorical variables.

19 As the information is based upon a self-assessment of the interviewed founders we are – as the vast majority of existing studies – not able to control for the *de facto* innovative output of the firms. Therefore, our results might be influenced by a self-appraisal of the interviewed persons.

Therefore, we define the following categorical variable to measure the innovation behavior of KIBS:[20]

$$Y_i = \begin{cases} 0 \text{ if firm i did not innovate} \\ 1 \text{ if firm i produced incremental, but no radical innovations} \\ 2 \text{ if firm i produced only or also radical innovation.} \end{cases}$$

To explain a firm's innovative activities within a multivariate framework, we follow two different estimation strategies suitable for categorical dependent variables. First, *ordered logit models* will be estimated. The underlying assumption of this type of model is that a firm's decision to innovate radically, incrementally or not can be described by an unobserved variable Y^*, and that it is possible to explain Y^* by a vector of independent variables x_i and a random component ε_i. The latter captures the non-systematic factors of influence and is assumed to be i.i.d. and logistically distributed:

$$Y_i^* = \beta' x_i + \varepsilon_i$$

with β as the vector of coefficients to be estimated. Since we can only observe the result of a firm's decision to innovate or not, we assume that a firm does not innovate if the latent variable driving the decision process is smaller than a certain threshold value s1, that it decides to produce incremental innovation if the value of Y_i^* is larger than s1, but smaller than s2 and that a firm decides to innovate radically if the latent variable is larger than s2. s1 and s2 are unknown parameters to be estimated together with β.

$$Y_i = \begin{cases} 0 & \text{if } Y_i^* = \beta' x_i + \varepsilon_i > s_1 \\ 1 & \text{if } s_1 < Y_i^* = \beta' x_i + \varepsilon_i \leq s_2 \\ 2 & \text{if } Y_i^* = \beta' x_i + \varepsilon_i \leq s_1. \end{cases}$$

We will apply the maximum likelihood method to estimate the unknown coefficient vector and to explain the probabilities of not innovating $P(Y_i = 0)$, of incremental innovation $P(Y_i = 1)$, and of radical innovations $P(Y_i = 2)$, (for details see e.g. Greene, 2003). Standard errors are estimated robustly to heteroscedasticity by using the Huber and White estimator.

The second type of model we use is the *multinomial logit model.* In contrast to the ordered logit model, the information of the ranking of the dependent variable is not used, the dependent variable is treated purely qualitative. While this loss of information might be a disadvantage, an advantage of this model is that the estimated coefficients – not to confuse with the marginal effects – are not restricted to be the same for all categories of outcome. This al-

20 Alternatively, we also used an even more detailed breakdown of the dependent variable into five categories (no innovation, only incremental innovation, only radical innovation, radical innovation and one type of incremental innovation, all types of innovation) to test the sensitivity of the results. As the main results were quite the same and the further distinction did not really lead to additional insights we do not present detailed estimations here.

lows for more flexibility to identify differences in the effects of possible determinants on the decision to innovate incrementally or radically. However, the number of parameters to be estimated is considerably larger and the validity of the independence of irrelevant alternatives assumption (IIA-assumption) has to be checked. The IIA-assumption means that the relation of the probabilities of two outcomes is always independent from the values of the other categories.

Based on the theoretical considerations and the hypotheses in section 3, our vector of variables explaining a firm's innovative activities comprises both internal capabilities, mainly of the firm founder, external linkages of the firm as well as firm-specific and – at least in a general manner – industry-specific characteristics. We put special emphasis on the role of linkages and networks of the knowledge intensive business services.[21]

The *managerial characteristics* (see hypotheses 1 and 2) are measured by a variety of variables. We proxy the professional experience of a founder by his *professional background.* A set of dummy variables control the fact whether before the foundation the founder worked at a university or similar scientific institution in the private economy – partly with the additional distinction between small and medium-sized firms and large firms – or whether he or she was self-employed or a free-lance worker. We add a dummy variable for team foundations because a *team of founders* is believed to have better access to networks and sources of external knowledge. Additionally, we take into account whether team founders have a *diversified professional background* or not, as different professional backgrounds of the founders in a team might be decisive for the innovative activities of a firm. The decision to innovate may also be stimulated if a concrete idea from the founder's former occupation was decisive for the foundation as there were already concrete linkages and ideas to build upon. Last but not least, we consider the founder's age and sex as founder-specific control variables.

With respect to the existing amount of *external linkages* of the firms (hypotheses 3 and 4) and the possible role of *spatial proximity* (hypothesis 5) for innovation, we also include several indicators into the model. At first, we consider whether the KIBS have *access to science-related external knowledge* by partners from universities or research laboratories, *access to knowledge by clients, suppliers or other firms from the private economy and/or access to knowledge by partners from other public institutions* such as administrations or chambers for example. In addition to this mere information of having cooperation partners or not, we include information about the form and intensity of the cooperation (e.g. cooperation contracts, joint projects, mission oriented research, informal contacts). A dummy variable indicates whether the services of a firm enter into the R&D-process, the production process or internal or-

21 As our analyses focus on newly founded KIBS there is less heterogeneity in our sample with respect to firm size, industries and firm age than in studies dealing with the manufacturing sector or the service sector in total.

ganization measures of their clients ("*close integration into their clients innovation processes*") or whether they only enter into sales and distribution or as non-technical advice ("no close integration into their clients innovation processes").

We test the hypothesis that a founder who stems from the region has already more pronounced linkages, and, therefore, perhaps better access to knowledge with a dummy variable that measures whether the *last occupation of the founder was within the region* or not. If, in contrast, access to knowledge for innovation is not bound to regional contacts, we should not expect a positive impact on a firm's innovation behavior. A possible impact of a regional lead client on a firm's innovative activity is measured by a simple dummy variable, and we add the *share of turnover earned from manufacturing clients* to examine whether a close relationship of KIBS to clients from manufacturing helps to stimulate firm innovation.

As *firm-specific control variables*, *firm size*, either as the logarithm of employment in 2003 or dummy variables for the categories, and *firm age* are included. Existing studies for manufacturing or the service sector as a whole indicate that firm innovation depends positively on size and negatively on age – though often in a nonlinear way. As we measure innovation by a simple output measure, we expect that the probability of innovation increases with a firm's investment in R&D input into the innovation processes. The *share of R&D expenditures from total turnover* shall indicate whether more input in R&D helps to produce innovation and in particular radical innovation.

Finally, we include a set of sectoral dummy variables into the model to account for *sector-specific factors* as e.g. costs of innovation, the expected demand conditions in different industries of the KIBS sector, the degree of price competition and non-price competition in the market and market structure explicitly in this study.

5. Empirical Results

5.1 Descriptive Statistics

After dropping observations with missing values in any of the relevant variables, 489 firms remain for the following multivariate analyses. Almost 13 percent of the KIBS (63 firms) answered that they produced neither incremental nor radical innovation since their foundation. While 72 firms (15 percent) innovated at most incrementally, the majority of firms (72 percent) answered that they produced also or only radical innovation.[22]

22 With respect to the three regions analyzed we do not find significant differences in the innovation behavior of the KIBS. In Bremen, 73 percent of the firms are radical innovators and 13 percent innovate only incrementally. In Munich the corresponding shares are 72 percent and 15 percent and in Stuttgart 71 percent and 15 percent.

Table 10.1: Descriptive statistics

	Mean	St.dev.	Min.	Max.	Median
Managerial/internal capabilities					
Professional background: scientific research (ref.: private economy)	0.14	0.34	0	1	0
Professional background: self-employed (ref.: private economy)	0.35	0.48	0	1	0
Concrete idea from an earlier occupation led to foundation (1 = yes)	0.85	0.36	0	1	1
Team foundation (1 = yes)	0.62	0.49	0	1	1
Team foundation with diversified professional background of team founders (1 = yes)	0.27	0.44	0	1	0
External linkages and spatial proximity					
Access to knowledge by partners from universities etc. (1 = yes)	0.37	0.48	0	1	0
Access to knowledge by partners from clients, suppliers or other firms (1 = yes)	0.67	0.47	0	1	1
Access to knowledge by partners from other public institutions (1 = yes)	0.11	0.32	0	1	0
Intense cooperation with partners from universities etc. (1 = yes)	0.22	0.41	0	1	0
Intense cooperation with partners from private economy (1 = yes)	0.38	0.49	0	1	0
Closeness of integration into the customers' innovation processes (1 = close)	0.72	0.45	0	1	1
Share of turnover with clients from manufacturing (%)	0.50	0.36	0	1	0.5
Regional lead customer with crucial influence on foundation (1 = yes)	0.30	0.46	0	1	0
Firm-specific determinants					
R&D-expenditures (share of total turnover in %)	0.17	0.25	0	2.6	0.1
Firm size (log. of employment 2003)	1.51	0.97	0	5.01	1.39
Firm age (in years)	3.63	2.00	0	7	3
Age of the founder (in years)	41.76	8.79	18	67	41
Sex of the founder (1 = male)	0.87	0.33	0	1	1
Industry-specific determinants					
Software (ref.: technical services)	0.17	0.38	0	1	0
Other activities related to data processing (ref.: technical services)	0.21	0.41	0	1	0
Consultancy (ref.: technical services)	0.21	0.41	0	1	0
Advertisement (ref.: technical services)	0.17	0.38	0	1	0

Source: KIBS Foundation Survey 2003, n=489

Table 10.1 gives the descriptive statistics of the variables included in the models. A comparison of the descriptive statistics with those for the whole sample of 547 firms shows that there does not seem to be a severe bias due to the missing values.

5.2 Results from Ordered Logit Models

First, we present results for the estimation of ordered logit models taking into account the ranking of the dependent variable. In section 5.3, we will then analyze whether the application of a multinomial logit model leads to additional insights.

To check the sensitivity of the results a large variety of ordered logit models were estimated. As the findings are generally rather stable and do not depend on the concrete choice of the model, we only present four different models (see table 10.2).

Table 10.2: Determinants of innovation in newly founded KIBS (results of ordered logit estimation, robust p-values in parentheses)

Dependent variable: 0 = no innovation, 1 = incremental innovation, 2 = radical innovation				
	(1)	(2)	(3)	(4)
Managerial/internal capabilities				
Age of the founder (in years)	-0.014 (0.270)	-0.013 (0.286)	-0.014 (0.271)	-0.017 (0.192)
Sex of the founder (1 = male)	0.586 (0.088)*	0.659 (0.064)*	0.650 (0.069)*	0.655 (0.066)*
Professional background: scientific research (ref.: private economy)	0.319 (0.397)	0.206 (0.617)	0.226 (0.581)	0.269 (0.514)
Professional background: self-employed (ref.: private economy)	-0.174 (0.474)	-0.226 (0.349)	-0.196 (0.423)	-0.200 (0.420)
Concrete idea from an earlier occupation led to foundation (1 = yes)	0.224 (0.458)	0.305 (0.330)	0.268 (0.403)	0.259 (0.421)
Team foundation (1 = yes)	0.152 (0.571)	0.197 (0.472)	0.195 (0.481)	0.198 (0.469)
Team foundation with diversified prof. background of team founders (1 = yes)	-0.467 (0.110)	-0.540 (0.078)*	-0.567 (0.065)*	-0.564 (0.067)*
External linkages and spatial proximity				
Access to knowledge by partners from universities etc. (1 = yes)	0.725 (0.004)***	0.583 (0.055)*	0.643 (0.037)**	0.703 (0.019)**
Access to knowledge by partners from clients, suppliers or other firms (1 = yes)	0.046 (0.849)	-0.442 (0.112)	-0.434 (0.122)	-0.457 (0.113)
Access to knowledge by partners from other public institutions (1 = yes)	0.813 (0.048)**	0.894 (0.038)**	0.927 (0.033)**	0.937 (0.031)**
Intense cooperation with partners from universities etc. (1 = yes)		0.507 (0.286)	0.445 (0.352)	0.381 (0.424)
Closeness of integration into the custom- ers' innovation processes (1 = close)	0.425 (0.077)*	0.467 (0.057)*	0.408 (0.097)*	0.377 (0.127)

Continuation *table 10.2*

Dependent variable: 0 = no innovation, 1 = incremental innovation, 2 = radical innovation				
	(1)	(2)	(3)	(4)
Share of turnover with clients from manufacturing (%)			0.232 (0.441)	0.256 (0.396)
Regional lead customer with crucial influence on foundation (1 = yes)	0.101 (0.692)	0.073 (0.779)	0.059 (0.825)	0.046 (0.864)
Firm-specific determinants				
R&D-expenditures (share of total turnover in %)	4.160 (0.001)***	4.037 (0.001)***	3.930 (0.002)***	4.023 (0.001)***
Firm size (log. of employment 2003)	0.176 (0.145)	0.170 (0.171)	0.179 (0.154)	
5 to 10 employees (ref.: 1-4 employees)				0.391 (0.164)
11 to 20 employees (ref.: 1-4 employees)				-0.079 (0.842)
More than 20 employees (ref.: 1-4 employees)				0.776 (0.077)*
Firm age (in years)	0.028 (0.623)	0.036 (0.545)	0.031 (0.596)	0.034 (0.574)
Industry-specific determinants				
Software (ref.: technical services)	0.399 (0.257)	0.363 (0.309)	0.365 (0.323)	0.315 (0.389)
Other activities related to data processing (ref.: technical services)	0.392 (0.231)	0.524 (0.121)	0.488 (0.162)	0.467 (0.180)
Consultancy (ref.: technical services)	0.398 (0.173)	0.361 (0.213)	0.341 (0.248)	0.315 (0.291)
Advertisement (ref.: technical services)	1.267 (0.002)***	1.314 (0.001)***	1.272 (0.003)***	1.242 (0.003)***
Observations	489	489	482	482
Pseudo R^2	0.144	0.138	0.135	0.139
Log-likelihood	-337.9	-328.7	-324.9	-323.6
Wald-Test	59.57 (0.000)***	65.28 (0.000)***	64.28 (0.000)***	65.57 (0.000)***
Test for joint significance of the industry dummies	9.76 (0.045)**	10.28 (0.036)**	9.07 (0.059)*	8.69 (0.070)*
Likelihood of the corresponding multinomial logit model	-324.1	-313.3	-307.9	-306.3
Plausibility test of goodness of fit compared to a multinomial logit, p values	0.091*	0.074*	0.049**	0.074*

*/**/*** significant at 10/5/1%-levels, respectively. Source: KIBS Foundation Survey 2003.

To enable a more meaningful interpretation of the results of ordered logit estimations, we will consider the marginal effects of a change of an explaining variable to each outcome of the dependent variable. Table 10.3 presents the marginal effects for model 4. The results for the other models are quite similar.

Considering *firm-specific characteristics*, one can conclude that for innovative activities in newly founded KIBS we cannot find strong empirical evidence for the Schumpeterian hypothesis of a comparative advantage in innovative activities for large firms. Though the sign of the logarithm of employment used as an indicator for firm size is always positive, the relationship is nonetheless insignificant. If one considers a set of firm size dummy variables instead of the continuous variable then a slightly different situation occurs. The probability that KIBS produce radical innovation is significantly larger, approximately 10.6 percentage points, for firms with 20 + employees compared to small firms with four or less employees. It has to be noted, however, that the firm size distribution in the KIBS sector is rather different from the size distribution. For example, in the manufacturing sector firms with 20 or more employees are still considered as small firms.

Table 10.3: Determinants of innovation in newly founded KIBS (results of ordered logit estimation, marginal effects, robust p values in parentheses)

	Marginal effects for model (4) from table 10.2		
	0 No innovation	1 Incremental innovation	2 Radical innovation
Managerial/internal capabilities			
Age of the founder (in years)	0.001 (0.201)	0.002 (0.196)	-0.003 (0.194)
Sex of the founder	-0.058 (0.140)	-0.066 (0.082*)	0.124 (0.103)
Professional background: scientific research (ref.: private economy)	-0.018 (0.479)	-0.025 (0.495)	0.042 (0.488)
Professional background: self-employed (ref.: private economy)	0.015 (0.439)	0.019 (0.421)	-0.034 (0.428)
Team foundation (1 = yes)	-0.014 (0.476)	-0.019 (0.472)	0.033 (0.473)
Team foundation with diversified prof. background of team founders (1 = yes)	0.045 (0.089*)	0.056 (0.078*)	-0.101 (0.079*)
Concrete idea from an earlier occupation led to foundation (1 = yes)	-0.020 (0.455)	-0.025 (0.433)	0.045 (0.442)
External linkages and spatial proximity			
Access to knowledge by partners from universities etc. (1 = yes)	-0.047 (0.024**)	-0.064 (0.018**)	0.111 (0.017**)
Access to knowledge by partners from clients, suppliers or other firms (1 = yes)	0.031 (0.091*)	0.042 (0.106)	-0.073 (0.095*)
Access to knowledge by partners from other public institutions (1 = yes)	-0.050 (0.009***)	-0.075 (0.007***)	0.125 (0.006***)
Intense cooperation with partners from universities etc. (1 = yes)	-0.025 (0.370)	-0.035 (0.399)	0.060 (0.386)
Intense cooperation with partners from private economy (1 = yes)	-0.068 (0.003***)	-0.092 (0.001***)	0.160 (0.001***)
Closeness of integration into the custom- ers' innovation processes (1 = close)	-0.029 (0.163)	-0.037 (0.135)	0.066 (0.143)

Continuation *table 10.3:*

	Marginal effects for model (4) from table 10.2		
	0 No innovation	1 Incremental innovation	2 Radical innovation
Share of turnover with clients from manufacturing (%)	0.000 (0.409)	0.000 (0.398)	0.000 (0.401)
Regional lead customer with crucial influence on foundation (1 = yes)	-0.003 (0.865)	-0.004 (0.864)	0.008 (0.863)
Firm-specific determinants			
R&D-expenditures (share of total turnover in %)	-0.003 (0.000***)	-0.004 (0.001***)	0.007 (0.000***)
5 to 10 employees (ref.: 1 to 4 employees)	-0.026 (0.145)	-0.036 (0.150)	0.062 (0.144)
11 to 20 employees (ref.: 1 to 4 employees)	-0.006 (0.845)	0.008 (0.843)	-0.013 (0.844)
More than 20 employees (ref.: 1 to 4 employees)	-0.043 (0.025**)	-0.063 (0.038**)	0.106 (0.029**)
Firm age (in years)	-0.002 (0.578)	-0.003 (0.576)	0.006 (0.576)
Industry-specific determinants			
Software (ref.: technical services)	-0.021 (0.354)	-0.029 (0.365)	0.049 (0.358)
Other activities related to data processing (ref.: technical services)	-0.030 (0.138)	-0.042 (0.152)	0.072 (0.142)
Consultancy (ref.: technical services)	-0.021 (0.260)	-0.029 (0.271)	0.050 (0.264)
Advertisement (ref.: technical services)	-0.065 (0.000***)	-0.100 (0.000***)	0.162 (0.000***)

*/**/*** significant at 10/5/1%-levels, respectively. Source: KIBS Foundation Survey 2003.

With respect to a possible age dependence of innovation in the KIBS sector we do not find empirical evidence for a positive or negative relationship. However, as the question about innovation in our survey did not refer to a certain period before the interrogation one could be surprised to find that younger KIBS did not produce less innovation than their older counterparts. Also one should keep in mind that our survey focused on firms founded since 1996 and thus not older than seven years.

Considering the engagement of a firm in R&D one should clearly expect that the probability of radical and/or incremental innovation increases if a firm invests a larger share of its turnover into R&D. The results confirm that for radical innovation this positive impact is highly significant.

The age of the *founder* seems to have a slight negative impact on the probability to perform radical innovation, though statistical significance is not given. The coefficients of the sex dummy are positive and at least weakly statistically significant in all the models. This means that the probability to inno-

vate radically is larger for male founders than for female founders.[23] The marginal effect for radical innovation is about 12.4 percentage points and slightly significant, whereas the marginal effects for incremental innovation and no innovation are negative.[24]

In the ordered logit regressions, the professional background of the founder as a measure of his/her *professional capabilities* cannot be shown to have a significant impact on the decision to innovate.[25] Though the coefficients for a scientific background are always positive compared to founders stemming from the private economy, and albeit the coefficients for formerly self-employed or free-lancing founders are always negative, the relationship is not statistically significant.[26] Whether a concrete idea from a former occupation led to the foundation or not, it does not explain the probability of innovation. Also, team foundations do not have a higher probability to innovate incrementally or radically than start-ups founded by a single person. In the models shown in tables 10.2 and 10.3 the team variable was split into two variables. One measures whether a start-up is a team foundation or not and a second interaction variable measures whether a team of founders has a diversified professional background or not. As one may assume that the teams with founders from different backgrounds could be more innovative due to information advantages than team foundations where all the founders have the same background. However, our results do not confirm this hypothesis. In contrast, team foundations with diversified professional background even produce, at least slightly, less innovation than team foundations that do not have diversified founders.

To summarize, we do not find empirical evidence for our hypothesis (H1) that the professional background of the founder(s) is decisive for firm innovation. Moreover, team foundations do not show to innovate more intensely than start-ups of a single founder (H2).

With respect to the role of *external linkages*, our multivariate analyses clearly confirm the importance of interaction and networking for innovation behavior. The hypothesis that access to knowledge and information is of utmost importance for the innovative activities of KIBS (H3) can clearly be underlined by our empirical results. In particular, access to scientific institutions and universities leads to a considerably higher probability to produce radical innovations (see at first model 1). Alike, the access to knowledge of partners

23 This may partly result from the fact that women are working in less innovative sectors than men and that our sectoral dummy variables might not totally capture this effect.

24 Unfortunately, we can only speculate about the reasons for this result in this paper. It might be explained by differences in risk aversion, network access or simply by the fact that men overstate the amount of innovation they produced in a systematic manner.

25 We will have to modify this finding at least a bit when analyzing the results of the multinomial logit estimation in section 5.3.

26 We will modify this latter result when discussing the findings from the multinomial logit models in section 5.3.

from other public institutions (e.g. public administration or chambers) has a positive and significant impact on the probability to innovate radically. It might be surprising at the first glance that the probability to innovate radically does not positively depend upon the access to knowledge by suppliers, clients and other firms from the private economy. However, we can shed some light on this by additionally taking into account the intensity of cooperation (H4). In models 2 to 4, we add two variables measuring the form and the intensity of cooperation with partners from universities etc. and private firms. We gain additional insight considering the impact of partnership and access to knowledge on the decision to innovate. While with respect to external scientific knowledge, it is important to have cooperation partners there seems to be no (additional) need for formal cooperative contracts or similar ways of intense cooperation. The results for access to knowledge by firm partners are rather different: though, there is no significant impact of this kind of access on innovation in general, there is a remarkable positive impact on the probability to innovate radically if a KIBS firm cooperates with suppliers, clients or other firms in a more formal and, therefore, intense manner. KIBS with cooperative contracts, joint projects or mission oriented research with other private firms have a highly significant larger probability to produce radical innovations than firms whose contacts to other firms are rather informal und less intense. This result is consistent with the assumption that the probability of radical innovation is larger if newly founded KIBS are closely integrated into the R&D processes of their customers though the significance of this relationship is not given in every case.

One may also expect that KIBS, which earn a large share of their turnover from manufacturing clients, might be forced to innovate more frequently and more intensively. In the ordered logit framework, however, we do not find a significant influence from manufacturing clients on the innovation decisions of KIBS start-ups. We will have to modify this result at least to some extent when discussing the findings from multinomial logit models in section 5.3.

In our analysis, the variables considering a possible role of spatial proximity do not indicate a significant relation between spatial proximity and firm innovation. In particular, there is no impact at all on the probability to innovate if the founders stem from the region.[27] We also included dummy variables for the three regions Bremen, Munich and Stuttgart into our models. However, as the dummies were never significant and as they do not have a joint impact on the innovative behavior of the KIBS we restrained them from presenting them within this study. Moreover, an impact of a regional lead client influencing the decision to start-up on the probability to innovate could not be proved.

27 As the p-value of this variable was typically over 0.8 we did not present results including this variable.

The dummy variables for the different sub-sectors of the KIBS sector are – at least weakly – jointly significant. This emphasizes that differences in innovative activities can at least be partly explained by sectoral characteristics as market structure, expected demand, price and quality competition, and so on.

5.3 Results from Multinomial Logit Models

The estimation of ordered logit models has the advantage that the information of the order of the dependent variable (here: no innovation, incremental innovation, radical innovation) is used. However, the determinants of "radical innovation" may be rather different from "no innovation" and "incremental innovation". To check for the sensitivity of the results and to gain further insights into these possible differences we additionally estimate the corresponding multinomial logit models where the coefficient does not have to be the same for all categories of outcome. Some plausibility tests for the goodness of fit of the ordered logit model suggest that this might be a promising idea as the rather large values of the chi-squared statistic indicate that a multinomial logit model might be a feasible alternative (see table 10.2).[28]

The central assumption for applying a multinomial logit model is the assumption of the independence of irrelevant alternatives (IIA-assumption).[29] A Hausman test does not reject the null hypothesis that the IIA-assumption is fulfilled in any single case. The Small-Hsiao test of the IIA-assumption leads to partly inconsistent results, which have to be taken into account when interpreting the results. Likelihood-ratio tests and corresponding Wald tests for combining outcome categories all lead to the result that it is reasonable to distinguish between the three categories "no innovation", "incremental innovation" and "radical innovation" without combining two of these outcomes.

Table 10.4 presents the results of the multinomial logit estimations, whereby, the outcome "no innovation" was chosen as the base category. In the following, we do not refer to every single result, but point out some additional insights gained by applying the multinomial logit instead of ordered logit estimation.

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28 The test we applied is only "suggestive" as the ordered logit model is not nested within the multinomial logit model. We compared the likelihood value of the ordered logit model with that obtained by fitting a multinomial logit by applying a common likelihood ratio test. The procedure is explained in Hamilton (2002, 102).

29 For a more detailed explanation of this assumption see e.g. Greene (2003).

Table 10.4: Results from multinomial logit estimation (coefficient of "no innovation" = 0, robust p values in parentheses)

	Model 1		Model 2		Model 3		Model 4	
	Incremental innovation	Radical innovation	Incremental innovation	Radical innovation	Incremental innovation	Radical innovation	Incremal innovation	Radical innovation
Managerial/internal capabilities								
Age of the founder	0.001 (0.983)	-0.018 (0.298)	-0.000 (0.996)	-0.017 (0.322)	-0.004 (0.867)	-0.019 (0.278)	-0.004 (0.869)	-0.020 (0.243)
Sex of the founder	0.536 (0.334)	0.735 (0.072)*	0.538 (0.331)	0.797 (0.060)*	0.515 (0.350)	0.776 (0.068)*	0.511 (0.353)	0.774 (0.072)*
Professional background: scientific research (ref.: private economy)	-0.060 (0.926)	0.253 (0.650)	0.066 (0.921)	0.263 (0.656)	0.175 (0.791)	0.334 (0.567)	0.200 (0.762)	0.380 (0.511)
Professional background: self-employed (ref.: private economy)	-1.018 (0.015)**	-0.632 (0.049)**	-1.118 (0.008)***	-0.725 (0.025)**	-1.073 (0.012)**	-0.684 (0.041)**	-1.104 (0.010)**	-0.708 (0.039)**
Concrete idea from an earlier occupation led to foundation (1 = yes)	0.594 (0.239)	0.386 (0.288)	0.692 (0.178)	0.535 (0.168)	0.706 (0.175)	0.526 (0.196)	0.703 (0.178)	0.508 (0.209)
Team foundation (1 = yes)	0.410 (0.364)	0.315 (0.387)	0.462 (0.319)	0.378 (0.326)	0.580 (0.220)	0.465 (0.241)	0.589 (0.214)	0.472 (0.230)
Team foundation with diversified prof. background of team founders (1 = yes)	0.193 (0.718)	-0.393 (0.379)	0.162 (0.769)	-0.466 (0.314)	0.173 (0.760)	-0.489 (0.299)	0.180 (0.755)	-0.490 (0.307)
External linkages and spatial proximity								
Access to knowledge by partners from universities etc. (1 = yes)	-0.054 (0.904)	0.737 (0.044)**	0.493 (0.358)	0.870 (0.061)*	0.569 (0.319)	0.967 (0.052)*	0.635 (0.244)	1.063 (0.024)**
Access to knowledge by partners from clients, suppliers or other firms (1 = yes)	0.615 (0.126)	0.282 (0.367)	0.179 (0.682)	-0.469 (0.199)	0.259 (0.565)	-0.419 (0.267)	0.254 (0.575)	-0.446 (0.247)
Access to knowledge by partners from other public institutions (1 = yes)	1.886 (0.022)**	1.973 (0.008)***	1.998 (0.016)**	2.138 (0.005)***	2.178 (0.008)***	2.290 (0.002)***	2.297 (0.004)***	2.410 (0.001)***

Continuation *table 10.4*

	Model 1		Model 2		Model 3		Model 4	
	Incremental innovation	Radical innovation	Incremental innovation	Radical innovation	Incremental innovation	Radical innovation	Incremal innovation	Radical innovation
Intense cooperation with partners from universities etc. (1 = yes)			-1.286 (0.142)	-0.199 (0.775)	-1.329 (0.130)	-0.277 (0.695)	-1.362 (0.108)	-0.359 (0.595)
Intense cooperation with partners from private economy (1 = yes)			1.006 (0.074)*	1.569 (0.001)***	0.961 (0.091)*	1.568 (0.002)***	1.001 (0.079)*	1.644 (0.001)***
Closeness of integration into the customers' innovation processes	0.799 (0.049)**	0.750 (0.012)**	0.847 (0.044)**	0.840 (0.008)***	0.694 (0.104)	0.729 (0.023)**	0.691 (0.109)	0.709 (0.029)**
Share of turnover with clients from manufacturing					1.132 (0.043)**	0.728 (0.105)	1.175 (0.037)**	0.788 (0.082)*
Regional lead customer with crucial influence on foundation (1 = yes)	-0.804 (0.066)*	-0.289 (0.404)	-0.899 (0.046)**	-0.371 (0.294)	-1.050 (0.027)**	-0.480 (0.199)	-1.046 (0.026)**	-0.491 (0.188)
Firm-specific determinants								
R&D-expenditures (share of total Turnover in %)	2.172 (0.439)	5.467 (0.042)**	1.909 (0.464)	5.136 (0.037)**	1.525 (0.555)	4.833 (0.046)**	1.679 (0.519)	5.036 (0.040)**
Firm size (log. of employment 2003)	0.181 (0.368)	0.267 (0.153)	0.218 (0.310)	0.281 (0.162)	0.161 (0.464)	0.260 (0.202)		
5 to 10 employees (ref: 1-4 employees)							0.514 (0.268)	0.702 (0.076)*
11 to 20 employees (ref: 1-4 employees)							-0.052 (0.942)	-0.099 (0.873)
More than 20 employees (ref: 1-4 employees)							0.325 (0.717)	0.917 (0.268)
Firm age (in years)	-0.003 (0.979)	0.024 (0.761)	-0.018 (0.855)	0.020 (0.807)	-0.030 (0.757)	0.010 (0.899)	-0.025 (0.807)	0.015 (0.859)
Industry-specific determinants								
Software (ref.: technical services)	0.697 (0.256)	0.724 (0.175)	0.775 (0.200)	0.755 (0.145)	0.840 (0.187)	0.785 (0.151)	0.767 (0.228)	0.701 (0.201)

Continuation *table 10.4*

	Model 1		Model 2		Model 3		Model 4	
	Incremental innovation	Radical innovation	Incremental innovation	Radical innovation	Incremental innovation	Radical innovation	Incremal innovation	Radical innovation
Other activities related to data processing (ref.: technical services)	0.299 (0.590)	0.557 (0.230)	0.495 (0.393)	0.788 (0.115)	0.609 (0.310)	0.794 (0.127)	0.637 (0.289)	0.808 (0.119)
Consultancy (ref.: technical services)	0.466 (0.397)	0.603 (0.158)	0.522 (0.346)	0.598 (0.168)	0.562 (0.314)	0.602 (0.171)	0.599 (0.287)	0.605 (0.174)
Advertisement (ref.: technical services)	0.454 (0.526)	1.475 (0.004)***	0.511 (0.481)	1.576 (0.002)***	0.531 (0.475)	1.573 (0.004)***	0.579 (0.445)	1.599 (0.005)***
Constant	-2.278 (0.093)*	-0.888 (0.413)	-2.375 (0.080)*	-1.178 (0.290)	-2.638 (0.063)*	-1.353 (0.262)	-2.634 (0.062)*	-1.184 (0.317)
Observations	489	489	489	489	482	482	482	482
Log-likelihood	-324.1		-313.3		-307.9		-306.3	
Wald-model-test	97.91 (0.000)***		102.31 (0.000)***		102.27 (0.000)***		109.49 (0.000)***	
Pseudo R-squared	0.1504		0.1787		0.1805		0.1848	
Wald-Test for joint significance of the industry dummies	1.47 (0.833)	8.37 (0.079)*	1.87 (0.760)	9.46 (0.051)*	2.06 (0.725)	8.58 (0.073)*	1.98 (0.733)	8.24 (0.083)
Wald-test for combining outcomes (H_0: categories can be collapsed								
test for combining 1 und 2	0.015***		0.001***		0.002***		0.001***	
test for combining 1 und 0	0.097*		0.125		0.070*		0.043**	
test for combining 2 und 0	0.000***		0.000***		0.000***		0.000***	

significant at 10 percent ** significant at 5 percent; *** significant at 1 percent. Source: KIBS Foundation Survey 2003.

Within the multinomial logit framework, the general results from the ordered logit regressions can almost all be confirmed. However, we gain some additional insights into the differences between the determinants of incremental and radical innovation. We find that the input in R&D leads to a statistically highly significant positive impact on the probability to produce radical innovation, but there is no reliable impact on the probability of incremental innovation. A LR-test of the significance of the difference between the coefficient estimates shows that this difference is highly significant (p-value: 0.001).

The upper findings with respect to the serious importance of access to knowledge by partners for innovation are distinctively underlined within a multinomial logit framework. Thereby, access to external scientific knowledge is particularly important for radical innovation, but not for incremental innovation. The impact of a close interaction with suppliers, clients or other firms from the private economy on a firm's decision to innovate is positive both for incremental innovation and even more distinctive for radical innovation.

In contrast to the results of the ordered logit model, the positive impact of manufacturing clients on the probability to innovate becomes significant. As a result, having clients from the manufacturing sector is more important for incremental innovation than for radical innovation though the difference is not significant. A further modification of the findings is that the probability to produce incremental and radical innovation is significantly lower for founders who were self-employed or free-lance workers before founding, whereas the difference between founders from universities or scientific institutions or founders from the private economy again is not significant. A regional lead customer who was important for the foundation does again neither hamper nor foster the probability of radical innovation. Yet, there is some evidence that it might hamper the probability to produce incremental innovation.

6. Summary and Conclusion

Existing empirical studies on firm innovation in the service sector and the KIBS sector are mostly based on case study evidence, the analyses of small samples or highly aggregated sectoral or regional data. The present paper supplements this literature by examining the determinants of firm innovative activity in the KIBS sector using firm micro data, thereby focusing on newly-founded KIBS. On the basis of the KIBS Foundation Survey 2003, a newly conducted dataset of 547 start-up firms in three German agglomeration regions, we are able to analyze possible determinants of innovation. In particu-

lar, the possible role of managerial characteristics of the founder(s), of the external linkages, interaction and networking and of spatial proximity, all of which so far have not been analyzed within multivariate analyses.

The central hypotheses examined in this study are that, due to the specific characteristics of start-up firms in the KIBS sector, managerial characteristics of the firm founders as well as interactive behavior of the firms, namely cooperation and networking, are decisive determinants of firm innovation.

Our empirical study strongly supports the hypotheses about the pivotal role of the access to knowledge in innovation processes, also in the service sector. Particularly when accomplishing radical innovation, access to formal knowledge (from universities etc.) is of major importance. A very interesting result of our empirical analyses is that for radical innovation, access to knowledge from universities and research institutions has a significantly positive influence. Whereas formal cooperation with these institutions does not increase the probability to innovate radically. In contrast, access to knowledge via private partners has no significant influence on the probability to perform radical innovation while cooperation with these partners has a highly significant impact.

The integration into R&D processes of clients and suppliers turned out to be an important determinant of innovative activity. Spatial proximity, on the other hand, which is claimed to be relevant by many authors with strong theoretical arguments, did not play a significant role in our estimations. On the contrary, having a regional lead customer during the early stages of a firm's development surprisingly appears to have a small, but significant negative impact on the realization of incremental innovations.

With respect to the managerial characteristics of the founders we find that they do not help explaining the innovative activities of the examined firms in a significant manner. Former self-employment seems to hamper firm innovation compared to founders who worked at a university or a comparable scientific institution or private firm before. Though this result might partially be explained by a more critical self-assessment of formerly self-employed or free-lancing persons, we cannot confirm the hypothesis that applied technological and organizational experiences of the founder(s) enhance the probability to innovate. One might suppose that the appraisals of the significance of user-producer interaction and the importance of managerial characteristics and prior knowledge have to be partially rethought regarding the KIBS sector.

Certainly, this study leaves some questions unanswered. A big problem every empirical study of innovation faces is the definition and measurement of innovation. As there is usually no patenting in the service sector and as the assessment of patents has its own problems, the information about innovations in this study has to be based on a rather soft criterion of innovation output, on simple questions whether a firm performs innovative activity or not and of which kind (incremental, radical). We do not know how efficiently an innovation was realized nor do we know the number or even the value of the

innovations.[30] Also with respect to our explaining variables, the managerial characteristics, external linkages and in particular spatial proximity, one should think of different possibilities in measuring them for future studies to confirm or question the findings of our study which took a first step in considering them within a multivariate framework. Moreover, it could be interesting not only to address the decision of a firm to innovate, but also its success in realizing the innovations and in bringing them to the market effectively.

Therefore, in future studies it would be desirable to examine these questions by expanded and adapted research designs, in particular by carrying out a panel study revealing the determinants of successful innovation in the service sector. From a theoretical point of view, it is necessary to carry on the work on concepts to measure innovative activity in the service sector.

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