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There is no territorial fatality!

(or how innovation interactions between KIBS and SMEs may modify the development patterns of peripheral regions)

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Introduction

Observing regions, for instance in Europe, one may easily notice inequalities in the resources they devote to innovation activities and in the results they reach in terms of economic success. In this respect, it may be assumed at first glance that a hierarchy of regional environment could be established. Nevertheless, it is advocated in the paper that this does not obligatorily imply a "territorial fatality".

More precisely, the analysis constitutes an attempt to highlight the role of actors who have been insufficiently taken into account by comparison to the ones traditionally examined: large companies, universities and other higher education institutions, technology transfer organisations, regional administrations and other public bodies. The actors on which the paper focuses are: (i) small and medium-sized manufacturing firms (SMEs); and (ii) knowledge-intensive business services (KIBS). In particular the case of SMEs is of interest since SMEs represent the largest proportion of manufacturing firms located in peripheral regions (and in certain peripheral regions, the whole population of manufacturing firms). For similar reasons, it seems relevant to examine also KIBS. The expansion of KIBS reflects the growing importance of their economic activity. Moreover, they are locally available even in regions with no or only little traditional innovation infrastructure. Additionally, the hypothesis is made that potentially the virtuous circle linking the innovation activities of SMEs and KIBS may compensate the impact of less favourable regional environments.

The paper contains two main sections. The first section establishes the theoretical framework of the analysis. At first, the nature of the innovation phenomenon is examined, stressing its interactive character. Then, since some regional environments seem to be more favourable to innovation than others, the question of territorial fatality is addressed. In this respect, the concept of a regional hierarchy featuring the inequality between environments in terms of innovation support is introduced. Finally, two models sketching interactions implying KIBS are discussed: the first arguing that the development of KIBS reinforces the domination of core regions, the second showing a possibility for peripheral regions to escape from territorial fatality thanks to the virtuous circle of innovation linking potentially KIBS and SMEs. The second section examines empirical results. With the help of three distinct statistical treatments, the regional innovation hierarchy is contested. In fact, the empirical evidence establishes that the influence of the type of regional environment is negligible compared to other determinants. Considering that SMEs and KIBS mutually benefit from the virtuous circle associating them, the consequences regarding regional evolution patterns are discussed in the concluding section.

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1 Innovation interactions between KIBS and SMEs and the evolution capacity of peripheral regions

This section provides a theoretical framework for the discussion of the potential impact of the growing importance of innovation-related interactions involving KIBS on regional evolution patterns. Firstly, the main features of the innovation phenomenon are shown adopting the views of evolutionary economics. In a second step, the influence of spatial factors on innovation is questioned, which leads to the introduction of the concept of a regional hierarchy, which seems to imply a territorial fatality. Finally, two diverging visions of interactions involving KIBS are considered: the first arguing that a reinforcement of the dominant position of core regions seems inevitable, the second allowing to potentially refute the territorial fatality.

1.1 Innovation interactions as an expression of firms' evolutionary capacities

The *neo-schumpeterian* or evolutionary approach of economics has profoundly modified the understanding of innovation phenomenon. As a synthesis, it can be assumed, that, from an evolutionary perspective, innovation is interpreted as **a non maximising, interactive, cumulative, specific and institutionalised process** (*cf.* AMENDOLA and GAFFARD,1988; and LARUE DE TOURNEMINE, 1991).

Firstly, evolutionary economics attribute a cumulative and interactive character to innovation processes. The importance of accumulation and interaction appears especially when analysing learning effects, for instance of "learning by doing" (ARROW, 1962), or "learning by using" (ROSENBERG, 1976) and of "learning by interacting" (LUNDVALL, 1988). Secondly, in the evolutionary approach, innovation reveals a specific character. The specifics of innovation abide by the principle of historical trajectories and paradigms (DOSI, 1982) and integrate the conception of the tacit nature of acquired knowledge. This leads to the idea of a programmed character of innovation in the behaviour of the firm (CLARK, 1986). Finally, innovation has an institutionalised character. The institutionalisation features mainly the role played by the selection environment of innovation (NELSON and WINTER 1974, 1975, 1977) and the importance of R&D departments (FREEMAN, 1982). As a consequence, **"innovation is a process"**, innovation-related knowledge is not *a priori* available, thus innovation constitutes a process, an action which is performed and diffused simultaneously **which is**: (i) **"non maximising":** due to the bounded rationality hypothesis, routines and heuristic behaviours are substituted to optimisation procedures; (ii) **"interactive"**: the notion of interaction allows the suppression of the apparent contradiction and for the link between the "demand pull" and "science push" approaches to be made; (iii) **"cumulative":** innovation appears as a dynamic phenomenon which results partly from cumulative processes like learn effects; (iv) **"specific"**: innovation-related knowledge and technology are not "manna from heaven" and innovation is perceived as a problem-solving activity; **and** (v) **"institutionalised":** the institutional dimension of innovation covers the role played by R&D (*i.e.* the institutionalisation of problem-solving activities) and the influence of innovation selection environments.

With regards to the focus of the paper on the relations between SMEs and KIBS and on their meaning for regional innovation potential, two additional remarks should be considered about the nature of innovation. Firstly, it is particularly important to underline that innovations take place in manufacturing firms as well as in service firms. This remark is necessary since innovation in services is often neglected by analysis which prefer to concentrate on manufacturing firms and manufactured artefacts (on this point, *cf.* GADREY *et al.*, 1993). The second remark deals with the meaning of the innovation phenomenon. One may easily observe the huge diversity of innovation in manufacturing and services in terms of forms, genesis and consequences. For an overview of this diversity, one may for instance consider the typologies of innovating firms provided respectively by PAVITT (1984) for the manufacturing sector and by HIPP (1999) for the service sector. Nevertheless, beyond this apparent diversity, a conceptual unity of innovation can be established from the evolutionary perspective. In fact, innovation is a phenomenon by which firms try to evolve in order to survive and expand, which means in economic terms to reach a reinforced competitiveness. This specific feature of the innovation phenomenon is of particular significance, notably for analysing changes affecting regions.

1.2 Firms innovation and regional hierarchy

As has been shown, the innovation phenomenon may be interpreted as a process based on knowledge development and exchanges. Knowledge flows are immaterial: one may refer for instance to KRUGMAN (1991, pp. 53-54) asserting that : "*Knowledge flows* (...) *are invisible; they leave no paper trail by which they may be measured and tracked, and there is nothing to prevent the theorist from assuming anything about them that he likes*"[1]. However, this does not necessarily imply that space is neutral in terms of innovation. On the contrary, arguments may be developed along three main dimensions showing that "space matters for innovation": proximity, systems and environment.

1 This assertion is neverthelss discussed by authors focusing on knowledge codified in the form of patents pretend, who consider in opposition to KRUGMAN (1991) that knowledge flows do sometimes leave a "paper trail" (*cf.* JAFFE, TRAJTENBERG and HENDERSON, 1993).

A first dimension introducing the influence of space on innovations relies on the **question of proximity, accessibility of information and learning**. This questioning deals primarily with knowledge spillovers. In this respect, ANSELIN, VARGA and ACS (1997), by establishing an empirical demonstration based on geographic spillovers taking the form of concentric rings, claim they have proved that "(...) *the positive and significant relationship between university research and innovative activity, both directly, as well as indirectly through its impact on private sector R&D.* (...) *the spillovers of university research on innovation extended over a range of 75 miles from the innovating MSA*[2]*, and over a range of 50 miles with respect to private R&D*" (ANSELIN, VARGA and ACS, 1997, p. 11). This can be interpreted for the present purpose as a first indication of a regional inequality in terms of innovation capacities.

The second dimension stressing divergences between territorial units consist of the systemic approach of innovation phenomena. In fact, this approach considers the **role and impact of innovation systems**, distinguishing mainly two levels: the national and the regional one. Systems may be defined in this respect as "*complexes of elements or components, which mutually condition and constrain one another, so that the whole complex works together, with some reasonably clearly defined overall function*" (EDQUIST, 1997, p. 13). In the continuation of FREEMAN (1987) and LUNDVALL (1988 & 1992) abundant literature can be found related to national innovation systems (NIS). The regional innovation system (RIS) approach (*cf.* COOKE *et al.* 1996; COOKE 1998) encompasses the concepts of "industrial district", "innovative milieu" and "regional learning" to the greatest extent. It allows a summary of the arguments in favour of an influence of the regional environment on firms' innovation capacities[3]. RIS can be perceived as a transposition of NIS at the regional level. From both regional and national perspectives, the system of innovation is constituted by elements and relationships interacting in the production, diffusion and use of new knowledge. Thus, it provides a set of arguments highlighting why and how certain regions (and *a fortiori* some countries) are more innovative than others.

The third dimension, which is interrelated with the two first dimensions discussed (i.e. proximity in knowledge interactions and differences between systems), consists of the **regional environment** surrounding a firm and potentially influencing its innovation capacities. The innovation environment encompasses and goes beyond the sole selection environment sketched in evolutionary economics [4]. In fact, referring to the view

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2 MSA: Metropolitan Statistical Area.

3 An alternative perception, which can be found in the literature but not retained here, should be briefly evoked. In fact, it is possible to define a region from an economic perspective, for instance with the help of the approach in terms of clusters (in the sense of industrial clusters given by PORTER, 1990). From this point of view, the industrial cluster may be seen as the sum of all the economic actors contributing directly to the dominant production process of the considered region.

4 As shown for instance by NELSON and WINTER (1974, pp. 891-894).

provided by CAMAGNI (1991), three "spaces" in which firms evolve may be identified[5]: (i) the "synergy space" or milieu (*i.e.* the environment of the firm); (ii) the "competition space" (*i.e.* the market); and (iii) the "co-operation space" (*i.e.* the networks in which the firm is involved). In a similar way, JULIEN (1996) stresses the importance of small firms' integration capacity within their environment. This integration favours shared learning effects, which in turn accelerate the development of an entrepreneurial spirit in facilitating risky decision-making for instance: "(...) *the stronger a small firm links with a dynamic environment, the more innovative it will be, and the greater its stimulating effect on the environment, through a double loop effect*" (JULIEN, 1996, p. 13). In this respect, an important aspect related to the influence of the regional environment relies on the "endowment" in terms of **Institutions of Technological Infrastructure (ITI)**. Apart from their legal identity such institutions can be defined, according to KOSCHATZKY and HÉRAUD (1996), as entities: (i) located in a specified territory; (ii) having a potential technological impact within this territory; and (iii) whose activities provide the input for research and innovation of firms[6]. Since ITI can be considered as constituting elements of the regional environment, uneven quantitative and qualitative endowments in terms of ITI imply inequities in the way innovating firms benefit from their regional environment.

Assuming that the impact of the innovation environment of a firm overlaps: (i) the effects of proximity with other actors involved in the innovation process; and (ii) the influences of the innovation system(s) from which the firm depends, one may try to synthesise the three dimensions. In fact, this leads to the consideration of **a hierarchy of firms' regional location in terms of innovation capacities**. To a certain extent, such a hierarchy seems coherent with the views expressed by the new growth theory (*cf.* in this respect ROMER, 1990; and BARRO and SALA-I-MARTIN, 1995) since it corresponds to a vision in which endogenous knowledge development leading to innovation) is more accurate in core regions than in peripheral ones. Schematically, it can be asserted in this approach that a regional hierarchy in terms of innovation environment implies that firms located in core regions mainly outperform the ones located in intermediate regions, which broadly benefit from better opportunities than the ones belonging to the "periphery"[7]. Consequently, the terms of "territorial fatality" can be evoked to outline a situation in which peripheral regions seem to be forced to lag be-

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[5] Apart from what CAMAGNI (1991) designates as the "organisation space" (*i.e*. the firm itself).

[6] The original development of the concept of ITI, as well as reflections on the possible measurement of their activities on a territorial level, have been performed in the frame of the Upper Rhine Valley (*i.e. Alsace* and *Baden*) which constitutes the area of empirical investigation of the present analysis (*cf.* KOSCHATZKY and HÉRAUD, 1996). Additionally, HÉRAUD and MULLER (1998) provide, for the same geographical area, a complementary analysis focusing on certain categories of French and German ITI.

[7] This basic categorisation presents the advantage of being easily compatible with most national classification of regions for instance on NUTS III level.

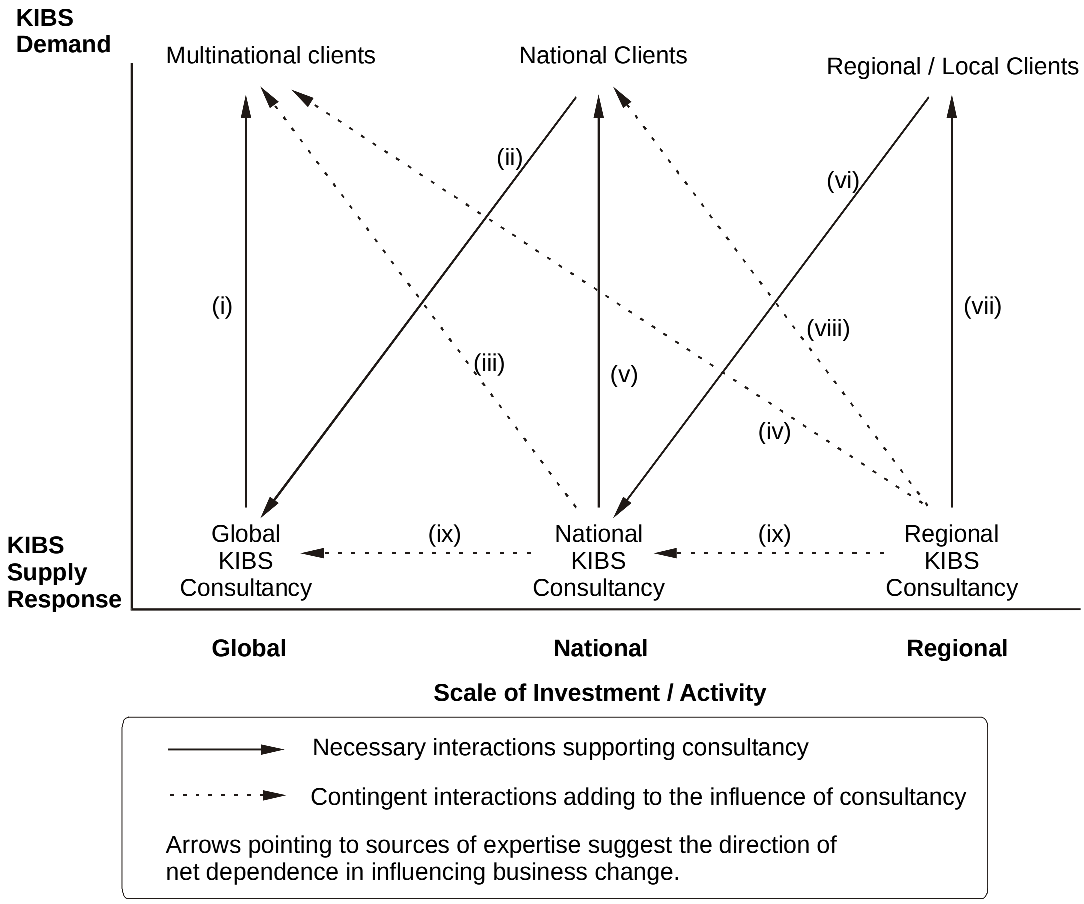
hind in terms of knowledge exchanges and development. Nevertheless, the goal of the paper is to refute this fatality in arguing that the "regional hierarchy" may be compensated for, at least potentially, by the virtuous innovation circle linking SMEs and KIBS shown in the next section.

1.3 Two visions of the way KIBS may affect regional evolution capacities

This section examines two visions of interactions involving KIBS and their possible consequences in terms of regional evolution capacities. The objective here is not to set these two visions against each other but to understand how the expansion of business consultancy could exert a crucial influence on the development of the innovation capacities of firms located in different regional environments.

According to the first vision, proposed in WOOD (1998), the expansion of KIBS leads to a reinforcement of the domination of the core. The model developed (*cf.* figure 1) features interactions involving KIBS and their clients on different spatial levels. This approach pays particular attention to large enterprises both in consultancy and manufacturing sectors as well as to the role of international and national-scaled interactions. In this perspective, the growing role of KIBS appears to be an opportunity for core regions (in particular big metropolis) and a threat for peripheral regions. Basically, KIBS bring knowledge and practice to bear on client activities which their own staff do not possess or would otherwise not be able to implement. In this respect, the model sketches a circulation of knowledge flows but since access to the different stages is not equal everywhere, the knowledge flows generate a reinforcement of regional inequalities. This could be compared to a kind of bottom-up effect "sucking up" the knowledge developed along the multiple clients-KIBS relations at the different levels of interaction. To summarise, it can be concluded that WOOD's model: (i) stresses the growing importance of consulting on innovation; (ii) highlights that the impact of KIBS on the different spatial levels is highly dependent on specific relationships with their clients; and (iii) implies as a consequence an increased regional inequality in both access and expansion of innovation-related knowledge.

Figure 1: KIBS demand and supply response from a spatial perspective



(i)	Global consultancies respond primarily to the requirements of multinational clients and agencies.
(ii)	Global consultancies increasingly act as conduits of innovative ideas and methodologies between the global and national scales.
(iii)	Successful medium-small nationally-based consultancies may develop internationalisation strategies by serving multinational clients seeking specialist expertise or familiarity with home country conditions.
(iv)	Successful regionally-based consultancies may also work for multinational clients operating in their regions on a similar basis to (iii), although their growth more often depends on serving national clients (viii).
(v)	Nationally-based consultancies, serving private and government clients within that market, provide the predominant volume of consultancy exchanges across a wide variety of expertise.
(vi)	Within national systems of consultancy-client interaction, regionally-based clients seeking consultancy support often depend on nationally-based consultancies.
(vii)	Regionally-based consultancies originate largely to serve regional clients, and adapt to these needs on the basis of local exchange and innovativeness.
(viii)	Successful regionally-based consultancies most often grow by serving national or even international (iv) clients on the basis of specialist skills or knowledge of local conditions.
(ix)	Contingent links may exist between international, national and regionally-based consultancies, either directly through subcontracting or networking relationships, or indirectly as a result of client tendering policy.

Adapted from W*OOD* *(1998, pp. 13-14, 21)*

The second vision of interactions involving KIBS consists of the virtuous circle linking the innovation capacities of KIBS and SMEs as shown in MULLER (1999). In this approach the interactive service relation linking KIBS to their manufacturing clients plays a central role. As has been shown notably by GALLOUJ (1994) business consultancy firms may assume a role of co-innovator for their clients. In turn, SMEs support the development of the knowledge base of KIBS. As CALLON, LARÉDO and RABEHARISOA (1997, p. 34) assert: "*the service* [relation] *creates a complex system of relationships between supply and demand: the conception of the service and its realisation cannot be divided and mobilises at the same time the producer and the consumer who co-operate closely*"[8]. Considered as a whole this mutual contribution constitutes a virtuous circle in which KIBS and SMEs may respectively benefit from their interactions through: (i) a better integration in their respective innovation environments; (ii) an improved activation of their internal innovation resources; and (iii) an improved activation of their external innovation resources (*cf.* figure 2). To summarise, "*it can be argued that* ***interacting KIBS and SMEs mutually contribute to their respective innovation capacities, in a similar but not identical way****. This mutual contribution is based on a "core sequence" which can be approximated with three "sub-sequences": (i) the interaction itself; (ii) the resulting knowledge base expansion; and (iii) the ensuing evolution of the firm. These three constituents of the whole phenomenon should not be seen in a linear perspective but as potentially inter-linked in a "knowledge-based loop" thanks to feed-back effects*." (MULLER 1999, p. 144).

The question to be answered is to what extent could the virtuous circle play a particular role for the development of peripheral regions? In fact, it appears that peripheral regions present a singularity: in relative terms, the proportion of SMEs in manufacturing and the share of small (not-national or international-oriented) business services is usually higher than in core and intermediate regions. This may be seen as a weakness (in addition to other factors hindering peripheral regions). Nevertheless, without contesting the validity of WOOD's model as a whole, this singularity may also constitute an opportunity for peripheral regions if one considers the mutual benefits SMEs and KIBS can gain from the virtuous circle shown as an alternative to WOOD's model.

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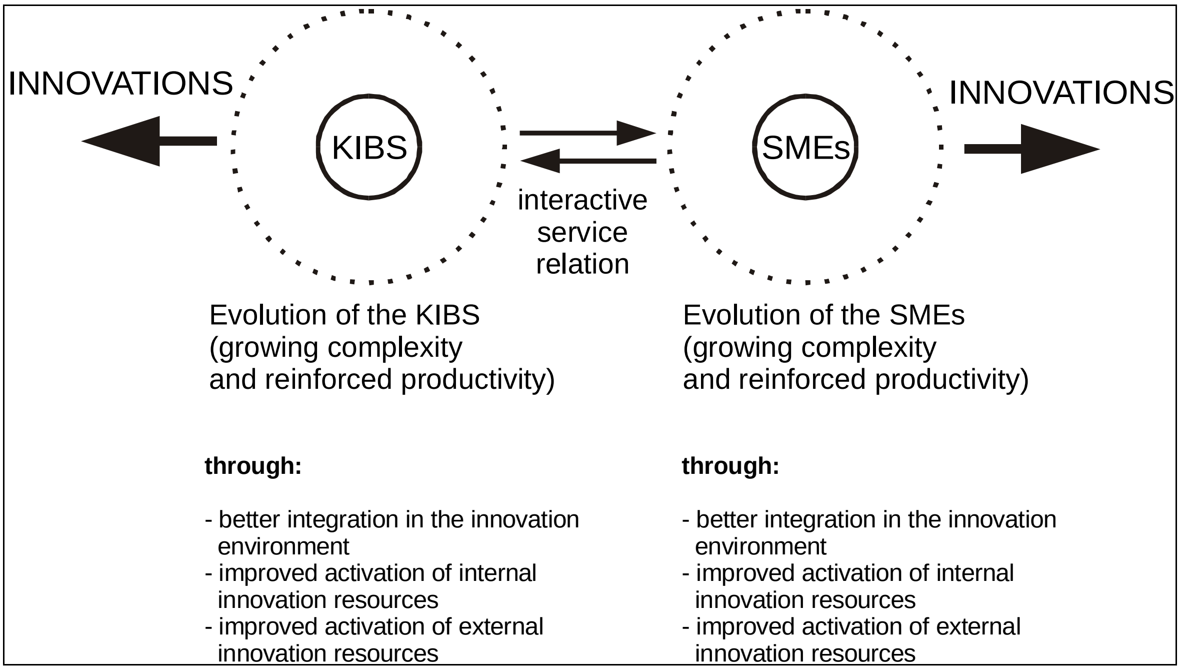
8 "*Le service* (...) *crée un système complexe de relations entre offre et demande: la conception de la prestation et sa réalisation ne peuvent être séparées et mobilisent à la fois le producteur et le consommateur qui coopèrent étroitement*" (CALLON, LARÉDO and RABEHARISOA, 1997, p. 34).

Figure 2: The mutual contribution of KIBS and SMEs to their innovation capacity



Adapted from M*ULLER (1999, pp. 48 and 55)*

The objective of this paper is not to contrast the two models of interaction with KIBS: they may co-exist in the sense that they describe phenomena occurring parallel or simultaneously at different levels. It is important to underline that **KIBS represent more for SMEs than just a simple information source**. As underlined by STRAMBACH (1998, p. 4): "*The purchase of knowledge-intensive services is not the same as the purchase of a standardised product or service. The exchange of knowledge products is associated with uncertainties and information asymmetries stemming from the special features of knowledge* (...)". The analysis discussed hereafter explores how peripheral region may increase their evolution capacities and in this respect, the empirical investigation provides some evidence of the mutual benefit of interaction for SMEs and KIBS, particularly in the context of a peripheral region. It is assumed that thanks to the virtuous circle, the regional environment hierarchy does not necessarily constitute a fatality.

2 Some empirical evidence

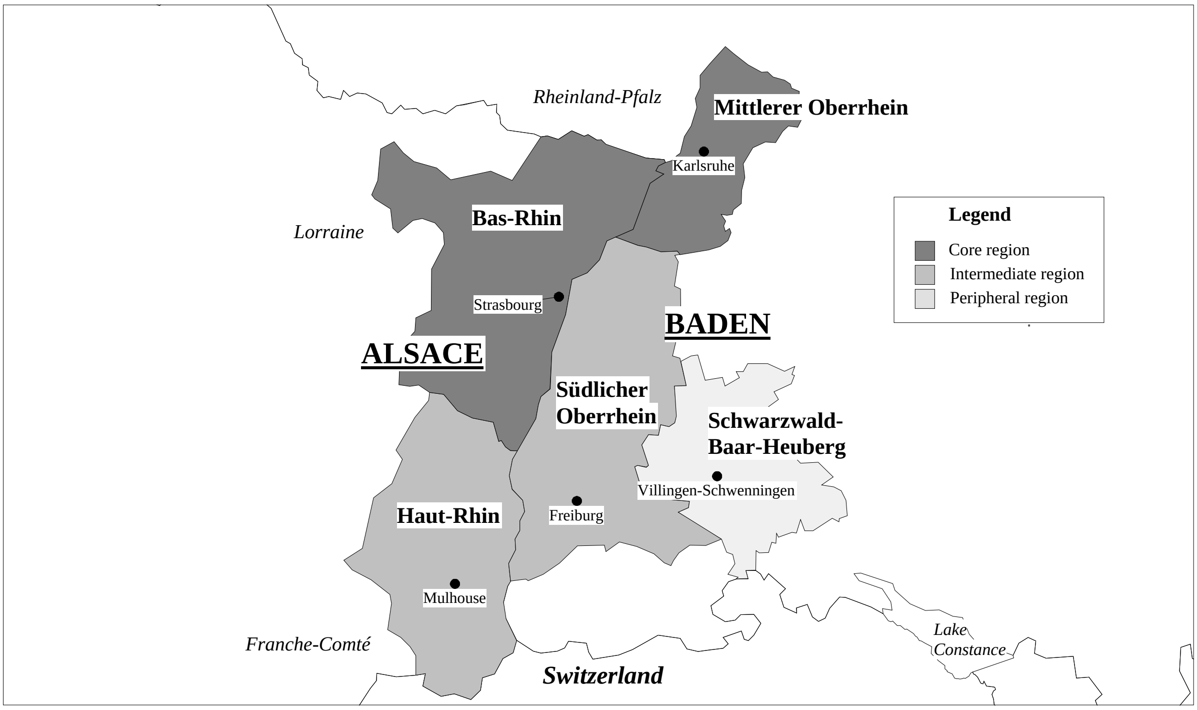
The empirical evidence contesting the fatality of the regional innovation hierarchy will be established with the help of three distinct steps, corresponding to three different statistical methods. In the first step, comparative charts will reveal that in the case regions the hierarchy cannot be established for SMEs and KIBS with regards to basic indicators of firms evolution capacities. The next step, consisting of multiple correspondence analysis, aims at detailing for SMEs and KIBS the variables affecting their behaviour in terms of evolution and at characterising it in terms of regional location. The final step, called "path modelling", is based on the successive combination of PROBIT analysis. With the help of this "path modelling" it can be established that, on the one hand, SMEs and KIBS mutually benefit from the virtuous circle associating them and that, on the other hand, the influence of the type of regional environment is negligible in comparison with other determinants.

The data used for the analysis were collected using a postal inquiry (in the respective national languages) in Alsace and Baden[9] which led to the constitution of two distinct samples: one encompassing SMEs (n=726), the other consisting of KIBS (n=486)[10]. Considering the location of research, communication and transportation infrastructures, three types of innovation-related regional environment can be delimited corresponding to administrative units: (i) core: Bas-Rhin and Mittlerer Oberrhein; (ii) intermediate: Haut-Rhin and Südlicher Oberrhein; and (iii) peripheral: Schwarzwald-Baar-Heuberg (*cf.* figure 3).

9 The data collection took the form of a postal survey, performed in 1995-1996 asking firm representatives to consider activities related to innovation, interaction and general business for the time period 1992-1995. This operation took place in the frame of a broader project entitled "Technological Change and Regional Development in Europe", granted by the *Deutsche Forschungsgemeinschaft* (DFG, the German Research Association). This joint research project conjointly involved three research teams: the Department of Economic Geography at the University of Hannover, the Faculty of Economics and Business Administration of the Technical University Bergakademie Freiberg and the Fraunhofer Institute for Systems and Innovation Research (FhG ISI) in Karlsruhe. A recent special issue of the review Raumordnung und Raumforschung (RuR 4, 1998) presents different aspects of the methodology and of the results of the overall project.

10 The constitution of the samples are detailed in appendix 1 and 2.

Figure 3: The surveyed regions



2.1 Comparative charts

The following charts show the frequencies of basic characteristics featuring innovation behaviour of firms in distinguishing the type of regional environment in which the firms are located. Three basic variables are retained: (i) the introduction of innovations by the firm during the considered 3-years period; (ii) the research and development (R&D) intensity (*i.e.* the level of expenses in proportion of the annual sales, which can be interpreted as an indicator of the activation of internal innovation resources); and (iii) the existence of interactions between SMEs and KIBS (which can be interpreted as an indicator of the activation of external innovation resources). The charts are drawn respectively for SMEs (*cf.* figure 4) and for KIBS (*cf.* figure 5).

Considering the propensity of SMEs and KIBS to introduce innovation, no significant bias in favour of core regions can be observed. On the contrary, in the case of SMEs, the proportion of innovating firms is higher in the "periphery" than in the "core" (69,4% *vs.* 63,3%). In the same way, no significant differences can be observed between "peripheral"' and "core" KIBS (73,5% *vs.* 74,8% of innovating firms).

The examination of the level of R&D according to firms' location reveals that firms located in the "periphery" clearly overstep their counterparts in the "core". This difference in the propensity to realise a high level of R&D investment can be established for

SMEs (11,9% in the "core" *vs.* 14,9% in the "periphery") and for KIBS (26,1 % *vs.* 32,4%).

The third set of charts, depicting innovation-related interactions (respectively with KIBS in the case of SMEs and with SMEs in the case of KIBS), displays similar results. In fact, the proportion of interacting firms is lower in the "core" (SMEs: 63,1% ; KIBS 58,3%) than in the "periphery" (SMEs: 76,9% ; KIBS 66,2%).

To summarise, the comparative charts provide no evidence of a regional hierarchy of environments related to innovation. On the contrary, at least for the examined samples and case regions, SMEs and KIBS seem to adapt themselves successfully to environments supposed to be less favourable for innovation activities. Additionally, the similarity between SMEs and KIBS in terms of results support the hypothesis of a link between the two types of firms

Figure 4: The SME sample

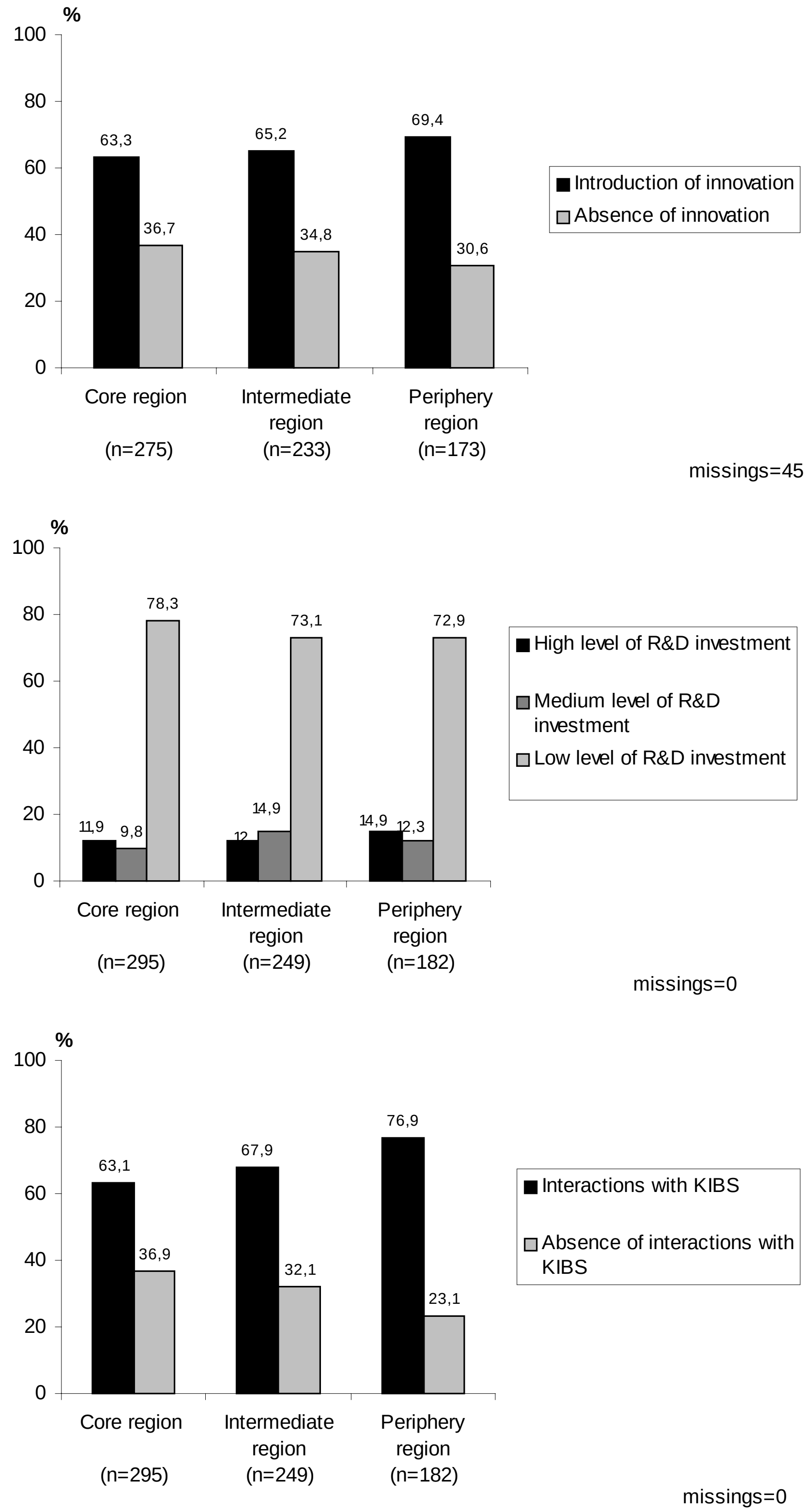
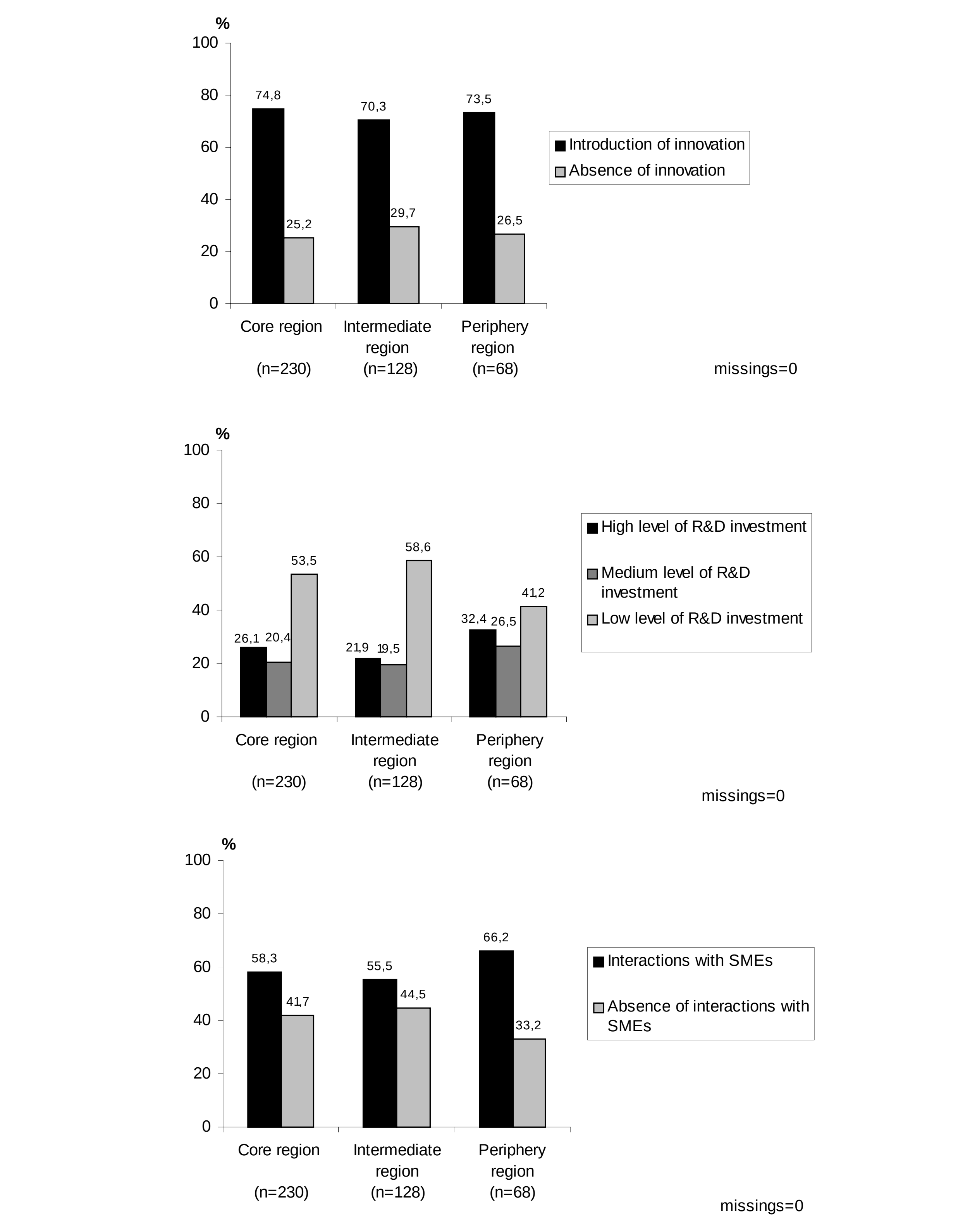


Figure 5: The KIBS sample



2.2 Multiple correspondence analysis

The analysis of the multiple correspondences within a set of variables constitutes an interesting tool allowing relations which could otherwise not be detected to be highlighted. The development of correspondence analysis derives mainly from the pioneer work performed in the 60's by J. P. BENZÉCRI[11]. Originally, such procedures were limited to the analysis of contingency tables (crosstabs of two nominal characters). Meantime, correspondence analysis has been extended (at least theoretically) to an unlimited number of characters. Thanks to their mathematical properties and due to their richness in terms of interpretation potentialities, correspondence analysis constitute a powerful tool for exploiting qualitative data. All variables in a multiple correspondence analysis (also called homogeneity analysis) are inspected for their categorial information only. That is, the only consideration is the fact that some objects are in the same category while others are not. One important advantage (due to the presence of qualitative or categorised variables only) is the possibility of considering non-linear relations between variables.

[11] See for instance BENZÉCRI (1992) for a detailed presentation and overview of the possibilities in this field.

Figure 6: Multiple correspondence analysis of the SME sample

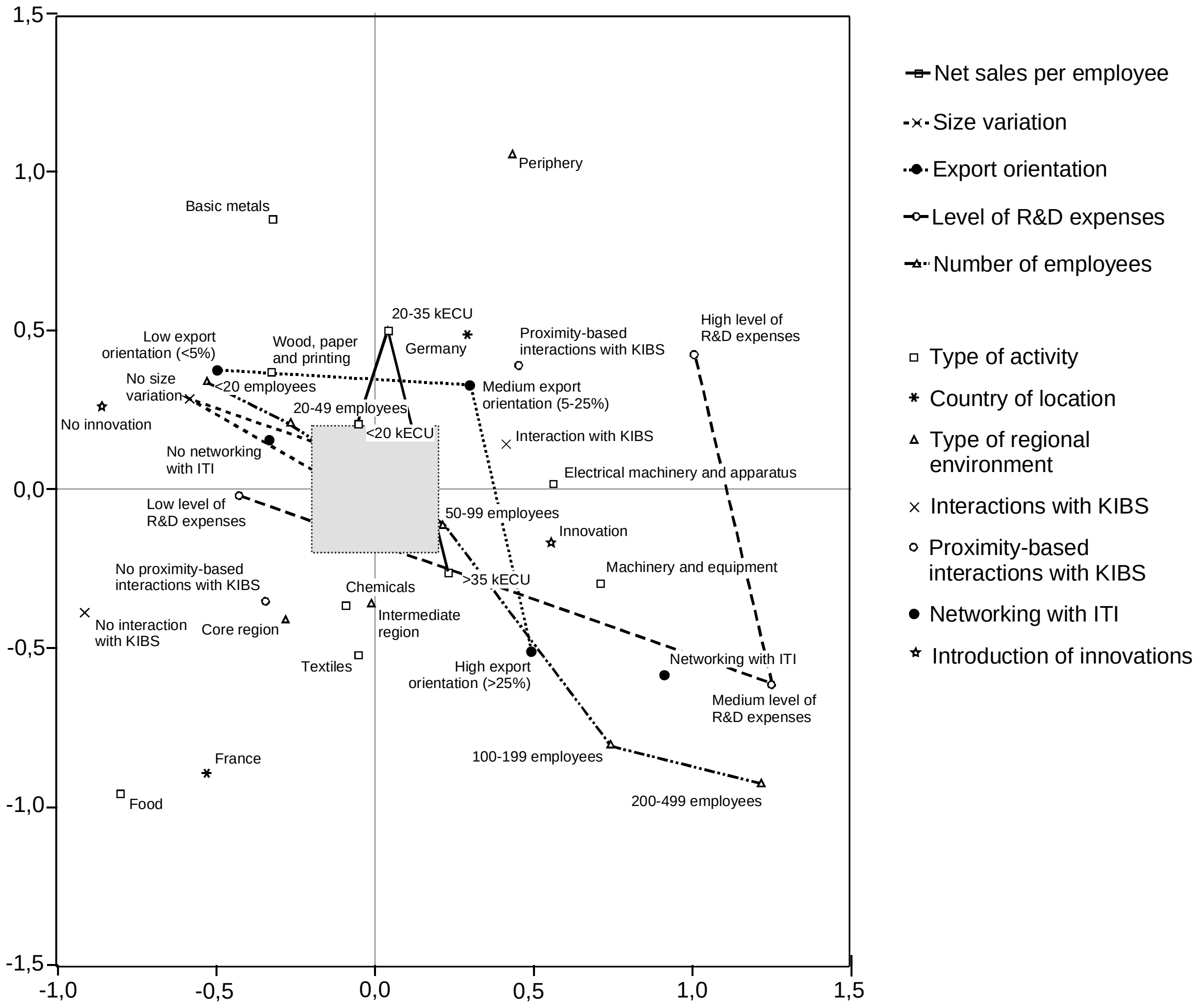
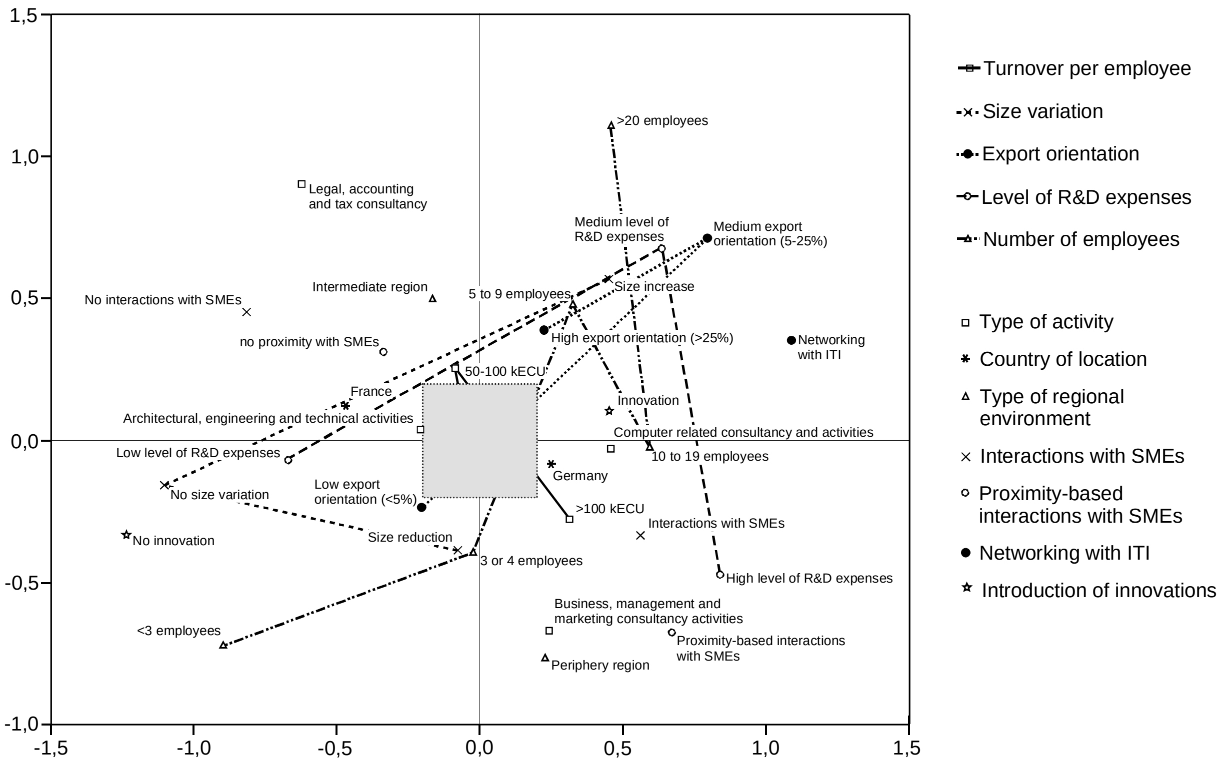


Figure 6 draws the multiple correspondence analysis performed on the SME sample with the help of 12 variables[12]. Basically, the first dimension may be seen as opposing the firms which are R&D-intensive, innovative, interacting with KIBS, relatively bigger and networking with ITI (eastern part of the graph) to their less R&D-intensive, non innovative, non interactive, relatively smaller and non networking counterparts (western part of the graph). In the same way, the country of location, the type of regional environment and the sector of activity constitute the variables which contribute the most to the constitution of the second dimension of the graph. This dimension distinguishes firms located in the "periphery" (northern part of the graph) to firms situated in core and intermediate regions (southern part of the graph). In fact, the analysis quite strongly contrasts two types of behaviour: innovating and interacting *vs.* non-innovating and non-interacting firms (and thus reveals the role potentially played by

[12] The variables are exposed in appendix 3, the discrimination measures of the multiple correspondence analysis performed on the SME sample are detailed in appendix 4.

interactions with KIBS). However, if a clear opposition can be observed related to the country of location which reflects divergent behaviours, notably concerning interactions with KIBS (German SMEs are more innovative and interact more with KIBS than their French counterparts) no clear divergence can be observed related to the type of regional environment. In other words, it is not possible, considering the multiple correspondence analysis of the SME sample, to establish any evidence of a regional hierarchy of innovation environments.

Figure 7: Multiple correspondence analysis of the KIBS sample



Examining the multiple correspondence analysis performed on the KIBS sample (*cf.* figure 7) and referring to the most important contributors[13], it can be assumed that the first axis contrasts basically innovating, more R&D intensive and interacting KIBS (eastern part of the graph) with service firms which mostly did not introduce innovations or did not perform R&D and which were not or were less in contact with SMEs (western part of the graph). The constitution of the second dimension is based primarily on the size and sector of the considered firms as well as on the existence of proximity-based interactions with SMEs. As a consequence, the graph may be seen as opposing its northern part (characterised by bigger firms, no or only limited interactions

13 The discrimination measures of the multiple correspondence analysis performed on the KIBS sample are detailed in appendix 5.

with SMEs on a proximity base and typically being active as legal, accounting or tax consultants) to its southern part (constituted by smaller KIBS, typically doing business, management or marketing consultancy and characterised by a higher propensity to interact with SMEs on a proximity base). As was the case for the SME sample, no indication of an influence of the type of regional environment can be detected on the basis of the results of the multiple correspondence analysis of the KIBS sample.

2.3 Path modelling

The methodology of path modelling has been developed specifically for the detection and investigation of influences between variables sets (*cf.* MULLER, 1999, pp. 98-101). The path-modelling procedure is based on the successive performance of PROBIT algorithms. PROBIT algorithms estimate maximum-likelihood model in order to detect dependencies associating a dependent variable to explanatory (or independent) variables. The general form of the model to be estimated is:

$$\mathbf{Pr\ [E = 1] = \Phi[\beta_0 + \beta_1 A + \beta_2 B + ... + \beta_n X]}$$

with Φ being the cumulative normal distribution, E (dichotomic variable) the dependent variable, A, B and X being the explanatory variables. β_0 is the constant, β_1, β_2 and β_n are the coefficients of the independent variables in the equation. The path-model is obtained by placing selected variables (according to the conceptual model developed) alternatively in the role: (i) of dependent variable in respect to some variables; or (ii) of independent variable in comparison to others. Since the application of PROBIT requires *dichotomic dependent variables* it is necessary to binarise the variables of the analysis. This can be done in a relevant way on the basis of the previous analytical steps, especially in exploiting the results of the multiple correspondence analysis. The set of "paths" resulting from the procedure can be interpreted as a "picture" of the interrelations between the variables. Variables can at the same time be explanatory (or independent) and dependent, depending on their relative position. As a consequence the identification of significant dependencies allows the interpretation of the revealed "paths" in terms of causality effects, and to distinguish between direct and indirect dependencies. In the present case, path modelling is used to test interrelations between the variables allocated to three sets enabling the depiction of the characteristics of the examined firms;: (i) the determinants set encompassing the structural and environmental determinants potentially affecting innovation-related behaviours of the firm; (ii) the knowledge set featuring how innovation resources are exploited; and (iii) the evolution set pointing out the effects of the two previous sets on a firm's activities and results (*cf.* MULLER, 1999, pp. 78-79).

The first path diagram allows a synthetic view of the elements significantly determining the evolution mechanisms of the SMEs examined (*cf.* figure 8 and appendix 6). In fact, it appears that the performance of innovation is directly and strongly influenced by most of the variables of the "knowledge set": (i) by the level of R&D expenses; (ii) by the existence of interactions with KIBS; and (iii) by networking with ITI. Additionally, the influence exerted by the variables belonging to the "determinants set" on knowledge and evolution variables give some indication concerning their "relative weights": the size and the sector of a firm appear to have the most influence. The size factor in particular plays a role in influencing the variables in the "knowledge set". Finally, considering territorial determinants, the variable "country of location" discloses no significant influence related to the evolution capacities of the considered SMEs, but indicates strongly that national systems matter in terms of their propensity to interact with KIBS (either on a proximity basis or not) as well as in terms of R&D intensity. Nevertheless, and this constitutes a decisive element regarding the issue considered, the variable "type of regional environment" does not point to any significant influence on other variables. In this respect, the type of regional environment surrounding a SME seems neither to induce particular behaviours nor to generate specific consequences in terms of firm evolution. This suggests that, at least for the samples and territorial units considered, the idea of a regional hierarchy of innovation environments has no relevance.

Considering the results of the PROBIT analyses dealing with the KIBS sample and the ensuing path modelling (*cf.* figure 9 and appendix 7), the following key findings can be advanced. Firstly, the variables constituting the "evolution set" of the model are influenced by knowledge-base related variables as well as by variables corresponding to structural determinants (*i.e.* the size of the firm and its sector of activity). Secondly, the variable "introduction of innovations" shows an even more complex structure in terms of influences. In fact, it is affected by: (i) internal resources (the level of R&D expenditures); (ii) by external factors (networking with ITI and proximity-based interactions with SMEs); and (iii) by the size of the firm (the propensity to innovate increases with the size). Finally, considering structural and locational variables, it appears that the size of the firm and the sector of activity rather have an impact on variables from the "evolution set" than on the ones related to the knowledge base aspects. On the contrary, the country of location only influences the last category of variables (*i.e.* the R&D intensity and the contacts with KIBS) whereas the type of regional environment does not significantly affect any other variable. At least for the considered KIBS sample and in parallel to what has been assumed for the SME sample, this pleads against the idea of a regional hierarchy in terms of innovation environment.

Figure 8: Path modelling: the SME sample

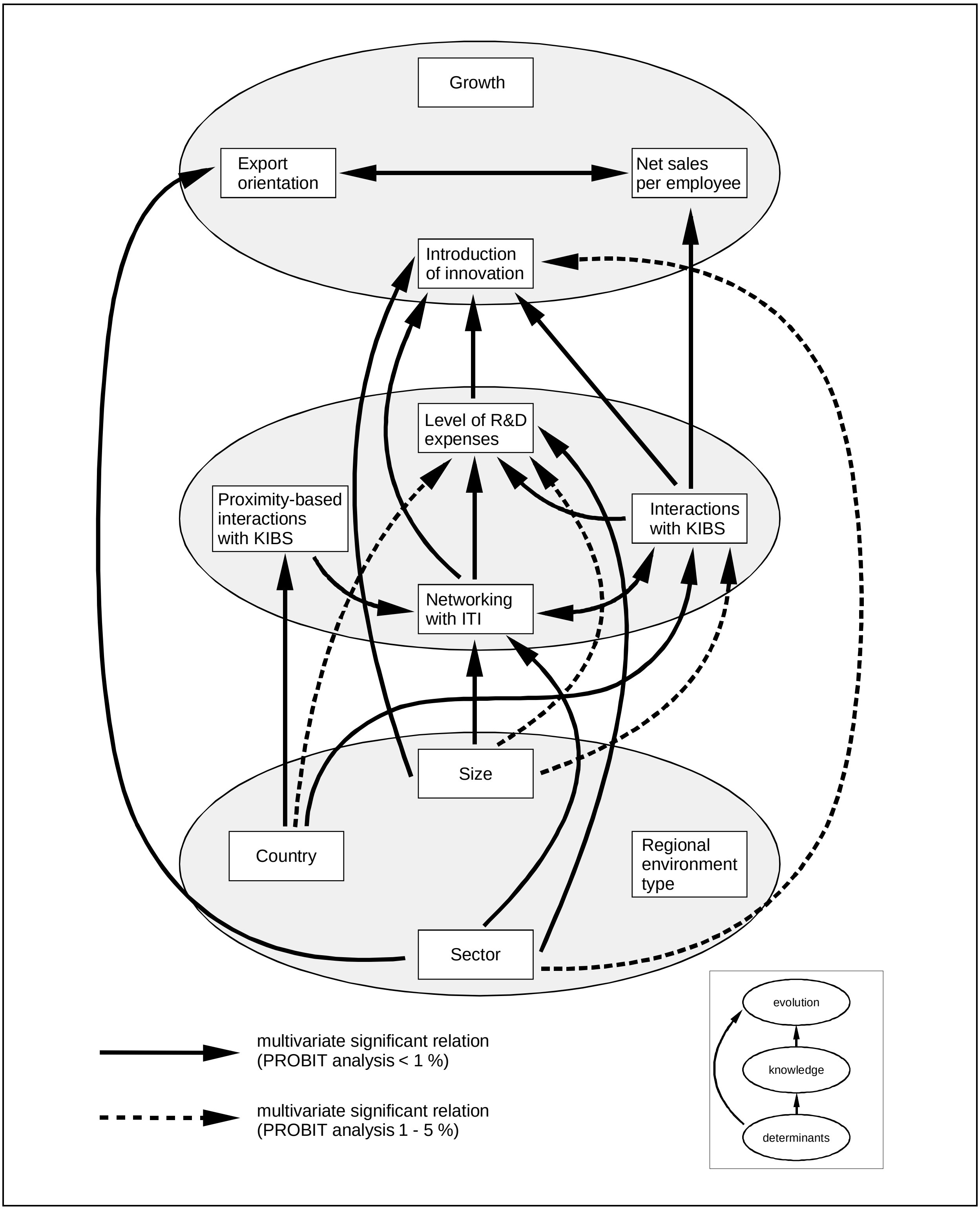
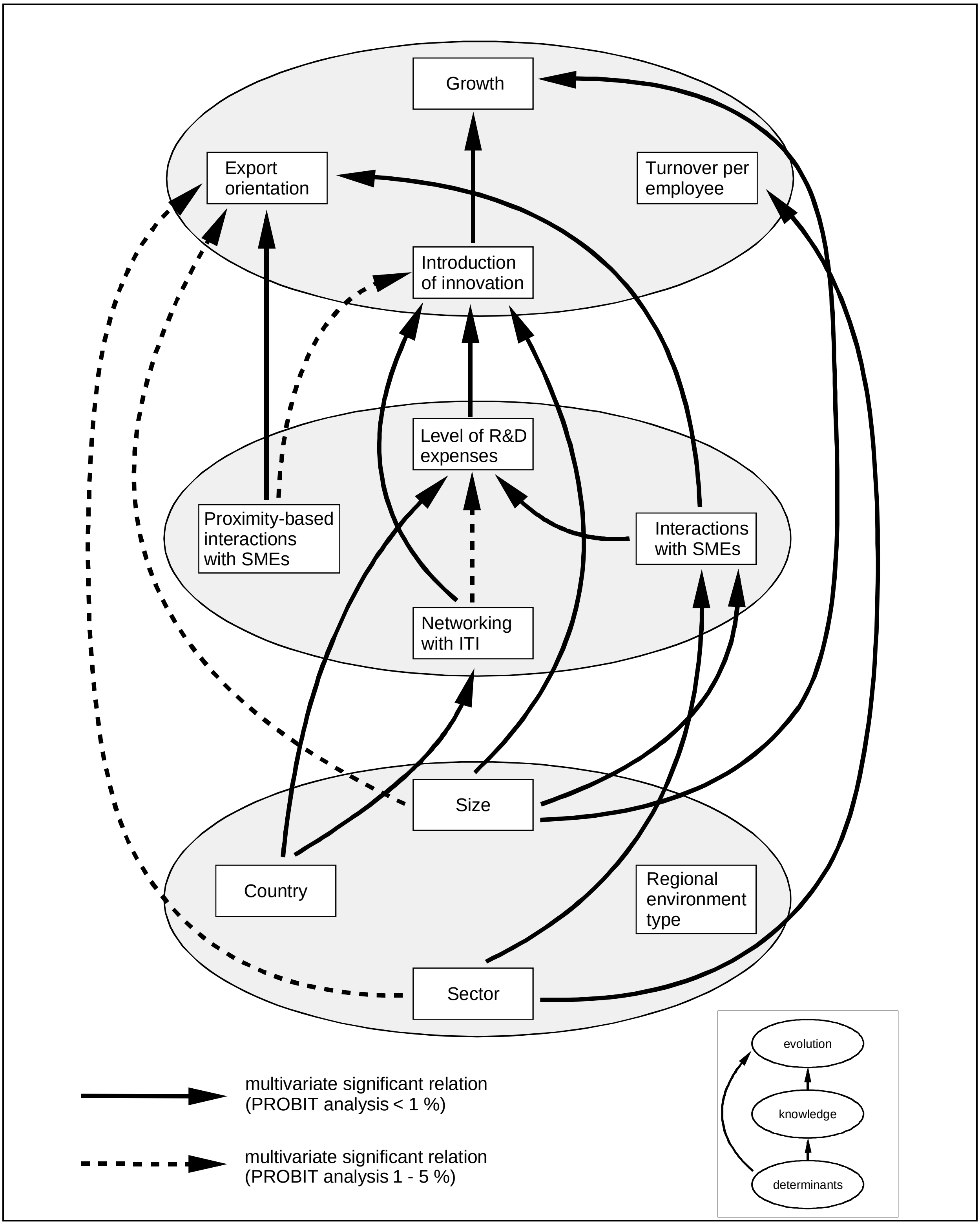


Figure 9: Path modelling: the KIBS sample



Conclusion: Which consequences regarding regional evolution patterns?

Referring to the empirical evidence outlined above for the considered SMEs and KIBS, no significant influence of the observed types of regional environment could be detected: (i) on the activation of their internal resources; (ii) on the activation of their external resources, and (iii) on their evolution capacities. As a consequence, no regional hierarchy can be established in the case of the examined area. The question can be asked to which extent this area is representative of the diversity of regional environments, for instance in Europe, and if these results can be generalised. However, these findings have an exemplary character, arguing against the idea of a territorial fatality.

In fact, these results demonstrate that regional inequalities (in terms of innovation environment) may be successfully compensated by firms located on a specific territory. It appears clearly that innovation is at first a matter of knowledge development and exchanges and as a consequence that the impact of the regional environment should not be overestimated. In this respect, the positive influence of the virtuous circle linking SMEs and KIBS may be seen as contributing actively to the reduction of regional inequalities. One may assume that in regions where firms adopt adequate behaviour such as setting up "knowledge systems" associating KIBS and SMEs" no territorial fatality paralysing innovation capacities should be expected.

Considering the implications for policies, and trying to go beyond the "basics" (development of educational resources, development of physical and knowledge-related infrastructures, improvement of the quality of life, etc.), three categories of recommendations may be of interest for everyone in charge of regional development and innovation support. Firstly, the improvement of innovation-related interactions between KIBS and SMEs may be considered as a way to boost the innovation capacities within a region. Such an improvement is "cheap and flexible", compared for instance to the building-up of an (administrative) technology transfer infrastructure. Secondly, and more generally, it may be relevant for ensuring regional development to focus more on services and less on manufacturing. Since numerous services are linked (both as suppliers and as users) to the manufacturing sector, a crow-bar effect in terms of investment can be expected. Finally, a possibility not to be neglected is to support actors mobilising resources outside the region. This constitutes basically a way to compensate innovation resources leaking at regional level (such as technical knowledge, specialised services, highly skilled manpower). Numerous regional initiatives aiming at supporting innovation capacities pay a particular attention to proximity-based interactions, i.e. to relations associating actors within the region, even if it is not necessarily meaningful. In this respect, it appears crucial to consider regions as open systems to escape the territorial fatality.

References

AMENDOLA, M./GAFFARD, J. L. (1988): La dynamique économique de l'innovation. Economica, Paris.

ANSELIN, L./VARGA, A/ACS, Z. J. (1997): Entrepreneurship, Geographic Spillovers and University Research: a Spatial Econometric Approach. Paper presented at the International Conference on Innovation and Performance of SMEs. 17th March 1997, Cambridge.

ARROW, K. (1962): The Economic Implication of Learning by Doing. In: Review of Economic Studies. Vol. 29, n. 80. pp. 155-173.

BARRO, R. J./SALA-I-MARTIN, X. (1995): Economic Growth. McGraw-Hill, New York.

BENZÉCRI, J.-P. (1992): Correspondence Analysis Handbook. Marcel Dekker, New York.

CALLON, M./LAREDO, P./RABEHARISOA, V. (1997): Que signifie "innover" dans les services - une triple rupture avec le modèle de l'innovation industrielle. In: La Recherche. 295. pp. 34-36.

CAMAGNI, R. (1991): Local "Milieu", Uncertainty and Innovation Networks: Towards a New Dynamic Theory of Economic Space. In: CAMAGNI, R. (Ed.) (1991): Innovation Networks: Spatial perspectives. Belhaven Press, London, New York. pp. 121-144.

CLARK, N. (1986): Introduction: Economic Analysis and Technological Change: a Review of Some Recent Developments. In: MACLEOD, R. (Ed.) (1986): Technology and the Human Prospect. Pinter Publishers, London. pp. 1-27.

COOKE, P. (1998): Origins of the concept. In: BRACZYK, H. J.; COOKE, P.; HEIDENREICH (1998) (Eds.): Regional Innovation Systems - The Role of Governance in a Globalized World. UCL Press, London. pp. 2-25.

COOKE, P./BOEKHOLT, P./SCHALL, N./SCHIENSTOCK, G. (1996): Regional Innovation Systems: Concepts, Analysis and Typology. Paper presented during the EU-RESTPOR Conference "Global Comparison of Regional RTD and Innovation Strategies for Development and Cohesion". Brussels, 19-21 September.

DOSI, G. (1982): Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technical Change. In: Research Policy. 11/3. pp. 147-162.

EDQUIST, C. (Ed.)(1997): Systems of Innovation. Technologies, Institutions and Organizations. Pinter Publishers, London.

FREEMAN, C. (1982): The Economics of Industrial Innovation. Pinter Publishers, London.

FREEMAN, C. (1987): Technology Policy and Economic Performance: Lessons from Japan. Pinter Publishers, London.

GADREY, J./GALLOUJ, F./LHUILLERY, S./WEINSTEIN, O. (1993): La R-D et l'innovation dans les services. Research report for the french "Ministère de l'Enseignement Supérieur et de la Recherche".

GALLOUJ, F. (1994): Economie de l'innovation dans les services. Editions L'Harmattan, Paris.

HÉRAUD, J.-A./MULLER, E (1998): The Impact of Universities and Research Institutions Labs on the Creation and Diffusion of Innovation-Relevant Knowledge: the Case of the Upper-Rhine Valley. Paper presented at the 38th Congress of the European Regional Science Association, August 28-31 1998, Vienna.

HIPP, C. (1999): Innovationsprozesse im Dienstleistungssektor – Eine theoretisch und empirisch basierte Innovationstypologie. Ph.D. dissertation, Institut für Volkswirtschaftslehre und Recht der Universität Stuttgart.

JAFFE, A./TRAJTENBERG, M./HENDERSON, R. (1993): Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. In: Quarterly Journal of Economics. August. pp. 577-598.

JULIEN, P.-A. (1996): Information control: a key factor in small business development. Paper presented at the 41st ICSB world conference, June 17-19, Stockholm.

KOSCHATZKY, K./HÉRAUD, J.-A. (1996): Institutions of Technological Infrastructure. Final report to Eurostat on the project "Feasibility study on the statistical measurement of the Institutions of Technological Infrastructure". FhG-ISI, Karlsruhe and BETA (Université Louis Pasteur), Strasbourg.

KRUGMAN, P. (1991): Geography and Trade. The MIT Press, Cambridge.

LARUE DE TOURNEMINE, R. (1991): Stratégies technologiques et processus d'innovation. Les Editions d'Organisation, Paris.

LUNDVALL, B. A. (1988): Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation. DOSI, G./FREEMAN, C./NELSON, R./SILVERBERG, G./SOETE, L. (Eds.) (1988): Technical Change and Economic Theory. Pinter Publishers, London. pp. 349-369.

LUNDVALL, B. A. (1992) (Ed.): National System of Innovation. Towards a Theory of Innovation and Interactive Learning. Pinter Publishers, London.

MULLER, E. (1999): Innovation Interactions Between Knowledge-Intensive Business Services and Small and Medium-sized Enterprises – Analysis in Terms of Evolution, Knowledge and Territories. Ph.D. dissertation, Faculté des Sciences Économiques et de Gestion, Université Louis Pasteur, Strasbourg.

NELSON, R./WINTER, S. (1974): Neoclassical vs. Evolutionary Theories of Economic Growth. Critique and Prospectus. In: Economic Journal. December, pp. 886-905.

NELSON, R./WINTER, S. (1975): Growth Theory from an Evolutionary Perspective: The Differential Productivity Puzzle. In: The American Economic Review. 65/2. pp. 338-344.

NELSON, R./WINTER, S. (1977): In Search of a Useful Theory of Innovation. In: Research Policy. 6. pp. 36-76.

PAVITT, K. (1984): Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory. In: Research Policy. 13. pp. 343-373.

PORTER, M. (1990): The Competitive Advantage of Nations. Macmillan, London.

ROMER, P. M. (1990): Endogenous Technological Change. In: Journal of Political Economy. 98. pp. 71-102.

ROSENBERG, N. (1976): Perspective on Technology. Harvard University Press.

STRAMBACH, S. (1998): Knowledge-Intensive Business Services (KIBS) as an Element of Learning Regions - the Case of Baden-Württemberg. Paper presented at the ERSA Conference, August 28-31 1998, Vienna.

WOOD, P. (1998): The Rise of Consultancy and the Prospect for Regions. Paper presented at the 38th Congress of the European Regional Science Association, August 28-31 1998, Vienna.

Appendix 1: The sector distribution of the SME sample (N_{Alsace} = 267; N_{Baden} = 459)

Sector (in %)	Alsatian population[a)]	Alsatian sample	Badian population [b)]	Badian sample
Manufacture of food products	21,7	22,4	6,9	3,7
Manufacture of textiles	7,3	6,8	5,9	6,1
Manufacture of wood, paper	17,3	14,4	18,2	16,9
Manufacture of chemicals	14,3	13,3	17,9	12,3
Manufacture of basic metals	16,2	19,4	16,0	22,4
Manufacture of machinery and equipment	13,7	9,9	18,6	19,1
Manufacture of electrical machinery and apparatus	9,4	13,7	16,5	19,5
Total	100	100	100	100

a) Distribution based on the data provided by INSEE (French statistical office).

b) Distribution based on the data provided by the IHK (German Chamber of Commerce) of Karlsruhe and Freiburg, detailed data was not available for the sub-region Schwarzwald-Baar-Heuberg.

Appendix 2: The sector distribution of the KIBS sample (N_{Alsace} = 149; N_{Baden} = 277)

Sector (in %)	Alsatian population[a)]	Alsatian sample	Badian population [b)]	Badian sample
Computer related consultancy and activities	15,0	16,3	26,7	27,2
Legal, accounting and tax consultancy	34,8	16,3	8,1	16,1
Business, management and marketing consultancy activities	21,5	25,1	31,2	24,7
Architectural, engineering and technical activities	28,6	42,1	33,9	31,9
Total	100	100	100	100

a) Distribution based on the data provided by INSEE (French statistical office).

b) Distribution based on the data provided by the IHK (German Chamber of Commerce) of Karlsruhe and Freiburg, detailed data was not available for the sub-region Schwarzwald-Baar-Heuberg.

Appendix 3: Variables of the analysis

Variables related to firms evolution capacity	SME sample	KIBS sample
• *Growth of the number of employees*	GROWTH	GROWTH
• *Net sales/employee or turnover/employee*	NETSALES	TURNOVER
• *Export orientation*	LEVEXP	LEVEXP
• *Introduction of innovation*	INNOV	INNOV
Variables related to firms knowledge processing potential		
• *Interaction with KIBS/SMEs*	IKIBS	ISMES
• *Proximity-based interaction with KIBS/SMEs*	PKIBS	PSMES
• *Networking with ITI*	NITI	NITI
• *R&D intensity*	LEVRD	LEVRD
Variables related to firms structure and environment characterisation		
• *Sector of activity*	SECTOR	SECTOR
• *Size*	SIZE	SIZE
• *Location referring to the national system*	COUNT	COUNT
• *Location referring to the type of regional environment*	REGTYP	REGTYP

Appendix 4: Discrimination measures of the correspondence analysis (SMEs)

Variables	Discrimination measures* on dimension 1	Discrimination measures* on dimension 2
COUNT	0,156	0,441
LEVRD	0,470	0,075
SECTOR	0,238	0,285
SIZE	0,308	0,200
REGTYP	0,075	0,393
INNOV	0,423	0,040
IKIBS	0,387	0,061
NITI	0,297	0,108
LEVEXP	0,176	0,130
PKIBS	0,164	0,131
NETSALES	0,012	0,077
GROWTH	0,054	0,020

(*) Discrimination measures indicate the variables' contribution to the constitution of the axes.

Appendix 5: Discrimination measures of the correspondence analysis (KIBS)

Variables	Discrimination measures* on dimension 1	Discrimination measures* on dimension 2
SIZE	0,304	0,378
LEVRD	0,501	0,155
ISMES	0,459	0,150
INNOV	0,558	0,037
PSMES	0,208	0,215
SECTOR	0,141	0,246
GROWTH	0,219	0,157
LEVEXP	0,130	0,127
REGTYP	0,017	0,167
NITI	0,130	0,018
COUNT	0,113	0,008
TURNOVER	0,029	0,043

(*) Discrimination measures indicate the variables' contribution to the constitution of the axes.

Appendix 6: PROBIT analysis (SME sample)

probit growth levexp netsales innov levrd ikibs pkibs niti size count regtyp sector

Iteration 0: Log Likelihood =-497.63196
Iteration 1: Log Likelihood =-489.90571
Iteration 2: Log Likelihood =-489.90295

Probit Estimates — Number of obs = 726; chi2(11) = 15.46; Prob > chi2 = 0.1625
Log Likelihood = -489.90295 — Pseudo R2 = 0.0155

growth	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
levexp	-.0264581	.1239865	-0.213	0.831	-.2694672	.216551
netsales	-.0278085	.1237584	-0.225	0.822	-.2703706	.2147536
innov	.187143	.1166413	1.604	0.109	-.0414698	.4157558
levrd	.1439793	.1276901	1.128	0.260	-.1062887	.3942473
ikibs	-.0197486	.139119	-0.142	0.887	-.2924169	.2529197
pkibs	.0928085	.1212172	0.766	0.444	-.144773	.3303899
niti	-.1367577	.1214217	-1.126	0.260	-.3747398	.1012245
size	-.2095225	.1298739	-1.613	0.107	-.4640706	.0450256
count	.2336407	.1136555	2.056	0.040	.01088	.4564015
regtyp	-.1864015	.1212427	-1.537	0.124	-.4240327	.0512298
sector	-.0971811	.1104876	-0.880	0.379	-.3137328	.1193705
_cons	-.1665875	.1345765	-1.238	0.216	-.4303526	.0971777

probit levexp growth netsales innov levrd ikibs pkibs niti size count regtyp sector

Iteration 0: Log Likelihood = -361.6224
Iteration 1: Log Likelihood =-329.15619
Iteration 2: Log Likelihood =-328.88532
Iteration 3: Log Likelihood =-328.88522

Probit Estimates — Number of obs = 726; chi2(11) = 65.47; Prob > chi2 = 0.0000
Log Likelihood = -328.88522 — Pseudo R2 = 0.0905

levexp	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth	-.0235864	.1134153	-0.208	0.835	-.2458763	.1987034
netsales	.4521262	.1354239	3.339	0.001	.1867003	.7175521
innov	.0734648	.1415536	0.519	0.604	-.203975	.3509047
levrd	.1206269	.1457066	0.828	0.408	-.1649528	.4062067
ikibs	.2596041	.1623882	1.599	0.110	-.058671	.5778792
pkibs	-.2512962	.1379451	-1.822	0.068	-.5216637	.0190712
niti	-.1301741	.141585	-0.919	0.358	-.4076756	.1473274
size	.2292541	.1450866	1.580	0.114	-.0551104	.5136185
count	.2525239	.1351763	1.868	0.062	-.0124168	.5174647
regtyp	-.0205957	.1445533	-0.142	0.887	-.303915	.2627236
sector	.7035514	.1217544	5.778	0.000	.4649172	.9421855
_cons	-1.46276	.1762393	-8.300	0.000	-1.808183	-1.117338

probit netsales levexp growth innov levrd ikibs pkibs niti size count regtyp sector

Iteration 0: Log Likelihood =-348.69595
Iteration 1: Log Likelihood =-332.92009
Iteration 2: Log Likelihood =-332.81581
Iteration 3: Log Likelihood =-332.81579

Probit Estimates — Number of obs = 726; chi2(11) = 31.76; Prob > chi2 = 0.0008
Log Likelihood = -332.81579 — Pseudo R2 = 0.0455

netsales	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
levexp	.4561824	.1351723	3.375	0.001	.1912495	.7211152
growth	-.0241915	.1125004	-0.215	0.830	-.2446882	.1963051
innov	.1802831	.136172	1.324	0.186	-.0866091	.4471754
levrd	-.1625968	.1463575	-1.111	0.267	-.4494522	.1242586
ikibs	.514356	.1627816	3.160	0.002	.1953099	.8334021
pkibs	-.1658073	.1340069	-1.237	0.216	-.428456	.0968414
niti	.1276284	.1377912	0.926	0.354	-.1424374	.3976942
size	-.2486895	.15403	-1.615	0.106	-.5505827	.0532038
count	-.053723	.1324467	-0.406	0.685	-.3133138	.2058677
regtyp	.119716	.1421595	0.842	0.400	-.1589114	.3983435
sector	-.1444223	.1314677	-1.099	0.272	-.4020943	.1132498
_cons	-1.364866	.1738245	-7.852	0.000	-1.705556	-1.024176

probit innov levrd ikibs pkibs niti size count regtyp sector

Note: levrd~=0 predicts success perfectly
levrd dropped and 197 obs not used

Iteration 0: Log Likelihood =-365.76602
Iteration 1: Log Likelihood =-326.61253
Iteration 2: Log Likelihood = -326.1773
Iteration 3: Log Likelihood =-326.17704

Probit Estimates — Number of obs = 529; chi2(7) = 79.18; Prob > chi2 = 0.0000
Log Likelihood = -326.17704 — Pseudo R2 = 0.1082

innov	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ikibs	.4994687	.1612672	3.097	0.002	.1833907	.8155466
pkibs	.0932864	.1532947	0.609	0.543	-.2071657	.3937386
niti	.6324277	.158229	3.997	0.000	.3223045	.9425509
size	.6622936	.1742468	3.801	0.000	.3207762	1.003811
count	.1072515	.1340611	0.800	0.424	-.1555035	.3700064
regtyp	-.0117776	.1550419	-0.076	0.939	-.3156541	.2920989
sector	.2810334	.136951	2.052	0.040	.0126144	.5494524
_cons	-.734153	.1559307	-4.708	0.000	-1.039772	-.4285345

probit levrd ikibs pkibs niti size count regtyp sector

```
Iteration 0:  Log Likelihood = -424.4173
Iteration 1:  Log Likelihood = -348.2112
Iteration 2:  Log Likelihood = -345.6933
Iteration 3:  Log Likelihood =-345.67479
Iteration 4:  Log Likelihood =-345.67479

Probit Estimates                                        Number of obs =    726
                                                        chi2(7)       = 157.49
                                                        Prob > chi2   = 0.0000
Log Likelihood = -345.67479                             Pseudo R2     = 0.1855

------------------------------------------------------------------------------
   levrd |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
   ikibs |   .7375006   .1642424      4.490   0.000       .4155913    1.05941
   pkibs |   .0232757   .1300986      0.179   0.858      -.2317129    .2782643
    niti |    .413342   .1282257      3.224   0.001       .1620243    .6646597
    size |   .3324186   .1383681      2.402   0.016        .061222    .6036151
   count |   -.288782   .1343281     -2.150   0.032      -.5520602   -.0255038
  regtyp |  -.1483937   .1327111     -1.118   0.263      -.4085027    .1117152
  sector |   .8107999   .1136462      7.134   0.000       .5880574    1.033542
   _cons |  -1.477929   .1649427     -8.960   0.000       -1.80121   -1.154647
------------------------------------------------------------------------------
```

probit ikibs niti size count regtyp sector

```
Iteration 0:  Log Likelihood =-454.10673
Iteration 1:  Log Likelihood =-412.13479
Iteration 2:  Log Likelihood =-411.55381
Iteration 3:  Log Likelihood =-411.55309

Probit Estimates                                        Number of obs =    726
                                                        chi2(5)       =  85.11
                                                        Prob > chi2   = 0.0000
Log Likelihood = -411.55309                             Pseudo R2     = 0.0937

------------------------------------------------------------------------------
   ikibs |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
    niti |   .6707749   .1335722      5.022   0.000       .4089781    .9325717
    size |   .3125476   .1438969      2.172   0.030       .0305148    .5945804
   count |  -.6971617   .1173189     -5.942   0.000      -.9271025   -.4672209
  regtyp |   .0077425   .1345739      0.058   0.954      -.2560174    .2715024
  sector |  -.1338844   .1116785     -1.199   0.231      -.3527702    .0850014
   _cons |   .5853824   .1139643      5.137   0.000       .3620164    .8087483
------------------------------------------------------------------------------
```

probit pkibs niti size count regtyp sector

```
Iteration 0:  Log Likelihood =-497.12234
Iteration 1:  Log Likelihood =-488.99401
Iteration 2:  Log Likelihood =-488.99191
Iteration 3:  Log Likelihood =-488.99191

Probit Estimates                                        Number of obs =    726
                                                        chi2(5)       =  16.26
                                                        Prob > chi2   = 0.0061
Log Likelihood = -488.99191                             Pseudo R2     = 0.0164

------------------------------------------------------------------------------
   pkibs |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
    niti |   .0621194   .1153937      0.538   0.590      -.1640481     .288287
    size |  -.1016474   .1264205     -0.804   0.421       -.349427    .1461323
   count |  -.3800612    .110407     -3.442   0.001      -.5964548   -.1636675
  regtyp |   -.015481   .1196438     -0.129   0.897      -.2499785    .2190165
  sector |  -.0035422   .1030774     -0.034   0.973      -.2055701    .1984858
   _cons |  -.0095921   .1038094     -0.092   0.926      -.2130548    .1938707
------------------------------------------------------------------------------
```

probit niti ikibs pkibs count size sector regtyp

```
Iteration 0:  Log Likelihood =-414.18731
Iteration 1:  Log Likelihood =-352.44452
Iteration 2:  Log Likelihood =-351.74283
Iteration 3:  Log Likelihood = -351.7419

Probit Estimates                                        Number of obs =    726
                                                        chi2(6)       = 124.89
                                                        Prob > chi2   = 0.0000
Log Likelihood =  -351.7419                             Pseudo R2     = 0.1508

------------------------------------------------------------------------------
    niti |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
   ikibs |    .868817   .1517942      5.724   0.000        .571306    1.166328
   pkibs |  -.3592631   .1274199     -2.820   0.005      -.6090015   -.1095247
   count |   .1816331   .1288793      1.409   0.159      -.0709656    .4342318
    size |   .9459261   .1256349      7.529   0.000       .6996861    1.192166
  sector |   .3435802   .1146756      2.996   0.003       .1188203    .5683402
  regtyp |  -.0555008   .1382873     -0.401   0.688      -.3265389    .2155374
   _cons |  -1.503876   .1621525     -9.274   0.000      -1.821689   -1.186063
------------------------------------------------------------------------------
```

Appendix 7: PROBIT analysis (KIBS sample)

probit growth levexp turnover innov levrd ismes psmes niti size count regtyp sector

Iteration 0: Log Likelihood =-276.96985
Iteration 1: Log Likelihood =-235.97357
Iteration 2: Log Likelihood =-235.05285
Iteration 3: Log Likelihood =-235.04971
Iteration 4: Log Likelihood =-235.04971

Probit Estimates — Number of obs = 426; chi2(11) = 83.84; Prob > chi2 = 0.0000; Pseudo R2 = 0.1514

Log Likelihood = -235.04971

growth	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
levexp	.2586918	.1634324	1.583	0.113	-.0616298	.5790134
turnover	.2935072	.1563021	1.878	0.060	-.0128393	.5998537
innov	.5730635	.2051875	2.793	0.005	.1709033	.9752237
levrd	-.0407501	.163849	-0.249	0.804	-.3618882	.2803881
ismes	-.1726563	.1867892	-0.924	0.355	-.5387564	.1934438
psmes	.2589506	.1824663	1.419	0.156	-.0986768	.616578
niti	.0759467	.2198264	0.345	0.730	-.3549052	.5067985
size	.9147817	.1472782	6.211	0.000	.6261218	1.203442
count	.2614375	.1553814	1.683	0.092	-.0431045	.5659796
regtyp	.2225584	.2054467	1.083	0.279	-.1801098	.6252266
sector	-.0933378	.1409467	-0.662	0.508	-.3695883	.1829127
_cons	-1.688821	.2547009	-6.631	0.000	-2.188026	-1.189617

probit levexp growth turnover innov levrd ismes psmes niti size count regtyp sector

Iteration 0: Log Likelihood =-235.63238
Iteration 1: Log Likelihood =-200.83601
Iteration 2: Log Likelihood = -200.2099
Iteration 3: Log Likelihood =-200.20842
Iteration 4: Log Likelihood =-200.20842

Probit Estimates — Number of obs = 426; chi2(11) = 70.85; Prob > chi2 = 0.0000; Pseudo R2 = 0.1503

Log Likelihood = -200.20842

levexp	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
growth	.2537634	.1576095	1.610	0.107	-.0551456	.5626723
turnover	.2841767	.1630888	1.742	0.081	-.0354715	.6038248
innov	.0027216	.2273639	0.012	0.990	-.4429035	.4483466
levrd	.3752691	.1818668	2.063	0.039	.0188168	.7317214
ismes	.7830308	.1822757	4.296	0.000	.425777	1.140285
psmes	-.7088483	.1817114	-3.901	0.000	-1.064996	-.3527006
niti	.2211765	.2301666	0.961	0.337	-.2299418	.6722947
size	.3934704	.1634981	2.407	0.016	.0730201	.7139207
count	-.0389084	.1672547	-0.233	0.816	-.3667215	.2889048
regtyp	.3562133	.2201699	1.618	0.106	-.0753118	.7877384
sector	-.2999891	.1498363	-2.002	0.045	-.5936628	-.0063154
_cons	-1.749811	.2703447	-6.473	0.000	-2.279677	-1.219946

probit turnover levexp growth innov levrd ismes psmes niti size count regtyp sector

Iteration 0: Log Likelihood = -239.0039
Iteration 1: Log Likelihood =-226.98888
Iteration 2: Log Likelihood =-226.93761
Iteration 3: Log Likelihood =-226.93761

Probit Estimates — Number of obs = 426; chi2(11) = 24.13; Prob > chi2 = 0.0122; Pseudo R2 = 0.0505

Log Likelihood = -226.93761

turnover	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
levexp	.2966816	.1657048	1.790	0.073	-.0280939	.6214571
growth	.2641894	.1537591	1.718	0.086	-.037173	.5655518
innov	.1927117	.2052283	0.939	0.348	-.2095284	.5949518
levrd	-.1020388	.1718836	-0.594	0.553	-.4389245	.2348469
ismes	.2285387	.1813061	1.261	0.207	-.1268147	.5838921
psmes	-.2574605	.1813019	-1.420	0.156	-.6128057	.0978847
niti	-.1236488	.2328159	-0.531	0.595	-.5799596	.332662
size	-.2073791	.1564588	-1.325	0.185	-.5140326	.0992745
count	-.2287497	.1580951	-1.447	0.148	-.5386105	.081111
regtyp	.1059018	.1975012	0.536	0.592	-.2811934	.492997
sector	.3970765	.1406232	2.824	0.005	.1214601	.672693
_cons	-1.107467	.231383	-4.786	0.000	-1.560969	-.6539642

probit innov levrd ismes psmes niti size count regtyp sector

Note: levrd~=0 predicts success perfectly
levrd dropped and 200 obs not used

Note: niti~=0 predicts success perfectly
niti dropped and 12 obs not used

Iteration 0: Log Likelihood =-147.87523
Iteration 1: Log Likelihood =-125.56874
Iteration 2: Log Likelihood =-125.34637
Iteration 3: Log Likelihood =-125.34629

Probit Estimates — Number of obs = 214; chi2(6) = 45.06; Prob > chi2 = 0.0000; Pseudo R2 = 0.1524

Log Likelihood = -125.34629

innov	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ismes	-.1866416	.2605415	-0.716	0.474	-.6972935	.3240104
psmes	.7530764	.294149	2.560	0.010	.1765549	1.329598
size	1.056903	.1889024	5.595	0.000	.6866613	1.427145
count	.3188353	.1990749	1.602	0.109	-.0713444	.7090149
regtyp	.0988443	.291205	0.339	0.734	-.471907	.6695957
sector	.1643506	.1908191	0.861	0.389	-.2096481	.5383492
_cons	-.9573663	.2804404	-3.414	0.001	-1.507019	-.4077133

probit levrd ismes psmes niti size count regtyp sector

```
Iteration 0:  Log Likelihood =-294.48678
Iteration 1:  Log Likelihood =-261.42798
Iteration 2:  Log Likelihood =-261.18637
Iteration 3:  Log Likelihood =-261.18633

Probit Estimates                                      Number of obs =    426
                                                      chi2(7)       =  66.60
                                                      Prob > chi2   = 0.0000
Log Likelihood = -261.18633                           Pseudo R2     = 0.1131

------------------------------------------------------------------------------
   levrd |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
   ismes |   .7451784   .1644704      4.531   0.000       .4228224    1.067534
   psmes |   -.155014   .1661879     -0.933   0.351      -.4807362    .1707083
    niti |   .4527946   .2222982      2.037   0.042       .0170982     .888491
    size |   .2084052    .131434      1.586   0.113      -.0492007    .4660112
   count |  -.3904393   .1457869     -2.678   0.007      -.6761764   -.1047022
  regtyp |  -.1790364   .1852699     -0.966   0.334      -.5421588     .184086
  sector |   .2171681   .1306147      1.663   0.096       -.038832    .4731682
   _cons |  -.4480533   .1947872     -2.300   0.021      -.8298292   -.0662774
------------------------------------------------------------------------------
```

probit ismes niti size count regtyp sector

```
Iteration 0:  Log Likelihood =-288.82075
Iteration 1:  Log Likelihood =-268.12995
Iteration 2:  Log Likelihood =-268.01939
Iteration 3:  Log Likelihood =-268.01937

Probit Estimates                                      Number of obs =    426
                                                      chi2(5)       =  41.60
                                                      Prob > chi2   = 0.0000
Log Likelihood = -268.01937                           Pseudo R2     = 0.0720

------------------------------------------------------------------------------
   ismes |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
    niti |    .429492   .2338868      1.836   0.066      -.0289178    .8879018
    size |   .3746418    .127878      2.930   0.003       .1240055    .6252781
   count |  -.1803166   .1420441     -1.269   0.204      -.4587178    .0980847
  regtyp |  -.1532309   .1865271     -0.821   0.411      -.5188174    .2123555
  sector |    .577855    .127207      4.543   0.000       .3285339    .8271762
   _cons |  -.0829924   .1837685     -0.452   0.652      -.4431722    .2771873
------------------------------------------------------------------------------
```

probit psmes niti size count regtyp sector

```
Iteration 0:  Log Likelihood =-266.80463
Iteration 1:  Log Likelihood =-262.23199
Iteration 2:  Log Likelihood =-262.23008

Probit Estimates                                      Number of obs =    426
                                                      chi2(5)       =   9.15
                                                      Prob > chi2   = 0.1033
Log Likelihood = -262.23008                           Pseudo R2     = 0.0171

------------------------------------------------------------------------------
   psmes |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
    niti |   .1738437   .2132073      0.815   0.415      -.2440349    .5917222
    size |  -.0484944   .1295515     -0.374   0.708      -.3024106    .2054218
   count |   -.014127   .1460805     -0.097   0.923      -.3004396    .2721856
  regtyp |  -.2230986   .1801641     -1.238   0.216      -.5762138    .1300167
  sector |   .3137847   .1280011      2.451   0.014       .0629072    .5646622
   _cons |  -.4293507   .1825892     -2.351   0.019      -.7872189   -.0714825
------------------------------------------------------------------------------
```

probit niti ismes psmes count size sector regtyp

```
Iteration 0:  Log Likelihood = -137.1623
Iteration 1:  Log Likelihood =-126.36177
Iteration 2:  Log Likelihood =-125.79383
Iteration 3:  Log Likelihood = -125.7866
Iteration 4:  Log Likelihood = -125.7866

Probit Estimates                                      Number of obs =    426
                                                      chi2(6)       =  22.75
                                                      Prob > chi2   = 0.0009
Log Likelihood =  -125.7866                           Pseudo R2     = 0.0829

------------------------------------------------------------------------------
    niti |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
   ismes |   .3682405   .2294234      1.605   0.108      -.0814211    .8179022
   psmes |  -.0267771   .2112848     -0.127   0.899      -.4408878    .3873335
   count |  -.7876322   .2447246     -3.218   0.001      -1.267284   -.3079808
    size |   .2785939   .1847363      1.508   0.132      -.0834826    .6406704
  sector |  -.0306546   .1806659     -0.170   0.865      -.3847532    .3234441
  regtyp |   .1202182   .2312529      0.520   0.603      -.3330291    .5734655
   _cons |  -1.586852   .2762283     -5.745   0.000       -2.12825   -1.045455
------------------------------------------------------------------------------
```

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