Knowledge-intensive business and R&D services in regional innovation systems: the German experience

Paper prepared by Dr. Thomas Stahlecker[1]

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Summary

Knowledge-intensive business services (KIBS) – like for instance R&D services - have grown considerably in many European and Asian countries over the last 15 years which suggests that they have a significant influence on innovation activities across the whole economy. KIBS are private companies providing expert knowledge and R&D services to companies, and are thus seen as vital source of information, advice and specialized knowledge for other industries (Toivonen 2004). In regional innovation systems, KIBS firms benefit from both physical and institutional "proximity" as the interaction between client and service provider can be facilitated by spatial proximity. Thus, the integration of KIBS firms in regional innovation systems appears to be an important factor for the competitiveness of firms themselves as well as for the "system" as a whole. Against this background the paper pursues three main objectives: After a short conceptual introduction highlighting the main characteristics/functions of KIBS firms and the role they play between the poles of regionalization and internationalisation, a short overview of the most recent trends as regards the establishment and development of KIBS firms on the regional level in Germany will be given. Second, the Fraunhofer-Gesellschaft with their different research institutes located in all over Germany will be presented as a practical example of an R&D service provider with a high relevance for the systemic level (i.e. innovation system, networks and clusters). Finally and third, the paper will focus on KIBS and service innovation policies designed and implemented on the national and regional level in Germany. This part will give a general overview of such policy directions and – using the example of Baden-Wuerttemberg – will also highlight an example of a "good practice" policy approach.

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1 Full address of the author: Dr. Thomas Stahlecker, Fraunhofer-Institute for Systems and Innovation Research ISI, Coordinator Research Unit "Regions & Clusters", Breslauer Str. 48, 76139 Karlsruhe, Germany, Phone +49 721 6809 173, Fax +49 721 6809 176, Email: thomas.stahlecker@isi.fraunhofer.de, http://www.isi.fraunhofer.de/isi-de/p/mitarbeiter-seiten/ts.php

1. Introduction: KIBS between the poles of regionalization and internationalisation

Since the mid 1990s knowledge-intensive business services (KIBS) and R&D services as an important sub-category are regarded as main drivers of technological and knowledge-based change in many "mature" economies, particularly on the regional level. KIBS are private companies providing expert knowledge to companies and are thus seen as vital source of information, advice and specialized knowledge for other industries like for instance the manufacturing sector (Toivonen 2004). According to Strambach (2001) KIBS can be defined by the following characteristics: they are human-capital- and know-how-intensive, have a high degree of intangibility and the difficulty of standardisation in their services. Furthermore KIBS are characterized by an intensive interaction process between supplier and client. KIBS are intermediate services and offer knowledge and know-how inputs to other businesses (Shearmur/Doloreux 2013; Muller/Doloreux 2009). Their services are co-produced with clients which results in relatively little standardisation and the emergence of service products as client and provider interact (Miles 2012).

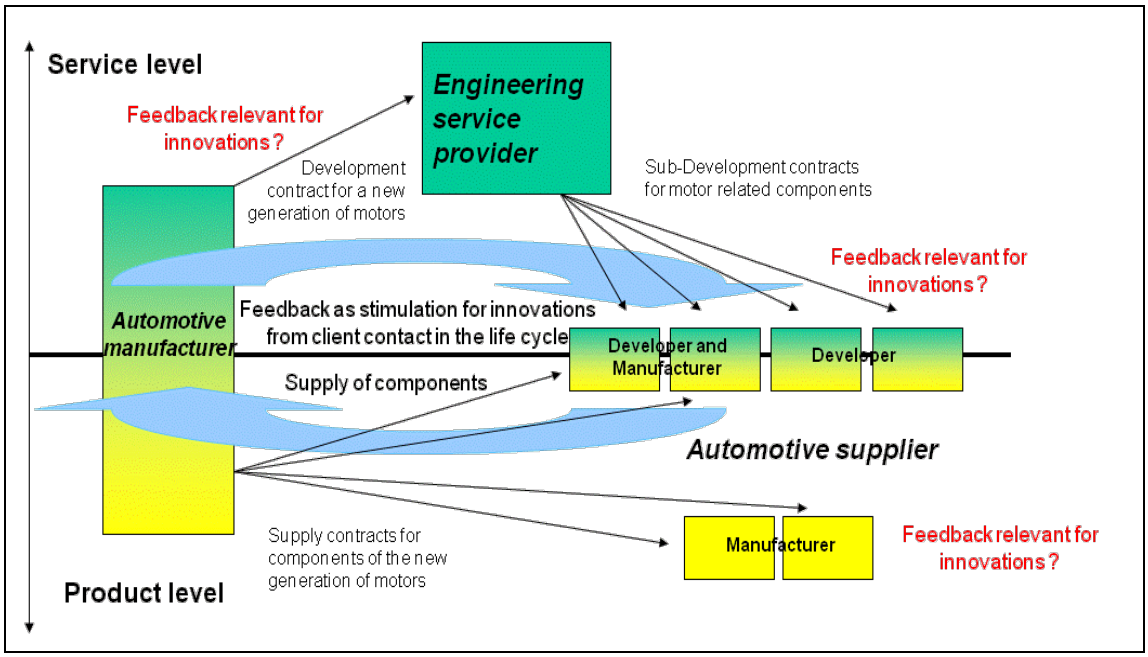
Knowledge- and know-how inputs by KIBS to other businesses often happen within the context of *innovation activities*. As innovation within firms is more and more dependent on the acquisition of knowledge and know-how from the outside (Chesbrough 2003), KIBS firms and R&D service providers are important actors regarding the division of labour within the innovation process. Against this background, knowledge dynamics and input to firms' innovation activities is often associated with considerable (science-based) KIBS start-up intensities (Stahlecker 2006; Stahlecker/Muller 2006; Koschatzky/Stahlecker 2010).

The ways KIBS contribute to knowledge and innovation dynamics requires a *multilevel analysis* which has to integrate the firm perspective (micro-level, innovation process) and the "spatial level", the latter against the background of the assumption that spatial proximity between provider and client is often regarded as necessary for service co-production (Cooke/Leydesdorff 2006). Thus, in regional innovation systems as well as in institutional stabilized regional clusters, KIBS firms benefit from both physical and institutional "proximity" as the interaction between client and service provider has a highly social dimension which can be facilitated by spatial proximity. However, other authors suggest that service relationships can also successfully be conducted at a distance once trust and understanding exists between provider and client (MacPherson 2008). Obviously, KIBS play an important role in transferring best practices and knowledge across geographic scales. For instance, globalised knowledge-networks can be accessed by KIBS in major cities and transfer knowledge (services) to more local actors (often located in smaller cities). Hence, according to Strambach (2008),

geographic separation between service client and provider may in some cases *even be necessary* for KIBS to play their role. In the process of providing knowledge and R&D services into the innovation process of client firms, KIBS are positioned between the poles of regionalisation – with strong linkages into regional innovation systems – and internationalisation – with the necessity to access global knowledge pools and the ability to internationalise their services.

Own research on the impact of external orientation or interaction with client firms on KIBS' own innovation ability has shown, that the question whether innovative ability of KIBS is affected by diverse feedbacks of information from clients appears to be highly relevant (see Lay et al. 2009). It became clear that useful information gained in innovation projects from service contacts with customers appear to be hindered less by the number of interfaces in the information channels rather than by the potential intensity of service contacts with clients. Figure 1 visualises these findings using the example of the automotive value chain. In the illustrated scenario, an engineering service provider acts as a subcontractor for the automotive industry. Information feedbacks relevant for the service provider's innovation activities can be direct (in the case of a direct provision of the R&D service) or indirect (in the case of sub-development contracts). Independent of how the value chain is organised (direct contracts or sub-contracts), the possibility to interact with the service client and to understand the clients' problems increases with the physical presence of the service provider (in person) at the client. Against this background, spatial proximity can facilitate the interaction between service provider and client but is not a "must-have" as the extensive and increasing service exports and internationalisation activities of German KIBS document (Stahlecker et al. 2006).

Figure 1: Example for integration of R&D service provider within the automotive value chain and consequences for innovations



Source: Lay et al. 2009

Regarding the increase of internationalisation activities as a general phenomenon in developed countries, KIBS firms and R&D service providers are extraordinary creative in terms of organizing their international value chains and knowledge networks. Having recognized the importance of direct physical contacts with a view to own innovation processes, KIBS try to compensate the lack of spatial proximity in the course of service exports by either sending domestic staff to customers abroad ("presence of natural persons) or by establishing "commercial presences" close to foreign clients (e.g. service centers, sales departments) (Lay et al. 2009).

2. Recent trends and development of KIBS and R&D services in Germany

2.1 KIBS in the light of quantitative indicators

The aim of this chapter is to give an overview of the main trends and the development of the KIBS sector in Germany on the regional level. This will be done on the basis of quantitative indicators, which are available on the regional level and allow a comparison between the federal states. The definition of KIBS used for the quantitative analy-

sis is a narrow one which comprises the following service industry segments (based on NACE Rev. 2[2]):

- Computer programming, consultancy and related activities
- Information service activities
- Professional scientific and technical activities[3]

The following figure or the two maps illustrate the significance of the KIBS sector in Germany as a whole and the different federal states in particular[4]. In absolute numbers, KIBS employment is particularly high in the densely populated states with major cities like in Upper Bavaria (Munich), Stuttgart, Frankfurt, Cologne/Düsseldorf, Hamburg and Berlin. In 2011 Upper Bavaria had the largest KIBS sector in Germany with 272.000 employees, followed by the region Frankfurt/Darmstadt with 244.000 employees and the region of Cologne with 208.000 employees. The region of Stuttgart – one of the strongest manufacturing regions in Germany after all - follows on fourth place with 202.000 employees. Rural areas like Trier (south-western part of Rhineland-Palatinate), Upper-Palatinate (northern Bavaria) and Giessen are the regions with the lowest number of KIBS employees.

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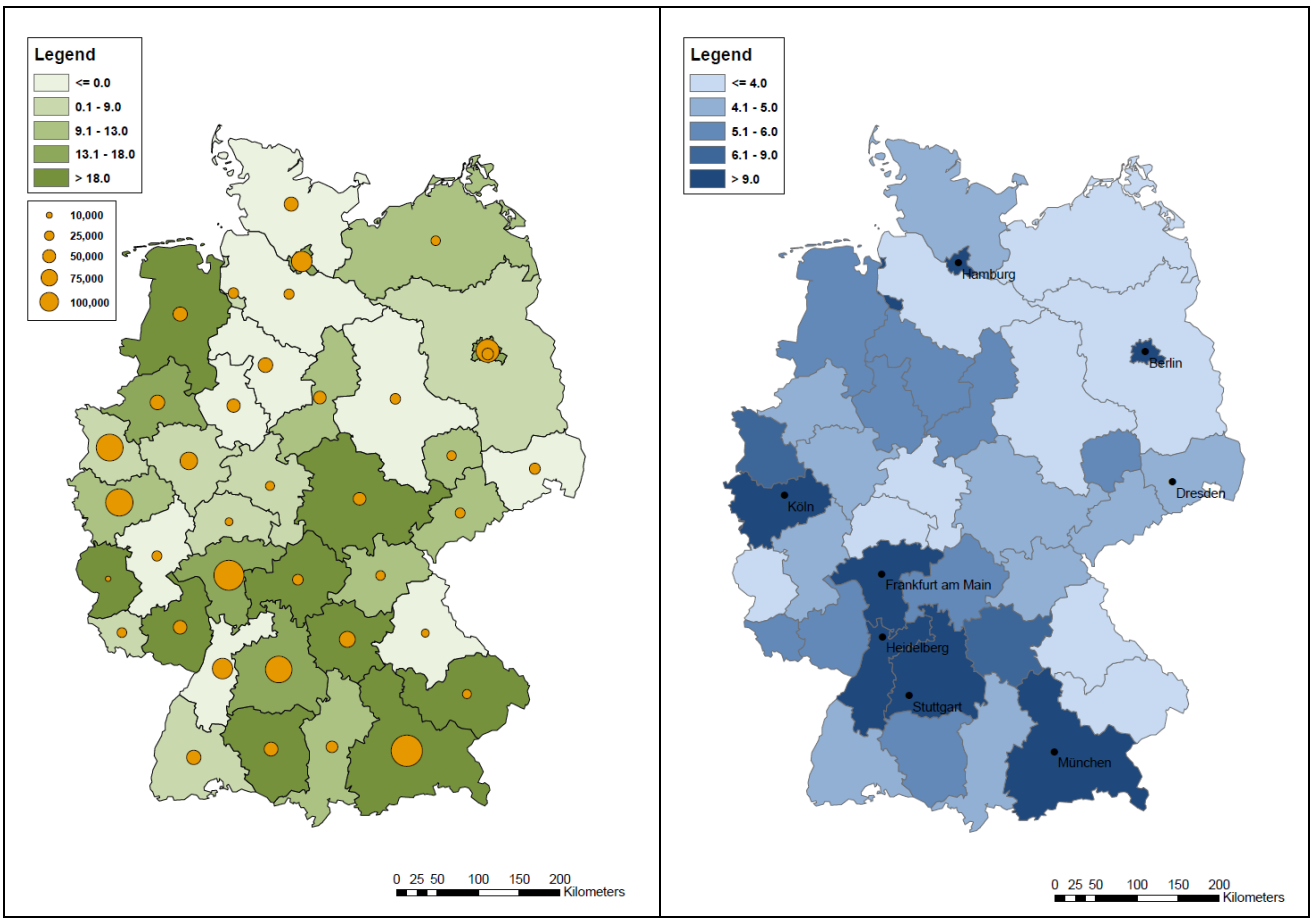
2 See also: Eurostat indicators of High-tech industry and knowledge-intensive services, January 2014.

3 Professional scientific and technical activities contain the following sub-categories (based on NACE Rev. 2): Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis; Scientific research and development, Advertising and market research, Other professional, scientific and technical activities, Veterinary activities.

4 Although the focus of the paper is on KIBS, figure A1 in the Annex shows the significance of Knowledge-intensive services (KIS) – based on a broader definition - in regional innovation systems in Germany. Compared (and in addition) to the definition of KIBS, KIS also comprise the following sub-categories (based on NACE Rev. 2): Water transport, Air transport; Publishing activities; Motion pictures; Programming and broadcasting activities; Telecommunications; Financial and insurance activities; Employment activities (temporary employment companies); Security and investigation activities; Public administration and defense, social security; Education; Human health and social work; Arts, entertainment and recreation. Due to the broader definition, the shares of KIS employment on total employment are clearly higher reaching values of up to 52% (in Berlin) (see figure A1 in the Annex).

Figure 2: Significance of KIBS in regional innovation systems in Germany (administrative regions): KIBS employment growth 2008-2011 and absolute number of KIBS employment 2011 (left map); KIBS share on total employment 2011 (right map)



Source: own calculations and map design, based on Eurostat

In terms of KIBS growth, figure 2 (left map) also shows the dynamic of employment in the period 2008-2011. What can be observed is that the some of the well performing regions – in terms of absolute basic values in 2008 – could enlarge their KIBS sector considerably. Upper Bavaria stands on top position in this regard: with a growth rate of 19,9% to a staggering 272.000 KIBS employees Upper Bavaria is among the strongest German regions in KIBS employment and dynamic. Other regions with a quite high growth dynamic, however from a different basic position, are the regions of Tübingen, Lower Bavaria, Mittelfranken, Unterfranken, Weser-Ems (in Lower Saxony) and Rhinehesse-Palatinate. The region with the highest growth rate between 2008-2011 is Thuringia. Negative growth rates or a loss in KIBS employment can be observed in the regions Upper-Palatinate (-54%), Lüneburg/Lower Saxony (-28%), and Detmold/Northrhine-Westphalia (-10%).

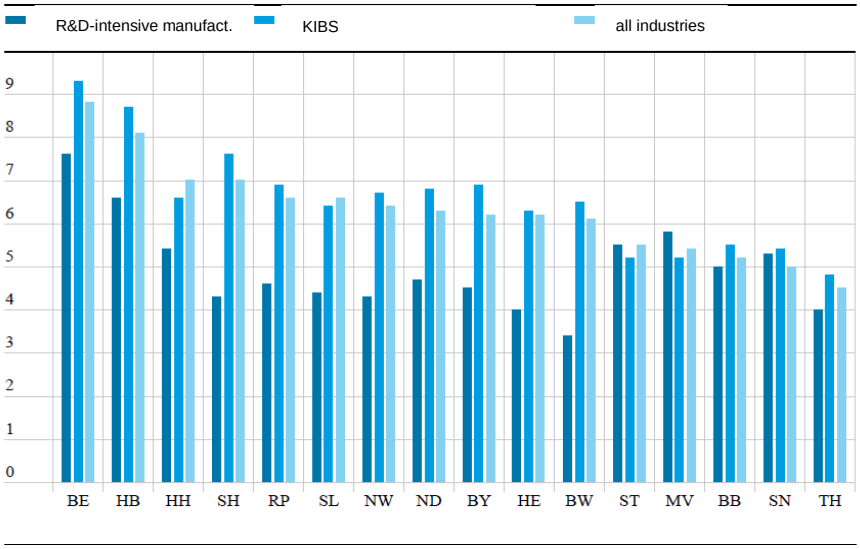
Regarding the share of KIBS employment on total employment in 2011 figure 2 (right map) finally proves what the absolute values in KIBS employment already partly showed. KIBS core regions are Upper Bavaria (12% on total employment), Stuttgart (10%), Darmstadt/Frankfurt (13%), Cologne/Düsseldorf (9%), Hamburg (13%), and Berlin (9%). Furthermore, the regions of Karlsruhe (9%) and Bremen (10%) have also a relatively strong KIBS sector.[5]

What can be concluded on the basis of the employment data so far is that regions with economic and technological strengths (including a powerful manufacturing sector) like Upper Bavaria, Stuttgart, Karlsruhe, Cologne and Darmstadt/Frankfurt are among the most important KIBS regions in Germany. Their regional innovation systems are obviously absorbing high-quality services which results in both a competitive manufacturing and KIBS sector. Other regions like Hamburg, Bremen and Berlin offer opportunities for KIBS due to structural advantages characteristic for metropolitan regions. In these regions, the manufacturing sector is not the main driver for KIBS dynamic rather than endogenous location factors like the harbor economy in Hamburg, technology-oriented companies in Bremen and Berlin and an above-average share of high-qualified university graduates (particularly in the IT/software industry).

In addition to the employment indicator the following figure sheds light on the regional potential to generate KIBS firms in terms of the number of firm foundations or start-ups in proportion to the total stock of companies in the different federal states. The analysis of the dynamics of start-up activities in KIBS industries gives evidence on the regional potential to renew the stock of companies in general and on business opportunities of the knowledge-based regional economy in particular (see Stahlecker (2006) for a comprehensive analysis of regional ties within the founding and early-development process of KIBS).

5 For a comprehensive analysis of KIBS in a regional perspective in Europe see Schricke et al. (2012).

Figure 3: Number of firm foundations in proportion to the total stock of companies in the different federal states[6] of Germany 2010-2012



Source: EFI 2014, based on Mannheimer Unternehmenspanel (ZEW)

The development of the number of regional KIBS firm foundations in the period 2010-2012 shows the highest values in nearly all federal states compared to R&D-intensive manufacturing firms and all industries. The two city states Berlin and Bremen show the most dynamic KIBS foundation intensity with above 9% KIBS start-ups in proportion to the total stock of companies for Berlin and slightly below 9% for Bremen. These two cities have also the highest start-up intensity in general (all industries) - definitively a concentration effect of economic activities in densely populated areas. Among the “area states”, Schleswig-Holstein stands out generating most KIBS (in proportion to the total stock of companies). The rest of the western federal states show an equal number of KIBS start-ups (as well as of R&D- intensive manufacturing companies). The five eastern federal states on the other hand feature a different pattern of firm foundations: here, the two types of firms, R&D-intensive manufacturing firms and KIBS firms, show a similar dynamic regarding start-up activities. The values are between 5-6% new firms in proportion to the total stock of companies. With a view to the R&D-intensive manufacturing firms, the gap to the western federal states is a result of the high public fund-

6 Compared to figure 2 this figure contains data on the level of the 16 German federal states, whereas figure 2 contains data for the different so-called administrative regions which are positioned within the administrative hierarchy between the federal states and the municipalities (counties and cities).

For the the 16 federal states the following abbreviations are used: BE=Berlin, HB=Bremen, HH=Hamburg, SH=Schleswig-Holstein, RP=Rhineland-Palatinate, SL=Saarland, NW=Northrhine-Westphalia, ND=Lower-Saxony, BY=Bavaria, HE=Hesse, BW=Baden-Wuerttemberg, ST=Saxony, MW=Mecklenburg-West Pomerania, BB=Brandenburg, SN=Saxony-Anhalt, TH=Thuringia.

ing rates for R&D- and technology oriented manufacturing firms reached in the five eastern states.[7]

2.2 Fraunhofer-Gesellschaft as a practical case of a (semi-)public R&D service provider

Fraunhofer-Gesellschaft is Germany's (and Europe's) largest *application-oriented research organisation*. With a workforce of over 23.000 scientist/researchers/engineers, technical and administrative staff research projects (contract research) are carried out in of 67 institutes and research units located in all over Germany. The organisation's core task is to carry out research of practical utility in close cooperation with its customers from industry and the public sector. In this way the Fraunhofer-Gesellschaft shapes the innovation process in Germany and drives forward the development of key technologies. The annual research budget totals €2 billion. Of this sum, €1.7 billion is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding[8].

Fraunhofer research activities are decentralized. The different institutes are organised on the form of "profit-centers" and identify areas of technology relevant to industry and the short-term and long-term demands of the contract research market. Fraunhofer-Gesellschaft can be characterized as a semi(-public) organisation. Pre-competitive research is publicly funded which amounts to 30% of the total annual budget. The public funds can be regarded as a "basic/institutional" funding. On the basis of the pre-competitive research *contract research projects and R&D services* are conducted for customers. Thematically or technologically the 67 institutes conduct research into health, nutrition and environment, safety and security, information and communication, transportation and mobility, energy and living, and resource efficient production. In various technology fields Fraunhofer-Gesellschaft is among the top patenting institutions in Germany.

Due to its function as R&D service provider and its decentralized structure, the different institutes are important actors in the respective regional innovation systems. However, the impact and qualitative function in the regional innovations systems varies according to the regional economic and technological pre-conditions. The more the technological

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7 For data on the development of the number of new firm formations (start-ups) in the knowledge-based economy *in Germany as a whole* see figure A2 in the Annex.

8 See: http://www.fraunhofer.de/en/about-fraunhofer/facts-and-figures.html

profile of a given institute is in line with the specific needs of the regional industry or companies, the stronger their role as a R&D service provider is.

Establishment of Fraunhofer Innovation Clusters to support regional embeddedness

Special emphasis is put on the *advantages of the embeddedness of Fraunhofer-Institutes into their respective regional innovation systems* in the course of the establishment of the so-called Fraunhofer Innovation Clusters. By identifying and financially supporting innovation clusters the Fraunhofer-Gesellschaft makes use of the cluster concept which underlines the importance of regional and institutional "proximity" within the innovation process. Clusters facilitate knowledge-exchange, network formation, the formation of a "critical mass" of complementary comperencies and the closing of the gap between science and business.

Fraunhofer-Gesellschaft has recognized the potential of regional clusters and launched the initiative to strengthen existing regional strengths. Fraunhofer Innovation Clusters are primarily project clusters in which different Fraunhofer-Institutes and business companies are cooperating on the level of the federal states. Since 2008 Fraunhofer has selected 22 project clusters in different thematic fields. The project are co-funded by Fraunhofer and the participating companies. Thus, the logic is to *stimulate innovation activities by financial commitments* – of both, Fraunhofer and industry.

One example of an innovation cluster is "Green Photonics" in Jena. Within this project the Fraunhofer Institute for Applied Optics and Precision Engineering together with the Universities of Jena and Ilmenau and 10 business companies search for solutions in the fields of energy efficient lighting, energy technology, environment sensors, energy and ressource efficient production, and green optics.

Other clusters include thematic fields like Bioenergy, Cloud Computing for Logistics, Digital Production, Future Urban Security, Life Cycle Engineering for turbo-engines, Next Generation ID, Personal Health, Regional Eco Mobility 2030, etc.

3. Policy directions for KIBS and service innovations

In Germany, specific policies to support or foster knowledge-intensive business services are a relatively new phenomenon, at least on the regional level. In fact, the policy directions focus rather on innovations in the service sector than on the KIBS sector as a whole. Apart from macro policies like the Directive on services of the European Commission – regulating the cross-border provision of services within the context of a free movement of service providers (e.g. single individuals) and consequences for domestic firms/suppliers – policy directions with a focus on KIBS and particularly service innovations are primarily formulated and implemented by the Federal government. In this regard, the German Ministry of Research and Education (BMBF) is the main player – both in terms of the financial scope, the thematic width and the impact of the funded projects. The 16 federal states on the other hand recognized the importance of the KIBS sector and innovations in the business service sector as well, but only a few of them formulated explicit strategies or policies for KIBS. As will be shown further below, *policies for KIBS on the regional/federal states level* is rather an integrated part of inno-

vation or technology policy as a whole, with KIBS firms being eligible for funding within the context of specific R&D, innovation or entrepreneurships programs.

The main initiative of the Federal government regarding service innovations in the last couple of years is called *"Innovations with Services"* and was launched by the BMBF in 2006 (BMBF 2006). It is the first integrated program with a focus on the funding of research in services. The thematic priorities are innovation management, innovations in growth fields and people in the service industry. Both, the initiative and services as a specific field of innovation are a part of the Federal Government's 2006 "High-Tech Strategy" which is the overall technology/innovation strategy for Germany (BMBF 2007). The main objective of the funding scheme "Innovations with services" is to contribute to excellence of the German service industry and service related research in a way that the manufacturing already achieved. In addition to increase the quality in innovation management, the goal is to improve the framework conditions for investment and research and development of new services, which originate at the interface of service- and technology development.

Against the background of structural weaknesses of Germany's service sector like below investments in R&D, little service export activities, regulation, underdeveloped public research potentials with a focus on services, the *funding scheme until 2013 supported different research projects with partners both from (public) research as well as from industry.* The coupling of the two spheres – practices and research/science - is regarded as a main driver for the innovativeness in the service sector. The integration of practice and research/science safeguards applicable findings, immediate transfer and simultaneous learning in the science and business sector.

The *specific funding priorities* with the respective funding budgets are indicated in the table below. The different priorities are the result of a systematic analysis of the strengths, weaknesses, opportunities and threads related to the service sector and research in services in Germany. As can be seen in the table, the main research fields are a) export and internationalisation of services, b) integration of production and services, and c) technology and services within the context of demographic change. Concrete research and innovation activities behind these priorities relate for instance to methods for designing service innovations, new business concepts, concepts for the interaction of labor- and technology arrangement, innovations in remote services, development of human resources, service products, work-life-balance concepts in the service sector, etc.

As regards the *regional innovation systems* in which the projects are implemented, only indirect interrelationships can be observed. The program or the different projects funded within the program pursue no "system-forming" objectives. As a federal program,

first and foremost national objectives are pursued. However, many project consortiums contain a "regional dimension" in terms of project partner being located in spatial proximity. In these cases, the project results are often transferred to business companies outside the core partners of the consortium. These so-called transfer- or application partners are as a rule companies, which apply the service related research results or serve as partners giving advice during the R&D process (with a view to application).

Table 1: Funding budgets and period in the different funding priorities within the program „Innovations with services"

Funding priority	Funding budget in Euro	Realization period of projects
Export and internationalisation of services	23.196.937	2005-2010
Integration of production and services	20.096.589	2006-2010
Service quality by professional labor	16.053.592	2008-2012
Technology and services within the context of demographic change	22.362.923	2008-2012
Productivity of services	3.789.295	2009-2013
Personal services using the example of rare diseases	6.515.177	2008-2013
Program support, transfer, other activities	4.669.914	2006-2012
Total	**96.684.427**	**2005-2013**

Source: VDI TZ 2012, based on ZTC

As mentioned above, most of the *federal states have not yet implemented specific KIBS policies*. Against the background that regional funds for technological development or innovation support are pretty small, priorities are targeted on R&D and technological development rather than on the KIBS sector (strategies of "technology-push"). In addition, in many regional administrations a clear understanding of what service innovations are and what R&D in the service sector looks like is missing. In fact, many service innovations – for instance in the financial sector or the advertisement industry – are hard to comprehend and often too "close to the market"[9], with the result that funding agencies and the ministries in charge shy away from funding single projects and business firms. The following box gives an example of KIBS related policies designed

9 The German Ministry of Education and Research (BMBF) regards the program "Innovations with services" mainly as a research-oriented instrument with a strong input from the science (universities and non-university research institutes as major partners in the different projects). However, this rationale is not a contradiction to the fact that business companies are integrated, be it as core partners or transfer partners.

and implemented by a German federal state. Baden-Wuerttemberg, known for its strong automotive and mechanical engineering industry is among the few states with an autonomous “Offensive for Services” of its own.

The Baden-Wuerttemberg “Offensive for Services” as an example for a regional initiative

The Baden-Wuerttemberg “Offensive for Services” has been launched in 2002 by the Ministry of Economic Affairs of Baden-Wuerttemberg at the suggestion of the Enquete-Commission “Medium-sized businesses”. The main objective is the linking of the manufacturing sector with innovative, knowledge-intensive business services. Against the background of a strong and highly competitive manufacturing sector the integration of services is regarded as an important locational advantage. In the course of the “Offensive for Services” the services “mentality” should be strengthened by information-, qualification- and advisory offers and by specific competitions.

Concrete support and funding of KIBS firms or innovative service companies is delivered within the context of different schemes. The most important schemes are as follows:

- Support program Coaching (in the thematic fields innovation and cooperation),
- Innovation vouchers for SMEs (e.g. for scientifc activities prior to the development of innovative services),
- Support program vocational subjects (focus on new service markets, e.g. Service engineering),
- Support program “Events” (e.g. presentation series, participation at congresses, advanced vocational training, strengthening innovation capability, strengthening cooperation between SMEs and research institutes).

As regards the target group, the following KIBS segments are eligible for funding: media and telecommunication, mobility and logistics, financial services, health and social, leisure/adventure and sports, cultural and creative industry, environmental services, and household related services.

In addition to the funding schemes mentioned above, the government of Baden-Wuerttemberg has laucnhed a so-called “Service Competition” which pursues the goal to increase the appreciation for the high quality of services provided by KIBS firms. Currently, KIBS firms can apply within two thematic segments: exemplary (ggod) customer service and exemplary service innovation. The competition happens in a two years cycle, with a high-ranked jury picking the winner after a final presentation from the final participants. The award ceremony is held by the Minister of Finance and Economic Affairs of Baden-Wuerttemberg.

4. Conclusions

The analysis in the course of this paper has found evidence that KIBS firms and R&D service provider are important actors within regional innovation system in Germany, both in terms of knowledge- and problem-solving capacities as well as regarding the contribution to innovation activities at the customers. However, the significance of KIBS in regional innovation systems differs considerably as the quantitative analysis has shown. The capability of a region to generate high numbers of KIBS firms is obviously a combination of density factors – typical for large cities and metropolitan regions – and

location factors related to “absorptive capacities” or market pull of innovative manufacturing firms, other KIBS or technology oriented firms in particular. Furthermore, research institutes and universities take over the role of incubators for KIBS start-ups or spin-offs with a strong science-base. Regarding the manufacturing and technology base as important location factors for KIBS dynamics, the regions of Stuttgart and Upper Bavaria (with Munich as the main location) clearly stand out, both with a view to the absolute number of KIBS employees and the dynamic of start-ups. Particular in these two regions a definitive “trade-off” between innovative manufacturing companies and KIBS performance can be observed with the result of dense manufacturing-service networks as an essential feature of the two regional innovation systems. These favorable framework conditions also result in considerable KIBS internationalization activities (Stahlecker et al. 2006), be it in the frame of accessing international value chains from the domestic location or by direct investments abroad (e.g. by establishing service centers or sales departments). Within this particular context the safeguarding of the KIBS’ own innovation capability appears to be one of the main challenges.

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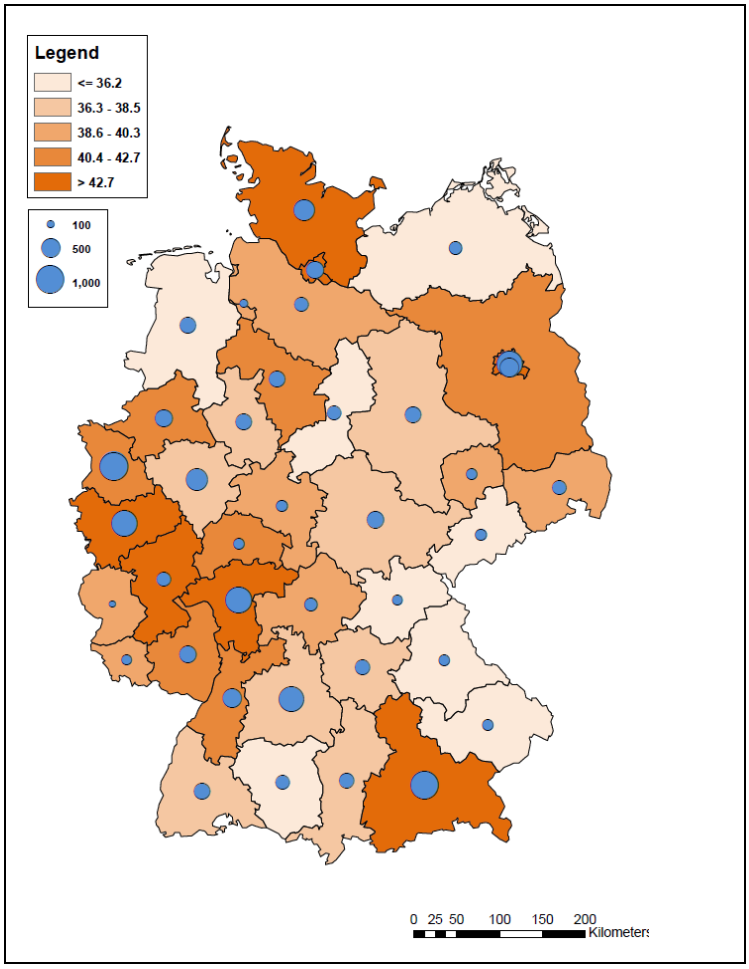
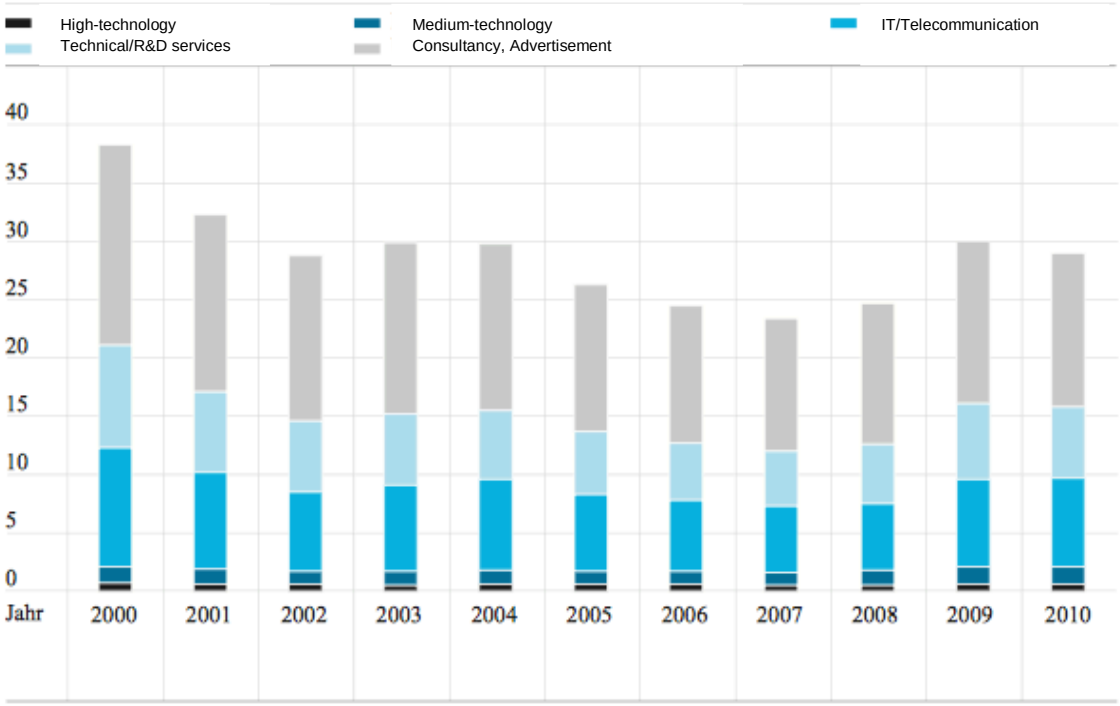
Annex

Figure A1: Knowledge-intensive services (KIS): share on total employment 2012 (orange fields) and absolute number of KIS employment 2012 (blue pies, in 1.000)



Source: own calculations and map design, based on Eurostat

Figure A2: Development of the number of new firm formations (start-ups) in the knowledge-based economy in Germany (number of start-ups in 1.000)



Source: EFI 2012, based on Müller et al. 2012