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Stephanie Daimer
Jochen Dehio
Michael Rothgang

Knowledge triangle policies and practices in Germany

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Hohenzollernstr. 1–3 | 45128 Essen, Germany
Phone: +49 201–81 49-0 | E-Mail: rwi@rwi-essen.de
www.rwi-essen.de

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Key Messages of Part 1

1. This is the summary of a case study on knowledge triangle (KT) policies and practices in Germany, which has been developed as part of an OECD study, which compared KT policies and practices across OECD countries. Our study addresses characteristics of the situation in Germany, where the interaction between the different policy levels is rather crucial for understanding KT policies and (non-university) public research institutions (PRIs) play an important role in the KT.

2. The term "knowledge triangle" is not widely used in Germany, but there are many developments with KT relevance taking place in the HEIs and PRIs. We see different forms of interaction, between the different angles of the KT: between research and innovation (with a clear focus on the "third mission" of HEIs), between research and education (strongly reinforced in the past few years by instruments aiming at a higher quality of education) and between innovation and education (e.g. via participation of representatives from the economy and society in the accreditation process of new B.A. and M.A. study programmes). Changing societal demands addressed by R&D policies in recent years have helped to trigger some of these developments. Third mission policies and science-industry linkages are thriving, but adoption by HEIs and PRIs is very different, depending on the institutions' structure, culture and location (regional context).

3. Similarly, at the policy level, the interactions between all three KT angles have not been the major focus of policies or strategies. Nevertheless, the German High-Tech Strategy, which is the overarching policy strategy, does define strong links between research and innovation as a major objective and addresses the need for a well-qualified workforce as a central task. There is also an explicit commitment to the third mission in the legal basis: The Framework Act for Higher Education defined "knowledge and technology transfer" as a third task for HEIs in 1998.

4. At the same time, policies with a focus on HEIs pursue a variety of objectives. Alongside challenge orientation, these include a general strengthening of the third mission of HEIs, a focus on excellent research (e.g. with the excellence initiative and complementary policies at the Länder level), investing in the quality of education, and place-based policies (e.g. the research campus models ("Förderinitiative Forschungscampus") and cluster policies). Over the past ten years, these policies have been accompanied by a substantial increase of public investments in R&D (alongside an increase in private R&D funding). The share of institutional (block) funding as opposed to competitive, project-based funding for HEIs is still relatively high in Germany when compared to other countries. Nevertheless, the performance-based allocation of institutional funding has become more significant over the past ten to 15 years and is now an important aspect in the governance of HEIs by the responsible ministries at the level of the federal states (Länder).

5. In Germany, the tasks are split between the different kinds of HEIs (primarily between universities and universities of applied sciences). Furthermore, different roles of HEIs in local innovation environments can be observed, depending on the economic structures in the regions. In this diverse HEI landscape, different types of universities strive for excellence in basic research, application-oriented research and in education, but organisational strategies rarely aim at an integrated KT vision. Nevertheless, we find many examples of well-integrated KT angles in German HEIs.

Key Messages of Part 2

1. The second part presents results from case studies of two German higher education institutions (HEI). It addresses specific characteristics of the situation in Germany, where interaction between different policy levels is crucial for understanding KT policies, and where (non-university) public research institutions (PRIs) play an important role in the KT. Third mission policies and science-industry linkages are thriving, but their adoption by HEIs and PRIs varies greatly depending on the institutions' structure, culture and location (regional context). For the case studies, two HEIs were chosen that display the differences in Germany with respect to framework conditions and policies, as well as the different positioning of HEIs in the knowledge triangle: Heidelberg University and the Bremen University of Applied Sciences. In addition, results of previous studies on the regional engagement of eight other HEIs are analysed.

2. Heidelberg University, the oldest university in Germany, is located in a thriving highly industrialized metropolitan region. It is a large, comprehensive university with 30,000 students, and a focus on medicine, natural sciences, mathematics, computer sciences, social sciences and humanities. As a top recipient of public funding, especially in basic research, the university has a strong focus on scientific excellence.

3. Bremen University of Applied Sciences was founded in 1982 during a period when new applied universities were being established to open up the university system to new groups of students. Bremen has undergone substantial structural changes in important sectors like shipbuilding. Although Bremen is known as a city of trade, industrial sectors (like the automobile and food industries) have always also been important here. Bremen has one of the larger German universities of applied sciences with a focus on business administration and engineering. The focus of the university has always been on promoting students from less socially privileged groups in response to additional demand from industry.

4. In both HEIs, the KT concept does not play an explicit role in the strategic development of their activities. This is also valid for other German universities. To the best of our knowledge, there is only one exception in Germany: the Karlsruhe Institute of Technology (KIT) explicitly uses the term "knowledge triangle" in its mission statement since the merger of its teaching and research institutions in 2009.

5. The activities that relate to the KT are important for the two cases which are studied in depth. The main activities and strategies of both HEIs can be located on different angles of the KT. Heidelberg University's mission is excellent research. The university's institutional strategy was successful in the national Excellence Initiative. Important activities are located between research and education as well as between research and innovation. In the strategic fields of focus (like medicine), the university aims to integrate research and teaching and achieve a high quality of teaching. The university has close links to industry, some of which have been institutionalized by long-term activities and programmes (like industry-on-campus-programmes, a federally-funded research campus ("Förderinititative Forschungscampus") and two federally-funded Leading-Edge clusters ("Spitzencluster")).

6. The strategy of Bremen University of Applied Sciences is centred on education and life-long learning. One relevant activity is its participation in a diversity audit programme, in which strategies are developed to address the diversity of student groups. The international orientation of education (through both mandatory time abroad for students and attracting international students) is important in the university's strategy, also with respect to the international character of many local firms. The links to research, which is application-oriented, and to innovation are expressed in internship programmes and bachelor and master theses, which take up topics from firms. Practical cooperation between professors, students and firm representatives with the professor acting as a consultant is at the core of KT activities. In order to increase contacts to industry, the university is represented in local firm clusters and networks.

7. The local focus in the two HEIs is quite different: The role of Bremen University of Applied Sciences has been influenced by the features of the regional innovation system and Länder policy that addresses these features. Within the federal state of Bremen, the University of Bremen, being another important HEI in the region with a different strategy, aims at excellent scientific research. At the same time, the innovation system here is also characterised by a substantial number of PRIs that perform excellent research. Within this framework, the University of Applied Sciences specifically addresses the demands of local industry. Activities that address non-economic aspects are also important for the university: being part of a diverse district of Bremen (Neustadt) and giving impulses for societal development in individual projects.

8. In comparison, Heidelberg University has always been a top research performer in many disciplines and a focal point in regional, national and international terms. Regional integration is seen as enriching national and international activities and strategies. The university has developed strong strategic partnerships with firms and PRIs in the region. In line with the overall university strategy, the focus of these partnerships is on research excellence. While there is little specific focus on regional demands, many regional activities and indirect impacts can be found. The university is an important regional employer, its reputation contributes to the branding of the region, and its historical buildings add to the cultural and touristic attractiveness of Heidelberg.

9. When taking other evidence into account, it becomes obvious that the individual activities of the faculties and the (strategic) activities of university management are rather disconnected, but in effect often complementary, because individual activities and university-wide strategic approaches serve the same goals. Many faculty choices to engage regionally are strongly contingent on intrinsic academic motivations – not management-driven. The Dresden University of Technology is one example, where the regional activities of different levels (individual professors, faculties, university management) seemed to be complementary, but there was a common understanding that

it could be further improved if there were a dedicated concept for regional engagement in place. The preparation of the proposal for the national "Excellence Initiative", where regional activities were considered more strategically, suggests that university management could support further regional – and with it KT – development by orchestrating and guiding activities.

10. A number of more recent policy approaches has been conducive for KT development such as place-based instruments like cluster policies and the research campus models or the embedding of HEI policies in a broader regional policy approach. Other approaches like the anti-cyclical trend of increasing institutional block funding are too young to be assessed as to whether they will help to further strengthen KT developments, but as an unusual policy approach, this deserves further attention.

11. Our findings show that the different approaches toward the KT are partly caused by the fact that Heidelberg and Bremen represent to different types of HEIs in Germany (general universities, which have stronger research profiles than universities of applied sciences, which often focus on education). However, other factors also play an important role in the positioning of the HEIs in the KT: (1) historical developments and the structure of the innovation system (what firms, other HEIs, or PRIs are in the region?), (2) Länder policies and strategies that foster certain paths of development of the HEIs in and with their regions, (3) Strategies and perceptions of the acting persons both in the relevant Länder ministries and the HEIs; and (4) HEI policies at the federal level (e.g. the Excellence Initiative).

Part 1: State of affairs and developments at the country level

1.1 Introduction

Undoubtedly, universities are acting in response to the requirements posed by their major income streams. Hence, with public universities (or more generally Higher Education Institutions (HEI)) being dependent to a large extent on national public funding, a strong impact of national STI policies, and in particular HEI policies, on the development of HEIs can be expected. In the past 15-20 years, political framework conditions in Germany like in many other European countries have changed substantially due to the Bologna process, new public management and more autonomy combined with a more indicator based steering process, or *Centre of Excellence* initiatives.

At the same time, processes of knowledge production have changed. Despite important differences between new modes of knowledge production, many of them share a similar feature. In these processes, different types of actors take part in an interactive co-construction-type of knowledge generation (e.g. Mode 2 (Gibbons et al. 1994), Triple Helix (Etzkowitz & Leydesdorff 2000), post-normal science (Funtowicz & Ravetz 1993), open innovation (Chesbrough 2003; 2006; Gassmann et al. 2010) or social innovation (Moulaert et al. 2013, Howaldt und Schwarz 2010)). And, perhaps most importantly, the role of research and innovation for society has changed enormously, with the grand societal challenges posing new rationales for policy-making (Mowery et al. 2010; Foray et al. 2012; Steward, 2012; Weber & Rohracher, 2012; Kallerud et al. 2013; Kuhlmann & Rip, 2014; Lindner et al. 2016). In STI policies, this means that societal needs have become influential shapers of research priorities. Linked to these developments, science-society relations are in a process of re-adjustment. This in turn creates pressure on organizations like universities to change processes and structures and redefine their mission and strategies (e.g. Mowery & Sampat 2005; Samarasekera 2009; Markkula 20011; Benneworth 2013).

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In fact, we witness HEIs adapting to these changing environments in very diverse ways. So the reasons for different directions of change and different role models universities aspire to must be multi-faceted and the setting, in which national STI policies can trigger such changes, is a complex one. Against this background, we propose a study of change of universities that focuses on the effects of national policies and specific features of HEI governance. At the same time, we look at the influence of broader international developments as well as at societal developments and regional context factors with an effect on university development.

The units of observation of our study are HEIs (universities and universities of applied sciences) in Germany and their change during the past ten years. We seek to answer two research questions:

1) Can we see knowledge triangles emerging as a result of the change processes of HEIs in Germany?
2) Which factors have triggered recent developments and what is the role for (national) policies in this process?

The notion of the "Knowledge Triangle (KT)" has been coined in the policy discourse of the European Union's Lisbon Strategy in 2000. It expresses a desired direction of development for (regional) knowledge hubs with HEIs at their core. The KT stresses an integrated approach to research, education, and innovation with the aim to drive economic growth (Sjoer et al. 2012; Maassen & Stensaker 2011). Being a normative policy idea framed at the European level, the KT approach somehow reinforces developments at national level, such as the attention towards the "third mission" of universities to spur innovation (and economic growth). It also allows addressing broader societal challenges like sustainability or equal opportunities. Moreover, as it requires actors working together in different ways and in new constellations, it fits the developments of the time towards new modes of knowledge production and changing science-society relationships (Markkula 2011). However, there is a tension with the excellence of science policies of the past decade and the publication and citation metrics dominating the performance measurement of scientists and academic institutions.

Part 1: State of affairs and developments at the country level

So, it becomes relevant to study empirically, whether the KT has become a desired model and goal for universities' development, or whether we find – in absence of explicit references to the KT – de facto developments of KT relevance such as growing integration between the angles of the KT, research and innovation, research and education as well as education and innovation. The OECD has recently undertaken a cross-national comparison of KT practices among OECD countries, as there have been only few empirical works so far (Kruecken 2003; Pirttivaara et al. 2013; Sjoer et al. 2012; Markkula 2011). This report was prepared as a country case study about Germany in this OECD project.

Our study builds on a few previous studies about the societal and regional embeddedness of universities in Germany (Technopolis et al. 2012; Stifterverband 2013; Koschatzky et al. 2013; Kroll et al. 2015; Rothgang et al. 2015; RWI/FCON 2015). To this, it adds two case studies, which address specific characteristics of the situation in Germany, where looking at interactions between different policy levels is crucial for understanding KT policies (as in fact institutional funding and HEI governance is in the competence of the federal states), and where (non-university) public research institutions (PRIs) [1] play an important role in the KT. For the case studies, two HEIs were chosen that display the differences in Germany with respect to framework conditions and policies, as well as the different positioning of HEIs in the knowledge triangle: Heidelberg University and the Bremen University of Applied Sciences.

The first part of this study addresses KT policies and strategies at country level. We focus especially on the position of higher education institutions (HEIs), the funding of research and higher education, the role of place-based policies, and the evaluation of higher education and research. The second part of the study is

[1] *According to an OECD definition, the term 'public research institutions' includes government research laboratories and establishments engaged in R&D activities such as administration, health, defence and cultural services, public hospitals and clinics, technology centres and science parks (OECD 2011a: 18). Other terms that are often used with sometimes differing content are "public research institutes", "public research organisations" (OECD 2011b) and "Research Performing Organisations" (see e.g. http://www.research-in-germany.org/en/research-landscape/research-organisations.html, last accessed 23 February 2016).*

dedicated to the case-study analysis followed by a broader conclusion and discussion.

1.2 The higher education sector in the knowledge triangle

Main types of education institutions, differentiation, and the role of government policies

The main types of higher education institutions in Germany are (general) universities, universities of applied sciences, and art academies (with music conservatories as a special type of art academy). Art academies are often put on equal footing with universities. As in other countries, general differences between universities and universities of applied sciences concern the fields of studies that are offered (certain fields like medicine or teaching can only be studied at universities), the extent of scientific research done (with a substantially higher share in universities), and the right to award a doctoral degree, which has been reserved for universities. With regard to this last point, things have started to change recently, when the federal state (Land) Hesse has paved the way for granting the right to award doctorates to individual departments at certain universities of applied sciences with a strong research focus.[2]

Of the 427 HEIs in Germany in 2014/15, 30% were universities, 58% universities of applied sciences, and 12% art academies (Table 1). Their relative importance can be assessed by looking at their shares of the total 2.6 million students in Germany. As universities are, on average, larger than universities of applied sciences or art academies, their share of all students is about two thirds, while one third of students are enrolled in universities of applied sciences and only one per cent in art and music colleges. Thus, universities are the most important kind of HEIs with

[2] *Other federal states ("Länder") like Baden-Wuerttemberg, Schleswig-Holstein or North Rhine-Westphalia have also changed their HEI legislation in this regard, but have opted for different forms of implementation. Instead of granting individual rights to the universities of applied science, they favour cooperation models between universities and universities of applied sciences, or cooperation by a group of universities of applied sciences (Burchhard 2015, Haerdle 2015).*

respect to the education of young academics, although universities of applied sciences are also becoming more important. 32% of all HEIs are private universities or private universities of applied sciences; however, due to their rather low share of the total number of students (less than 7%), these are only of moderate importance with respect to KT.

Table 1
Main types of HEIs in Germany

Type	Number	Share	Number of Students	Share of Students
(General) Universities	129	30.2	1,701,800	65.0
Universities of Applied Sciences	246	57.6	879,897	33.6
Art or Music Colleges	52	12.2	35,184	1.3
Total	427	100.0	2,616,881	100.0
of which: Private Universities	135	31.6	180,476	6.9

Universities include 22 pedagogical or theological colleges. Universities of applied sciences include 29 HEI for public administration which are internal federal and Länder universities for employees in public administration.
Sources: Statistical offices of the federal and Länder governments. http://www.statistik-portal.de/Statistik-Portal/de_jb04_jahrtab50.asp, https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/Hochschulen/Hochschulen.html#Tabellen.

There are several dimensions of differentiation of HEIs. Government policies play an important role in this differentiation, which is also influenced by other factors like historical developments, strategies of the HEIs, and international developments:

- The Bologna process (leading to an adoption of bachelor and master degrees in German universities and universities of applied sciences) has contributed to a trend towards **a partial convergence of the two general types of HEIs**. Compared to the pre-Bologna situation, universities now offer – in addition to their research-oriented study programmes – more practice-oriented bachelor degrees, while universities of applied sciences offer some more scientific master degrees and have upped their research activities. Although the ma-

jority of practice-oriented (B.A.) study programmes is still offered by the universities of applied sciences, the task sharing between the two kinds of HEIs has become blurred in some instances (Wissenschaftsrat 2012: 22).

- The Excellence Initiative for universities (see section 3) was expected to contribute to a **differentiation between universities** (DFG & WR 2008, p. 59ff.). It aims at increasing the international competitiveness of German universities by making them more attractive to first-class researchers and research funds (Wissenschaftsrat 2010: 25). The evaluation of the Excellence Initiative, however, has not found any evidence that it has had impacts on the overall science system with regard to a more differentiated landscape of HEIs (IEKE 2016).

- Increased demands on HEIs with respect to the roles and goals they should address as well as new funding programmes (see section 3) have triggered the development of new organisational units that lead to **increased differentiation within HEIs**, but – indirectly – also contributed to the differentiation between HEIs (Reichert et al. 2012). Examples for such organisational change in education are colleges, professional schools, centres for lifelong learning, and graduate schools for Ph.D. students. Centres for advanced studies, long-term strategic partnerships with public research institutes and industry-on-campus-models have been developed in research. The autonomy of these units varies, but they increasingly operate at least partly independently of HEIs and are often organised as public-private partnerships (PPPs). These new units address new demands and interact with traditional units at the same time.

- Länder government policies and HEI policies partly aim at and contribute to a **differentiation between different types of universities of applied sciences** with the primary aim of addressing the need for a qualified workforce in the regions as well as intensifying science-industry cooperation. For example, so-called "dual HEIs" have been established across Germany. They offer study programmes which combine academic degrees with training qualifications obtained by spending half the course time in practical professional training at a local firm.

- **Private HEIs** play an increasing (but still small) role in the overall picture. They are still more closely related to the needs and requirements of companies, both in research and in education.

The scientific council argues for a stronger differentiation of HEIs in order to be able to address the multiple demands that are made of the system at the same time (e.g. supply qualified graduates, perform first-class research, and contribute to the solution of economic and social challenges (Wissenschaftsrat 2010: 6)). To conclude, there are several trends that lead to an increased differentiation between HEIs in Germany (like excellence-oriented policies and increased heterogeneity of the demands from HEIs. At the same time, there are some Universities of applied sciences with a high amount of financial resources that increase their focus on research such that – at the margin – there is a tendency of universities and universities of applied sciences to converge.

Position of HEIs with respect to research, education, and innovation

HEIs in Germany are important for research, education, and innovation, but also for the development of local communities beyond purely economic aspects. Furthermore, PRIs play an important role in the KT in Germany. They contribute substantially to public research (both application-oriented basic research and applied research), but also to doctoral education in cooperation with universities. The role of HEIs and their relationship to PRIs with respect to research, education, and innovation can be described as follows:

- In post-school education, HEIs are the core actors in German KT. The division between universities and universities of applied sciences used to be quite clear-cut in the past: Graduates from general universities not only had practice-oriented qualifications, but also qualifications in scientific methods and knowledge. Complementary to this, graduates from universities of applied sciences had a more practical training and (to some degree) less pronounced training in scientific knowledge. Universities of applied sciences especially – but of course not solely - addressed the education requirements of the KT regions. However, education is subject to constant change and innovative

approaches can be found regardless of the type of HEI. Such innovative approaches have KT relevance, for example, new methods of research-based learning, new ways for practice-oriented education to address specific markets, as well as approaches exploring "education with and for society" (HRK 2014).

- HEIs (especially universities) play a core role in basic and application-oriented research. Universities supply general basic knowledge but are also a source of application-oriented knowledge which is inspired by the problems faced by businesses. As there are often long-term relationships between university researchers and businesses, we often find rather intensive forms of not only unidirectional knowledge transfer, but also mutual exchange and learning. Universities of applied sciences focus on the education of a highly qualified workforce. In recent years, the higher education laws of the Länder have obliged these HEIs to develop foci on applied and solution-oriented research in response to the demand of regional industries. Some universities of applied sciences now have substantial research capacities and are competitive with national and international players in their specific technology fields. Thus, a simple delineation between the two major types of HEI in Germany is no longer possible.
- In general, there is a division of labour between HEIs and PRIs that do more basic research (e.g. Max Planck Institutes) or more applied research (e.g. Fraunhofer Institutes). PRIs and universities are often closely linked via professorships. University professors lead research groups or institutes of public research organisations. Thus, their intramural and extramural research programmes and post-graduate education are normally closely connected. There is some overlap between the research performed by HEIs and PRIs. In particular, universities have a very broad scope.
- While the core of application-oriented research and innovation lies in the business sector, HEIs in Germany contribute significantly to innovation. This takes place either in the form of innovation created in HEIs (e.g. by spin-offs) or collaborative research. In addition, due to their basic research, universities are able to develop the knowledge stock in application-oriented basic

research which receives impulses from research problems that originate from industry and builds on basic knowledge at the same time. Networking with industry has increased since the Framework Act for Higher Education included transfer activities as a third mission for HEIs. One indicator of this development is the share of HEI expenditure in R&D financed by industry. With 14% in 2012, it is considerably above the OECD average of 5.9% (OECD 2015: 65). The universities' focus is more national and international than regional. Universities have recently increased their regional activities. Especially larger universities perceive this as not contradicting internationalisation, but enriching it (Schnabl 2014: 40).

- In Germany, a tendency to move from individual cooperation projects to more strategic forms of cooperation with long-term interactions between firm representatives and university researchers can be observed (e.g. via endowed professorships, Frank et al. 2007: 7). This tendency relates to the increased importance of public-private partnerships between HEIs and firms (Koschatzky 2014: 109). The growing autonomy of HEIs since the 1990s favours such partnerships (Vogel, Stratmann 2000). The degree of cooperation between industry and university spin-offs varies widely. While some universities have a large number of spin-offs, the majority of universities in Germany have only a few (Hemer et al. 2010: 34).

Interaction of HEIs with other sectors

The bigger picture shows that German HEIs are interacting strongly with other sectors. The aspects of differentiation described so far also underline that the activities and strategies of HEIs vary to a large extent, and hence, also the type and intensity of interaction with other sectors are different across HEIs.

Interactions with industry, the public sector and society take similar forms as regards education.

Typical forms are:

- HEI graduates, who find employment in businesses and public services;

- Multiple dual degree programmes that comprise work in firms or public services and education at HEIs;
- Universities of applied sciences cooperate especially closely with the local economy and society when designing their degree programmes[3];
- Students in engineering programmes often write their final thesis in cooperation with firms.

There seems to be still more potential to increase the cooperation between HEIs and industry in education (e.g. by integrating practical content into the HEI curricula, see Frank et al. 2007: 11).

Interactions with industry in research and innovation are manifold. Increasingly, they are complemented by interactions with society.

Interactions with industry in research and innovation are intensive due to the strong industrial base in Germany. HEIs (especially universities) have a long history of cooperation with large and innovative smaller firms. Less innovative or less R&D-intensive industries have been less involved in these forms of cooperation. As application-oriented research aims at creating knowledge for innovation, the delineation between research and innovation activities is blurred. Both activities are more intense in economically stronger regions and in more applied university disciplines (e.g. engineering). They are strong in high-tech industries and technological disciplines. At the same time, it is often acknowledged that disciplinary and organisational cultures hamper application orientation. For example, the innovative potential of the social sciences and humanities is still largely untapped (Daimer et al. 2014: 58f.). Typical forms of interaction are:

- R&D cooperation between HEIs and businesses.

[3] *See http://www.akkreditierungsrat.de/index.php?id=programmakkreditierung&L=0, last accessed 22 February 2016.*

- Strategic partnerships between universities and industry including joint research agendas, industry-on-campus-models, institutionalisation of these partnerships in some cases (e.g. PPPs).
- HEI spin-offs that contribute to the local economy.

Local businesses and their demands also radiate into the HEIs and modify their roles and processes in KT. In addition, HEIs provide an **infrastructure** that attracts firms and PRIs and contributes to the quality of life for the population in KT regions.

Interactions with the public sector are most obvious in the links to public sector research given the importance of the four major PRIs in the German science system (see the sections above).

1.3 KT-related policies and their impacts

Split competences between the federal government and the "Länder"

The relationship between policy and single HEIs at the Länder (and to a smaller degree at the federal) level is characterized by incentives and framework conditions that are set by policy: As the Länder policy level has always been responsible for sciences and HEI education, the relationship between the two sectors is most intensive at this level. However, since the end of the 1950s, the federal government has increasingly taken more responsibility, especially since the formation of the National Science Council in 1957, which gives advice to the federal and Länder governments on the development of the tertiary education system. Over time, a coordination of federal and Länder policies has developed, for which the main responsibility is still with the Länder governments. At the same time, the federal government has assumed responsibility in certain fields, mainly in project-based funding. The activities are coordinated in the Joint Science Conference (Gemeinsame Wissenschaftskonferenz), which was established in 2007. This addresses questions on research funding, science and research policy strategies,

and the science system. Its members comprise the federal and Länder ministers in charge of science, research and finance.[4]

For the communication and interaction with different policy levels, public and publicly accredited private HEIs cooperate at the German rectors' conference (Hochschulrektorenkonferenz). The German rectors' conference provides a platform for forming a common opinion shared by HEIs and for voicing joint statements to the public, federal, Länder and EU authorities. This platform allows an intensive and effective exchange with the Länder and federal policy levels.

The 'Third-Mission' and the role of government policies

Looking at the types of HEI interactions discussed above, it becomes clear that HEIs in Germany have broadened their range of missions. In addition to education and research, aspects of knowledge transfer and a broader interaction with industry, society and the regional economy have become more important, although research cooperation with industry has always been performed by HEIs. Still, this more intensive interaction with the environment is often primarily oriented towards economic aspects and not so much towards embeddedness in the regional society. Although the latter takes place, this is generally not actively pursued and the 'corporate citizenship' of HEIs is less pronounced than in other countries (Berthold et al. 2010).

The idea of the "third mission" of HEIs and the role of government policy in promoting third mission activities did not emerge from an overall strategy targeting that goal, but from multiple policy initiatives and HEI activities. This development has been promoted directly and indirectly by government policy at the federal, Länder and European level:

- Since the end of the 1990s, German HEIs have been confronted by essential changes in their framework conditions, which have resulted in the attachment of more importance to the KT in their strategic actions. The Framework

[4] *See http://www.gwk-bonn.de/, last accessed 19 January 2016.*

Act for Higher Education defined "knowledge and technology transfer" as a third task for HEIs in 1998.

- In Länder policies, there has been a tendency towards a more output- and performance-oriented model of supervision of HEIs since the 1990s. Prior to this, a bureaucratic model with detailed steering of financial inputs was practised. This tendency has led to (a) a greater independence of the HEIs and autonomy[5] of the university administration at least to the situation before when there was steering by individual policy decicions, (b) an increasing distribution of public funds based on performance indicators and management based on contracts negotiated individually with the HEIs; (c) increased financial autonomy of HEIs due to study fees.[6] The internal differentiation in the role of HEIs with respect to KT is substantially influenced by the indicators that are used to measure performance.
- The increased emphasis on third mission activities has created pressure on the other HEI missions, in particular as activities oriented towards increasing scientific excellence in research and third mission activities partly compete for the same resources. The situation seems to have changed since 2006/2007, when the federal and Länder governments committed themselves to large, strategic and long-term investments in the science system. The three major programmes launched at that time aim at substantially improving quality in research and education (Excellence initiative, HEI pact, and Pact for Research and Innovation, see below). In fact, the programmes to induce a higher level of scientific excellence started by the federal government and to a lesser extent also by the Länder governments have also resulted in more third mission activities, as HEIs often build their excellence strategies on existing strengths in local KTs (see the examples discussed below).

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[5] The increased budget autonomy was followed by several autonomy regulations at the Länder level. The 2005 autonomy contract with the University of Darmstadt is referred to as the pilot case (Fittkau 2015).

[6] Only temporarily, as study fees have since been abolished again.

- Technology transfer offices that have been set up at many HEIs have only partly been successful in increasing third mission activities. On the one hand, this is due to causes in the HEI structures (insufficient incentives for cooperation with industry) and, on the other hand, due to causes in part of the industry environment. While large firms and SMEs in technologically advanced industries normally have no problems in taking up results from HEI research, firms in other industries often do not have enough experience in university-industry relations.[7] In addition, many of these firms do not have their own R&D departments.

- The influence of European policies on HEIs and their development –and thus also KT - has risen over time. Until the end of the 1990s, the international mobility of students was at the centre of EU policy (with the ERASMUS and LEONARDO-DA-VINCI programmes that especially influenced the international acknowledgement of study courses at foreign HEIs). However, the framework programmes and other initiatives like EUREKA also played a part in some developments with KT relevance in Germany by fostering HEI-industry cooperation and cooperation between HEIs and PRIs at national and international level.

- The Bologna process resulted in a reform of the education system. This change also influenced the knowledge flows between HEIs and industry. In particular, HEI degrees became more comparable, in an international context as well. The overall assessment of the bachelor and master degrees by industry is heterogeneous. This shows that the Bologna process has had a mixed effect on qualification with regard to industry demands: In a company survey of about 850 firms from industry and services, about 20 per cent assess the bachelor graduates as “sufficiently qualified” (about one-third think this is the case for master graduates). 40 percent think bachelor students are quite qualified, while another 40 per cent think this is (rather) not the case. For master graduates, the results are better, and only 20% of the firm representatives assess the graduates as (rather) not qualified. Still, businesses

[7] *This conclusion follows from a study for the Land Bremen (RWI/FCON 2015: 125).*

point to deficits in the practical orientation of curricula, the social and communicative competences of graduates, and the length of practical periods during the course of studies (DAAD 2011: 46 to 49).

- The development of the third mission is partly due to government policy, but partly also to HEIs' own initiative, as they want to use their greater independence to initiate new activities. In this respect, the degree of commitment of individuals who make use of the increased autonomy of HEIs plays an especially important role (Henke et al. 2015: 15-16). However, the overall effect of the increased autonomy of HEIs on third mission activities and the knowledge triangle is ambiguous. While some HEIs have certainly used their increased independence to foster third mission activities, others have used their developing independence to focus more strongly on fostering scientific excellence (which of course will possibly also promote the third mission in the long run through the increased visibility and quality of research).

There is no general federal government strategy with respect to KT, but the German innovation strategy, the High-Tech Strategy, allows a KT interpretation. This strategy aims at an integrated perspective of research and innovation, which is being coordinated among several ministries. Moreover, the strategy addresses the need to maintain the supply of qualified personnel. Multiple initiatives and measures launched by the High-Tech Strategy and in other contexts influence the interaction of actors in KT and the related knowledge flows. Given the multitude of activities, there is no integrated system to evaluate the performance of HEIs and provide incentives for HEI development. At the same time, these activities are not recorded or communicated in any systematic manner (Henke et al. 2015, see also section 4).

Project-based funding at national level: targeting the "third mission" of HEIs

Competitive, project-based funding at national level addresses KT-related activities in different ways. In recent years, a number of complex policy measures have been launched at the federal level in order to support the development of the third mission of HEIs. In the last 10 to 15 years, many new policy approaches have been

implemented to complement collaborative research ("Verbundforschung") as the classical format of project-based funding. Collaborative research describes project collaborations between heterogeneous partners, either between academic and industrial partners or between academic and non-academic partners and is still the most frequently used format in thematic R&D funding programmes in Germany today.[8]

From a KT perspective, it is important to note that the new German policies to foster the third mission of HEIs are based on an understanding which cannot simply be described as "technology transfer". Rather than simply handing over academic knowledge to industry for further development at a certain point in time, the different policies aim at establishing formats for joint and mutual R&D processes between public research and industry that start in the early phases of knowledge generation and may last until market invention.[9] Moreover, these programmes aim to establish service structures supporting technology transfer and the entrepreneurial activities of HEIs as well as raising awareness and triggering behavioural changes in academia towards third mission activities. In terms of their policy objectives, the most important programmes have the following targets and characteristics:

- The EXIST programme represents a varying number of university-based start-up schemes that range from general qualification and support, funding for drafting a business plan, up to seed funding of the development phase of the business. The programme also addresses education, as the funded HEIs

[8] R&D programmes which support cooperation between HEIs and firms include for example: (1) the thematic programmes of the Federal Ministry of Education and Research, (2) the programme promoting "Industrial Collective Research", (3) the ZIM programme (Zentrales Innovationsprogramm für den Mittelstand – Central Innovation Programme for SMEs), (4) KMU Innovativ, and (5) specialized programmes to stimulate R&D cooperation between HEIs and firms in the priority tasks of the German High-Tech Strategy.

[9] One example is the industrial collective research (ICR), which provides a unique framework for research collaborations: an industry-supported network of firms and research institutes conducts research for firms in low- and medium-technology branches. The research projects are mainly financed by a publicly-funded programme (Rothgang et al. 2011).

need to cover entrepreneurship education. The programme has been running for more than 15 years (Kulicke 2014). [10]

- "Applied Research and Development at universities of applied sciences" has been running since 2003 in cooperation with the Länder. Its several sub-measures aim at strengthening research at universities of applied sciences and accelerating technology transfer. Another important objective is a closer connection between research and education in the funded projects. Investment in this programme has quadrupled since 2005, from roughly €10 million to more than €45 million.[11]
- The SIGNO programmes and its successor WIPANO support "universities, companies, and independent inventors with legal protection and commercial exploitation of their innovative ideas".[12]
- The pilot measure "Validation of the innovation potential of scientific research – VIP" and its successor "Validation of the technological and societal innovation potential of scientific research – VIP+" aim at supporting translational research and development activities in order to spot the innovative potential of scientific findings at a very early stage.[13]

Evaluation studies of these measures show remarkably positive results. These measures contribute to transferring innovative ideas into marketable products, they help to intensify science-industry links and have led to more university spin-

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[10] *See http://www.exist.de/EN/program/About-EXIST/content.html, last accessed on 20 January 2016.*

[11] *See BMBF at https://www.bmbf.de/de/forschung-an-fachhochschulen-543.html, last accessed on 17 January 2016.*

[12] *See PT Juelich (project agency), "SIGNO – Protection of Ideas for Commercial Use", available at https://www.ptj.de/signo-en, last accessed on 7 December 2015, and WIPANO at http://www.bmwi.de/DE/Themen/Technologie/Rahmenbedingungen/patente,did=746982.html, last accessed on 17 January 2016.*

[13] *See BMBF at https://www.bmbf.de/de/vip-technologische-und-gesellschaftliche-innovationspotenziale-erschliessen-563.html, last accessed 17 January 2016.*

offs. These measures have triggered mostly technological innovations. More recently, there has also been a focus on non-technological innovations. Examples are "Social innovation for more quality of life for the elderly", a measure in the programme for universities of applied sciences,[14] and the call for "societal innovations" and innovations from the Social Sciences and Humanities in the advanced validation research measure VIP, called VIP+.

The evaluations of these programmes also point to two major difficulties which might hamper sustainable impacts: First, project-based technology transfer activities require a favourable institutional culture in order to become sustainably attractive to researchers (Daimer et al. 2014). Secondly, measures which support new technology transfer support services (e.g. EXIST, SIGNO) have changed the landscape of transfer intermediaries in Germany. A large variety of such structures is now in place with varying levels of success depending on their professionalization and, again, the institutional cultures they are embedded in.

For these reasons, **programmes addressing organisations as a whole** are increasingly complementing individual funding. To give an example, EXIST has established a competition to strengthen institutional commitment to entrepreneurial activities.[15]

"Förderinitiative Forschungscampus" (Research campus) is another programme involving the commitment and strategic planning of whole universities, which de facto realizes the KT idea. This competition mobilised more than 90 HEIs in 2012 to develop project proposals for public-private partnerships with the aim of bringing together public and private competences at one location and establishing strategic long-term relationships between universities, research institutes and com-

[14] *See BMBF at https://www.bmbf.de/de/silqua-fh-soziale-innovationen-fuer-lebensqualitaet-im-alter-553.html, last accessed 17 January 2016.*

[15] *See EXIST Gründershochschule at BMWi, http://www.exist.de/DE/Programm/Exist-Gruendungskultur/EXIST-Gruenderhochschule/inhalt.html, last accessed on 17 January 2016.*

panies as well as other (regional) actors such as public authorities, NGOs or interest associations. Nine public-private partnerships have been selected, which each receive up to 2 million euros per year for up to 15 years.[16] It is too early to investigate how these nine models will develop and influence the local KT, but it is already clear that the substantial mobilising effect of this call shows that a change has taken place in the German university landscape regarding the interest of both firms and universities in closer cooperation between industry and science.

Cluster policies at national and regional level

Cluster policies have been important place-based policies in Germany for many years. In total, 370 cluster initiatives can be found at the federal and Länder level that are focused on innovation (Figure 1). While the Leading-Edge Clusters in the figure are characterized by a clear development strategy towards an advanced technological goal in order to increase the competitiveness of the cluster, participants of the go-cluster programme are characterized by rather advanced cluster management organisations.[17] While the Leading-Edge Cluster Competition promotes cluster development by financing cooperative research projects that relate to the common cluster strategies, the programme go-cluster increases the visibility of excellent cluster organizations and helps them with their work, networking, and provides seminars on cluster management topics.[18]

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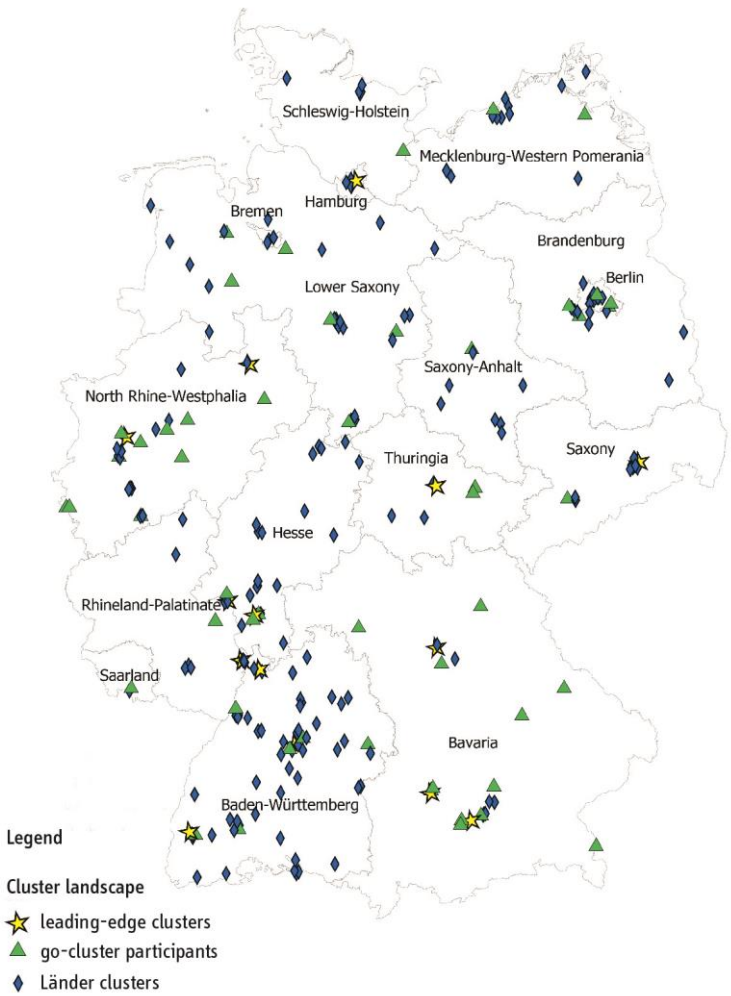
[16] *See BMBF at https://www.bmbf.de/pub/Forschungscampus_2014_bf.pdf, last accessed 17 January 2016.*

[17] *See http://www.clusterplattform.de/CLUSTER/Navigation/DE/Bund/go-cluster/go-cluster.html, last accessed 24 February 2016.*

[18] *http://www.clusterplattform.de/CLUSTER/Navigation/EN/NationalLevel/go-cluster/go-cluster.html, last accessed 29 August 2016.*

Figure 1
Federal and Länder clusters and networks in Germany



Source: Rothgang et al. 2015: 25. – Date: November 2013. Comments: The marked locations are for the contact address of the cluster organisations. If a cluster is represented in several categories (e.g. a Leading-Edge Cluster and member of go-cluster), it still appears only once on the map.

Part 1: State of affairs and developments at the country level

The core idea of innovation-related cluster policies is to promote the development of close ties between excellent research and industry in certain technologies in a region and to activate partners in the innovation process along the value chain. The implementation of cluster policies requires the development of cluster initiatives that organise the joint activities of their local members. As the experience in Germany shows, cluster policies contribute to better integration of all sides of the KT. The focus of the clusters fostered by such programmes (whether networking, joint research activities or education) varies from programme to programme and also from cluster to cluster. The shared strategies formulated by the HEIs, firms, and other actors in the cluster initiative play an important role for its impact on the KT.

The national "Leading edge cluster competition" (LECC) addressed all sides of the KT and the interactions between them. This programme fosters cluster-specific education and qualification, industry investments in research, joint research agendas of research organisations and industry, and innovative forms of cooperation. HEIs need to engage at the organisational and personal (project-based) level. Common cluster strategies were developed by the participating firms, HEIs and PRIs. These comprise jointly developed research strategies, but also address education and qualification topics. Evaluation of the LECC showed that the programme has had a substantial impulse that resulted in multiple local activities. The LECC has resulted in an increased density of the research networks, initiated cross-cluster cooperation activities and the HEIs have profited from professional technology transfer activities offered by cluster organisations (Rothgang et al. 2015).

Cluster programmes have also been used extensively by all Länder to stimulate knowledge exchange between industry and HEIs (e.g. Bavaria, Baden-Wuerttemberg, or North Rhine-Westphalia). Some of these programmes have been evaluated. Existing evaluation studies note relevant effects on the regional knowledge

economies.[19] The cooperation between administrative regions can also be fostered by cluster policies: The concerted innovation strategy of Berlin and Brandenburg that aims at developing cluster structures in both Länder has been pointed out as a good example of this approach.[20]

The impacts of the Excellence Initiative and other massive investments from a KT perspective

Massive additional public investments in the German science system were made in the "Hochschulpakt" and the Excellence Initiative to benefit HEIs and, in the case of the Pact for Research and Innovation, to benefit PRIs and partly also HEIs. These programmes were not constructed from an overall KT perspective; instead they are intended to strengthen individual angles. Nevertheless, they have triggered some dynamics, which can be expected to enhance different KT aspects.

The "Hochschulpakt", which will run until at least 2020, grants HEIs institutional funding - a budgetary increase - to cope with the higher numbers of students enrolling after educational reform as well as to maintain the capacities and quality of higher education. The HEI pact's second pillar is overhead grants of 20% on top of projects funded by the DFG (Deutsche Forschungsgemeinschaft – German Research Foundation). While the first pillar helps to compensate the HEIs' growing expenditures for the growing number of students, the second pillar grants them more financial leeway. In 2011, the German Research Ministry (BMBF) also decided to grant overheads in addition to project funding. A recent study found that DFG and BMBF overheads have indeed contributed to compensating HEIs' costs

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[19] *See the Regional innovation monitor assessments for Baden-Wuerttemberg at https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/cluster-policy-baden-wuerttemberg, Bavaria at https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/policy-document/cluster-offensive-bavaria, Brandenburg at https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/cluster-support-0 , and North-Rhine Westphalia at https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/policy-document/north-rhine-westphalian-cluster-strategy, last accessed on 17 January 2016.*

[20] *This was emphasized by interview partners in the course of this study.*

for central services related to projects funded by third parties. Moreover, the overheads have allowed those in charge of HEI to invest strategically in research with positive effects on their competitiveness, as well as innovative and strategic capabilities (Astor et al. 2014: 7).

The "Pact for Research and Innovation" between the federal government, the DFG, and the four umbrella organizations of non-university PRIs (Fraunhofer Society, Helmholtz-Association, Max Planck Society, and Leibniz-Association) aims at ensuring financial stability for PRIs with a steady increase in institutional funding of up to 5 per cent per year until 2020 for the DFG and PRIs organized in the four umbrella organizations. The additional funds for DFG are allocated to HEIs to a large extent by way of DFG project funding (based on peer review decisions). In order to monitor the Pact's funding of the PRIs, a public monitoring process was established on an annual basis. This transparency has an incentivizing effect on the organisations to comply with the indicators – among them many research-oriented output measures, but also two groups of indicators for KT-related interactions under the headings "Science and Economy" and "Networking in the science system" (see e.g. GWK 2015).

The Excellence Initiative (EI) is organised as a national competition for universities and aims to increase research excellence. The current second funding phase lasts until 2017, but the Heads of the Federal and Länder Governments have already announced that excellence funding will be continued. They aim is to ensure a level of future funding for excellent cutting-edge research at universities which is at least equal to the amount jointly provided under the excellence initiative so far. Currently, three funding formats are being used: graduate schools for doctoral students, excellence clusters and future concepts (university strategies). The EI has caused a unique dynamic development in the German science system. The evaluation of the period 2007-2015 shows that it has strengthened excellent research in Germany, in particular by funding excellence clusters (IEKE 2016). It has also led to additional measures to support excellent research and strategy building of universities in several regions, e.g. "Spitzenforschung und Innovation in den neuen Ländern" (for Eastern Germany, funded by the Federal Ministry of Research and Education (BMBF)), Excellence Initiative (Saxony), the LOEWE programme in

Hesse, "Forschungsinitiative" of Rhineland-Palatinate, and the "Forschungsoffensive" of Baden-Wuerttemberg (DFG & WR 2008, p. 59ff.).[21] There was the expectation that the EI would trigger a more differentiated landscape of HEIs in Germany (DFG & WR 2008, p. 59ff.), but the evaluation has not yet found any evidence to support this.

The evaluation commission stresses the ambivalent effect of the EI on the governance of HEIs. On the one hand, the different formats, i.e. the graduate schools for doctoral students, excellence clusters and future concepts (comprehensive university strategies) require intensive coordination across faculties and with the university management. This has led to an increased collective understanding within the universities. On the other hand, in particular the excellence clusters appear to have developed into strong separate organisational units with more autonomy, which creates challenges for a central comprehensive steering by the university management (IEKE 2016).

The EI's focus is on excellent research, but its first phases indicated some impacts on education as well as on different third mission activities of the universities. Although the evaluation criteria for the university strategies (future concepts) in the first phase of the competition (2005-2012) were focused on research (DFG & WR 2008, p. 21f.), the second phase of the competition (2009-2017) explicitly involves a KT-relevant criterion in the evaluation of future concepts: They should mention aspects of research-based education and explain how the research activities can impact the education of the institution.[22] The selected future concepts (9 in phase 1 and 11 in phase 2) are de facto clear mission statements in favour of strengthening the link between research and education as well as other particular

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[21] *There is also a programme in Lower Saxony, called "vorab" (in advance) with an excellence focus, however this started in 2005 –before the national EI. See http://www.mwk.niedersachsen.de/startseite/themen/forschung/forschungsfoerderung_durch_mwk/niedersaechsisches_vorab_und_volkswagenstiftung/volkswagenstiftung-118900.html, last accessed 23 February 2016.*

[22] *See http://www.gwk-bonn.de/themen/wissenschaftspakte/exzellenzinitiative/, last accessed 23 February 2016.*

KT interactions. Some future concepts clearly aim at fully integrating all sides of the KT. To give a few examples:

- the universities of Aachen, Göttingen and Karlsruhe have developed the co-operation with non-university research institutes into strategic, long-term relationships. The concept of the University of Karlsruhe was based on the foundation of the Karlsruhe Institute of Technology in 2006 – a merger with the partner institutions based on a KT mission (see a case study in Technopolis et al. 2012).
- The Free University of Berlin, the universities of Aachen, Heidelberg and Karlsruhe and Technical University of Munich have highlighted interactions with industry as core parts of their concepts. Interactions include jointly setting up research agendas, industry labs on campus and personnel exchanges. The Technical University of Munich has labelled itself the "entrepreneurial university" with the central mission of setting up highly professional support services for researchers which help to transfer ideas into the market.
- The universities of Tuebingen and Dresden have been successful in the second phase with application-oriented concepts, which highlight broader third mission activities and goals which include aspects of societal relevance.

It is not yet clear whether these future concepts will lead to further KT integration, as this was not the focus of the recently published evaluation report. Moreover, it remains to be seen how the instruments of the Excellence Initiative will be revised in its next phase and whether this revision will include further KT integration as an explicit goal.

1.4 Funding of research and higher education

The funding of research and higher education in Germany is on a sound footing. The massive recent investments have benefitted HEIs and have helped directly or indirectly to foster further KT developments.

Knowledge triangle policies and practices in Germany

Relative positioning of Germany

Germany's R&D intensity (GERD - total intramural R&D expenditure/GDP) was estimated at 2.88% in 2012 and 2.85% in 2013 compared to 2.4% in the OECD. This is very close to the 3% target set in the Europe2020 strategy (Barcelona target), which has been endorsed by German policy. Only the Scandinavian countries, Japan, Korea, China and Israel spend more on R&D. The United States' R&D intensity is 2.79%.[23]

In absolute terms, Germany increased its GERD from €56.0 billion in 2005 to €79.1 billion in 2012, which is equivalent to a growth rate of more than 40% in that period.[24]

Structure of German R&D investments

The main funding sources for R&D expenditure are the business enterprise sector, accounting for about two thirds, and the government sector, accounting for about one third (28%). This relationship has characterized the structure of German R&D expenditure since 2000 and has remained stable over the years. Business investments in R&D have increased parallel to the increase of government investments (GBAORD) ever since 2007, when budgets started to grow substantially in order to meet the Barcelona target.

The federal government has committed itself to a constant growth of investment (GBAORD) from 2006 onwards, and kept up the pace even during the financial crisis in 2008, when most OECD governments decided to cut spending. With the investments, a strategic decision was made together with the Länder governments

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[23] *Bundesbericht Forschung und Innovation – Federal Report on Research and Innovation 2014; updated by BMBF in March 2015, available at http://www.datenportal.bmbf.de/portal/en/chart-1.1.1.pdf, last accessed 25 February 2016 and OECD (2014) Science, Technology and Industry Outlook 2014.*

[24] *Bundesbericht Forschung und Innovation – Federal Report on Research and Innovation 2014; updated by BMBF in March 2015, available at http://www.datenportal.bmbf.de/portal/en/chart-1.1.1.pdf, last accessed 25 February 2016.*

to develop "a new architecture of the science system."[25] The biggest part of these massive investments is earmarked to benefit HEIs, organised in three large programmes (Excellence Initiative, HEI pact, Pact for research and innovation, see section 3 above).

GBAORD used to be shared almost equally between the federal government and the 16 Länder governments. Since 2007, federal-level R&D investments have grown stronger than GBAORD at the Länder level, leading to a 57% share of federal GBAORD in 2012 versus 43% spent by the Länder governments.[26] However, the increase of federal-level spending was not meant to result in a redistribution of funding between the federal government and the Länder governments. Instead, it is expected that the Länder governments will also up their spending to realize a substantial growth in the R&D budget over time.[27]

The federal and Länder governments have some separate and some shared responsibilities for financing research and innovation, in particular as regards the funding of higher education institutions (HEI). The Länder governments finance HEIs to a large extent. Up to 2014, universities could (only) receive federal-level funds (or funding shared by the federal government and the Länder) to establish research facilities as well as via competitive project-based funding for R&D. After a revision of responsibilities at the end of 2014, policymakers, stakeholders and experts expect new avenues to open up, especially for the institutional funding of HEIs in Germany through federal and shared funding. These include the oppor-

[25] *Bundesbericht Forschung und Innovation – Federal Report on Research and Innovation 2014, p. 33ff.*

[26] *Bundesbericht Forschung und Innovation – Federal Report on Research and Innovation 2014.*

[27] *Innovationsindikator (Innovation Indicator) 2015, p. 10, available at http://www.innovationsindikator.de/fileadmin/2015/PDF/Innovationsindikator_2015_Web_en.pdf, last accessed 25 February 2016.*

tunity to finance strategic cooperation between universities and extramural research institutes, which is regarded as an important means to intensify KT structures and strengthen HEIs as their central component.[28]

The expenditures of HEIs and other performing sectors

- The main R&D performing sectors are (in 2012): the business enterprise sector with a share in total R&D of 68%, the HEI sector with 18%, and the government and private non-profit sector with 14%. The share of the government sector is comparatively larger than in other countries, because of the four large public research organisations (see for more details below).
- The majority of HEIs in Germany are publicly owned. They receive the largest share of institutional funding from the governments of the Länder plus subsidies for research from the federal government, the DFG, and other public authorities. Third-party funding is largely from public sources, too: around 30% from the DFG, 25% from federal programmes and 5% from other public authorities. Other sources are the European Union programmes (around 10%), industry (around 20%), foundations and others (around 10%). Over the years, the share of third-party funding has increased from less than a third to almost half (see Figure 2).[29]
- Since 2005, German universities have become more autonomous with regard to their expenditures. Input-oriented steering models have been complemented and more and more replaced by output-indicator-based performance measurement. With respect to the degree of autonomy of universities, Germany ranks somewhere in the middle in an international comparison (Fittkau 2015).

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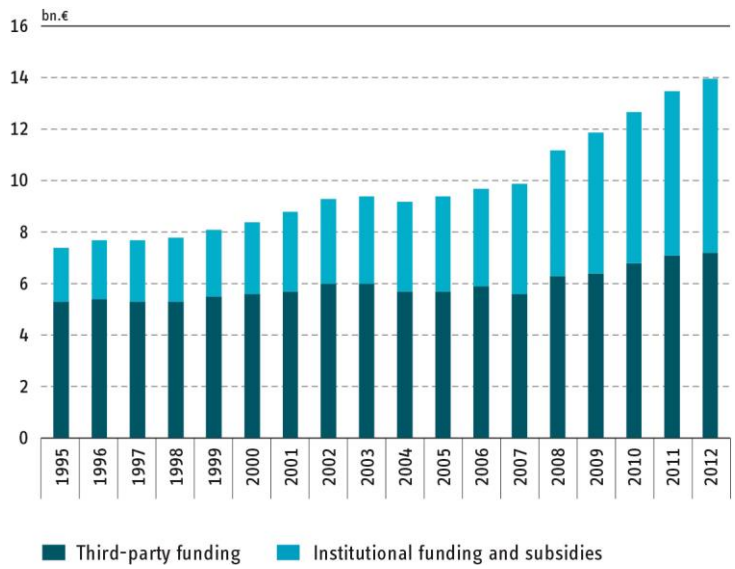
[28] *DIE ZEIT, No 51, 11.12.2014, available at http://www.zeit.de/2014/51/kooperationsverbot-bund-hochschulen-johanna-wanka, last accessed 25 February 2016.*

[29] *The OECD (2013), OECD Science, Technology and Industry Scoreboard 2013, OECD Publishing (available at http://dx.doi.org/10.1787/sti_scoreboard-2013-en, last accessed 25 February 2016) mentions a share of 80% of institutional funding for HEI. This figure probably refers to the total budget of universities including education, while the numbers above refer only to the R&D budget of HEIs.*

Figure 2
Expenditures of HEIs for research and development

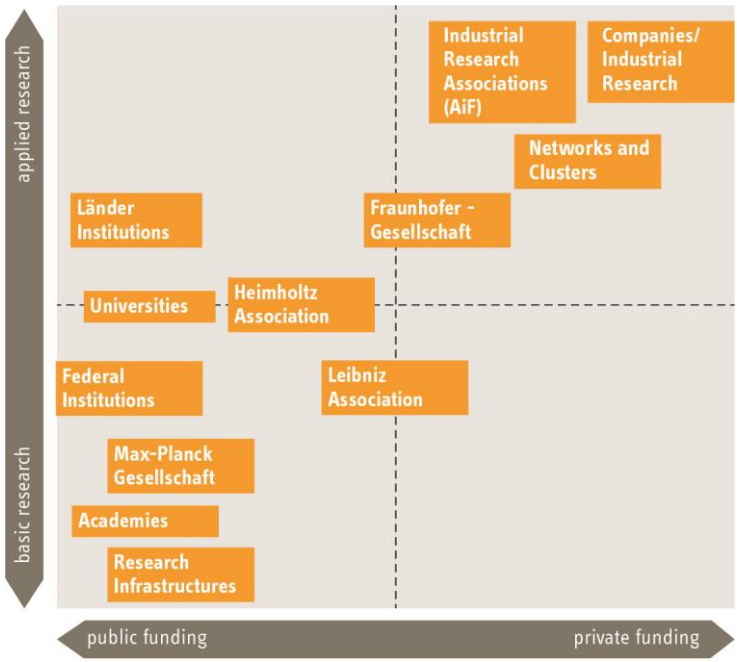


Source: German Federal Statistical Office, own compilation.

- Public research organisations (in particular Max-Planck Society, Helmholtz Association, Fraunhofer-Gesellschaft and Leibniz Association) play a more important role in the German research and innovation system compared to other countries. 17% of the scientific personnel work in PRIs. As Figure 3 shows, each organisation follows a different mission from basic research up to applied research. The figure also shows that these organisations are supported for the most part by public funds. Moreover, the shares of institutional funding to project-based funding vary between the organisations: in 2011, these were 80:20 for the Max-Planck Society, 77:23 for Leibniz, 62:38 for the Helmholtz Association, and 30:70 for Fraunhofer.[30]

[30] *Bundesbericht Forschung und Innovation – Federal Report on Research and Innovation 2014, Table 15 and Figure 8.*

Figure 3
The German research landscape



Source: Federal Ministry of Education and Research (BMBF), available at http://www.research-in-germany.org/en/research-landscape/research-organisations.html, last accessed 24 February 2016 (Profiles of the different types of research performing organisations can be found on the website.)

Types and targets of government funding of R&D

The share of institutional "block funding" of R&D decreased slightly from 66% of the R&D expenditures of the HEI sector in 2009 to 63% in 2011.[31] Thus, competitive project-based funding is less than 40%. This relationship reflects the "new architecture" of investments in 2006/2007, when institutional funding was increased (mainly for education in the HEIs), while other OECD countries have increased the

[31] *More recent figures are not available. Source: Statistisches Bundesamt.*

amount of project-based funding relative to institutional funding over the last few years.[32]

Project-based funding has increasingly been shifted towards priority areas related to societal and global challenges since 2006, when the first German High-Tech Strategy was established as the central innovation strategy. More and more of the objectives of the large thematic programmes are being rephrased. At the same time, a number of new – horizontal - measures have recently been introduced, in particular technology transfer activities (see section 1.3).[33]

1.5 The role of place-based policies in the KT

Location of HEIs in urban vs. rural regions

As it is to be expected, HEIs and students in Germany are concentrated in regions with major cities (urban districts) and other urban areas. This is the case for both universities and universities of applied sciences although the latter are also more likely in less metropolitan or more rural areas (Figure 4). 62% of all universities and 58% of all universities of applied sciences are located in regions with large cities (also 81% of the art and music colleges). While 24% of the universities are located in other urban areas, 14.5% are also located in more or less rural areas (although these are generally smaller ones). While 25% of the universities of applied sciences (not much more than universities) are in other city areas, 16.9% are in rural areas.

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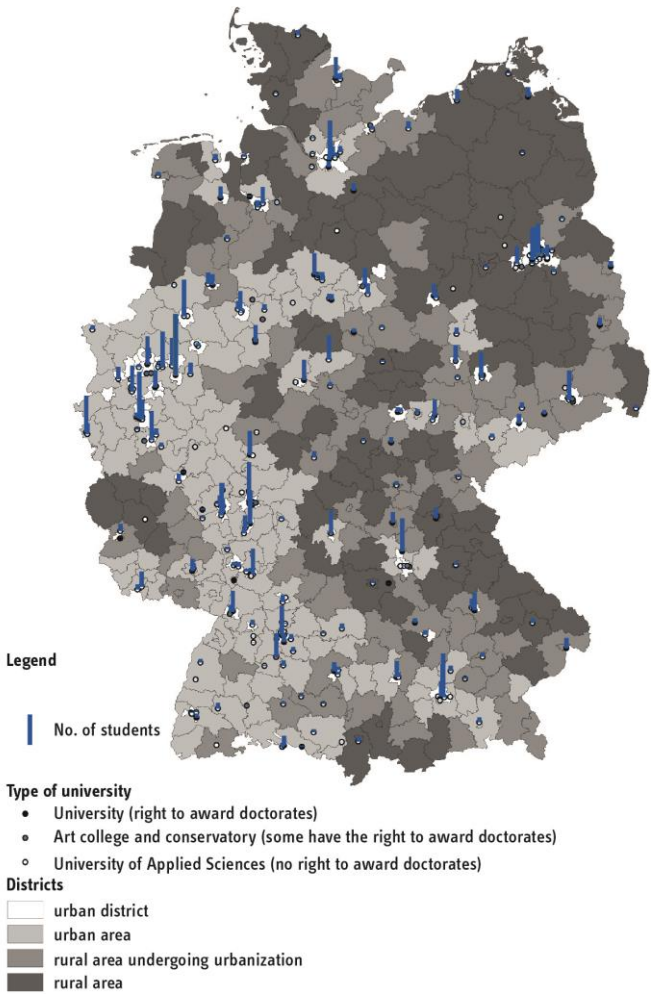
[32] *Sources: Bundesbericht Forschung und Innovation – Federal Report on Research and Innovation 2014, Table 1.17, available at http://www.datenportal.bmbf.de/portal/en/Table-1.1.7.html, last accessed 25 February 2016; OECD Scoping paper ON FINANCING OF PUBLIC RESEARCH IN THE CONTEXT OF THE KNOWLEDGE TRIANGLE PROJECT DSTI/STP/TIP(2015)5*

[33] *Cf. OECD STI Outlook 2014 on government strategies and spending for mission-oriented research. A scan of currently open calls in the German database for promotional measures, available at http://www.foerderdatenbank.de/Foerder-DB/Navigation/Foerderrecherche/, last accessed 15 January 2016) listed 82 thematic, mission-oriented measures at the federal level vs. 18 thematically open funding opportunities.*

Figure 4

Type of university, district characteristics, and number of students



Source: Authors, Data from: Hochschulkompass: List of type of university, number of students and address, available at http://www.hochschulkompass.de/service/impressum.html, last accessed 08 December 2015. Federal Institute for Research on Building, Urban Affairs and Spatial Development: Classification of districts in Germany, available at http://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Downloads/downloads_node.html, last accessed 08 December 2015. Due to slight differences in the timing of data and the delineation of HEIs, there are small differences to the figures given in Table 1 (basis: 400 HEIs with 2,660 mill. students).

There is a similar picture regarding the number of students, with universities of applied sciences playing a more important role in rural areas. 75% of all university students and 62% of the students at universities of applied sciences study in HEI in city areas, while 7.6% of the university students and 12.2% of the students at universities of applied sciences study at HEIs in rural areas. This distribution reflects the demand for highly qualified labour, which is more concentrated in municipal areas. However, some rural regions also feature a substantial demand for highly qualified labour: It is a general feature of German industry that family-owned SMEs (but also large firms) have traditionally been successful, and a substantial number of these companies have also developed in more rural areas, especially in the south and in parts of North Rhine-Westphalia. These firms often have problems hiring qualified personnel, but this is not due to a lack of HEI capacities but rather to the insufficient attractiveness of these regions to qualified workers compared to municipal regions.

Local embeddedness of HEIs

In the last decades, the foundation of new universities and universities of applied sciences in Germany has often followed a policy of regionalisation at the state level. Newly founded HEIs should contribute to regional and sectoral development. At the same time, the focus of university activities has often been national or international with regard to their orientation towards research and education, while universities of applied sciences have addressed local demands to a greater extent (but not solely) (Back, Fürst 2011: 19). Substantial regional orientation of HEI research remains the exception –contrary to many HEIs in the US (Bergmann 2010: 326). However, there is a more recent tendency of the increasing importance of local embeddedness, of universities as well, and there are also examples of universities and universities of applied sciences trying to address local needs more intensively (Koschatzky et al. 2011, 2013a).

- Although the labour markets for university graduates are generally more national and international, firms quite frequently rely on graduates from their local environment. This is more often the case for HEIs in larger agglomerations, while graduates of more rural HEIs often have to move to other regions.

At the same time, HEIs (especially universities of applied sciences) have recently shown the tendency to address the qualification needs of the local industry to a larger extent.

- Similar results can be seen for research cooperations: These are often national or international. However, if there is a good match between the industrial structure of the regions and the research and qualification fields of the university, substantial regional anchoring of universities can evolve in metropolitan areas (as is the case, e.g. for the automobile industry in Stuttgart, or for biotechnology in the Munich area). Universities of applied sciences also provide applied research geared towards industry demands, but to a considerably smaller extent due to the higher mandatory teaching assignment of the lecturers.
- The effect of HEIs on the quality of life in the KT has to be differentiated, because this aspect affects different groups of the regional population differently (Back, Fürst 2011: 25). However, in general terms, it turns out that HEIs can create and contribute to the development of a creative and innovative milieu that has the potential to attract people from outside the region and, at the same time, increases the quality of life of the local resident population. At the same time, studies show that the extent of these effects should not be overrated compared to income generation or cultural activities and that they cannot usually be separated from each other.

The interaction with local authorities takes many forms. Apart from the individual engagement of professors in the regional context (e.g. providing expertise for the local government or other public or non-profit bodies), which has increased over the last 5 to 10 years, universities are increasingly visibly involved at the level of organisations (Koschatzky et al. 2013a). A few examples can illustrate this:

- The University and the University of Applied Sciences of Dortmund won the 2015 prize for HEI communication because they demonstrated how they assumed responsibilities for the city, and showed a number of long-term activities addressed at specific target groups. [34]
- Another example is a welcome centre set up for foreign experts, scientists and PhD students that come to the Technical University of Dresden or other companies in the Dresden area.[35]
- The University of Lüneburg has set up an incubator concept, which was entitled to more than €80 million funding from the European structural funds and regional funding from Lower Saxony, in order to develop meaningful impulses for the local economy in close cooperation with the local authorities (Hufnagl 2014: 137 f.).[36]
- A competition financed by two charitable trusts fosters innovative local initiatives that support the role of HEIs in local societies.[37]

Policy Strategies, Governance and Funding at Institutional Level

Recently, the local embeddedness of HEIs has been fostered by policies on the Länder and national level. For example, programme cluster policies have been initiated by all Länder governments to increase the cooperation between HEIs, PRIs and industry. Universities of applied sciences have been actively developed by Länder policies in order to address the demands of smaller urban areas.

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[34] *See http://www.hrk.de/presse/pressemitteilungen/pressemitteilung/meldung/preis-fuer-hochschulkommunikation-2015-unsere-hochschule-unsere-stadt-universitaet-und/, last accessed 4 December2015.*

[35] *See https://tu-dresden.de/internationales/welcomecenter/startseite/welcome_center, last accessed 4 December 2015.*

[36] *See http://www.leuphana.de/en/partners/innovation-incubator-lueneburg.html, last accessed 25 January 2016.*

[37] *The six funded HEIs and more information can be found at http://www.stifterverband.info/wissenschaft_und_hochschule/hochschulen_im_wettbewerb/mehr_als_forschung_und_lehre/, last accessed 18 January 2016.*

Federal policies have also had a – partly more indirect - effect on local embeddedness. Programmes to increase local cooperation with different targets have contributed to embeddedness at the regional level. This is the case for programmes that (a) foster scientific excellence (Excellence Initiative, see section 3), (b) aim to improve national competitiveness by strengthening local cooperation (Spitzencluster, Forschungscampus, see section 3), and (c) give impulses for development in former East Germany (Unternehmen Region – "Entrepreneurial Regions"[38]). In addition, HEIs have also used their greater independence to increase their local embeddedness (although this has not happened everywhere).

Cluster policies have been very prominent since the 1990s as an instrument to increase the local embeddedness of HEIs. They employ a common strategy to target the cooperation of local actors (firms, HEIs, and PRIs). As innovation, research and education are often the targets of cluster initiatives, many of them also foster the local embeddedness of HEIs (although more indirectly and not as a universal target). Their contribution to embeddedness depends on the efficiency of the initiative, the extent of local focus (which differs from programme to programme), and the importance of local cooperations of HEIs. There are substantial differences in all of these criteria in Germany. A major impulse towards local embeddedness has resulted from clusters in the Leading-Edge Cluster Competition that has been rather successful in fostering additional R&D cooperation between firms and HEIs (see also section 3).

While the local embeddedness of HEIs has certainly increased, the success of these policies has been limited for several reasons (Back, Fürst 2011: 19-30): HEI strategies targeting local embeddedness are usually not considered as important as scientific excellence, which requires primarily national and international networking and orientation. In addition, the economic absorptive capacity of HEI regions may be limited if only a few knowledge-intensive firms (whether large firms or SMEs) are located in the HEI region, or if there is no long-standing culture of cooperating with local firms. In addition, the incentive structures for university

[38] *See http://www.unternehmen-region.de/en/6499.php, last accessed 03 February 2016.*

employees to cooperate with local actors are often lacking, as these aspects are not valued highly enough. Transfer offices have not been particularly successful in promoting local knowledge exchange or spin-offs (which often has to do with unfavourable framework conditions). Last but not least, the trend of turning HEIs into "entrepreneurial universities" that act as entrepreneurs in their local economy (e.g. by commercializing research results, promoting start-ups) has been rather slow to develop in Germany.

1.6 Evaluation of higher education and research

Funding instruments and policies for research, higher education and innovation in Germany are very diverse: a substantial share of public funding is the responsibility of the Länder, institutional funding takes very different forms (cf. section 4 above about funding), and programmes for competitive project-based funding are increasingly complex. Evaluation practices are therefore also highly diverse, which is why evaluations of KT-related activities vary to a great extent. More attention has been paid to measuring KT-relevant impacts over the past years and there is increasing evidence of their materialization (see section 3 for types of impacts).

Challenges for the evaluation and impact assessment of KT-related activities

Complex policy measures often require the development of specific indicators and the potential for standardisation is small. Furthermore, the approaches to impact measurement are currently open and diverse, not only because of the variety of impacts, but also because impact assessments take place at different points in time over the lifetime of the measures. With complex programmes, there is an increasing need for theories of intervention which establish causal processes between public intervention and the observed effects. Such impact models regularly show that effects can rarely be attributed to one policy intervention. Instead, they are the product of a combination of policies and other factors, and impact measurement has to disentangle the *contribution* of specific triggers rather than being able to establish direct causal relationships between inputs and effects.

At the same time, we observe a wide acceptance of evaluation as a legitimation instrument, aiming at maximizing the impact of public spending. There is, for example, more pressure by the Federal Court of Auditors to monitor the profitability of public spending in the course of evaluation studies (Kind et al. 2014). One effect of this is that the terms of references are becoming more standardized with clear prescriptions regarding the use of indicators and methods. Furthermore, individual ministries are making major efforts to design and implement guidelines and standards (e.g. BMWi 2013). As a consequence, evaluation runs the risk of becoming an increasingly routine matter based on the same approaches and methods.

While evaluation is a systematic activity at national level, the measures of the Länder governments are only subject to systematic evaluation if they are funded by the European structural funds; this is the case for most programmes in the former East Germany. Not much is known about the impacts of many other programmes financed by the Länder.

Some KT-relevance in performance monitoring of HEIs and research institutions

Institutional funding provides the larger share of German public R&D investments (see section 4 on funding). **Non-university public research institutions (PRIs)** have established evaluation routines for their institutes and use different performance measures for the internal budget allocation to these institutes. The federal ministries and the Länder allocate institutional funding which has been accompanied by a public monitoring process of performance indicators since the "Pact for Research and Innovation" was launched in 2005. Some indicators with KT relevance play a role in this monitoring, ("Science and Economy" and "Networking in the science system", see e.g. GWK 2015).

Relatively small shares of the institutional funding of **higher education institutions (HEIs)** are based on performance-based criteria (Nickel & Ziegele 2008, p. 6). When the financing of HEIs started to change in the mid 1990s, strongly input-oriented budgeting was replaced by a more flexible output-oriented allocation of funds to universities. This gave universities more autonomy with regard to their internal allocation of funds. The 16 Länder have different laws and administrative

procedures for HEI financing. In most cases, the HEIs and Länder governments agree on a performance-based allocation of funds. Output indicators may vary to some extent of course, but are mainly well-established indicators for measuring the performance of education and research. Typical education indicators include the number of students, the size and/or diversity of the degree programmes offered, the number of degrees obtained as well as advanced professional training programmes. Research performance is typically measured based on the number of publications, citations, and third-party funding (Schultz 2015). Moreover, each HEI negotiates individual target agreements with the responsible ministry, which can include KT-relevant criteria. Analyses of the performance-based allocation of funds indicate that the overall financial distribution effect has been small, especially as the overall budgets were scarce at least until the mid 2000s. However, the transparency provided by performance measures and the communication of a university's internal and external performance indicators have changed incentive systems and caused the faculties to adapt their behaviour (Jaeger 2008, Schultz 2015). This has led to analysts also pointing out the risks that indicator-oriented behaviour might lead to counter-productive effects for the overall objectives, e.g. an enormous increase in third-party funding can lead to overall lower research performance measured by publications (Schmoch & Schubert 2009).

Whether KT-related performance measures play a role in HEI funding has to be analysed on a case-by-case basis. This will be done in part 2 of this study for the two case study examples.

Part 2: Case studies of two selected higher education institutions

2.1 Introduction and methodological approach

While the first part of the case study on knowledge triangle (KT) policies and practices in Germany addressed the country level, the second part presents results from case studies of two German higher education institutions (HEI). It addresses specific characteristics of the situation in Germany, where the interaction between the different policy levels is crucial to understand KT policies and where (non-university) public research institutions (PRIs) play an important role in the KT. Third mission policies and science-industry linkages are thriving, but adoption by HEIs and PRIs varies widely, depending on the institutions' structure, culture and location (regional context). For the case studies, two HEIs were chosen that display the variety in Germany with respect to framework conditions and policies, as well as the positioning of HEIs in the knowledge triangle.

In our case study, we look at the KT from different perspectives: (i) the institutional profile and strategy, (ii) institutional policies to support KT and third mission activities (including non-economic factors), (iii) the location of the HEIs and role of regional characteristics, as well as (iv) the role of different factors that explain the development of KT activities (government and leadership, motivations of the actors as well as policy influences). With respect to the KT activities, we focus both on the organizational level and the role of individuals that act in the given environment. The HEIs are viewed as actors in a regional innovation system with PRIs as other important actor group. In order to explain the development of the KT, the interplay between the HEIs as organizations and policy (both at the Länder and the federal level) and the influence of individuals in that context are taken into account.

Part 2: Case studies of two selected higher education institutions

We selected the two cases from a set of ten HEIs, for which previous studies already provide detailed information about their regional engagement (see also Annex).[39] As table 2 below shows, these cases differ according to the following characteristics:

- Economic conditions of regions
- Location in federal states (Länder)
- Involvement in national excellence programmes (Excellence Initiative, Leading-Edge cluster competition[40])
- Relationships with PRIs (e.g. research campus models that foster close cooperation between HEIs, PRIs, and firms under one roof, and which have developed in several regions in recent years with the help of federal and Länder financing).

From the list of 10 HEIs, we selected the following two for a small empirical study based on interviews with the aim to deepen our understanding of the cases in the light of the research questions of this case study. We selected these cases because of their already existing and diverse forms of regional connectedness, their location in regions with different economic conditions and in different federal states. The two HEIs that are proposed for the empirical study are:

1. Hochschule Bremen, an applied university with a distinct regional profile.
2. Universität Heidelberg, a large, comprehensive University.

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[39] Nine cases, including the University of Heidelberg, were covered in the study by Koschatzky et al. (2013). The sample selection was based on the following criteria: Participation of the HEIs in two quantitative surveys about regional engagement (cf. Kroll et al. 2015), balanced geographic representation and a mixture of different types of HEIs. To assess the situation in Bremen, information was used from a recent study on the regional innovation system (RWI/FCon 2015).

[40] The German nomenclature for the programme is "Spitzencluster-Wettbewerb".

Table 2

Sample of HEIs in Germany from which the two cases were selected

HEI Federal State	Regional Activities/ Role	Regional Character	Relationships with PRIs
RWTH Aachen* NRW	Large univ., intensive links to PRIs/ industry, effects: large firms settling in the region, many start-ups (technical)	Unique potential for industrial co-operation	Research campus models; Jülich Aachen Research Alliance (JARA)
HTW Berlin Berlin	Small uas****: Regional networking benefits education and research (with SMEs)	Metropolitan, service economy, creative industries	-
Universität Bonn NRW**	Large univ.: regional labour market/ research coop. (in life sciences)	many NGOs/ IGOs; metropolitan, industrialized	Cooperation Aachen, Bonn, Cologne with Max-Planck, Fraunhofer etc.
Hochschule Bremen Bremen	uas: Focus on educating the local labour force	Industrialized, structural change	Local collaboration with PRIs addressing needs of local companies
TU Dresden* Saxony	Large tech. univ,, role for regional development; focus on regional cooperation	Industrialized, large companies lacking; transformation	Close collaboration with many local PRIs (e.g. as Leading-Edge cluster)
Universität Göttingen(*) Lower Saxony	Large univ., research orientation, developing its regional role	Few research-intensive companies	Many PRIs (basic research, (life sciences)
Universität Heidelberg* BW***	Large univ., strong excellence orientation; cooperation with regional industry	Highly industrial, metropolitan region	Research campus; PRIs oriented towards basic research (life sciences)
FH Köln NRW	Largest uas: focus on educating local labour force and research cooperations	Metropolitan, industrialized	ABC-Cooperation (links to many PRIs)
Leuphana Uni. Lüneburg Lower Saxony	Small univ., focus on regional cooperation (Incubator project); educating the local labour force	Structurally lagging	-
FH Trier Rhineland-Palatinate	Small uas, focus on local labour force; develop regional cooperations	Structurally lagging	-

*Excellent University - **NRW: North Rhine Westphalia. - *** BW: Baden-Wuerttemberg. - ****uas: university of applied sciences.

Part 2: Case studies of two selected higher education institutions

For each case, we analysed information gathered from documents and webpages of the HEIs, secondary sources and interviews with representatives from the selected HEIs, one related PRI and the responsible Länder ministries.[41] While four interviews were conducted directly for the case studies, the analysis is based on a substantially higher number of interviews that had been conducted before (29 interviews in 2014 with representatives from HEIs, research institutes, intermediaries and the administration, in the case of Bremen, 7 in the case of Heidelberg between 2012 and 2014). The material from previous studies on the two cases gave a lot of insight also for this study on the KT. So, the additional interviews conducted in the course of this study served to deepen specific aspects of KT relevance.

In a second step, we combined the results from these two cases with findings from another eight previous case studies and with quantitative evidence available for Germany in order to account for the fact that the German HEI landscape is highly diverse.

2.2 University of Heidelberg

2.2.1 Institutional profile and strategy

Founded in 1386, the university of Heidelberg is the oldest German university and among the most renowned in Europe, if not the world. In the top international rankings (Best Global Universities, Shanghai and Times Higher Education), Heidelberg ranks first or second of German universities and in two cases among the TOP 50 universities worldwide. The university is a founding Member of the League of European Research Universities (LERU) and the Coimbra Group.

The University of Heidelberg is a large, comprehensive university covering medicine, natural sciences, mathematics and computer sciences, social sciences, and humanities. It has more than 30,000 students and employs approximately

[41] *In the case of Heidelberg, the university and ministry representatives opted out because of work commitments. This was compensated by using existing material from previous case studies.*

14,000 staff (8,000 excluding medicine), of which 500 (300) are professors, and 5,600 (2,600) academic staff.

There is a strong focus on excellent research. Heidelberg was successful in both phases of the German Excellence Initiative (EI) with its institutional strategy (future concept), called "Heidelberg: Realising the Potential of a Comprehensive University". Moreover, it operates two excellence clusters and three graduate schools funded by the EI. As a part of its excellence strategy, Heidelberg has defined four main research fields. These are:

- FoF 1: Molecular and Cellular Basis of Life
- FoF 2: Structure and Pattern Formation in the Material World
- FoF 3: Cultural Dynamics in Globalised Worlds
- FoF 4: Self-regulation and Regulation: Individuals and Organisations

The University of Heidelberg is a top recipient of public funding, in particular basic research funding from the DFG (German Research Foundation). The largest shares of public funding go to medicine, then to the natural sciences and the humanities.

Heidelberg is – like the vast majority of German universities – a public institution and receives more than 60% of its budget from the state government of Baden-Wuerttemberg. More than one third of the budget is funded by competitively won R&D contracts. There is no exact figure available for the share of third-party funds in total R&D expenditures, but the absolute amount of third-party funding is fairly high at €250 million. Looking at the sources of third-party funds, Heidelberg has a comparatively high share of basic research funding from DFG (40% compared to 30% on average in German HEIs) and from foundations (22% compared to 10% on average). Comparatively lower shares are from federal funding (15% compared to 25% on average), industry (15% versus 20% on average) and the European Union (7% compared to 10%).

2.2.2 Institutional policy to support KT and the third mission

The University of Heidelberg is at the centre of a well-developed KT. However, the term KT as such is not explicitly used, but many aspects of the KT concept are present in the mission statement, strategy documents, the governance of the university and various activities. The main angle is (excellent) research and there are strong links between research and education as well between research and innovation. For example, the strategic future concept ties research to education when it says that "The central objectives [...] are to consolidate and expand the fields of focus, which allows to thematically integrate and support a major part of the university's research and teaching, thereby initiating qualitative progress university-wide."[42]

The mission statement accounts for the usefulness of research in a very broad sense when it describes two functions (among others) of the university like this: "to create and safeguard the conditions for comprehensive, interdisciplinary collaboration that will make possible essential contributions toward the solution of major issues facing humanity, society, and government in an increasingly changing world"; and "to make research results available to society and encourage their utilisation in all sectors of public life."[43]

Heidelberg University has established a specific structure to implement its institutional strategy. Besides the statutory organs of the university – the rectorate, senate and university council – there are additional bodies involved in developing, implementing and supervising the institutional strategy. With its Research Councils (for the fields of focus), the Commission for Research and Strategy, the Steering Committee, and the Academic Advisory Council, Heidelberg University has established a governance structure (see Figure 5), which aims to integrate and coordinate formerly unconnected activities and units – with some relevance for the KT, such as:

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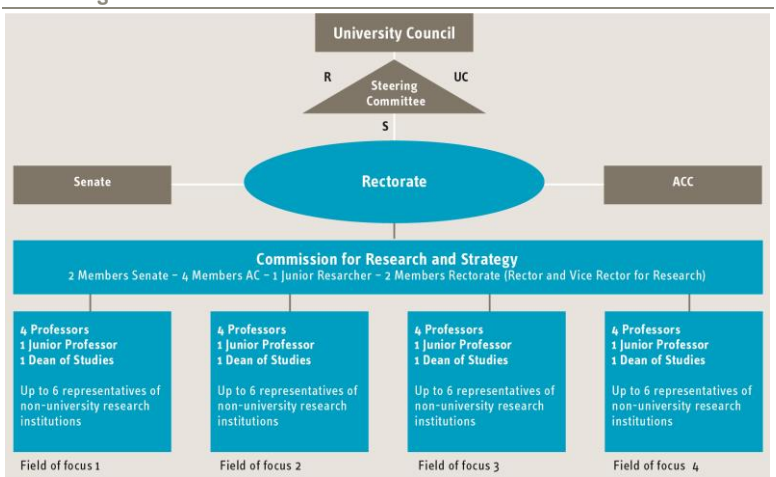
[42] *Source: http://www.uni-heidelberg.de/excellenceinitiative/, 15.3.2016.*

[43] *Source: http://www.uni-heidelberg.de/university/profile/mission.html, 8.7.2016.*

- Coordination and integration of different disciplines[44] in Research Councils – and between different Research Councils;
- Junior Researchers present in Research Councils and Boards[45];
- Industry representatives in Research Councils and the Academic Advisory Council;
- Representatives of (regional) non-university research institutions acting in Research Councils.

Figure 5
Governance structure to implement the institutional strategy of the University of Heidelberg



Source: http://www.uni-heidelberg.de/excellenceinitiative/institutionalstrategy/governance.html *15.07.2015*

[44] *Interdisciplinary research often stems from a more problem-oriented approach to research. In this sense, this development can be regarded as having relevance for the KT.*

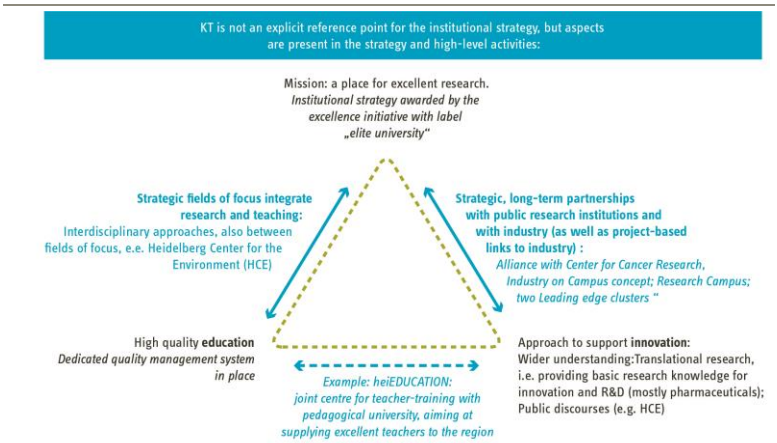
[45] *The KT relevance might be seen in the fact that junior researchers might add different views on problems and maybe a different view on the link to education.*

Moreover, a project office of the Excellence Initiative has been created. It acts as the interface between the institutions supported by the EI and the rectorate. It coordinates all the activities and projects related to the institutional strategy.

How the university balances its various missions

As a world class research university, Heidelberg has a strong focus on (international) excellence. All activities with relevance for the education or innovation angles are developed from the research angle (Figure 6; see sections 2.3 and 2.4 for examples of activities).

Figure 6
University of Heidelberg: Knowledge Triangle understanding and selected activities



Source: Own compilation (Fraunhofer ISI)

Third mission activities do not focus primarily on a direct contribution to industry-led innovation. Heidelberg's approach is better described as establishing strategic partnerships with research institutions and with industry, for example, in industry-on-campus models. The mission is not to do application- and market-oriented research, but to do translational research, which aims at making basic research results available for further R&D by partners or for cancer therapy in the university

hospital. The strategy is to be locally anchored and globally visible. The university aims at (research) activities of an international standard which produce material and immaterial advantages for the region at the same time (Schnabl 2013: 127 f., 134, cf. Power and Malmberg 2008).

2.2.3 Location of the HEI and role of regional activities

Heidelberg (with 150,000 inhabitants), is located in the Rhine-Neckar region, a highly industrial and metropolitan region in the southern German federal state of Baden-Wuerttemberg. The university and other HEIs in the region together with a large number of non-academic PRIs provide an ideal backdrop for knowledge-intensive industries such as biomedical applications and other biotechnologies, chemical industry, ICT, plant and manufacturing, systems engineering, automotive industries and energy technologies. The region is blessed with large firms acting as patrons for the region.

The University, in particular the university hospital is an important employer in the region. The university's expenditure in the region for personnel as well as for investment and tangible expenses amounts to 60% of its total expenditure (Schnabl 2013: 127, cf. Glückler and König 2011). The university partners many other regional employers in a Dual Career Service in order to further increase the attractiveness of the region as a place to live and work, in particular for international researchers.

The reputation of the University contributes to the branding of the region, and the historical buildings add to the cultural and touristic attractiveness of Heidelberg. There are various other ways the University contributes to the cultural and social life of the region such as public lectures and discourse formats, seminars for children and many forms of dedicated volunteerism.[46]

[46] *For voluntary engagement, see* http://www.uni-heidelberg.de/university/friends/dedicated_volunteerism.html *15.07.2015*

The regional dimension of the KT

Strategic partnerships with PRIs in the region are central activities to work towards the mission of excellent research at the international level. Probably the most important example of this aspect is the alliance between the university and the German cancer research center DKFZ (Deutsches Krebsforschungszentrum). This cooperation makes it possible to focus on basic research and translational research at the same time.

Like other PRIs, the DKFZ is located on campus in Heidelberg. Hence, these actors have always existed in a physically "connate" relationship. Institutionally, the most important links are the bridge professorships, where DKFZ's principal investigators hold chairs at the University of Heidelberg (and to a smaller extent also at other universities). The recruitment of professors follows strict academic criteria. The two institutions work closely together in education (master programmes and doctoral programmes) and in the qualification of early career researchers (post-doc stage). Joint research is developed both bottom-up and top-down. There is, for example, the strategic approach to joint basic research in the alliance between DKFZ and the Center for Molecular Biology (ZMBH) at Heidelberg University. The DKFZ, the University, and a few other partners have set up the German National Center for Tumor Diseases (NCT). It translates basic research results into cancer therapy as quickly as possible. The DKFZ and the University of Heidelberg are also involved in the German consortium for translational research (DKTK), where more than 20 institutions and teaching hospitals come together in translational research centres at eight locations across Germany.[47]

There is a long tradition of cooperation with innovative industry in the region, in particular with larger firms like BASF or Freudenberg. Due to the focus of the University on excellence, the primary choice for cooperation is not proximity, but shared research interests. Many partnerships have evolved into long-term, institutionalized forms of cooperation (innovation eco-systems):

[47] *See http://www.dktk-dkfz.de/en/home. 15.07.2015*

- **Industry-on-campus projects**: Heidelberg University can be seen as a pioneer among German universities with this approach (Schnabl 2013: 128), where a university cooperates with industry and other partners in strategic basic research. At the moment, there are four IoC-projects: Catalysis Research Laboratory (CaRLa, a PPP since 2006), Heidelberg Collaboratory for Image Processing (HCI, since 2008), Innovation Lab (iL, now a substantial part of the Leading-Edge cluster "Forum Organic Electronics") and Nikon Imaging Center (NIC).[48]

- **Leading-Edge clusters**: The university belongs to two excellent local cooperation networks designated by the Federal Ministry of Education and Research (BMBF) as Leading-Edge clusters in the framework of its High-Tech Strategy: "Biotech Cluster Rhine-Neckar (BioRN)" and "Forum Organic Electronics". In these networks, the University cooperates with PRIs and firms in R&D and other activities to pursue common technology and market-oriented strategies.

- **Research campus**: The M²OLIE collaboration (Mannheim Molecular Intervention Environment) is a research campus funded by the Federal Ministry of Education and Research as a public-private partnership to foster innovation. It aims at the development of a molecular intervention environment for cancer treatment. The medical faculty of Heidelberg, which has been working in a close partnership with the medical faculty of Mannheim since 2006, is a partner in this activity.

2.2.4 Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation

There are several activities – within the framework of the institutional strategy and beyond – with relevance for KT development. Most of these integrate two of the three dimensions, but often also have links to or implications for the third one.

[48] *Source: http://www.uni-heidelberg.de/research/transfer/industry/index.html, 12.7.2016.*

For example, the institutional strategy fosters collaboration and the integration of activities between different fields of focus: The **Heidelberg Center for the Environment (HCE)** is one example of such an activity which is "located" in the research angle, but which has important implications for (interdisciplinary) education as well as the third mission – in the sense of relevance for and engagement with society: "The HCE aims to develop scientific solutions to the existential challenges and ecological consequences of natural, technological and societal changes on humans. To reach its goal, the HCE embraces a broad spectrum of disciplines that includes geography, the geosciences, biodiversity research, environmental physics, the social, economic and legal sciences as well as pre- and protohistory and medieval studies. Furthermore, the centre integrates central aspects of environmental research into teaching and public discourse."[49]

Relationship Research – Innovation

This link is dominated by the approach of **translational research**: basic research contributes to innovation research, while there is less importance attached to "classical" transfer such as patents. It is to a smaller extent built on short-term projects, but mainly based on long-term strategic partnerships and networks such as the **industry-on-campus** activities, the **research campus** model and **Leading-Edge clusters** (see section 2.3).

Moreover, in cooperation with other HEIs and PRIs of the region, the University promotes **spin-offs** from all the scientific disciplines.[50]

The social sciences and humanities, which are traditionally strong in Heidelberg, also develop third mission activities. The **Centre for Social Investment (CSI),** for example, "is a central academic institute of the University of Heidelberg cooperating with the economics, social science, law and theological faculties. Its mission

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[49] *Source: http://www.uni-heidelberg.de/excellenceinitiative/institutionalstrategy/hce.html, 11.7.2016.*

[50] *See http://www.uni-heidelberg.de/research/transfer/start-up/startup_ex.html for a list of spin-offs and further information. 15.07.2015*

is to improve the theoretical and practical understanding of social investment through research, teaching, networking and consulting."[51] The centre receives about 80% of its funding from third parties (Schnabl 2013: 131). Five industrial foundations act as the main donors, but the institute also does contract research for non-profit organisations, foundations and companies (e.g. regarding corporate social responsibility).

Relationship Education - Research

In the second funding phase, the Excellence Initiative required universities to establish close links between research and teaching. Heidelberg has many measures and activities in place to support this. One example for how this is implemented is called "optimising the general conditions". This means establishing **research-oriented teaching** throughout all the phases of academic education. Measures and activities also address the management of diversity or the support of independent junior group leaders.[52]

Relationship Education - Innovation

This relationship is dominated by the "transfer via heads" – the education of a qualified workforce for the region. One very visible example is **heiEducation:** This joint centre for teacher-training with the pedagogical university aims at supplying excellent teachers to the region.[53]

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[51] *Source: https://www.csi.uni-heidelberg.de/ueber_e.htm, 12.7.2016.*

[52] *Source: http://www.uni-heidelberg.de/excellenceinitiative/institutionalstrategy/general_conditions.html, 12.7.2016.*

[53] *See https://hse-heidelberg.de/heidelberg-school-of-education/projektfoerderungen/projekt-heieducation/ (in German). 15.07.2016*

2.2.5 Governance and leadership, motivations, incentives for engagement, and the role of policy

Policy plays a role in several respects of the KT activities at Heidelberg University. A few examples are: The first industry-on-campus project CaRLa emerged out of a Sonderforschungsbereich (Collaborative Research Centre) funded by the DFG. The idea to apply for the Leading-Edge Cluster Competition with two clusters from the region originated in the political bodies of the metropolitan region Rhine-Neckar. The University rector, who is represented in the organisational bodies of the Rhine-Neckar region, committed the University to the strategies of the cluster organizations. Thus, the University is actively participating in the activities as well as the strategical development of these two cluster organizations, one in biotechnology (BioRN) and one in the rather new field of organic electronics (Forum Organic Electronics). While Heidelberg has a long tradition as a research university, participation in high-profile policy measures such as the Leading-Edge cluster competition or the Excellence Initiative have strengthened the strategic approach to university activities over the past few years (Schnabl 2013: 134).

Where individual activities are initiated by faculty (bottom-up), this is guided by academic motivations, mostly by specific interest in certain research themes. The University-internal governance system provides rewards for excellent research results, educational activities and improving the University's international reputation, but there are no specific incentives for regional engagement (Schnabl 2013: 135f.). The same criteria (excellent research and teaching and an international reputation) apply for the recruitment of professors.

Germany has always been a country with a relatively high share of institutional block funding of HEIs. Based on advice by the German Council of Science and Humanities (Wissenschaftsrat 2013b), this trend seems set to continue. In 2015, as the first federal state,[54] Baden-Wuerttemberg (where University of Heidelberg is

[54] *In Germany, the federal states are responsible for the institutional financing of HEIs as well as for HEI governance, e.g. by performance agreements. The federal government plays a role in*

located) decided to re-allocate funding with the aim to (further) increase the financial autonomy of HEIs: Besides an overall increase of the budget, the share of institutional block funding that allows strategic usage and long-term planning was increased in relation to (non-competitively granted) programme budgets, e.g. for the quality of teaching. The contract between the federal state and the HEIs[55] states that HEIs in return will

- work towards a joint indicator system to provide better information about successes and the potentials for improvement in the most relevant performance dimensions: Education, research, early-career researchers, gender equality, knowledge and technology transfer;
- commit themselves to improving the working conditions for academic and non-academic staff, increase the share of women researchers in high-level positions and improve their energy efficiency (in particular by reducing energy consumption);
- increase their efforts to build more strategic partnerships with industry.

2.3 University of Applied Sciences Bremen

2.3.1 Institutional profile and strategy

The Bremen University of Applied Sciences (Hochschule Bremen, HSB) was founded in 1982 during a period when the capacities of the Universities of Applied Sciences were increased in Germany following an initial phase beginning at the end of the 1960s when the government regulations were formulated for establishing this kind of university. The demands from the labour markets with firms searching intensively for a higher educated workforce also played an important role in setting up universities of applied sciences.

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the funding for HEIs, too, but this is mainly by way of programmes for research funding and investments in construction.

[55] *Hochschulfinanzierungsvertrag "Perspektive 2020" (in German) http://mwk.baden-wuerttemberg.de/fileadmin/redaktion/m-mwk/intern/dateien/Anlagen_PM/2015/003_PM_MP_Hochschulfinanzierungsvertrag.pdf, 13.6.2016.*

Part 2: Case studies of two selected higher education institutions

HSB developed from a fusion of four existing higher education institutions for economics and engineering, social education, socioeconomics, and Nautical science. In Bremen, as in other places, one core task of these newly founded practice-oriented universities was to open up the university system to new groups that had not attended HEIs before. With about 9,000 students, HSB is one of the larger universities of applied sciences, and belongs to the largest 15% of these universities (own calculations). More than one third of the students are from Bremen, about ten per cent from abroad. In 2013, there were 54 students for each of the 145 professors (Willms 2013: 20). Of the 1,600 graduates that leave the HSB each year, a large proportion stays in the region (especially the graduates that lived there before; Willms 2013: 68).

From the start, a clear focus of the HSB was on the international orientation of its activities. About half of the degree courses include an international semester, some also feature a double degree. More than 300 international cooperation agreements exist with other universities in about 70 countries. In the context of the internationalization strategy, an "International Graduate Center" (IGC) was founded in 2004.

The HSB has had five thematic priorities since 2007 (there had been nine before then) that relate to five faculties:

1. Business and economics
2. Architecture, construction, and environmental studies,
3. Social sciences,
4. Electrical engineering and informatics,
5. Natural sciences and engineering.

The profile of the approximately 70 degree courses is oriented towards the application-oriented requirements of the local economy in the state of Bremen.

In addition, the HSB established six research clusters in 2012, which addressed regional demands, but also topics of the German High-Tech Strategy and the EU Framework Programme Horizon 2020. At the same time, HSB focused its research

activities around these topics in order to create a clearer profile, increase technology transfer and be more successful in attracting third-party funds (Willms 2013: 75f.).[56]

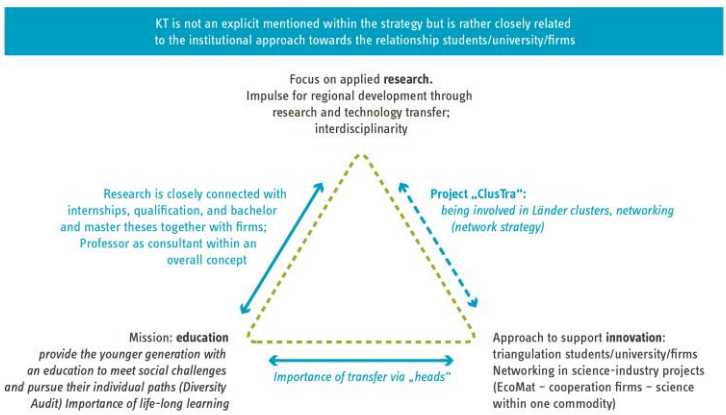
2.3.2 Institutional policy to support KT and the third mission

Like the University of Heidelberg, HSB does not explicitly mention the KT in its strategy. At the same time, many aspects of the KT concept have been integrated into the goals and activities of the organization.

Figure 7 shows the position of the HSB in the KT. As the mission of the university shows, a clear focus lies on the angle of education: providing the younger generation with an education to meet social challenges and pursue their individual paths. While research is application-oriented, obtaining impulses from firms, the overall approach towards the KT can be described as "triangulation". That means that the different relevant actors/persons are brought together (firms-students-scientists) in common activities. So, research is often done within internships and bachelor and masters theses with the professor as a consultant, who supports the joint activities. The relationship between research and innovation is fostered by networking activities between HSB and business firms and HSB's participation in relevant firm clusters and networks (ClusTra is a programme with this goal, see below). In addition, HSB is engaged in regional activities aiming at industry-science-cooperation like the Center for Eco-Efficient Materials and Technologies Eco-Mat, a technology centre, which aims at developing new material technologies in close cooperation between the local HEIs, PRIs, and firms. In respect to the relationship between education and innovation, HSB emphasizes the importance of knowledge transfer via heads. Other examples for projects that relate to the KT are described in section 3.4.

[56] *http://www.hs-bremen.de/internet/de/forschung/cluster. 10.07.2016.*

Figure 7
HSB: Knowledge Triangle Understanding and Selected Activities



Source: Own compilation (RWI).

This general orientation of HSB existed already from its foundation. In recent years, new initiatives have been started by both the university administration and local state policy that foster third mission activities. These initiatives focus among others on the networking of HSB with firms, integrating life-long learning into the curricula, and gearing both curricula and research towards the demands from the local economy even more strongly than before.

Third mission- and KT-related activities have been fostered with individual projects in recent years, especially through increasing networking with local industry, and defining core research areas of HSB (research clusters).

At the same time, HSB understands its third mission activities not only in economic terms, but also as a contribution to civil society, because it is located in a multicultural district in Bremen Neustadt. The goal in this respect is also to contribute to the development of the local society and to develop the competences of students beyond purely economic aspects. Examples are:

- The Bremen Diversity Award presented by Hochschule Bremen and Mercedes-Benz Bremen every year. Firms, organizations and initiatives can apply that deal productively with diversity and foster equal opportunities. The best/most innovative diversity idea is chosen, e.g. in 2014 an "International Café" received the award for the support and active integration of refugees.[57]
- The Bremen certificate for intercultural competence, a certificate of intercultural skills awarded by the Centre for Intercultural Management & Diversity. To obtain the certificate, the student must partake in a two-day intercultural training and must have completed two of three special elective subjects.[58] Topics are the knowledge of different cultures, experiences with different nationalities, and awareness of diversity.
- In the project "Third Mission – Environmental Management System" according to EMAS (Eco-Management and Audit Scheme), a management system was developed that supports the university's ecological behaviour in the form of internal audits.[59]

2.3.3 Location of the HEI and role of regional activities

The regional dimension

HSB has always addressed the demands of the local economy in the federal state of Bremen and the Metropolitan Area Northwest (including the regions around Bremen and Oldenburg): While Bremen was an important Hanseatic city with a long history in trade, the Metropolitan area of Bremen was and still is characterized by a substantial share of industry employment. The recent decades have been marked by a structural shift from shipbuilding to new industries (like automobile,

[57] http://www.hs-bremen.de/internet/de/einrichtungen/presse/mitteilungen/2014/detail/index_49486.html, http://diversity-preis-bremen.de/ 10.07.2016

[58] http://www.zim-bremen.com/de/zertifikate/ 12.07.2016

[59] http://www.hs-bremen.de/internet/de/hsb/projekte/umweltmanagementsystem/EMAS/ 10.07.2016

aircraft and aerospace industries, and production of offshore wind solutions). The maritime economy (especially the port and the related logistics) was and still is an important economic factor and employer in the region. While some sectors like the aircraft and aerospace industry cooperate quite closely with HEIs, this is not the case to the same extent for some traditionally important sectors like the food industry. In general, the cooperation between HEIs and firms (especially SMEs) could be increased and there are important activities in this direction (RWI und Fcon 2015).

The role of HSB in the local economy has to be understood within the context of the regional innovation system and the division of activities with other HEIs and research institutes in the region.[60] The science system of the region has undergone a remarkable development. The University of Bremen (founded in 1971, 19,000 students) as the largest HEI in the region has increased its reputation and focuses on scientific excellence. It is one of eleven German HEIs that were successful in the third round of the federal government's Excellence Initiative with their institutional strategy. In total, there are four state HEIs and three private HEIs in the region. In addition, Bremen has a high number of public research institutions (the highest number in Germany when related to the number of inhabitants).

In this innovation system, where many activities are focused on scientific excellence, the HSB has an important complementary role that is characterized by a strong focus on the regional economy and high regional interconnectedness. Education programmes are oriented towards the local economy. In designing and developing further study programmes, the differentiated demands of local industries like aircraft have been taken into account. HSB also follows a local (but at the same time international) network strategy. The idea is to be present in local clusters and firm networks, and follow large firms in their international activities. These international activities were already being pursued at an early stage even

[60] *One study focused on the role of HSB in the regional economy with respect to public finance and employment. The results show that about 2 thousand people are employed due to the state funding of HSB, and that there are positive effects for the federal state of Bremen with regard to income tax of about €37 mill. per year (Willms 2013: 46 and 49).*

before the Bologna process in order to address the requirements of regional firms. Over the past few years, this focus on impulses for regional development and knowledge transfer has been intensified. In addition, one activity of HSB has been to promote local spin-offs. In recent years, about 30 spin-offs were observed (Willms 2013: 72).

2.3.4 Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation

There are many activities of HSB that do not target a specific side of the KT, but are related to the KT in general. For example, HSB actively participates in the cluster and network activities in Bremen in order to (i) create a research profile by focusing on future topics, (ii) intensify technology transfer through better visibility of the research competences (iii) create innovative solutions through interdisciplinary cooperation, (iv) develop synergies (v) increase the success of attracting third-party funding by focusing competences, (vi) foster education of students and combine research and education within master programmes (Willms 2013: 74f.).

An example of one such activity is the **ClusTra** project. This project was funded until 2014 by the business development agency in Bremen (Wirtschaftsförderung Bremen) aimed at firm-oriented technology transfer into the innovation clusters in Bremen. This project established a central contact point for firms to pose research questions. Together with the firms involved, 18 projects and activities were developed. These included a website where projects would be collected, the development of dual degree courses, a newsletter for firms featuring ongoing HEI projects, the promotion of spin-offs from HSB, seminars and trainee programmes, career services to prepare students for their professional lives, and the development of a transfer office. This lead to an intensification of the contact between firms and HSB, while at the same time new requirements resulted for HSB regarding applied research and third-party funding projects.

Relationship Research - Innovation

HSB participates in several activities in Bremen in order to foster the relationship between research and innovation:

- There are several initiatives to foster spin-offs from HSB like the university initiative BRIDGE, which aims to support potential and promising ideas through consultation, workshops/seminars about business start-ups, competitions.[61] There is also close cooperation with business incubators such as "Gründerzentrum Airport" (GZA), "Bremer Innovations- und Technologiezentrum" (BITZ) and "u-institut für unternehmerisches Denken und Handeln".
- One other example is HSB's participation as a partner in the "Center for Eco-efficient Material and Technologies" (EcoMat). This technology centre, which is situated close to Bremen Airport and other industrial partners, aims to concentrate industrial and scientific expertise on innovative material and surface technologies and enable cooperation between science and industry.

Relationship Education - Research

While the overall strategy of HSB is to bring the different angles of the KT together, individual projects also target the relationship between education and research. The project "KBB trans" trains technology transfer mediators, who then coordinate research and enterprise experts in the development of feasible and practical innovative solutions. The project is funded by the EU's Lifelong Learning Programme.[62]

[61] http://www.bridge-online.de/bridge/ueber-bridge.html *12.07.2016*

[62] http://www.hs-bremen.de/internet/en/forschung/projekte/detail/index_37744.html *12.07.2016*

Relationship Education – Innovation

There are complementarities between education on the one hand and innovation on the other. As bachelors' and masters' theses often develop together with firms and on topics that are relevant for them, education and technology transfer are in fact combined. As HSB aims at networking with businesses and participating in common activities, many opportunities for such cooperation arise. KT connections between education and innovation are also addressed within regular educational programmes through (i) dual study programmes that combine education at the HSB with practical experience (partly with the opportunity to obtain an official degree for the vocational training), (ii) continuing training e.g. for firm employees which represents one key area of HSB activities.

2.3.5 Governance and leadership, motivations and incentives for engagement and the role of policy

In general, the policy in Bremen is influenced by the view that scientific excellence and economic impact are in principle complementary and that firms profit from first class research. This notion has a strong influence on policy geared towards the university and research institutes. At the same time, innovation policy also promotes the cooperation between firms and HEIs/research institutes. The main policy focus with respect to HSB is on increasing its contribution to meeting the demands of local industry in respect to both education and research.

Internal policies, especially recruitment of professors, also promote KT activities. As is also the case in the other Universities of Applied Sciences in Germany, professors do have practical experience from prior work outside the university, enabling them to understand the requirements for innovation activities and facilitating communication with firm representatives. At the same time, the possibilities for promoting third mission activities with incentives for the employees are restricted. Moreover, controlling the third party funds activities is difficult for HSB as for other universities as the funds are usually only temporary.

Part 2: Case studies of two selected higher education institutions

Framework conditions, especially the restriction of bloc funding, play an important role in HEI-related policies. In general, policy and the HSB as an individual organization tried to overcome these restrictions by attracting third-party funding and federally-financed PRIs that bring scientific expertise and at the same time do not burden the Länder government budget. However, this strategy leads to restrictions because funds are necessary to ensure the co-financing of federally-funded programmes or institutes. At the same time, at 6%, Bremen managed to maintain the highest share of public expenditure on education and R&D in the gross domestic product of all the German Länder (Statistische Ämter des Bundes und der Länder 2013: 65; Statistisches Bundesamt 2013: 103). This surely has several reasons, one being that Bremen as a city state has on average a higher necessity to provide an education infrastructure than other states in Germany.

The HEIs in Bremen and HSB also show comparatively high values regarding institutional bloc funding and third-party funding. The institutional bloc funding per student was €7,000 in 2010 (German average: €6,000); the third-party funding per professorship was €185,000 (Federal average: €125,000) (Statistisches Bundesamt 2013: 100). Even though the institutional bloc funding per student is relatively low, because it is associated with high productivity in education, HSB has been quite successful in attracting third-party funding.[63] In 2011, HSB had raised nearly €5 million of third-party funding, €35 000 per professorship, and had a top ranking compared to other universities of applied sciences in that respect (Willms 2013: 26). As originally planned increases of institutional bloc funding have since been reduced due to the overall necessity to economize in the education budget of Bremen, HSB has had to react by increasing the number of course offers with study fees, third-party funding, as well as increasing efficiency in education.

The recent Science Plan 2020 for Bremen, which was enacted in 2014, required HSB to consolidate its degree courses and orient itself even more towards the

[63] *It seems to be a contradiction that the share of public expenditure on education and R&D in GDP is high while at the same time the funding per student is relatively low. The explanation is that even though there are high expenditure there is a quite high number of students that leads to a low amount of block funding per student.*

demands from the local economy (Hochschule Bremen und Senatorin für Bildung und Wissenschaft in Bremen 2015). The reason behind this consolidation is an imbalance between the services offered by HSB and existing financial possibilities (Wissenschaftsrat 2013a). Therefore, the strategic focus of HSB was adjusted in the target agreement between HSB and the Länder administration in Bremen for the years 2015 to 2017, based on the Science Plan for Bremen 2020 (Senatorin für Bildung und Wissenschaft in Bremen 2015). This agreement relate to education, applied research, as well as knowledge and technology transfer. The range of subjects in education had to be more focused. Thus, HSB oriented its activities towards the targets set by the local state government, and also incorporated recent recommendations of the German Council of Science and Humanities (orientation of the course offerings towards the necessities of the regional firms and consolidation of the number of course offerings, focusing research activities towards a few core areas) (Wissenschaftsrat 2013a).

The Science Plan, which aims at a rather detailed level of steering, is important in coordinating targets between local state policy and the HSB (as well as other HEIs). The target and performance agreements made between the federal state of Bremen and the HSB are oriented towards political targets. At the same time, HSB has the opportunity to bring certain topics into the discussion (e.g. creating new vocational courses and formats for employees in life-long learning).

2.4 Main findings of the case studies and broader comparison

In this section, we summarize our findings from the two cases and compare them with other qualitative and quantitative evidence available for German HEIs.

Knowledge Triangle is used neither as a term nor as a concept in German HEIs

The KT concept does not play an explicit role in the strategic development of activities in either of the HEIs which were studied in depth, the University of Applied Sciences Bremen and the University of Heidelberg. This also holds true for other German HEIs as shown by the study by Koschatzky et al. (2013b), which provides

evidence for another eight cases covering a broad range of universities and universities of applied sciences from different German regions (see also Annex). None of them uses the term KT. To our knowledge, there is only one exception in Germany: the Karlsruhe Institute of Technology (KIT) has used the term explicitly in its mission statement since the merger of its teaching and research institutions in 2009. It claims that the merger puts the new KIT in a better position to integrate the three angles of education, research and innovation (Technopolis et al. 2012).[64]

HEIs have developed quite different profiles and strategies over the past 10-15 years, but many developments have implicit KT relevance

Activities that implicitly relate to the KT are important to both HEIs, but their main activities and strategies are located at different angles of the KT.

The mission of Heidelberg University has excellent research at its core. The institutional strategy of the university was successful in the national Excellence Initiative. Important activities are located between research and education, as well as between research and innovation. In the strategic fields of focus (like medicine), the university aims at integrating research and teaching and achieving a high quality of teaching. The university has close links to industry, some of which are institutionalized by long-term activities and programmes (like industry-on-campus programmes, a federally funded research campus and two federally funded Leading-Edge clusters). Given this profile, it seems natural, that the link between education and innovation is weaker.

The strategy of Bremen University of Applied Sciences centres on education and life-long learning. One relevant activity for this goal is the participation in a diversity audit programme in which strategies are developed to address the diversity of student groups. The international orientation of education (both through mandatory time abroad for students and attracting foreign students) is important for

[64] *See e.g. mission statement of KIT https://www.kit.edu/kit/english/15036.php, and other references, such as the mission statement of the KIT Energy Center http://www.energy.kit.edu/24.php , 14.7.2016*

the university strategy, also with respect to the international marketing activities of many local firms. The relations to research, which is application-oriented, and to innovation are represented by internship programmes and bachelor and masters' theses which take up topics from firms. The practical cooperation between professors, students and firm representatives with the professor acting as a consultant is at the core of the KT activities. In order to increase the contacts to industry, the university is represented in firm clusters and networks. In the Bremen region, this role of HSB has to be seen complementary with the Bremen University with its focus on scientific excellence and a stronger orientation towards research and innovation cooperation outside of Bremen.

Policy has had an impact on the developments in HEIs. This is not only true for Heidelberg and Bremen, but also for other HEIs (cf Koschatzky et al. 2013b). Besides place-based instruments such as cluster policies and the promotion of research campus models, there are dedicated supportive research policies (at the level of the federal state) for research infrastructures and a strong intermediary system (as in the case of Karlsruhe, see Technopolis et al. 2012), or the embedding of HEI policies in a broader regional policy approach (as in the case of Bremen, and similarly in Berlin). In addition, the national Excellence Initiative has left clear marks on the HEI landscape and has influenced HEI strategies and strategic capabilities in particular (e.g. in Heidelberg, Aachen, Dresden, Göttingen and many more).

KT models, in particular third mission activities, are highly diverse and do not serve the single purpose of generating economic impact

The described profiles illustrate the diversity of KT models in Germany. Bremen University of Applied Sciences focuses on the "transfer via heads" – the education of a skilled workforce tailored to the needs of the region. Moreover, it has developed a societal mission with its diversity policy that aims to open up academic education to students from socially disadvantaged groups. Cooperation with local industry in R&D projects is an aspect of the third mission, too, but not the central one.

Part 2: Case studies of two selected higher education institutions

Heidelberg University is characterised by the translational research approach: basic research contributes to innovation research, while there is less weight on "classical" transfer such as patents. This is founded on long-term strategic partnerships and networks such as the industry-on-campus activities, the research campus model and Leading-Edge clusters and on projects to a smaller extent. The social sciences and humanities, which are traditionally strong in Heidelberg, have also developed third mission activities (e.g. the Centre for Social Investment (CSI).

Looking at the available broader evidence from other case studies (e.g. Koschatzky et al. 2013b), it is clear that in regions with unique potential for cooperation with industry, the HEIs try and exploit this potential. Aachen University in North Rhine-Westphalia, for example, has a similar approach to Heidelberg when it engages in long-term strategic relationships like industry-on-campus projects or research campus models. Apart from activities driven by institutional strategy, there are numerous contract and consulting projects initiated by faculty as well as many examples of university employees being embedded in networks orientated towards regional transfer.

Historical patterns and the disciplinary strengths of HEIs often dominate third mission activities too, as in the case of the University of Bonn: Since Bonn was the former capital city of West Germany, the federal administration is still located there as are many NGOs and IGOs. The university maintains institutional linkages with them and other international organizations. The agricultural faculty recently created the cluster "Bonn.Realis" (Bonn Research Alliance of Innovative Information Systems in International Quality Food Chain and Crisis Communication), which mainly strives to enhance the quality of the food and human safety sector within the region.

Location of the HEIs matters for the role they can play and for the effects they can have on the region

The local focus in the HEIs examined varies strongly: The role played by Bremen University of Applied Sciences has been influenced by the features of the regional innovation system and Länder policy that addressed these features, but also by

the University's strategy. In the federal state of Bremen, the University of Bremen aims at scientific excellent research. At the same time, the innovation system is characterised by a substantial number of PRIs that perform excellent research. In this framework, Bremen University of Applied Sciences specifically addresses the demands of local industries. This is an important task because in many cases, local firms are only loosely connected to the regional HEIs and PRIs, especially in less technology-oriented sectors like the food industry and logistics. For HSB, activities that address non-economic aspects are also important, e.g. diversity, because it is part of a diverse district of Bremen (Neustadt), and giving impulses for societal development in individual projects.

In comparison, Heidelberg University has always been a top-performer in research in many disciplines and a focal point in regional, national and international terms. Regional integration is seen as an enrichment to national and international activities and strategies. The university has developed strong strategic partnerships with firms and PRIs in the region. In line with the overall university strategy, the focus of these partnerships is research excellence. While there is little specific focus on regional demands, many regional activities and indirect impacts can be found. The university is an important regional employer, its reputation contributes to the branding of the region, and the historical buildings add to the cultural and touristic attractiveness of Heidelberg.

Another example is Leuphana University located in Lüneburg, a structurally lagging region in Lower Saxony. Because of its location and history, it has a commitment to regional cooperation and educating the local labour force. Founded as a pedagogical university in 1946, it merged with the University of Applied Science North East Lower Saxony in 2005 and became a public law foundation, which greatly increased the university's autonomy. Due to the successful acquisition of the "innovation incubator", funded by EFRE (period from 2009 – 2015; budget approx. €98 million), the regional engagement of the university increased rapidly (Koschatzky et al. 2013b).

A quantitative study of the economic effects of HEIs on their regions indicates that the size of the effects may vary depending on the location of the HEI (Stifterverband

2013): In metropolitan regions like Heidelberg, the effect of HEIs on GDP growth and unemployment rate is almost twice as high as in other regions: a thriving industrial base and a lively research landscape are cross-fertilizing. Regions with structural problems, less inhabitants, or a smaller industrial base like Bremen or Lüneburg can profit from HEIs, too: Because of the lower number of inhabitants, the relative effect on GDP growth and unemployment is higher than in many cities.

Much regional engagement depends on the individual choices of faculty – and is not management-driven

The individual activities of faculty and the (strategic) activities of university management may appear rather disconnected, but in effect are often complementary. The two case studies show that activities are initiated by faculty members, university leadership, and also policy. There are different incentives to cooperate regionally for universities and universities of applied sciences: University faculties have an excellence orientation: they look for excellent partners and there is evidence that their excellence increases their attractiveness for industry. Where local business is not R&D-intensive, cooperation focuses on the education dimension – this is primarily done by universities of applied sciences, and on research topics that address the problems and challenges of single firms. University leadership increasingly supports engagement in strategic and long-term partnerships such as clusters and networks and campus models (research campus, industry-on-campus). Some of these activities build upon previous engagement of individual faculty members. Generally, the internal governance of the HEI does not provide any incentives for regional engagement. Reward systems are often oriented at standard indicators for excellent research. There are only a few cases – that tend to be universities of applied sciences – that do reward regional engagement (e.g. in Berlin or Cologne, see Koschatzky et al. 2013b).

A study by Kroll et al. (2015) summarizes the quantitative counterpart to the study by Koschatzky et al. (2013b). It draws on a sample of about 1.500 German academics. Building on the assumption that a large share of regional engagement depends on individual choices, it aims to identify and corroborate the role of key

factors influencing these choices. This study finds that choices to engage regionally are often strongly contingent on intrinsic academic motivations – and not management-driven. Although the authors observed manifold motivations, they found that there are basically three latent dimensions of faculty motivation that represent the angles of the KT: education motivations, research motivations or motivations to increase reputation outside academia and/or to be relevant / useful for the region. The example of HSB shows that there are also cases where regional engagement is strongly fostered by management and policy support.

At the Dresden University of Technology, the regional activities of different levels (individual professors, faculties, university management) seemed to be complementary, but there was a common understanding that they could be further improved if there were a dedicated concept for regional engagement in place (Koschatzky et al. 2013b). TU Dresden applied to the federal government's Excellence Initiative and created the "Dresden concept", which aims to set up common research platforms for the interaction of cultural and scientific actors. The joint development of the project and the allocation of resources were perceived to be an important step towards such a concept for regional engagement. This suggests that university management can support further regional – and with it KT – development by orchestrating and guiding activities.

Non-standard national or institutional policies/ strategies

Although the Excellence Initiative (EI) is oriented towards a rather "standard" objective of HEI policies, it seems to have indirectly triggered KT relevant developments in the applicant institutions. Many institutional strategies and measures contribute to the integration of at least two dimensions of the KT, primarily research and education. And the Technical University of Dresden has been successful in the EI with an unusual concept that addresses the third mission beyond the implications of excellent research: non-economic aspects of regional development and the inclusion of society. Overall, universities have developed more strategic capacities in response to the EI and other "standard" HEI policies such as steering by performance contracts or more (financial) autonomy for HEIs.

Although the excellence paradigm is dominant, there are quite a number of examples of policies allowing for place-based, more contextualized approaches to HEI development. Place-based instruments such as cluster policies and the research campus models have proven highly attractive to HEIs. Also dedicated supportive research policies (at the level of the federal state) for research infrastructures and a strong intermediary system have been identified as successful KT policies (as in the case of Karlsruhe). Similarly positive results could be observed from efforts to embed HEI policies in a broader regional policy approach (as in the case of Bremen, and similarly in Berlin and Lüneburg).

Germany has always been a country, where the share of the institutional block funding of HEIs has been comparatively high. This trend seems set to continue following the advice from the German Council of Science and Humanities (Wissenschaftsrat 2013). In 2015, Baden-Wuerttemberg (where the University of Heidelberg is located) was the first federal state to decide to re-allocate funding with the aim to (further) increase the financial autonomy of HEIs: Besides an overall increase of the budget, the share of institutional block funding for strategic usage and long-term planning was increased compared to (non-competitively granted) programme budgets, e.g. for the quality of teaching. It is too early to assess whether this policy will help to further strengthen KT developments, but it is an unusual policy approach that deserves further attention.

Another development to increase budgets strategically (without prescribed use) is the practice of granting overheads on top of federal project grants (BMBF and DFG). The practice of overheads has been positively evaluated with the result that the DFG has recently increased overheads from 20% to 22%.

Conclusions about the different types of HEIs

Our findings show that the different approaches toward the KT are partly caused by the fact that Heidelberg and Bremen represent to different types of HEIs in Germany (general universities, which have stronger research profiles than universities of applied sciences which often focus on education). However, other factors also play an important role in the positioning of HEIs in the KT: (1) historical

developments and the structure of the innovation system (what firms, other HEIs, or PRIs are in the region?), (2) Länder policies and strategies that foster certain HEI development paths in and with their regions, (3) strategies and perceptions of the acting persons in the relevant Länder ministries and the HEIs; and (4) HEI policies at the federal level (e.g. the Excellence Initiative).

As our analysis further shows, there is also a complementarity between universities and universities of applied science, with both kinds of HEIs addressing different aspects of the KT and the demands of the local economies in a different manner. This indicates that knowledge triangles might not only emerge from a single university (or other type of HEI) in a region, but might rest on a small set of core institutions, which complement each other. In the German case such a set of core institutions might be a general university and a university of applied sciences or a university and one or several large public research institutes.

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Annex: Characteristics of another eight HEIs[65]

A.1 RWTH Aachen University (Rheinisch-Westfälische Technische Hochschule Aachen)

1. Profile

- Founded in 1870 as the "Royal Rhenish-Westphalian Polytechnic School"
- Largest employer in the region (approx. 11,000 employees); large university with about 35,000 students
- Focuses on natural science, engineering and medicine
- Was funded in three phases of the Excellence Initiative

2. Institutional policy/ strategy to support KT

- The strategy paper aims at enhancing quality in teaching as well as improving research. Cooperative research within the regional environment takes place with companies and with other research institutes/ universities and plays a central role for the strategy processes of the university.
- One of the key factors in the strategy process was the Excellence Initiative, which led to the funding of the Aachen Institute for Advanced Study in Computational Engineering Science as well as three Excellence Clusters.
- Through interdisciplinary research, the university tries to generate synergies among the disciplines and develop new research fields.

[65] *Studied by Koschatzky et al. (2013b).*

3. **Location of the HEI and role of local/ regional activities**

- Located in North Rhine-Westphalia, in a region with unique potential for industrial cooperation, large firms settling in the region, many start-ups (technical disciplines).
- The region only takes indirect account of university-wide strategy processes.
- Besides its significant role as a renowned technical university, RWTH induces regional effects as a structural and dominant institution.
- Transfer "via heads": Led to the establishment of large companies and 1,400 start-ups.
- Embedded in regional transfer-orientated networks via various transfer-orientated institutions.
- Numerous contract and consulting projects are taking place independently of central strategy processes.
- Especially the application-orientated character enables cooperations with companies, associations and municipalities in the local area

4. **Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation**

- Intensive links to PRIs, e.g. two research campus models (Flexible Elektrische Netze; Digital Photonic Production); Jülich Aachen Research Alliance (JARA).
- 30 years ago, the university signed a cooperation agreement with the Chamber of Industry and Commerce in order to create networks with regional players and to align with regional development activities.
- Being part of "Innovationsregion Rheinisches Revier", the university tries to strengthen its regional linkages.

- RWTH is also part of HumTec, which constitutes a scientific framework for research teams → researchers from many different disciplines work together in order to address socially relevant topics.
- Another regional research cooperation is the "Meuse Rhine Triangle", which offers a broad and international framework for universities, research organizations and companies from Aachen, Maastricht, Limburg and Liège → the framework mainly focuses on life science and chemistry topics.
- Another key element in the future strategy of RWTH is the RWTH Aachen campus, which constitutes a new way of cooperating with research-intensive companies.

5. Governance and leadership

- The internal incentive structure emphasizes the character of the university and the challenges that stem from global competition.
- Regional activities are not promoted as such, but many activities build on the regional dimension.
- The university aims to reach opinion leadership in its main research field in the future → In order to strengthen these fields, the university RWTH Aachen will use the majority of funding for them.

A.2 University of Applied Sciences for Engineering and Economics Berlin (HTW Berlin)

1. Profile

- Mainly focuses on engineering and economic sciences; legal independence since 1994.
- Approx. 12,000 students enrolled; around 1,700 employees.
- The university has five faculties: engineering sciences I and II, economic sciences I and II and design.

2. Institutional Policy/ Strategy to support KT

- Besides the five faculties of the university, interdisciplinary competence fields are another main focus.
- HTW Berlin emphasizes the competence fields “banks and regional development”, “gameslab Berlin”, “sustainable energy supply for venues”, “regional industry culture” and “start up-competence centers”.
- The university tries to follow its guiding principle that highlights interpersonal cooperation and exchange with other universities and partners from the private economy, administration, culture and society of the region.
- By engaging in research, knowledge and technology transfer, the university aims to facilitate innovations and regional development in general.

3. Location of the HEI and role of local/ regional activities

- Small university of applied sciences within a metropolitan area, which hosts many creative industries.
- Regional networking offers benefits for education and research (cooperation with SMEs).
- The number of regional cooperation projects is crucial for the university’s annual budget.
- Regional cooperation and research for SMEs through the Institute of Applied Science in Berlin (HTW Berlin as one of four partners).
- Furthermore, numerous professors employed by HTW Berlin are also engaged in border-crossing clusters, which constitute a main part of the university’s innovation strategy.

4. **Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation**

   - Particularly relevant were cooperation projects with Radiodata GmbH Berlin (development of a demonstrator for professional mobile communication), Sarros GmbH, Berlin (robot-supported tests), Parabel Energy Systems GmbH, Potsdam (Research, development and analysis of solar thermal systems) or the association of German real-estate companies.
   - In cooperation with other universities and companies based in Berlin, HTW is also part of the support initiative "Forschungscampus (Research campus)".
   - In addition to that, HTW Berlin also tries to strengthen its corporate links with engagements in R&D and innovation platforms like KONTAKT, "Forschungsassistenzen" (funded by the EU structural support).
   - Within the framework of HAWtech (cooperation of the Universities of Applied Sciences in Aachen, Darmstadt, Dresden, Esslingen and Karlsruhe), HTW Berlin seeks to enhance its international networks under the auspices of the organization, to engage in interdisciplinary research and to develop new courses for students.

5. **Governance and leadership**

   - The university administration promotes regionally-orientated research, but financial incentives are limited.
   - Decrease of teaching hours, while there is only little scope for change (overall distribution scope is 7% of all HTW Berlin teaching hours).
   - Salary supplements exist (maximum €500 per month for both teaching and research).
   - Generally, the university administration is open-minded about new research projects, e.g. the establishment of a new research campus, but it mostly lacks the financial resources.

A.3 University of Bonn (Rheinische Friedrich-Wilhelms-Universität Bonn)

1. Profile

- Founded in 1818; today a cooperation-orientated research university.
- 27,000 students enrolled; more than 4,000 employees.
- The university has seven faculties (catholic-theological, evangelic-theological, law, medicine, philosophy, natural sciences and agricultural faculty).

2. Institutional Policy/ Strategy to support KT

- The University of Bonn views itself as an international and research-based university.
- Its efforts to establish regional links are firmly embedded in the "ABC-Wissenschaftsregion" (Aachen, Bonn, Cologne), which offers a platform for universities in close proximity, as well as in the cooperation with other organizations, like Fraunhofer CAESAR, Research Centre Jülich or the United Nations.
- The University of Bonn sees this tight-knit network of multidisciplinary partners as a contribution to regional engagement, but, first and foremost, as a competitive advantage for the acquisition of third-party funds.
- The university aims to facilitate knowledge and technology transfer in order to strengthen its position as a financially and scientifically independent organization.

3. Location of the HEI and role of local/ regional activities

- As a comparatively large institution, the University of Bonn mainly targets the regional labour market and research cooperation projects (primarily in life science).

- Since Bonn was the former capital of West Germany, the federal administration is still located there, as well as many NGOs and IGOs → the university maintains institutional linkages with them and other international organizations.
- The university is situated in a metropolitan and industrialized area.
- Research cooperation within the "ABC-Wissenschaftsregion" is the most important form of regional engagement.
- Access to third-party funds is facilitated through its embedding in regional research networks.
- Research activities with regional partners, especially from technical and scientific fields, are of high importance, since the region offers specific competencies.
- Regional networking enhances the professorship autonomy and extends the teaching offer.
- Generally close ties between graduate students and the regional labour market.

4. Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation

- Foundation of "Schlossakademie" and "PROFOB (Professional Food Bachelors)", which constitutes a cooperation, research and job market platform for the industry sector and the university → Especially SMEs profit from these platforms, as most of the companies are unable to set up their own trainee programme (they can connect with graduate students, even though they are comparatively small companies).
- The agricultural faculty recently created the cluster "Bonn.Realis" (Bonn Research Alliance of Innovative Information Systems in International Quality Food Chain and Crisis Communication), which mainly strives to enhance the quality of the food and human safety sector within the region.

- Specific examples of historically developed cooperation projects have mostly been created in the law and economic sciences faculty (e.g. “Forschungsinstitut für Zukunft der Arbeit”, “Zentrum für Europäische Integration” or “Bundesanstalt für Finanzdienstleistungen”).

5. Governance and leadership

- The regional networks do not result from incentive and governance instruments, but from inherent advantages.
- Bonus payment for examined third-party funds → higher bonuses for DFG-third-party funds than for funds from BMBF or the EU.

A.4 Dresden University of Technology (TU Dresden)

1. Profile

- Founded in 1828 as the “Royal Saxon Technical Educational Institution”.
- Traditional focus on engineering sciences and natural sciences supplemented by medicine, humanities and social sciences.
- Approx. 36,000 students enrolled; 21,200 of them majoring in engineering sciences and natural sciences.

2. Institutional Policy/ Strategy to support KT

- One of the main objectives of TU Dresden is the integration of science into society, as well as the enhancement of the interdisciplinary character of science.
- The university sees itself as a centre for knowledge and technology transfer, which is simultaneously embedded in the society and the region → Therefore, TU Dresden tries to contribute to the performance and competitiveness of regional companies and organizations.
- Since TU Dresden engages in many different cluster activities and helps to attract numerous innovation-orientated companies, it has gradually

become one of the most important location factors of the region and a significant employer.

3. **Location of the HEI and role of local/ regional activities**

   - Large university that takes a leading role in regional development.
   - Excellence University with focus on regional cooperation.
   - The university is situated in an industrialized region, although large companies are lacking → transformative development after German re-unification.
   - The lack of large companies in Dresden is noticeable, as contract research projects are mostly conducted outside the region.
   - SMEs cooperate with TU Dresden only if they receive promotions and support (e.g. ProInno, ZIM etc.).
   - At the level of individual professorships, regional activities facilitate the application of research ideas and cooperation with regional players; these regional activities also provide the opportunity to apply newly developed methods in a regional context.
   - At the level of faculties, concerted advertising activities help to attract graduate students from the region.
   - At the level of the university administration, TU Dresden benefits indirectly from the impact of regional-orientated activities; the state government provides various resources because these university activities play an important role for the Free State of Saxony.

4. **Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation**

   - TU Dresden successfully applied for the Excellence Initiative with the "Dresden concept²", which aims to set up common research platforms

for the interaction of cultural and scientific actors. The common development of the project and the allocation of resources was seen as the first step towards a more strategic approach to regional engagement.

- In order to promote regional research and network transfers, a network was founded for information and to support new entrepreneurs ("Dresden exists"). Additionally, an independent organization was established (TUDAG GmbH), which aims at facilitating the commercialisation of scientific results and the cooperation between the university and companies.
- In order to counteract demographic change, address the lack of students in their fields and reduce regional "braindrain", the engineering and natural science faculties set up several different cooperations with local schools.
- Close cooperation with regional Fraunhofer or Max-Planck Institutes, especially in the regional cluster activities of Silicon Saxony, Cool Silicon or Biosaxony.

5. Governance and leadership

- Although regional networks constitute an important task for the university, the internal incentive structures do not reflect this fact.
- Instead, the university administration tries to persuade actors to get involved in central projects.

A.5 University of Göttingen (Georg-August-Universität Göttingen)

1. Profile

- Founded in 1734; traditional focus on scientific excellence and basic research.
- The university puts special emphasis on natural sciences and humanities; noticeable lack of any engineering sciences.

- Approx. 23,500 students are enrolled, 5,500 in natural sciences and about 6,000 in law, economics or social sciences.
- First privately funded university in Lower Saxony.

2. Institutional Policy/ Strategy to support KT

- In its mission statement, the university emphasizes the freedom of research and autonomy, the importance of research and teaching, as well as the focus on humanities and natural sciences.
- In order to attract international researchers and students, and to facilitate the growth of international networks, the internationalization of research and development is a priority for the university.
- The institutionalization of cooperation with external research organizations is another key focus.
- Additionally, the university tries to maintain and extend the broad spectrum of interdisciplinary research fields and course offers in order to address upcoming issues in the future.

3. Location of the HEI and role of local/ regional activities

- Large, research-orientated university, which is about to develop its regional role.
- The region hosts a few research-intensive companies, but overall, there is only little cooperation potential → consequently, contract research does not take place very often.
- The university is one of the largest employers in the region and therefore represents an important location factor → the university is an important economic factor for the region.
- At the institutional level, no evidence of a strong active network with regional players.

- At the level of individual professorships, a few intensive regional networks exist; their major advantages lie in the integration of practical elements in teaching.
- At the managerial level, regional activities are promoted in order to avoid the lack of junior employees → the university aims to strengthen its profile as an excellent research university.
- The impact and dependence of the university and the region are mutually recognized → consequently, the university tries to enhance its links to the region by focusing its research on societal needs and requirements; initial approaches to address these issues are in the planning stage.
- The demand for regional technology transfer and research cooperation projects is addressed more by individual, application-orientated institutes and the university of applied sciences.

4. Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation

- The Göttingen Research Council was founded in 2006 and is the central committee for the development of the scientific region. It allocates local research capacities and offers a scientific platform for external research organizations like "Akademie der Wissenschaften zu Göttingen", "Deutsche Primatenzentrum", "Deutsche Zentrum für Luft- und Raumfahrt" and five Max-Planck-Institutes.
- The newly founded university "Welcome Center" tries to facilitate the seamless integration of international researchers and connect them with the local economy.
- Furthermore, the initiative "Genius Göttingen" attempts to enhance regional attractiveness in order to find new employees and promote the image of Göttingen as a "scientific landscape".

- With the projects "X-Lab²" and "Rent a scientist", the university tries to inspire young students at school for university research; by connecting with students at a comparatively early age, the university aims to counteract "braindrain" and rural migration.

5. Governance and leadership

- The internal incentive structures underline the research-orientated profile of the university.
- A stronger focus on regional activities is planned in the future.

A.6 Technical University of Cologne – University of Applied Sciences (Fachhochschule Köln)

1. Profile

- Founded in 1971 by combining several educational institutions.
- Largest university of applied sciences in Germany (20,000 students and 1,000 scientific employees).
- Besides eleven interdisciplinary faculties situated at four different locations in the greater region of Cologne, the Technical University also runs the Institute for Technology and Resource Management in the Tropics and Subtropics.

2. Institutional Policy/ Strategy to support KT

- According to the university's development plan, it aims to make a sustainable contribution to the development of society → and tries to reach this overall target by educating students and young researchers and applying the transferred knowledge.
- Additionally, the university tries to engage in sustainable support of international activities that focus on teaching, research and knowledge transfer.

- Following the American model, the university is attempting to become a "third generation university" that consistently facilitates innovative outcomes.
- Even though the university's development plan integrates institutional guidance until 2020, the university is eager to react flexibly to the changing environment and new challenges → Therefore, the subordinate strategy of the university aims to secure its research performance and teaching at all times.

3. Location of the HEI and role of local/ regional activities

- University focuses on educating the local labour force and research co-operations.
- The university is located in a metropolitan region with an industrialized character.
- Regional networks help to obtain third-party-funds → strengthening research through employees.
- Autonomy status of professorships, e.g. through focusing on own research topics.
- Improvement of teaching through the acquisition of external lecturers from the region as well as closer ties to regional companies (better job opportunities for graduate students).
- In the long run, regional networks help to sustain student places.

4. Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation

- The foundation of the Institute for Social Spaces (Institut für Sozialraumaktivitäten) highlights the interdisciplinary character of the university, as architects and social scientists work closely together in order to analyse social flashpoints.

- The university expresses its sustainable responsibility to the region and society by supporting the programme "RheinEnergieStiftung" that tries to facilitate networks of regional universities.
- In addition, the Technical University of Cologne wants a new research campus near the city centre (Köln-Deutz) that underlines the regional character and integration of the university's R&D in society.
- The faculty of computer sciences and engineering sciences is strongly engaged in institutionalized knowledge transfer → consequently, regional initiatives, like "Gründungsnetzwerk Oberberg GO MIT", "Innovationsallianz der NRW Hochschulen" or "IT-Forum Oberberg" connect regional actors from different fields.

5. Governance and leadership

- Internal research support is based on the start-up financing of cooperation projects with external partners → additionally, the internal research support incorporates an incentive system that awards obtained third-party funds.
- Financial allowances are integrated in faculty salaries in order to reward the regional engagement of new professors that aim to reach common objectives.
- Consequently, the effective support of regional cooperation is ensured at the professorship level.

A.7 Leuphana University of Lüneburg (Leuphana Universität Lüneburg)

1. Profile

- Founded as pedagogical university in 1946; merged with the University of Applied Science North East Lower Saxony in 2005 and became a public law foundation in 2003 → greatly increased the university's autonomy.

- During the 1980s and 1990s, the character of the university changed due to the growing number of new courses and subjects offered → today, the university is able to offer a broad portfolio of different disciplines.
- Four faculties: educational sciences, culture sciences, economic sciences and sustainability.
- 7,500 students are enrolled, employs 150 professors and 1,000 scientific employees.

2. Institutional Policy/ Strategy to support KT

- The university focuses on three key objectives in its mission statement; Firstly, to educate students on both a professional and personal level.
- Secondly, for its students to become responsible persons that reflect upon their actions on a daily basis.
- Thirdly, sustainability, which is underlined by the UNESCO Chair for Sustainability and the world's first MBA in corporate sustainability management in the department of natural sciences.

3. Location of the HEI and role of local/ regional activities

- Small university with a strong focus on regional cooperation (Incubator project, funded by EU Structural Funds); educating the local labour force.
- Located in a structurally lagging region.
- The regional engagement of the university grew rapidly after the successful acquisition of the innovative incubator (period from 2009 – 2015; budget approx. €98 million: In June 2012, 261 companies engaged and cooperated with the university in "Innovation Incubator" projects → 186 actors were from the project area, 128 of which were SMEs.
- The innovation incubator is the largest regional development project in Europe that was supported by the general directorate of regional policy

→ the incubator will be based on start-up financing and should facilitate future projects and policies.

- Immediately after the foundation of the university, teacher training was a key focus in order to strengthen regional education; nowadays, the university's portfolio is supplemented by many innovative courses and programmes, so that the region benefits from a multidisciplinary educated work force.

4. Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation

- The "Leuphana Energie-Forum" or "Leuphana auf dem Weg" were campaigns aimed at knowledge transfer to regional actors from the private economy and the public sector.
- Another contribution to avoid the continuing "braindrain" within the region is the annual "Kinder-Uni" that tries to connect with and attract school children to the local university.
- Based on the support via the innovation incubator, a research-based cooperation was set up between a local company from the measurement technology branch and the University's Faculty of Sustainability in order to develop an innovative sensor system that helps to improve water quality (project title: FeQuan).
- Additionally, the R&D project "Operations Excellence" was conducted to optimize the value-chain activities of local SMEs → The main objective of this project was to help these companies work more efficiently and sustainably in terms of resources and reduce their costs for internal processes.
- The project "EnERgion – Erneuerbare Energien in der Region Nord" aims to address one of the key issues of energy system transformation → the storage and retrieval of renewable energy.

5. **Governance and leadership**

   - The salary for professors is supplemented by the performance-orientated allocation of funds, which measures engagement in research and teaching. At the same time, the employment of women in professorships is promoted.
   - There are only indirect financial incentives for regional engagement through successful research activities.

A.8 Trier University of Applied Science (Hochschule Trier)

1. **Profile**

   - Independent since 1996; located on three campuses.
   - Specialises in engineering, economics and design; Focus on environmental topics at campus Birkenfeld.
   - Approx. 7,000 students.

2. **Institutional Policy/ Strategy to support KT**

   - Regional engagement is part of the university's mission, alongside internationalisation.

3. **Location of the HEI and role of local/ regional activities**

   - The region is structurally lagging, so there are only a few cooperation and transfer activities.
   - Because of the geographical distance between the three campuses, the focus is on several regions, not just one.
   - Cooperative research takes place with hospitals or the University of Trier. Moreover, the ICT department develops web applications for local clients.
   - Another type of engagement is a design competition.

4. **Examples of programmes, initiatives or centres that explicitly aim to integrate research, education and innovation**

   - Cooperation is promoted by the network TWIN-RLP, which was established by the federal state of Rhineland Palatinate in 2006. This network promotes the competences of the universities of applied sciences in the federal states.
   - Joint "Forschungskolleg" with the University of Applied Sciences Kaiserslautern, funded by the Federal Ministry of Education and Research (BMBF). The "Forschungskolleg" was set up as a project to encourage top graduates to continue studying and obtain a doctorate degree.
   - "proTon" is an R&D project funded by local sponsors. Since 2006, a research team, of 30 persons from different faculties (automotive, electronic engineering, ICT, design) including students has constructed vehicles based on alternative gear technologies for the Shell Eco-Marathon. Each year, the team is very successful.

5. **Governance and leadership**

   - Regional activities are mostly initiated by individual professors, driven by the motivation to increase the attractiveness of teaching
   - There are no specific incentives for regional engagement, but professors consider it to be important.
   - The acquisition of third-party funds can be rewarded by reducing teaching tasks.