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RUHR UNIVERSITÄT BOCHUM RUB

#701

Imprint

Ruhr Economic Papers

Published by

RWI Leibniz-Institut für Wirtschaftsforschung
Hohenzollernstr. 1-3, 45128 Essen, Germany

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Ruhr Economic Papers #701

Responsible Editor: Thomas K. Bauer

ISSN 1864-4872 (online) – ISBN 978-3-86788-815-8

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Bibliografische Informationen der Deutschen Nationalbibliothek

Die Deutsche Bibliothek verzeichnet diese Publikation in der deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über: *http://dnb.d-nb.de* abrufbar.

Das RWI wird vom Bund und vom Land Nordrhein-Westfalen gefördert.

http://dx.doi.org/10.4419/86788815
ISSN 1864-4872 (online)
ISBN 978-3-86788-815-8

Christian Warnecke and Daniel Weller[1]

Cooperation between Higher Education Institutions and Companies from a Spatial Perspective – An Empirical Analysis of Germany Using Bayesian Logistic Multilevel Models

Abstract

This research paper aims at highlighting factors which influence the spatial focus of interactions between higher education institutions (HEIs) and the economic system in Germany. In the pursuit of this goal, our research work employs a Bayesian statistical analysis of empirical data gathered from a German-wide online survey of professors (7,500 participants) focused on the extent of knowledge diffusion with respect to their institutions of origin. The results provided by our statistical analysis indicate that some fields of research are favourable in facilitating cooperation between companies and University professors in the region, while others are more prone to cooperate supra-regional. In the case of professors at Universities of Applied Sciences (UAS), the results reveal only a low influence concerning the research discipline. These findings are not surprising because of the narrow spectrum of research disciplines at UAS. Beyond these results, the time budget allocated for research poses as a major factor of influence for the cooperation activities of professors at UAS. These findings have been expected since UAS professors have less allocated time for research leading to a more regional focus of cooperation with companies. Surprisingly across all models, only a very few categories in total are credible for the "Application relevance of research" and the "Cooperation intensity".

JEL Classification: I23, I25, O32, O31, O33, R12

Keywords: University-industry links; knowledge transfer; collaborative research; Bayesian multilevel analysis; spatial analysis; German-wide survey

June 2017

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1. Introduction

According to a new understanding, innovation is not a mere result of a linear process, but rather a product of interactions between multiple regional actors (Acs 2002, p. ix). The *"Regional Systems of Innovation"* (Cooke 1992) (RIS) utilises this concept with a focus on regions as crucial elements within the innovation process (Trippl et al. 2015, p. 1723). Following Autio (1998, p. 133), the main institutions considered within this concept are public as well as private companies (*"knowledge application and exploitation sub-system"*) and higher education institutions (HEIs) (*"knowledge generation and diffusion sub-system"*).

The essential function of HEIs within this theoretical framework is characterised by three different tasks: production, accumulation and transfer of knowledge and technology (Fritsch and Slavtchev 2006, p. 2; Acosta et al. 2012, p. 693). However, in the economic system, the need to remain competitive is paramount (Kogut and Zander 1992, Teece 1996), which fosters the creation of *"new combinations"* (Schumpeter 1912, p. 158) of knowledge by harnessing external and internal expertise to generate innovation.

Due to their position at the center of the knowledge production process (Godin and Gingras 2000, p. 277; Gibbons et al., 1994; Perkmann et al. 2013, p. 423), HEIs serve as valuable source for external knowledge for companies (Meyer-Krahmer and Schmoch 1998, p. 835), which is fundamental for the generation of innovation (Maietta 2015, p. 1341; de Jong and Freel 2010, p. 48). An exchange of knowledge between these two systems seems to be crucially important for companies' innovative performances (Godin and Gingras 2000, p. 277; Cowan and Zinovyeva 2013, p. 788; Robin and Schubert 2013, p. 161). However, the existence of physical space within which each institution operates poses as a limitation, which should be overcome during the knowledge transfer process (Filieri 2010, p. 63).

Previous research on this topic is typically based on the extensive use of case studies in characterising factors which facilitate cooperation between HEIs and companies. In contrast, our research deviates from this practice by employing the use of complex statistical models in exploring these relations. Consequently, its aim is to fill the recent gap within this field of research by appraising the spatial interactions using a new methodological approach to statistical modelling and data from the largest survey to date on knowledge transfer with 7,500 responses by professors at German HEIs.

The main objective of this research paper is to identify credibly significant factors influencing the spatial focus of cooperation activities between professors as representatives of HEIs and companies in Germany.[1] To address this problem, Bayesian logistic multilevel models via Markov Chain Monte Carlo simulation (MCMC) are implemented by utilising responses from a German-wide online survey of professors. The necessity of such a multilevel approach arises from the hierarchical structure of our survey data.

[1] In Germany, tertiary education is primarily shaped by two different types of institutions - Universities and Universities of Applied Sciences (UAS) -, which have a varying emphasis on teaching and research, as well as different content orientation. While UAS have a strong focus on applied teaching and practical application of transferred scientific knowledge and research, Universities tend to gear towards more fundamental research and theory-based teaching (Warnecke 2015, p. 163).

Section 2 discusses the relevance of spatial proximity in the context of knowledge transfer and highlights both the novelty and degree of innovation of our empirical data. This provides an insight to why it is necessary to consider physical space with respect to knowledge flows. A feature of this study is the uniqueness of the applied data, which is highlighted by a comparison of previous studies with respect to survey responses. Section 3 presents the analytical part of this paper, which provides information on the data, the methodological approach and the results from the multilevel regression analysis. Following an introduction of primary and secondary empirical data considered in this study, a full description of the estimation approach, the construction of subsets and a description of general characteristics of Bayesian statistics is given. Before statistical results are reported, every variable used in the models is broadly depicted and five hypotheses are pointed out. The final section concludes this paper by summarising the results.

2. Theoretical framework

Diverging views exist on whether knowledge is locally bounded or spatially limitless. The idea of "*Regional Innovation System"* stresses the regional stimulating factor for innovation. In contrast, Cairncross (2001) argues that there is a so-called *"Death of Distance"* due to modern advances in communication technology. These opposing views are herein discussed.

Several authors promote the idea of spatial clustering of knowledge (e.g. Jaffe 1989; Jaffe et al. 1993; Bania et al. 1993; Acs et al. 1992, 1994; Maskell and Malmberg 1999; Bercovitz and Feldman 2006; Abramovsky et al. 2007; Hausman 2012; Belenzon and Schankerman 2013; Rothwell et al. 2013). These studies imply that a close physical proximity between individuals has a positive impact on knowledge exchange and innovation performance (*"proximity matters"*) (Koschatzky 2001, p. 114). Some reasons for this phenomenon, termed *"Regional Advantage"* (Saxenian 1994), can be found by a comparison of explicit and tacit knowledge (von Hippel 1994), as the latter is more relevant to innovation (Edquist 1997).

A general distinction can be drawn since explicit knowledge is codifiable through formulas, descriptions and other forms of documentation (Howells 2002, p. 872). A typical example would be the price of gold, which can be transferred over huge distances (Desrochers 2001, p. 25, Cowan and Zinovyeva 2013, p. 789). This according to Asheims and Isaksens (2002) accounts for the characterisation of codified knowledge as global ubiquitous knowledge. Tacit forms of knowledge, on the other hand, require direct interaction of individuals via face-to-face contacts due to their strong relation to a person's individual abilities (Howells 2002, p. 872). It is comparable to an art where no written instructions exist. These artistic skills must be taught from a master to his apprentice through examples and demonstration effectively restricting these explicit forms of interactive learning in space (Polanyi 1958, p. 52). Therefore, tacit knowledge is restricted to regions (Fritsch and Slavtchev 2006, p. 4), as people are tied to their regions of residence and economic activity.

Another reason for considering regional aspects in this context of research is the relevance of social contacts (Cowan and Zinovyeva 2013, p. 789), as they are quite difficult to preserve over long distances (Breschi and Lissoni 2009, p. 442). Close physical proximity between individuals helps build up social capital, which is necessary for sharing trust related issues. In this sense, physical proximity indirectly

contributes to most forms of innovation and interactive learning through supporting the relational forms[2] of proximity (Boschma 2005, p. 71).

The economic importance of regions outlined above appears to be a paradox in our highly technological world, which facilitates the exchange of information over thousands of kilometres without any loss of time or quality (Cairncross 2001; Acs 2002, p. 157). For instance, Torre (2008, p. 879) doubts that physical proximity holds sway as temporary geographical proximity is already sufficient from his point of view. Maskell et al. (2006) also emphasise the role of temporary geographical proximity. They focus on international conferences which serve as *"temporary clusters"*, thereby eliminating the restrictions from spatial proximity (Maskell et al. 2006, p. 999). The relevance of geographical proximity also depends on institutional factors like company sizes (Torre 2008, p. 886, Warnecke 2016, p. 170) since smaller companies have a higher tendency towards regional cooperation (de Jong and Freel 2010, p. 48; De Fuentes and Dutrénit 2014). With reference to Torre (2008, p. 886), they are bound to their regions, while the opposite holds true for larger companies.

The absorptive capacity of companies is the second aspect of critical importance (Laursen et al. 2011). With an increasing absorptive capacity, a potentially existing dependence on regional knowledge flows should decrease. Uzzi (1997) argues that too much proximity (*"embeddedness"*) limits economic performance because local networks are hardly able to absorb knowledge from outside the region hence being susceptible to exogenous shocks.

Furthermore, literature provides some examples that spillovers do not necessarily arise locally. For example, Bottazzi and Peri (2003) demonstrate that knowledge diffuses within a geographical radius of 300 km, while Maietta (2015, p. 1356) identifies relevant knowledge spillovers within in a range of 150 km. On another note, Audretsch and Stephan (1996, p. 650) have proven that 70% of links between higher education institutions and companies in the US biotechnology sector take place outside of regions. In this case, a region (e.g. San Francisco Bay Area) should be larger than single cities, but smaller than federal states or sub-national regions (Audretsch and Stephan 1996, p. 642).

Despite all these contradictions, it can still be concluded that tacit knowledge is a local 'sticky' form of knowledge (Asheim and Isaksen, 2002). Furthermore, sharing tacit knowledge is a *"contact sport"* (Agrawal 2006, p. 65) since it depends on close personal interaction (Morgan 2004, p. 12). Following Morgan (2004, p. 8), *„[...] something gets lost, or degraded […]"* when knowledge is transmitted over long distances. Despite globalisation and the worldwide cross-linkage of information and knowledge, physical proximity is still important and can be seen as *„[…] a powerful force in shaping patterns of innovation and learning […]"* (Healy 2009, p. 89).

Although a lot of research has been conducted with respect to the importance of proximity within the knowledge transfer process, there are still unanswered questions, like *"[…] when and why geographic proximity between actors would be crucial for successful interaction in innovation activities."* (Broström 2010, p. 1311). Our empirical study contributes to this field of research by further exploring factors which shape the spatial focus of cooperation between HEIs and economic industries (HI-interactions) with respect to Germany.

[2] With reference to Boschma (2005), geographical proximity is not the only form of proximity. Aside from this, relational forms of proximity such as cognitive, organisational, social and institutional proximity exist.

In principle, HI-interactions can be analysed from the perspectives of HEIs as well as companies (Motohashi 2005, p. 584; Schartinger et al. 2002, p. 308), but most published empirical studies are primarily based on company surveys (Cowan and Zinovyeva 2013, p. 789; e.g. Laursen and Salter 2004; Motohasi 2005; Segarra-Blasco and Arauzo-Carod 2008; Giuliani and Arza 2009; Broström 2010; de Jong and Freel 2010; Bruneel et al. 2010; Robin and Schubert 2013; Cowan and Zinovyeva 2013; Maietta 2015). The former perspective – especially research focusing on professors (e.g. Schartinger et al. 2002; Meyer-Krahmer and Schmoch 1998) – is widely unexplored due to a lack of broad survey data. Therefore, we have chosen to contribute to this research perspective by providing a unique combination of innovative survey data and complex statistical modelling.

In addressing arising questions as well as bridging the gap in this particular area of research, our empirical data were gathered from the largest survey among German professors carried out to date – a total number of 7,500 participants was realized.[3] Previous attempts made at gathering survey data of this nature yielded little results with only sparse, unrepresentative datasets (e.g. Knödler and Tiving (1996) [105]; Schmoch (1997) [433]; Backhaus (2000) [252]; Czarnitzki et al. (2000) [723]; Meißner (2001) [130]; Rosner and Weimann (2003) [72]; Rosenfeld et al. (2005) [131]; Gerlach et al. (2005) [174]; Spehl et al. (2006) [509]; Knappe (2006) [36]; Hagen (2006) [96]; Fritsch et al. (2007) [542]; Haisch (2008) [72]; Koschatzky et al. (2011) [1600]; Koglin (2011) [131]).[4]

These surveys received a combined total feedback of 5,006 participants with an average number of 313 responses per survey. Moreover, the results received from these surveys are mostly based on datasets including on average 1 to 3 HEIs and thus providing a insufficient foundation for credible conclusions. In comparison, our data provide information on 7,500 participants from 275 institutions in all federal states of Germany. Therefore, the dataset employed in this research paper captures a greater variety of German HEIs by providing responses from professors at very large Universities (e.g. Ludwig-Maximilian University of Munich) as well as medium-sized Universities (e.g. Chemnitz University of Technology), very small Universities (e.g. University of Erfurt) and UAS.

A huge share of the institutions included in our dataset is in the densely populated German states (e.g. North Rhine-Westphalia), but institutions from less densely populated German states (e.g. Saarland) are represented in this unique data compilation as well. In addition, our dataset provides of response from nearly all fields of research found at German HEIs, while previous studies had a strong focus on technical fields – thus providing a large compilation of information from a quantitative as well as qualitative perspective.

3. Econometric analysis

3.1. Data

The following analysis is mainly based on a German-wide online survey among professors on knowledge transfer from HEIs. The survey was conducted from March 2013 to September 2013 and reached a total number of 7,500 respondents after three reminders. The questionnaires focused on the intensity and spatial dimension of various channels of knowledge transfer, including some structural characteristics regarding the scholars. Within the duration of this survey, 47,472 E-Mails were sent (Warnecke 2016, p. 89 et seqq.) to addresses taken from the directory of professors (volume

[3] Further information concerning this survey can be found in section 3.1 and Warnecke (2006, p. 89 et seqq.).

[4] The number in square brackets is the amount of participants of the particular study.

I and II) (Deutscher Hochschulverband, 2011; Deutscher Hochschulverband, 2012). Furthermore, data provided by the Federal Statistical Office of Germany on *"Financial resources per professors"* and *"R&D-staff within the federal state per professor"* were added to our survey data (DeStatis 2014; DeStatis 2015). The data on *"Age of HEIs"* and *"Number of HEIs within a driving distance of 60 minutes by car"* were calculated based upon information from the handbook of Universities and Universities of Applied Science (UAS) [*"Handbuch der Universitäten und Fachhochschulen 2012"*] (De Gruyter Sauer, 2012).

3.2. Model

3.2.1. Overview

As previously stated, our dataset contains information about the individual characteristics of the professors (e.g. field of research and teaching), the institutional origin of the professors (e.g. name of the institution of research and/or teaching) and the federal states associated with each institution (e.g. North Rhine-Westphalia). This allows for a statistical integration of secondary data sources and indicates a hierarchical or nested data structure with three different levels: The individual responses of professors (level 1) and variables related to the HEIs (level 2) as well as the federal states (level 3). In order to handle this hierarchical structure of our data, a multilevel approach is employed.

In methodological literature, models with a particular focus on multiple levels have become known under a great variety of popular names, such as *"random coefficient models"* (de Leuuw and Kreft 1986; Longford 1993), *"variance component models"* (Longford 1987), *"hierarchical models"* (Bryk and Raudenbush 1992) or *"mixed-effects models"* (McLean et al. 1991). While all these models are not exactly the same from a mathematical point of view, they are largely similar and hence regarded as multilevel regression models within this research paper.[5]

A major benefit of multilevel models is the ability to explore effects of individual predictors while accounting for effects of observed as well as unobserved group characteristics, such as unobserved homo- and heterogeneity, thus providing an analytical benefit over regular regression models.

The general necessity for multilevel models arises from the fact that each individual response from professors within the survey is potentially influenced by both individual and contextual factors (e.g. financial resources per professor). Nevertheless, a vital consideration in hierarchical modelling is the trade-off between statistical complexity, which can result in an unnecessarily ambitious structure of multiple levels, and substantial effects, which may be located at higher levels. As hierarchical modelling structures can technically be considered as a generalized representation of regression models, the choice of a multilevel model should always be based on a precise theoretical basis or a substantial analysis of literature.

In our case, a previous study has shown that a multilevel approach is the suitable method for our types of data, although a Frequentist analysis within this earlier study has proven to be highly complex and very computationally intensive due to a group of sparsely populated clusters at the second and third level (Warnecke and Weller 2016). Accordingly, a Bayesian logistic multilevel model has been chosen to obtain more precise estimations and avoid difficult integration procedures.[6]

[5] The main commonality is that they are applied to hierarchical datasets with a single outcome or response variable given at the lowest level and explanatory variables observed at all existing levels.

[6] Further information on Bayesian statistics is given in section 3.2.2.

We would like to point out that a Bayesian approach to statistical modelling is capable of dealing with a higher degree of complexity than Frequentist methods as well as handling problems due to small sample sizes in higher level structures and thus is allowing researchers to focus much more on the exploration of substantial effects. Furthermore, we argue that a logistic three-level model is far from being unnecessarily ambitious.

The following equation displays a general logistic three-level model with a group variation intercept:

$$y^*_{ijk} = \log\left[\frac{\pi_{ijk}}{1-\pi_{ijk}}\right] = \beta_{0ijk} + \beta_1 x_{1ijk} + \beta_2 x_{2jk} + \beta_3 x_{3k} + v_k + u_{jk} + e_{ijk}$$

$$v_k \sim N(0, \sigma_v^2);\ u_{jk} \sim N(0, \sigma_u^2);\ e_{ijk} \sim N(0, \sigma_e^2)$$

In this equation, $\beta_{0ijk} + \beta_1 x_{1ijk} + \beta_2 x_{2jk} + \beta_3 x_{3k}$ denotes the population effects part of the model, while $v_k + u_{jk} + e_{ijk}$ represents the group effects part of the model.[7] The population effects part consists of a group variation intercept and predictor variables measured at each level, where x_{1ijk} is a level 1 predictor variable with coefficient β_1; x_{2jk} is a level 2 predictor variable with coefficient β_2 and x_{3k} is a level 3 predictor variable with coefficient β_3. The notation index i identifies individuals (professors), j represents the second level (HEIs) and k stands for the third level (federal states). In addition, all residual errors within the group effects part of the model are assumed to be normally distributed and statistically independent of predictor variables, while only the level 1 variance is fixed to $\frac{\pi^2}{3}$ as required in logistic regressions.

Our analysis considers three different company sizes (small, medium-sized and large companies) by utilising three different subsets of data: One subset includes Universities as well as UAS, while the remaining two subsets focus on Universities and UAS respectively. According to a definition of the European SME, every company with less than 50 employees is considered to be *"Small"*, while companies with 50 up to 250 employees are defined as *"Medium-sized"* and above 250 employees as *"Large"* (European Commission 2005, p. 14). This composition leads to nine different models, which are presented in Table 1:

Dataset / Company size	All HEIs	Universities	UAS
Small companies	1.a	1.b	1.c
Medium-sized companies	2.a	2.b	2.c
Large companies	3.a	3.b	3.c

Table 1: Composition of models; Source: Warnecke and Weller 2016, p. 9

We have chosen to use specific subset for Universities and UAS because these institutions differ significantly with respect to their functional characteristics: While research and teaching tend to be of equal importance at Universities, UAS have a much stronger focus on teaching – an average teaching load of professors at UAS is about 18 hours per week compared to 9 hours per week, which is the typical teaching load of professors at Universities. Additionally, UAS have a much smaller average

[7] In statistical literature, multilevel model equations are often described from a Frequentist perspective on statistical and probabilistic modelling, thus associated with the terms like *"fixed effects"* and *"random effects"* for both elements of the equation. Due to the Bayesian perspective on statistical modelling presented in this research paper, we avoid these terms following recommendations by Gelman and Hill (2006).

institutional size (approx. 6,000 students) compared to Universities (approx. 20,000 students). Another institutional distinction emerges from the fact that Universities are given the authority to award doctoral degrees and a much higher budget for research than UAS.

3.2.2. Bayesian Statistics

The key feature of Bayesian statistics is the frequent use of Bayes' theorem (Bayes 1763) leading to a fundamental distinction between observable quantities (i.e. survey data) and unknown quantities (i.e. coefficients), which can be thought of as random inference variables. In this research paper, we will refer to these quantities as θ and data as x.

In principle, Bayesian statistics diverges from the Frequentist framework by providing a different view of uncertainty. As every unknown parameter must be represented by a corresponding probability distribution before a statistical analysis, researchers are given a method to express their uncertainty about each parameter as well as to integrate previous knowledge into their models – thus presenting a practical alternative to highly complex analyses, which are often hard or impossible to realize via Maximum Likelihood estimation. A full review of Bayesian statistics is given by Jackman (2009) and Gelman et al. (2013).

While Bayesian modelling has a lot of practical benefits (e.g. higher precision results with small samples, probabilistic expression of uncertainty, etc.), a general concern is the fact that probability distributions can induce biases leading to potentially prejudiced results if those distributions are chosen incorrectly or highly subjective. We would like to point out that the choice of a probability distribution lies solely within a researcher's responsibility and should be argued for by presenting a credible reflection upon the benefits and pitfalls of a certain distribution.[8]

In a first step, researchers prepare an analytical model, which denotes a joined likelihood combining all variables to a full probability model by specifying $p(x|\theta)$. As stated previously, θ represents a probability distribution for each unknown parameter reflecting a researcher's uncertainty before any data analysis – this prior distribution is expressed by $p(\theta)$.

As empirical data x are analysed, they are conditioned within the context of Bayes' theorem to obtain the conditional distribution of unobserved quantities given the data – this is known as a posterior distribution, which expresses a researcher's uncertainty about θ after recognising the data:

$$p(\theta|x) = \frac{p(\theta)p(x|\theta)}{\int p(\theta)p(x|\theta)d\theta}$$

This formula states that a posterior probability results from a ratio of a product of prior probability and likelihood, as well as data.

In general, Bayesian statistics does not have more or better information than Frequentist statistics, but it provides an elegant way of presenting information with respect to connecting modelling with empirical data. Furthermore, Bayesian modelling procedures can handle a few analytical problems otherwise intractable by Frequentist Maximum Likelihood procedures.

[8] In this research paper, we present the argument for our particular prior distributions in section 3.2.3.

3.2.3. Estimation process

As stated previously, we chose to estimate a group of nine logistic multilevel models to uncover factors influencing the spatial focus of HI-interactions over institution types and company sizes. Since Bayesian analyses are computationally intensive, we apply a sequential estimation process, which combines a relatively high estimation precision with a high computational stability given a certain time frame (5 hours) for all models:

Firstly, we specify prior distributions for every population effect model parameter, but we chose to use relatively weak-informative priors by stipulating uniform distributions to reflect the fact that previous knowledge about this particular field of research is relatively sparse (Warnecke and Weller 2016). A key characteristic of weak-informative or non-informative prior distributions is that all parameters are essentially equal to estimations obtained by Maximum Likelihood procedures, but much less distorted.[9] In addition, it should be pointed out that these types of prior distributions can be used to let the data speak for themselves by allowing them to dominate the posterior distribution as well as to preserve statistical inferences from unjustified biases.

As prior distributions for the variances of the group effects residual errors, we apply inverse gamma distributions with shape and ratio parameters of 0.001. These distributions are commonly used as weak-informative priors in Bayesian multilevel modelling. Subsequently, initial values for all model parameters are established.

We apply various iterative generalized least squares estimations (IGLS) during this process, as our chosen statistical software MLwiN (Rasbash 2009) can estimate penalized quasi-likelihood (PQL) and marginal quasi-likelihood (MQL) of the first and second order. These estimation methods are necessary because the likelihood of the observed data in a multilevel model often has a closed form. All four methods have significant distortions (estimation biases) in case of small numbers of observations for the higher levels or very unevenly distributed predictor proportions. Within the framework of our analysis, we utilise both second-order methods for exploring proper initial values.

A penalized quasi-likelihood provides the most precise approach but takes a long time for converging and has proven to be the least stable, whilst a marginal quasi-likelihood is the most stable, but imprecise method. Our sequential estimation procedure starts by using MQL parameter estimations as starting values for the more precise PQL method, which subsequently provides adequate starting values for the Markov Chain Monte Carlo simulation (Browne 2009). This procedure has proven to be very efficient in solving numerical problems associated with Frequentist multilevel modelling.

After proper starting values are provided by Frequentist approaches and prior distributions for each model parameter are defined, a Markov Chain is established to obtain all parameters of a model by sequential sampling from the conditional joint posterior distribution. As a general practice, we disregard the first 750,000 values generated by the Markov Chains as every chain has to complete a certain number of iterations to approach its conditional joint posterior distribution and get over initial poor-quality estimates – this first phase is known as *"burn-in phase"*, *"warm-up phase"* or *"adaptation phase"*.

[9] At this point, it should be noted that a non-informative prior is a merely hypothetical concept, because prior distributions assume that every form of probability statement is to some extend an informative statement.

After this initial phase, a chain should converge to its stationary state and run for a *"monitoring phase"* or *"sampling phase"* of 4,250,000 iterations, which is used to calculate averaged estimates of the parameters of interest (e.g. means and standard deviations) for the posterior parameters. Furthermore, interval estimates are also easy to obtain from the posterior distribution (e.g. credible intervals, which are intervals within which a parameter of interest lies with a certain probability).

Since researchers are responsible for both, the length of the burn-in phase and monitoring phase, we have chosen relatively long phases to produce precise estimations. In addition, we have chosen these lengths to reflect the fact that we haven't used very informative priors to produce a more rapid convergence to the equilibrium distribution. In our pursuit to achieve highly effective sampling results, we chose to reduce all chains by a high thinning factor of 100, which means that only every 100th iteration is considered for the calculation of averaged estimates. This produces highly compressed, but less auto-correlated chains of 42,500 iterations.

To obtain posterior parameters during a monitoring phase, sampling procedures are applied to the joint posterior distribution. The problem of these sampling processes is that complex statistical models involve multidimensional integration procedures, which are often hard or impossible to solve analytically. In principle, the fundamental idea of sampling is that a group of parameters is updated and repeated for a certain number of iterations. As sampling from the posterior distribution can be realized via the Gibbs-Algorithm as well as the Metropolis-Hastings-Algorithm, we have chosen to estimate and compare our nine models with both sampling procedures for an evaluation of our modelling process. Both samplers yielded almost identical results, which we had expected because the Gibbs Sampler is a special case of the Metropolis-Hastings-Algorithm.

To ensure that all chains have reached their stationary state, we followed Geweke's work (1992) and compared the means of the parameters of interest for the first ten and the last fifty percent of chain iterations as convergence diagnostic within the respective models. All tests reported equal means, which strongly supports the hypothesis that the sampled values were drawn from conditional joint posterior distributions.

3.3. Variables

All dependent variables are binary responses indicating whether cooperation between professors and companies of relevant sizes takes place within (1) or outside the region of the HEI (0). To obtain these dichotomous responses, ordinal variables (see questionnaire (Appendix A1), 1st column, no. 13) were transformed as follows: *"University region up to 50 km"* (1) is allocated as 1. The categories *"Federal state (excl. university region)"* (2), *"Other parts of Germany"* (3) and *"International"* (4) were converted into 0.

As predictor variables, individual responses from our survey (level 1) as well as information related to HEIs (level 2) and federal states (level 3) are utilised. The following listing describes all variables which are either not self-explanatory or where additional information is necessary. A full summary of all utilised variables is provided in Table 2.

With respect to **scientific disciplines**, *"Medicine and health sciences"* and *"Veterinary medicine"* were merged in the course of the assessment. The same applies to *"Arts and aesthetics"* and *"Linguistics and Cultural studies"* due to their perceived close ties. To reduce complexities within the statistical estimation process, the discipline *"Sports"* was categorised under *"Others"*.

All employed variables for the **cooperation intensity** vary with respect to the independent variables, which implies that if the independent variable relates to medium-sized companies, the cooperation intensity will also refer to medium-sized companies.

The **age of the HEIs** was calculated using the founding year of each institution. Therefore, the oldest HEI in our dataset is 65 years old (2014 minus 1949) since the founding day (23th May 1949) of the Federal Republic of Germany was used as a reference.

The **number of HEIs within driving distance of 60 minutes** by car was estimated as follows: The coordinates of all relevant HEIs were referenced using the program IC-GeoAddressValidation for this transformation. Based on these references, the number of HEIs within driving distance of 60 minutes by car was determined using IC-DistanceAnalysis. A drive-time zone of 60 minutes is justified as it represents the maximum distance most commuters are willing to drive (Yang 2014, p. 309 et seq.).

Financial resources per professor are the sum of third party and basic funding within each institution divided by the corresponding number of professors.

R&D-staff within federal state per professor only captures the R&D from the private sector.

Variables	**Reference**
Variables related to professors	
Scientific discipline	See questionnaire (Appendix A1), 1st column, no. 4
Time budget for research	See questionnaire (Appendix A1), 1st column, no. 5
Application relevance of research	See questionnaire (Appendix A1), 1st column, no. 6
Number of supervised dissertations	See questionnaire (Appendix A1), 1st column, no. 7
Cooperation intensity with companies	See questionnaire (Appendix A1), 1st column, no. 12
Regional fit of the research	See questionnaire (Appendix A1), 1st column, no. 22
Variables related to HEIs	
Age of the HEIs	De Gruyter Sauer, 2012, own calculation (Appendix A2)
Number of HEIs within driving distance of 60 minutes by car	De Gruyter Sauer, 2012, own calculation (Appendix A2)
Financial resources per professors	DeStatis 2015 (Appendix A2), own calculation
Variables related to federal states	
R&D-staff within federal state per professors	DeStatis 2014 for R&D-staff (Appendix A3), special evaluation by DeStatis for total number of professors (Appendix A4), own calculation

Table 2: Variables; Source: Compiled and designed by the authors

3.4. Hypotheses

All factors contributing to a spatial focus of the HI-cooperation within regions are called *"pull factors"* (+), while all opposing factors are labelled *"push factors"* (-). The following listing is a description of our analytical hypotheses,[10] while Table 3 summarizes the expected directional effects of our model coefficients:

H1. Substantial differences in relation to the spatial pattern of cooperation activities for each scientific discipline are presumed to be existent (Martinelli et al. 2008; Bekkers and Freitags 2008, p. 1848). This suggests that some fields of research manifest as push attributes, while others present themselves as pull factors.

H2. A high teaching load is assumed to be an obstacle for cooperation outside of regions (Rosenfeld 2003, p. 9). With a decreasing time budget for teaching, more time for research should be available hence promoting cooperation activities outside of regions.

H3. Companies mostly search for cooperation partners within a close proximity (de Jong and Freel 2010, p. 52), as interaction on a regional level is comfortable and cost-effective. If a local supply of research provided by HEIs matches a potential local knowledge demand of companies, it is assumed to be more likely that cooperation would have a regional focus (de Jong and Freel 2010, p. 48; Maietta 2015, p. 1356).

H4. According to H3, cooperation outside of regions is assumed to be strengthened by a higher monetary budget per professor. In this sense, the financial budget per professor should be a push factor.

H5. A company's ability to integrate external knowledge into an innovation process depends largely upon its absorptive capacity (Cohen and Levinthal 1990, p. 141). An input-based measure of absorptive capacity is the number of persons in R&D departments (Lewandowska 2015, p. 39; Abreu et al. 2008, p. 15 et seq.). A high number of employees in R&D within federal states is presumed to lead to more cooperation on a regional level (pull factor).

In addition to these five hypotheses, we expect a group of predictor variables to have minor effects on regional cooperation between professors as representatives of their HEIs and companies. As there might be a higher local demand for applied research, we argue that an increased orientation of professors towards applied research increases the chance of a regional focus of cooperation. In contrast, we consider the number of supervised dissertations to be a push factor leading to more recognition of scholars outside of their regions and decreasing the chance of a regional cooperation.

Furthermore, we expect a higher frequency of local cooperation to be more easily facilitated and cost efficient than cooperation outside of regions since cooperation over spatial distances requires resources. Therefore, cooperation intensity is regarded as a pull factor. In addition, the age of an HEI could be considered a pull factor since a transformation of regional economies towards a higher absorptive capacity (Cohen and Levinthal 1990) is a protracted process (Jacob et al. 2003; p. 1555). On

[10] We have originally developed our hypotheses for a previous publication, which investigates this research topic from a Frequentist perceptive (Warnecke and Weller 2016, p. 12 et seq.).

the other hand, it could be argued that it takes a long time to receive recognition for scientific achievements outside a region, which would make the age of HEIs a push factor.

As a matter of fact, the number of HEIs within driving distance of 60 minutes by car could also be a pull as well as push factor: It might be a pull factor if a high number of HEIs in a particular area leads to companies, who are experienced in cooperating with academic agents. This type of clustering might facilitate regional HI-interaction (Broström 2010, p. 1312). On the other hand, a higher number of HEIs within a region could also indicate a strong competition over cooperation partners. Thus, it would be a push factor, as scholars would have to look for cooperation outside of their respective regions.

Individual variables	
Scientific discipline	+/-
Time budget for research	-
Application relevance of research	+
Number of supervised dissertations	-
Cooperation intensity with companies	+
Regional fit of the research	+
Variables related to the HEIs	
Age of the HEI	+/-
Number of HEIs within driving distance of 60 minutes by car	+/-
Financial resources per professors	-
Variables related to the federal state	
R&D-staff within federal state per professors	+

Table 3: Expected directional effect of coefficients; Source: Compiled and designed by the authors

4. Results

Tables 4 to 6 show the results of our Bayesian logistic multilevel regression models, where each table provides an overview of the models for our three datasets related to one of three company sizes. The following is a description of our models relating to Universities (1.b, 2.b, 3b) and UAS (1.c, 2.c, 3c) respectively.

All listed values are logit coefficients, which can be transformed to odds ratios using the natural exponential function for interpretation purposes. The odds ratios correspond a percentile change in the chance of cooperation taking place within regions of HEIs, where a value greater than 1 corresponds to an increase in chance with every additional unit or change of category to succeeding categories, while values lesser 1 represent a decreased chance for cooperation within regions of HEIs. Subsequently, each figure can be interpreted as follows:

The coefficient of -2.046 for *"Agricultural, forestry and food sciences"* (table 5, Universities) can be converted to a factor of 0.129 (=exp(-2.046)). Given this result, it could be inferred that a professor in this field of research has a reduced chance of cooperation within the region compared to professors in the reference category *"Management and economics"* – everything else being equal a reduction of 87.08 %. Another example is given by the estimated coefficient of -0.278 reported for time budget for research (table 6, UAS), which corresponds to a decreasing factor of 0.242. This simply implies that, if all other variables are held constant, an increase in the time budget for research by 10 % would induce a reduced chance for cooperation in the region by 24.27 %.

The statistical results show that some fields of study exert a credible influence on whether a cooperation between professors and companies takes place within the regions of their HEIs or not.

The fields of research *"Medicine, health sciences and veterinary medicine"*, *"Natural sciences"* and *"Law"* are statistically credible for all company sizes in the case of Universities, while *"Agricultural, forestry and food sciences"* as well as *"Engineering sciences"* are credible for small and medium-sized companies. Another statistically credible result is reported for *"Social sciences"* and medium-sized companies. Furthermore, the influence of research disciplines has proven to be strongest with respect to medium-sized companies for Universities. As a preliminary conclusion, our first hypothesis is largely confirmed with respect to Universities.

While there are no credible subjects for UAS relating to big companies, some credible results are evident for *"Engineering sciences"* regarding cooperation with small and medium-sized companies. In addition to that, there is a statistically credible influence of *"Arts, aesthetics, cultural studies and linguistics"* regarding cooperation with small companies. The same applies to *"Agricultural, forestry and food sciences"* concerning medium-sized companies. Consequently, our first hypothesis should be rejected for UAS.

As an interim result, more statistically credible influences of research disciplines can be observed for Universities in comparison with UAS. In these cases, the fields of research have a negative logit coefficient, which means that the chance of cooperating within the region is reduced in comparison to the reference category *"Management and economics"*. The effect of disciplines is stronger for Universities in cases where the category is credible for both Universities and UAS. By these results, it can be concluded that the disciplines of professors are more relevant for Universities compared to UAS regarding the spatial focus of cooperation.

In contrast, the time budget for research has a higher relevance for professors at UAS. This variable is statistically credible for every company size and has shown a negative logit coefficient. This further buttresses the fact that the time budget is the main factor shaping the spatial focus of cooperation with professors at UAS. In contrast, our models have shown only one acceptable coefficient for professors at Universities in the case of cooperation with small companies. These results lead to the conclusion that our second hypothesis can be confirmed for professors at UAS, while it must be rejected for professors at Universities.

The regional fit of research activities, which measures the extent of how strongly professors direct their research activities towards the needs of the regional economies, is credibly relevant for some categories for Universities and UAS. These coefficients are positive in value suggesting that a higher regional fit of research is a pull factor. Nonetheless, these effects are limited to cooperation with small and medium-sized companies as no credible coefficients are found for cooperation with big companies. Therefore, our third hypothesis should be accepted in these few relevant cases.

The application relevance of research is merely credible for one category with respect to cooperation with big companies in the case of professors at Universities. The same applies for the cooperation intensity with respect to cooperation with medium-sized companies.

Within the course of this research, we have shown that the context-related variables on the level of HEIs (the age of the HEI, the number of HEIs within an area of 60 minutes by car and the financial

resources of the professors) and the level of the federal states (number of R&D-staff per professor) were statistically trivial, so that our fourth and fifth hypotheses must be rejected.

However, a closer look at the Variance Partition Coefficients (VPC) (Goldstein 2011) shows that some proportions of variance within our models can be attributed to the second and third level. In the case of the Universities, the value of the VPC increases with company size for the second level as well as the third level. For the UAS, an increase was only evident for the second level. As bigger companies are much more capable of initiating cooperation with partners from outside their respective regions, institutional attributes of Universities and UAS should be considered more relevant for these types of companies. In conclusion, institutional attributes are an increasingly dominant factor governing the spatial focus of cooperation aside from individual factors. For the third level, an inverted relationship between company size and the VPC can be observed for UAS.

Bayesian Logistic Multilevel Models (Logit Coefficients)

Datasets	All HEIs	Universities	UAS
Models	1.a	1.b	1.c
Level 1: Professors	2,007	1,287	720
Level 2: HEIs	172	78	94
Level 3: Federal States	16	16	16
Population Effects:			
Variables related to professors:			
Scientific discipline (reference: Management and economics)			
Agricultural, forestry and food sciences	-1.3794*** (0.3107)	-1.7876*** (0.4388)	-0.9056* (0.5114)
Medicine, health sciences and veterinary medicine	-0.7899*** (0.2078)	-1.0016*** (0.2623)	0.2959 (0.6316)
Engineering sciences	-0.5087*** (0.1669)	-0.6442** (0.2576)	-0.5022** (0.2358)
Mathematics and computer sciences	0.2709 (0.2021)	0.1839 (0.2838)	0.4067 (0.312)
Natural sciences	-0.524*** (0.1906)	-0.664*** (0.2475)	-0.2576 (0.4229)
Law	-0.874** (0.3684)	-1.2395** (0.4814)	0.3112 (0.8256)
Social sciences	-0.3817 (0.2439)	-0.4075 (0.2997)	-0.4836 (0.5573)
Arts, aesthetics, cultural studies and linguistics	-0.3926 (0.2686)	-0.2879 (0.3217)	-1.3955** (0.6967)
Others scientific disciplines	-0.098 (0.293)	-0.2502 (0.3797)	0.2551 (0.5285)
Time budget for research	-0.1516*** (0.3072)	-0.1201*** (0.0372)	-0.1983*** (0.0675)
Application relevance of research (reference: Basic orientation)			
Fairly basic orientation	0.2943 (0.2446)	0.4016 (0.2623)	-0.6825 (0.824)
Mixed	0.0879 (0.2291)	0.2243 (0.2502)	-0.6347 (0.7497)
Fairly application based	0.0372 (0.2349)	0.0975 (0.263)	-0.5499 (0.7353)
Application base	0.3274 (0.2403)	0.2651 (0.2823)	-0.1711 (0.7351)
Number of supervised dissertations	-0.0178 (0.0188)	-0.0136 (0.0196)	0.0015 (0.1414)
Cooperation intensity (reference: Never)			
Rarely	0.7257* (0.4208)	0.8701* (0.4774)	-0.8094 (1.4846)
Now and then	0.7789* (0.4233)	0.7426 (0.4822)	-0.3083 (1.4866)
Often	0.6159 (0.4293)	0.6548 (0.4935)	-0.6194 (1.4859)
Very often	0.458 (0.4463)	0.666 (0.5274)	-0.9306 (1.4933)
Regional fit of research (reference: Strongly disagree)			

Disagree	0.2202	0.2447	0.2467
	(0.1538)	(0.1673)	(0.4305)
Mixed	0.3839**	0.4064**	0.5646
	(0.1584)	(0.1801)	(0.4077)
Agree	0.727***	0.2767	1.3378***
	(0.1718)	(0.216)	(0.4079)
Totally agree	0.6613**	-0.0164	1.3141***
	(0.2696)	(0.4571)	(0.4886)
Variables related to HEIs:			
Age of the HEI	-0.0045	-0.0088	-0.0045
	(0.0042)	(0.0056)	(0.0083)
Number of HEIs within driving distance of 60 min. by car	0.0079	0.0051	0.0094
	(0.0069)	(0.0078)	(0.0147)
Financial resources per professors	-0.0002	0.0003	-0.0005
	(0.0002)	(0.0003)	(0.0031)
Variables related to federal states:			
R&D-staff within federal state per professor	0.0037	-0.0106	0.0091
	(0.015)	(0.0168)	(0.0318)
Constant	-0.0196	-0.174	1.57
	(0.5377)	(0.6747)	(1.8652)
Group Effects:			
Level 2: Variance	0.0204	0.0246	0.0527
VPC	0.0062	0.0074	0.0158
Level 3: Variance	0.0324	0.0252	0.1485
VPC	0.0097	0.0075	0.0425

Explanatory notes: Standard Deviations in brackets; ***, ** and * denote credibility at 1, 5 and 10 percent levels.

Table 4: Results for model group I – cooperation with small companies

Source: Compiled and designed by the authors

Bayesian Logistic Multilevel Models (Logit Coefficients)

Datasets	All HEIs	Universities	UAS
Models	2.a	2.b	2.c
Level 1: Professors	1,741	1,057	684
Level 2: HEIs	173	79	94
Level 3: Federal State	16	16	16
Population Effects:			
Variables related to professors:			
Scientific discipline (reference: Management and economics)			
Agricultural, forestry and food sciences	-1.4685*** (0.4095)	-2.0462*** (0.6165)	-1.2828** (0.5972)
Medicine, health sciences and veterinary medicine	-0.9678*** (0.2485)	-1.508*** (0.3166)	0.005 (0.5868)
Engineering sciences	-0.8582*** (0.1747)	-1.1684*** (0.3)	-0.7194*** (0.2241)
Mathematics and computer sciences	0.0601 (0.204)	-0.3968 (0.3181)	0.3619 (0.2822)
Natural sciences	-0.9982*** (0.2288)	-1.5639*** (0.3059)	-0.2271 (0.4226)
Law	-0.986** (0.4577)	-2.6424*** (0.8717)	1.0211 (0.841)
Social sciences	-0.4882* (0.2719)	-0.7942** (0.3438)	-0.3388 (0.5472)
Arts, aesthetics, cultural studies and linguistics	-0.2737 (0.3211)	-0.6188 (0.386)	-0.6943 (0.8551)
Others scientific disciplines	-0.3122 (0.3252)	-0.7695 (0.4701)	0.0684 (0.484)
Time budget for research	-0.0948** (0.0379)	-0.0303 (0.0505)	-0.1934*** (0.0718)
Application relevance of research (reference: Basic orientation)			
Fairly basic orientation	-0.2119 (0.3320)	-0.0354 (0.3787)	-1.5015* (0.899)
Mixed	-0.2074 (0.3011)	-0.0007 (0.352)	-1.1004 (0.7826)
Fairly application based	-0.2445 (0.3069)	-0.1004 (0.3682)	-1.0383 (0.7702)
Application base	-0.0152 (0.31)	-0.0366 (0.3911)	-0.7534 (0.7639)
Number of supervised dissertations	-0.0285 (0.0251)	-0.0253 (0.0266)	-0.0074 (0.1458)
Cooperation intensity (reference: Never)			
Rarely	-0.4182 (0.4727)	-0.2796 (0.5578)	-0.8951 (1.1582)
Now and then	-0.7071 (0.479)	-0.6982 (0.5696)	-0.9191 (1.1631)
Often	-0.9321* (0.4884)	-1.3035** (0.6051)	-0.948** (1.1618)
Very often	-0.972* (0.5379)	-0.9174 (0.6976)	-1.1133* (1.2043)
Regional fit of research (reference: Strongly disagree)			

Disagree	0.0962	-0.0056	0.5544
	(0.2033)	(0.2341)	(0.4835)
Mixed	0.3493	0.3829	0.5804
	(0.2025)	(0.2414)	(0.454)
Agree	0.7192***	0.6456**	1.0536**
	(0.2093)	(0.2753)	(0.4435)
Totally agree	0.5577*	0.1058	0.984*
	(0.299)	(0.5669)	(0.5067)
Variables related to HEIs:			
Age of the HEI	-0.0024	-0.0037	0.0011
	(0.005)	(0.0074)	(0.0081)
Number of HEIs within driving distance of 60 min. by car	0.0074	0.0027	0.0121
	(0.0086)	(0.0114)	(0.0131)
Financial resources per professors	-0.0003	-0.0002	0.0001
	(0.0002)	(0.0004)	(0.0031)
Variables related to federal states:			
R&D-staff within federal state per professor	0.027	0.0385	0.009
	(0.0197)	(0.0249)	(0.0271)
Constant	0.4532	0.3956	1.0168
	(0.6243)	(0.8517)	(1.5039)
Group Effects:			
Level 2: Variance	0.0607	0.0593	0.1203
VPC	0.0181	0.0177	0.0353
Level 3: Variance	0.0635	0.0889	0.09
VPC	0.0186	0.0258	0.0257

Explanatory notes: Standard Deviations in brackets; ***, ** and * denote credibility at 1, 5 and 10 percent levels.

Table 5: Results for model group II – cooperation with medium-sized companies

Source: Compiled and designed by the authors

Bayesian Logistic Multilevel Models (Logit Coefficients)

Datasets	All HEIs	Universities	UAS
Models	3.a	3.b	3.c
Level 1: Professors	2,050	1,336	714
Level 2: HEIs	173	79	94
Level 3: Federal State	16	16	16
Population Effects:			
Variables related to professors:			
Scientific discipline (reference: Management and economics)			
Agricultural, forestry and food sciences	-0.5881 (0.449)	-1.0401 (0.6523)	-0.2572 (0.6718)
Medicine, health sciences and veterinary medicine	-0.7846*** (0.2924)	-1.2075*** (0.3769)	0.8959 (0.6667)
Engineering sciences	-0.4911** (0.2028)	-0.6936* (0.3572)	-0.3234 (0.2576)
Mathematics and computer sciences	-0.0404 (0.2334)	-0.355 (0.3776)	0.3414 (0.3135)
Natural sciences	-0.6079** (0.256)	-0.9075*** (0.3399)	-0.3076 (0.49)
Law	-1.7962** (0.8597)	-2.6594** (1.3426)	-1.0209 (1.4272)
Social sciences	-0.2353 (0.3097)	-0.275 (0.3929)	-0.4879 (0.6544)
Arts, aesthetics, cultural studies and linguistics	0.581 (0.3595)	0.4675 (0.435)	0.2462 (1.0267)
Others scientific disciplines	0.3246 (0.3566)	0.5767 (0.4846)	-0.1316 (0.582)
Time budget for research	-0.074* (0.0443)	0.0172 (0.0576)	-0.278*** (0.0904)
Application relevance of research (reference: Basic orientation)			
Fairly basic orientation	-0.1636 (0.3187)	0.0626 (0.3428)	-2.2487* (1.2293)
Mixed	-0.4131 (0.2956)	-0.2957 (0.3297)	-0.7907 (0.9153)
Fairly application based	-0.5024* (0.305)	-0.5323 (0.3594)	-0.6063 (0.9008)
Application base	-0.4617 (0.3116)	-0.8841** (0.4223)	-0.5637 (0.8971)
Number of supervised dissertations	-0.0561 (0.0365)	-0.0618 (0.0397)	-0.0108 (0.1708)
Cooperation intensity (reference: Never)			
Rarely	-0.2598 (0.4562)	-0.0165 (0.6206)	-0.706 (0.786)
Now and then	-0.5923 (0.4599)	-0.3999 (0.627)	-0.7653 (0.7902)
Often	-0.8483* (0.4676)	-0.6008 (0.6423)	-1.116 (0.7923)
Very often	-0.7538 (0.4933)	-0.8866 (0.6977)	-0.563 (0.8245)
Regional fit of research (reference: Strongly disagree)			

Disagree	-0.1846	-0.2405	-0.1696
	(0.235)	(0.2674)	(0.5914)
Mixed	0.2476	0.2148	0.3718
	(0.2296)	(0.2739)	(0.5443)
Agree	0.7058***	0.5734*	0.8814*
	(0.2342)	(0.3017)	(0.5335)
Totally agree	0.9102***	0.8003	1.0422*
	(0.3273)	(0.527)	(0.6024)
Variables related to HEIs:			
Age of the HEI	-0.0005	-0.0135	0.016*
	(0.0066)	(0.0106)	(0.0096)
Number of HEIs within driving distance of 60 min. by car	0.0166	0.0138	0.02
	(0.0114)	(0.0187)	(0.0144)
Financial resources per professors	-0.0003	-0.0002	-0.0013
	(0.0003)	(0.0005)	(0.0037)
Variables related to federal states:			
R&D-staff within federal state per professor	0.0325	0.0644	-0.0185
	(0.0232)	(0.0377)	(0.0297)
Constant	-0.7665	-0.745	-0.1155
	(0.665)	(1.0482)	(1.5586)
Group Effects:			
Level 2: Variance	0.1347	0.2352	0.171
VPC	0.0393	0.0667	0.0494
Level 3: Variance	0.0832	0.2252	0.0726
VPC	0.0237	0.0601	0.0206

Explanatory notes: Standard Deviations in brackets; ***, ** and * denote credibility at 1, 5 and 10 percent levels.

Table 6: Results for model group III – cooperation with big companies

Source: Compiled and designed by the authors

5. Conclusion

The regression results of our Bayesian logistic multilevel models portray credible influences of several research disciplines and the time budget for research of professors. Moreover, across all models, only very few credible categories in total were identified for the *"Application relevance of research"* and the *"Cooperation intensity"*. These findings demonstrate that the different professional backgrounds and the volume of time available for research are the main driving factors shaping the spatial focus of HI-cooperation. The results also reveal differences between Universities and UAS.

A comparison of both subsets showed that the fields of research are potentially more important for the spatial focus of the cooperation with regard to the Universities – the variety of disciplines at Universities might be causally responsible for this. While UAS mainly focus on management and engineering (Fritsch and Slavtchev 2005, p. 1), Universities provide a broad spectrum of different academic subjects.

In accordance with the results, the time budget for research is the dominant factor for UAS. This outcome is not very surprising since professors at UAS have a high teaching load with an obligation to teach 18 hours of course per week, while professors at Universities only teach 9 hours per week (Koglin 2011, p. 26). This result is confirmed by Warnecke (2016, p. 178): 81.65 % of the professors at UAS compared to 31.46 % at Universities claim that a high teaching load is a serious obstacle for external cooperation activity.

As there are no credible results found on level 2 and level 3, one could think that a multilevel model was unnecessary and overly complex. Nevertheless, we have shown by analysis of the VPC that some proportions of variance within our models are explained by the second and third level. Apart from that, a multilevel approach is appropriate due to the existence of structured data in the present case.

The results show that the major factors influencing the focus of cooperation can be derived from the typical characteristics of both types of tertiary institutions. In this respect, the findings reveal that both types of institutions can be viewed as some type of artefact established by legislators. A policy implication could be seen even in this rather exploratory oriented approach, which suggests that if the desired result is sought in another direction, the task in both types of institution should be redefined.

Acknowledgements:

We would like to thank Franz Tödtling (WU Wien), Martin Falk (WIFO), Burton Lee (Stanford University) and the participants of the GfR winter seminar 2016 in Innsbruck, the participants of the 16th ISS conference 2016 in Montreal as well the participants of the 56th ERSA conference 2016 in Vienna for their helpful comments and constructive suggestions. Many thanks to Sabine Josten and Peter Aloa for proofreading our English manuscript.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Conflict of interest: The authors declare that they have no conflict of interest.

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Appendix A1 Questionnaire

Below is the questionnaire coined from Warnecke 2016, the original German version (Table A1-1) and the English version (Table A1-2). The choice options for the question *"Please choose from one of the following lists the university from where you operate [were last active]"* (Warnecke 2016, p. 231) can be found in Table A1-3 for Universities (V1 – V4) and in Table A1-4 for UAS (V5 – V6) respectively. The first 4 columns in tables A1-1 and A1-2 depict the individual questions within the respective questionnaire variants. In the case of the first column ("V1, V5") there are variants 1 and 5.

Which questionnaire variant may be directed to which target group can be seen in Figure A1-1. For example, variant 2 (V2) consist of questions addressed towards university lecturers with professor titles, who are emeritus professors or retired.

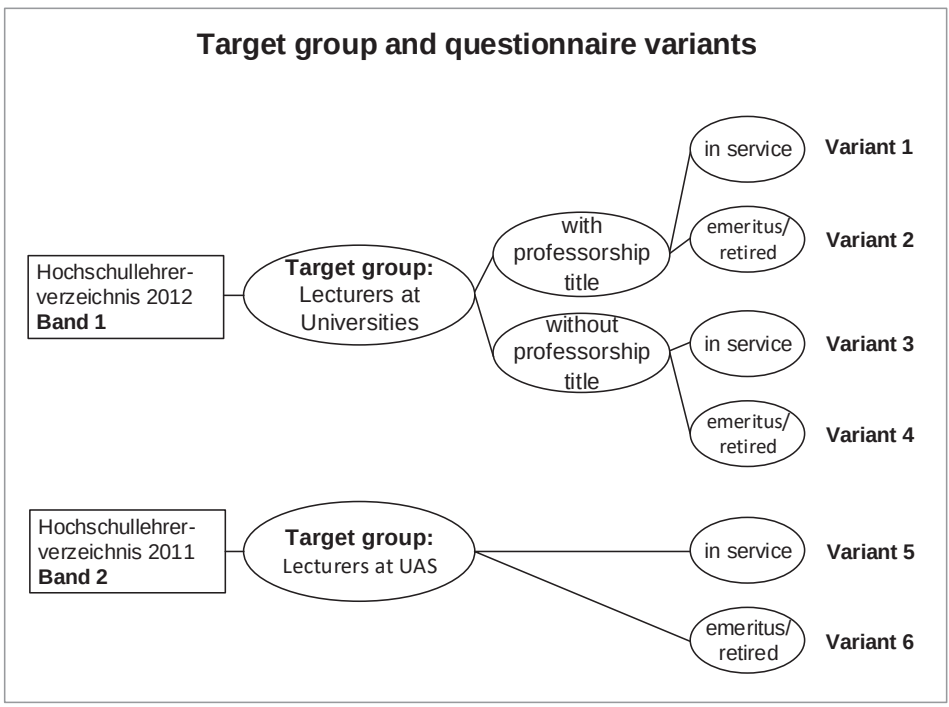

Figure A1-1: Target group and questionnaire variants
Source: Warnecke 2016, p. 90.

V1, V5	V2, V6	V3	V4	
1	1	1	1	*Sind Sie mit der Nutzung und Erhebung Ihrer Daten durch die Teilnahme an der folgenden Befragung einverstanden?* □ Ja, ich bin einverstanden. □ Nein, ich bin nicht einverstanden.
2	2	-	-	*Welche Professur haben [hatten] Sie inne?* □ Universitätsprofessur □ Honorarprofessur □ Sonstiges Auswahlmöglichkeit Fachhochschulprofessoren: □ FH-Professur □ Honorarprofessur □ Sonstiges
-	3	-	2	*Seit wann sind Sie emeritiert bzw. pensioniert? (Jahr)* ……
3	4	2	3	*Bitte wählen Sie aus einer der folgenden Listen die Hochschule aus, an der Sie tätig sind [zuletzt tätig waren]. Die Hochschulen in den Listen sind mit ihrem jeweiligen Standort angegeben und dementsprechend sortiert, um die Suche zu vereinfachen.* Table A1-3 bzw. Table A1-4
4	5	3	4	*Welche der angegebenen Fächergruppen gibt den Schwerpunkt Ihrer [damaligen] Lehrveranstaltungen an? Die Auswahl der Fächergruppen ist angelehnt an die Einteilung des Statistischen Bundesamtes (Fachserie 11, Reihe 4.3.2).* □ Agrar-, Forst- und Ernährungswissenschaften □ Humanmedizin/Gesundheitswissenschaften □ Ingenieurwissenschaften □ Kunst, Kunstwissenschaft □ Mathematik und Informatik □ Naturwissenschaften □ Rechtswissenschaften □ Sozialwissenschaften □ Sport □ Sprach- und Kulturwissenschaften □ Veterinärmedizin □ Wirtschaftswissenschaften □ Sonstiges □ Keine Angabe
5	6	4	5	*Wie verteilt [verteilte] sich Ihr berufliches Zeitbudget (bezogen auf Ihre Hochschultätigkeit) auf folgende Tätigkeiten?* *(Die Summe der Prozentangaben sollte 100 % betragen.)* 0 % 10 % 20 % 30 % 40 % 50 % 60 % 70 % 80 % 90 % 100 % Keine Angabe Lehrtätigkeit □ □ □ □ □ □ □ □ □ □ □ □ Forschung und Transfer □ □ □ □ □ □ □ □ □ □ □ □ (Selbst)Verwaltungsaufgaben □ □ □ □ □ □ □ □ □ □ □ □

V1, V5	V2, V6	V3	V4	
6	7	5	6	*Wie schätzen Sie [retrospektiv] den generellen Anwendungsbezug Ihrer Lehre und Forschung ein?* Grundlagenorientiert / Eher grundlagenorientiert / Gemischt / Eher anwendungsbezogen / Anwendungsbezogen / Keine Angabe Forschung □ □ □ □ □ □ Lehre □ □ □ □ □ □
7	-	6	-	*Bitte schätzen Sie die Anzahl der jährlich durch Sie betreuten Abschlussarbeiten.* Abschlussarbeiten (Bachelor, Master, Diplom): …… Dissertationen: ……
8	-	7	-	*Bitte schätzen Sie, in welchem Ausmaß von ihnen betreute Abschlussarbeiten einen regionalen Bezug zum Hochschulstandort (inkl. 50 km Umkreis) haben. Gemeint sind sowohl rein inhaltlicher regionaler Bezug als auch Arbeiten, die mit einem regionalen Praxispartner zusammen betreut wurden.* Regionaler Bezug von Abschlussarbeiten: keinerlei regionaler Bezug □ □ □ □ □ □ □ □ □ □ □ Ausschließ-lich regionaler Bezug □ keine Angabe
9	8	8	7	*In welchem Rahmen sind [waren] Praxisakteure (z. B. Unternehmen und fachliche Einrichtungen) in Ihre Lehre integriert? (Mehrfachnennungen möglich)* □ Vorträge, Lehrveranstaltungen oder Seminare durch Praxisakteure □ Projekte mit/für Praxisakteure(n) in Lehrveranstaltungen □ Vermittlung studentische Nebentätigkeit/fachbezogener Praktika bei Praxisakteuren □ Verbindung über duales Studium □ Es sind keine Praxisakteure im Bereich Lehre integriert □ Sonstiges: ……
10	-	9	-	*Inwieweit sind Sie zusätzlich zu Ihrer Tätigkeit als Hochschullehrer in die nachfolgenden hochschulexternen Aktivitäten eingebunden?* □ Ich bin Mitglied im Aufsichtsrat einer AG □ Ich bin Mitglied im Aufsichtsrat einer GmbH □ Ich bin Mitglied im Aufsichtsrat einer sonstigen Organisation □ Ich bin in sonstigen universitätsexternen Kommissionen, Gremien □ Trifft nicht zu □ Keine Angabe

V1, V5	V2, V6	V3	V4	
				bzw. Arbeitsgruppen tätig
11	-	10	-	*In welchem räumlichen Umfeld finden diese zuvor genannten hochschulexternen Aktivitäten überwiegend statt? (Mehrfachnennungen möglich)* □ Hochschulregion (Umkreis 50km) □ Übriges Bundesland □ Übriges Deutschland □ International □ Frage trifft nicht zu
12	9	11	8	*Wie häufig arbeiten [haben] Sie in Forschungs- und Praxisprojekten mit den folgenden Gruppen zusammen [zusammengearbeitet]?* Sehr häufig / Häufig / An und zu / Selten / Nie / Keine Angabe Unternehmen der Privatwirtschaft (<50 Beschäftigte) □ □ □ □ □ □ Unternehmen der Privatwirtschaft (50-250 Beschäftigte) □ □ □ □ □ □ Unternehmen der Privatwirtschaft (>250 Beschäftigte) □ □ □ □ □ □ Interessengruppen, Vereine, Stiftungen, Verbände □ □ □ □ □ □ Wissenschaftliche Institutionen, Hochschulen und Forschungseinrichtungen □ □ □ □ □ □ Sonstige staatliche Institutionen, öffentlicher Betrieb □ □ □ □ □ □
13	10	12	9	*In welcher Entfernung befinden [befanden] sich die Kooperationspartner überwiegend, mit denen Sie in Forschungs- und Praxisprojekten zusammenarbeiten [zusammengearbeitet haben]?* Hochschulregion bis 50km / Übriges Bundesland / Übrigens Deutschland / International / Keine Angabe Unternehmen der Privatwirtschaft (<50 Beschäftigte) □ □ □ □ □ Unternehmen der Privatwirtschaft (50-250 Beschäftigte) □ □ □ □ □ Unternehmen der Privatwirtschaft (>250 Beschäftigte) □ □ □ □ □ Interessengruppen, Vereine, Stiftungen, Verbände □ □ □ □ □ Wissenschaftliche Institutionen, Hochschulen und Forschungseinrichtungen □ □ □ □ □ Sonstige staatliche Institutionen, öffentlicher Betrieb □ □ □ □ □

V1, V5	V2, V6	V3	V4	
14	11	13	10	*Wie entstehen [entstanden] die Kontakte zu Ihren Praxispartnern? (Mehrfachnennungen möglich)* □ Tagungen, Konferenzen □ Bestehende Kontakte aus vorheriger Beschäftigung/Tätigkeit □ Transferzentren, Transferabteilungen □ Anfragen seitens der Praxispartner □ Eigene Kaltakquise □ Mitgliedschaft in thematisch relevanten Netzwerken □ Sonstiges: ……
15	12	14	11	*Für wie ausschlaggebend halten Sie die folgenden Aspekte für eine erfolgreiche Kooperation mit externen Partnern?* Vertrauen wichtig □ □ □ □ □ unwichtig Gleiche Wellenlänge wichtig □ □ □ □ □ unwichtig Räumliche Nähe zum Kooperationspartner wichtig □ □ □ □ □ unwichtig Moderne Kommunikation (z. B. Videokonferenzen etc.) wichtig □ □ □ □ □ unwichtig Bereits bestehende Kontakte wichtig □ □ □ □ □ unwichtig Häufige persönliche Kontakte wichtig □ □ □ □ □ unwichtig Hohe fachliche Übereinstimmung (inhaltlich, qualitativ) wichtig □ □ □ □ □ unwichtig Vertragliche Regelung der Zusammenarbeit wichtig □ □ □ □ □ unwichtig Gleiche Ziele wichtig □ □ □ □ □ unwichtig Sonstiges: ……

V1, V5	V2, V6	V3	V4	
16	13	15	12	*Welche der nachfolgenden Aspekte stellen am ehesten ein Hindernis für die Kooperation mit externen Partnern dar? (Beziehen Sie Ihre Antworten auf die Hochschule an der Sie momentan tätig sind [zuletzt tätig waren]). Bitte Zutreffendes ankreuzen. (Mehrfachnennungen möglich)* □ Bürokratische Hemmnisse auf Seiten der Unternehmen □ Nebentätigkeitsrecht/Genehmigungspflicht □ Mangelhafte Ressourcenausstattung (Personal, Sachmittel) □ Unzureichende Qualifikation der Mitarbeiter im Unternehmen □ Hohes Lehrdeputat □ Geheimhaltungs-interesse der Unternehmen (keine Publikationsmöglichkeit) □ Divergierende Zeithorizonte □ Abstimmungs- und Kommunikationsschwierigkeiten □ Keine geeigneten Kooperationspartner in der Region □ Aufwand und Kosten der Zusammenarbeit □ Geringe Zahlungsbereitschaft der Unternehmen □ Zu geringe staatliche Förderung von F+E-Kooperationen □ Kosten und Risiken der ersten Zusammenarbeit schwer einschätzbar □ Gefahr des Abwanderns von Mitarbeitern zum Kooperationspartner □ Keine Angabe Sonstiges: .....
17	-	16	-	*Bitte schätzen Sie, wie viele Publikationen von Ihnen insgesamt jährlich verfasst werden.* *(Bitte tragen Sie die geschätzte jährliche Gesamtzahl ein.)* Wissenschaftliche Veröffentlichungen, z. B. in Fachzeitschriften und Sammelbänden: □ 0 □ 1-2 □ 3-5 □ 6-10 □ 11-15 □ 16-20 □ Über 20 □ Keine Angabe „Graue Literatur“ (z. B. Tagungsberichte, Praxiszeitschriften z. B. IHK- Zeitschriften, Online-Veröffentlichungen, Institutsschriften): □ 0 □ 1-2 □ 3-5 □ 6-10 □ 11-15 □ 16-20 □ Über 20 □ Keine Angabe Sonstiges: □ 0 □ 1-2 □ 3-5 □ 6-10 □ 11-15 □ 16-20 □ Über 20 □ Keine Angabe

V1, V5	V2, V6	V3	V4	
18	-	17	-	*Bitte schätzen Sie, welcher Anteil dieser Publikationen einen inhaltlich regionalen Bezug aufweist.* a. Anteil mit inhaltlichem Bezug zur **Hochschulregion** (Umkreis 50km) □ 0 % □ 10 % □ 20 % □ 30 % □ 40 % □ 50 % □ 60 % □ 70 % □ 80 % □ 90 % □ 100 % □ Keine Angabe b. Anteil mit inhaltlichem Bezug zum **übrigen Bundesland** □ 0 % □ 10 % □ 20 % □ 30 % □ 40 % □ 50 % □ 60 % □ 70 % □ 80 % □ 90 % □ 100 % □ Keine Angabe
19	-	18	-	*Unternehmensgründungen (Spin-Offs) sind ein wichtiger Effekt von Forschung und Lehre. Haben Sie selbst, ehemalige Mitarbeiter oder Doktoranden in den letzten 5 Jahren Unternehmen gegründet?* □ Ja, Gründungen mit hoher Forschungsintensität. Anzahl: …… □ Ja, Gründungen mit niedriger Forschungsintensität. Anzahl: …… □ Keine Gründungen.
20	-	19	-	*In welcher Entfernung fanden diese Unternehmensgründungen überwiegend statt? (Mehrfachnennungen möglich)* □ Hochschulregion (Umkreis 50km) □ Übriges Bundesland □ Übriges Deutschland □ International □ Frage trifft nicht zu
21	14	20	13	*Als wie bedeutsam für die regionale Entwicklung würden Sie Ausgründung aus Ihrer Hochschule generell einschätzen? [Beziehen Sie Ihre Antworten auf den Standort, an dem Sie zuletzt tätig waren.]* Unbedeutsam □ Wenig bedeutsam □ Eher bedeutsam □ Sehr bedeutsam □ Keine Angabe □

V1, V5	V2, V6	V3	V4	
22	15	21	14	*Inwiefern stimmen Sie den folgenden Aussagen zu? [(Beziehen Sie Ihre Antworten bitte auf den Standort, an dem Sie zuletzt tätig waren.)]*

	Trifft gar nicht zu				Trifft voll und ganz zu
Die Hochschule richtet ihr **Lehrangebot** auf den Bedarf der regionalen Wirtschaft aus.	□	□	□	□	□
Die Hochschule richtet ihre **Forschungsaktivität** auf den Bedarf der regionalen Wirtschaft aus.	□	□	□	□	□
Die Hochschule ist für Unternehmen ein wichtiger **regionaler Standortfaktor**, da sie sich positiv auf die Attraktivität der Region als Unternehmensstandort auswirkt.	□	□	□	□	□
Durch die Anwesenheit der Hochschule ist das regionale **Angebot für die Freizeitgestaltung, das kulturelle und künstlerische Angebot** (z. B. Musik, Kunst, Sport) reichhaltiger.	□	□	□	□	□
Das **Innovationsklima** in der Region profitiert von der Existenz der Hochschule.	□	□	□	□	□
Die Existenz der Hochschule prägt das **Image** der Region.	□	□	□	□	□
Die regionale **Wirtschaft** wird durch die Hochschule **stabilisiert**.	□	□	□	□	□
Die Hochschule hat positiven Einfluss auf die **Qualität der Region als Wohnort**.	□	□	□	□	□

Table A1-1: Questionnaire (German version)
Source: Warnecke 2016, p. 231 et seqq.

V1, V5	V2, V6	V3	V4	
1	1	1	1	*Do you agree with the use and collection of your data by participating in the following survey?* □ Yes I agree. □ No, I do not agree.
2	2	-	-	*Which professorship do [have] you hold?* □ University professor □ Honorary professor □ Others Options UAS professors: □ FH-Professor □ Honorary professor □ Others
-	3	-	2	*Since when were you Professor Emeritus or retired? (Year)* ……
3	4	2	3	*Please choose from one of the following lists the university from where you operate [were last active]. The universities in the lists are given with their respective locations and sorted accordingly in order to simplify the search.* Table A1-3 bzw. Table A1-4
4	5	3	4	*Which of the following groups of subjects indicates the focus of your [former] Courses? The choice of subject groups is based on the classification from the Statistischen Bundesamtes (subject-matter series 11, number 4.3.2).* □ Agricultural, Forestry and Food Sciences □ Engineering Sciences □ Mathematics and computer science □ Law □ Sport □ Veterinary Medicine □ Others □ Medicine / Health sciences □ Art and Aesthetics □ Natural Sciences □ Social Sciences □ Linguistics and Cultural Studies □ Economics □ Not specified
5	6	4	5	*Allocate your professional time budget (based on your academic work) to the following activities?* *(The sum of the percentages should be 100 %)* Teaching Activities □ □ □ □ □ □ □ □ □ □ □ □ Research and Knowledge Transfer □ □ □ □ □ □ □ □ □ □ □ □ Administrative Tasks □ □ □ □ □ □ □ □ □ □ □ □ (0 % 10 % 20 % 30 % 40 % 50 % 60 % 70 % 80 % 90 % 100 % Not specified)

V1, V5	V2, V6	V3	V4	
6	7	5	6	*How would you rate [retrospectively] the general application relevance of your teaching and research?* Basic orientation / Fairly Basic orientation / Mixed / Fairly Application Based / Application Based / Not Specified Research □ □ □ □ □ □ Teaching □ □ □ □ □ □
7	-	6	-	*Please estimate the number of theses supervised by you yearly.* Final theses (Bachelor, Master, Diplom): …… Dissertations: ……
8	-	7	-	*Please estimate, to what extent the supervised theses have regional connection to the university location (incl. 50 km radius). This refers to both purely regional related content as well as works that have been supervised by a regional practice partner.* Regional Reference of Final theses — No regional reference at all □ □ □ □ □ □ □ □ □ □ □ Exclusive regional reference □ Not specified
9	8	8	7	*To what extent are [were] practical actors (such as Business and professional establishments) integrated into your teaching? (Multiple selections possible.)* □ Lectures, courses or seminars through practical actors □ Projects with / for practical actors in coursework □ Facilitation of student part time jobs / subject-related internships with practical actors □ Connection via dual study programs □ There are no integrated practical actors in teaching □ Others: ……
10	-	9	-	*To what extent are you involved in addition to your work as a university lecturer in the following non-university activities?* □ I am a member of the Supervisory Board of a joint-stock company □ I am a member of the Supervisory Board of a GmbH □ I am a member of the Supervisory board of other organization □ I am active in other internal university committees, boards or working groups □ Does not apply □ Not specified

V1, V5	V2, V6	V3	V4	
11	-	10	-	*In which spatial environment are these aforementioned University external activities predominantly held? (Multiple answers possible)* □ University Region (within 50km) □ Federal State (excl. University Region) □ Other Parts of Germany □ International □ Question does not apply
12	9	11	8	*How often do [have] you jointly work [collaborated] in research and practical projects with the following groups?*

	Very Often	Often	Now and then	Rarely	Never	Not specified
Private Enterprises (<50 Employees)	□	□	□	□	□	□
Private Enterprises (50-250 Employees)	□	□	□	□	□	□
Private Enterprises (>250 Employees)	□	□	□	□	□	□
Interest groups, Societies, Foundations, Associations	□	□	□	□	□	□
Scientific institutions, Universities and Research institutes	□	□	□	□	□	□
Other Government Agencies and Establishments	□	□	□	□	□	□

13	10	12	9	*How far away are [were] the cooperation partner with whom you mainly work together [collaborated] for research and practical projects?*	

	University Region up to 50 km	Federal State (excl. University	Other Parts of Germany	International	Not specified
Private Enterprises (<50 Employees)	□	□	□	□	□
Private Enterprises (50-250 Employees)	□	□	□	□	□
Private Enterprises (>250 Employees))	□	□	□	□	□
Interest groups, Societies, Foundations, Associations	□	□	□	□	□
Scientific institutions, Universities and Research institutes	□	□	□	□	□
Other Government Agencies and Establishments	□	□	□	□	□

V1, V5	V2, V6	V3	V4	
14	11	13	10	*How do [did] you come about the contacts to your practical partners? (multiple selections possible)* □ Meetings, conferences □ Existing contacts from previous jobs / activities □ Transfer centers, transfer departments □ Requests from the practical partners □ Cold calling □ Membership in thematically relevant networks □ Others: ……
15	12	14	11	*How important do you consider the following aspects for a successful cooperation with external partners?* Trust significant □ □ □ □ □ insignificant Same Wavelength significant □ □ □ □ □ insignificant Spatial Proximity To Partners significant □ □ □ □ □ insignificant Modern Communication (e.g. Video Conferencing, etc.) significant □ □ □ □ □ insignificant Preexisting Contacts significant □ □ □ □ □ insignificant Frequent Personal Contacts significant □ □ □ □ □ insignificant High Professional Compliance (Content, Quality) significant □ □ □ □ □ insignificant Contractual Arrangements For Cooperation significant □ □ □ □ □ insignificant Same Goals significant □ □ □ □ □ insignificant Others: ……

V1, V5	V2, V6	V3	V4	
16	13	15	12	*Which of the following aspects are most likely to constitute an obstacle for cooperation with external partners? (Your answers should refer to the University where you currently work [were last active]). Please tick the appropriate box. (Multiple answers possible)* □ Bureaucratic obstacles on the part of companies □ Civil Service Law / Permit Requirement □ Inadequate available resources (manpower, material resources) □ Inadequate qualification of employees in the company □ High teaching load □ Confidential interests of the company (no possibility of publication) □ Divergent time horizons □ Coordination and communication difficulties □ No suitable cooperation partners in the region □ Effort and cost of cooperation □ Low willingness of companies to pay □ Insufficient government funding of R & D collaborations □ Costs and risks of the first collaboration unpredictable □ Risk of transition from employees to partners □ Not specified Others: .....
17	-	16	-	*Please estimate how many publications you submit annually altogether. (Please enter the estimated annual total.)* 0 / 1-2 / 3-5 / 6-10 / 11-15 / 16-20 / Over 20 / Not specified Scientific publications, e.g. in journals and anthologies: □ □ □ □ □ □ □ □ "Grey literature" (e.g. conference reports, application based periodicals e.g. IHK magazines, online publications, Institute's internal series of papers): □ □ □ □ □ □ □ □ Others: □ □ □ □ □ □ □ □

V1, V5	V2, V6	V3	V4	
18	-	17	-	*Please estimate what proportion of these publications has content with regional reference.* a. Share content related to the University Region (within 50km) □ 0 % □ 10 % □ 20 % □ 30 % □ 40 % □ 50 % □ 60 % □ 70 % □ 80 % □ 90 % □ 100 % □ Not specified b. Share content related to Federal State (excl. University Region) □ 0 % □ 10 % □ 20 % □ 30 % □ 40 % □ 50 % □ 60 % □ 70 % □ 80 % □ 90 % □ 100 % □ Not specified
19	-	18	-	*Business start-ups (spin-offs) are an important effect of research and teaching. Have you, former scientific employees or doctoral candidates established any business in the last 5 years?* □ Yes, start-ups with high research intensity. Quantity: …… □ Yes, start-ups with low research intensity. Quantity: …… □ No start-ups.
20	-	19	-	*How far away were these business start-ups mostly located? (Multiple answers possible.)* □ University Region (within 50km) □ Federal State (excl. University Region) □ Other Areas in Germany □ International □ Question does not apply
21	14	20	13	*With reference to regional development, kindly evaluate spin-off from your university in general? [Draw your conclusion based on the location where you last worked.]* □ Insignificant □ Little significance □ Fairly significant □ Very significant □ Not specified

V1, V5	V2, V6	V3	V4						
22	15	21	14	*To what extent do you agree with the following statements? [(Please refer to the location where you last worked.)]*					
					Strongly disagree				Totally agree
				The University aligns its **curriculum** to the needs of the regional economy.	□	□	□	□	□
				The University directs its **research activity** to the needs of the regional economy.	□	□	□	□	□
				The University is an important **regional location factor** for companies, as it has a positive effect on the region's attractiveness as a business location	□	□	□	□	□
				Due to the presence of the University, the regional offer for **leisure activities, the cultural and artistic activities** (such as art, music, sports) is rich.	□	□	□	□	□
				The **innovation climate** in the region benefits from the existence of the university.	□	□	□	□	□
				The existence of the university shapes the **image** of the region.	□	□	□	□	□
				The regional **economy** is **stabilized** by the university.	□	□	□	□	□
				The university has a positive influence on the **quality of the region as a place of residence**.	□	□	□	□	□

Table A1-2: Questionnaire (English Version)
Source: Warnecke 2016, p. 231 et seqq.

Name der Universität / University name
Aachen Rheinisch-Westfälische Technische Hochschule Aachen
Augsburg Universität Augsburg
Bamberg Otto-Friedrich-Universität Bamberg
Bayreuth Universität Bayreuth
Benediktbeuern Philosophisch-Theologische Hochschule der Salesianer Don Boscos Benediktbeuern, Theologische Fakultät
Berlin Charité - Universitätsmedizin Berlin Gliedkörperschaft der Freien Universität Berlin und der Humboldt-Universität zu Berlin
Berlin ESCP-Europe Berlin
Berlin European School of Management and Technology
Berlin Freie Universität Berlin
Berlin Hertie School of Governance GmbH
Berlin Humboldt-Universität zu Berlin
Berlin International Psychoanalytic University Berlin
Berlin Steinbeis-Hochschule Berlin
Berlin Technische Universität Berlin
Bielefeld Kirchliche Hochschule Wuppertal/Bethel, Arbeitsbereich Bethel
Bielefeld Universität Bielefeld
Bochum Ruhr-Universität Bochum
Bonn Rheinische Friedrich-Wilhelms- Universität Bonn
Braunschweig Technische Universität Carolo-Wilhelmina zu Braunschweig
Bremen Jacobs University Bremen
Bremen Universität Bremen
Chemnitz Technische Universität Chemnitz
Clausthal-Zellerfeld Technische Universität Clausthal
Cottbus Brandenburgische Technische Universität Cottbus
Darmstadt Technische Universität Darmstadt
Dortmund Technische Universität Dortmund
Dresden DIU Dresden International University
Dresden Technische Universität Dresden
Duisburg Universität Duisburg-Essen
Düsseldorf Heinrich Heine-Universität Düsseldorf
Eichstätt Katholische Universität Eichstätt-Ingolstadt
Erfurt Universität Erfurt
Erlangen Friedrich-Alexander-Universität Erlangen-Nürnberg
Essen Universität Duisburg-Essen
Flensburg Universität Flensburg
Frankfurt Frankfurt School of Finance & Management GmbH
Frankfurt Johann Wolfgang Goethe-Universität Frankfurt am Main
Frankfurt Philosophisch-Theologische Hochschule Sankt Georgen, Theologische Fakultät
Frankfurt/Oder Europa-Universität Viadrina Frankfurt (Oder)
Freiberg Technische Universität Bergakademie Freiberg
Freiburg Albert-Ludwigs-Universität Freiburg
Freiburg Pädagogische Hochschule Freiburg
Friedrichshafen Zeppelin University GmbH
Fulda Theologische Fakultät Fulda
Gießen Justus-Liebig-Universität Gießen
Göttingen Georg-August-Universität Göttingen
Greifswald Ernst-Moritz-Arndt-Universität Greifswald
Hagen Fern Universität in Hagen
Halle Martin-Luther-Universität Halle-Wittenberg
Hamburg Bucerius Law School, Hochschule für Rechtswissenschaft gemeinnützige GmbH
Hamburg Hafen City Universität
Hamburg Helmut-Schmidt-Universität, Universität der Bundeswehr Hamburg
Hamburg Technische Universität Hamburg-Harburg

Name der Universität / University name
Hamburg Universität Hamburg
Hannover GISMA Business School
Hannover Gottfried Wilhelm Leibniz Universität Hannover
Hannover Medizinische Hochschule Hannover
Hannover Tierärztliche Hochschule Hannover
Heidelberg Hochschule für Jüdische Studien
Heidelberg Pädagogische Hochschule Heidelberg
Heidelberg Ruprecht-Karls-Universität Heidelberg
Hildesheim Universität Hildesheim
Ilmenau Technische Universität Ilmenau
Jena Friedrich-Schiller-Universität Jena
Kaiserslautern Technische Universität Kaiserslautern
Karlsruhe Karlsruhe Institute of Technology
Karlsruhe Pädagogische Hochschule Karlsruhe
Kassel Universität Kassel
Kiel Christian-Albrechts-Universität zu Kiel
Koblenz-Metternich Universität Koblenz-Landau
Köln Deutsche Sporthochschule Köln
Köln Universität zu Köln
Konstanz Universität Konstanz
Lahr Wissenschaftliche Hochschule Lahr (WHL)
Leipzig Handelshochschule Leipzig (HHL)
Leipzig Universität Leipzig
Lippstadt IBS International Business School GmbH
Lübeck Universität zu Lübeck
Ludwigsburg Pädagogische Hochschule Ludwigsburg
Lüneburg Leuphana Universität Lüneburg
Magdeburg Otto-von-Guericke-Universität Magdeburg
Mainz Johannes Gutenberg-Universität Mainz
Mannheim Universität Mannheim
Marburg Philipps-Universität Marburg
Möckern-Friedensau Theologische Hochschule Friedensau
München Hochschule für Philosophie, Philosophische Fakultät S.J.
München Hochschule für Politik München
München Ludwig-Maximilians-Universität
München Munich Business School
München Technische Universität München
München Ukrainische Freie Universität
Münster Deutsche Hochschule der Polizei
Münster Philosophisch-Theologische Hochschule Münster
Münster Westfälische Wilhelms-Universität Münster
Neubiberg Universität der Bundeswehr München
Neuendettelsau Augustana Theologische Hochschule der Evangelisch-Lutherischen Kirche in Bayern
Oberursel (Taunus) Lutherische Theologische Hochschule
Oldenburg Carl von Ossietzky Universität
Osnabrück Universität Osnabrück
Paderborn Theologische Fakultät Paderborn
Paderborn Universität Paderborn
Passau Universität Passau
Potsdam Universität Potsdam
Regensburg Universität Regensburg
Rostock Universität Rostock
Saarbrücken Universität des Saarlandes
Sankt Augustin Philosophisch-Theologische Hochschule SVD Sankt Augustin, Theologische Fakultät
Schwäbisch Gmünd Pädagogische Hochschule Schwäbisch Gmünd

Name der Universität / University name
Siegen Universität Siegen
Speyer Deutsche Hochschule für Verwaltungswissenschaften Speyer
Stuttgart Freie Hochschule Stuttgart, Seminar für Waldorfpädagogik
Stuttgart Universität Hohenheim
Stuttgart Universität Stuttgart
Trier Theologische Fakultät Trier
Trier Universität Trier
Tübingen Eberhard-Karls-Universität Tübingen
Ulm Universität Ulm
Vallendar Philosophisch-Theologische Hochschule Vallendar
Vallendar WHU - Otto Beisheim School of Management
Vechta Universität Vechta
Weilheim-Bierbronnen Gustav-Siewerth-Akademie, Staatlich anerkannte Wissenschaftliche Hochschule
Weimar Bauhaus-Universität Weimar
Weingarten Pädagogische Hochschule Weingarten
Wiesbaden EBS Universität
Witten Private Universität Witten/Herdecke
Wuppertal Bergische Universität Wuppertal
Wuppertal Kirchliche Hochschule Wuppertal/Bethel, Arbeitsbereich Wuppertal
Würzburg Bayerische Julius-Maximilians-Universität Würzburg
Zittau Internationales Hochschulinstitut Zittau

Table A1-3: Dropdown list of the institution names (Universities)
Source: Warnecke 2016, p. 238 et seqq, Deutscher Hochschulverband 2012, p. 1093 et seq.

Name der Fachhochschule / UAS name
Aalen Hochschule Aalen Technik und Wirtschaft
Altenholz Fachhochschule für Verwaltung und Dienstleistung
Amberg Hochschule Amberg-Weiden, Hochschule für angewandte Wissenschaften
Ansbach Hochschule für angewandte Wissenschaften - Fachhochschule Ansbach
Arnstadt FH KUNST Arnstadt
Aschaffenburg Hochschule Aschaffenburg
Aschersleben Fachhochschule Polizei Sachsen- Anhalt
Augsburg Fachhochschule Augsburg, Hochschule für Angewandte Wissenschaften
Bad Hersfeld Hochschule der Gesetzlichen Unfallversicherung, Private FH des Bundesverbandes der Unfallversicherungsträger e.V.
Bad Homburg Accadis - Private Hochschule für Internationales Management
Bad Honnef Internationale Fachhochschule Bad Honnef - Bonn, International University of Applied Sciences Bad Honnef - Bonn
Bad Münstereifel Fachhochschule für Rechtspflege Nordrhein-Westfalen
Bad Sooden-Allendorf Fachhochschule Nordhessen der DIPLOMA Private Hochschulgesellschaft mbH
Berlin Alice-Salomon-Fachhochschule Berlin
Berlin bbw Hochschule, Staatlich anerkannte private Fachhochschule
Berlin Berliner Technische Kunsthochschule, Hochschule für Gestaltung (FH)
Berlin BEST-Sabel-Fachhochschule
Berlin Beuth Hochschule für Technik Berlin
Berlin design akademie berlin, Hochschule für Kommunikation und Design (FH)
Berlin Evangelische Fachhochschule Berlin, Fachhochschule für Sozialarbeit und Sozialpädagogik, KdöR
Berlin Hochschule für Gesundheit und Sport GmbH
Berlin Hochschule für Technik und Wirtschaft Berlin
Berlin Hochschule für Wirtschaft und Recht Berlin, Berlin School of Economics and Law
Berlin Internationale Fachhochschule für Exekutives Management (IFH), Staatlich anerkannte private Fachhochschule
Berlin Katholische Hochschule für Sozialwesen Berlin
Berlin MEDIADESIGN Hochschule für Design und Informatik, Staatlich anerkannte Fachhochschule
Berlin SRH Hochschule Berlin, Private University of Applied Sciences
Biberach/Riß Hochschule Biberach, Biberach University of Applied Sciences
Bielefeld Fachhochschule Bielefeld, University of Applied Sciences
Bielefeld Fachhochschule der Diakonie GmbH
Bielefeld Fachhochschule des Mittelstandes
Bingen Fachhochschule Bingen
Bochum Evangelische Fachhochschule Rheinland-Westfalen-Lippe
Bochum Hochschule Bochum
Bochum Hochschule für Gesundheit
Bochum Technische Fachhochschule Georg Agricola für Rohstoff, Energie und Umwelt zu Bochum, Staatlich anerkannte Fachhochschule der DMT-Gesellschaft für Lehre und Bildung mbH
Bochum Evangelische Fachhochschule Rheinland-Westfalen-Lippe
Bochum Hochschule Bochum
Bochum Evangelische Fachhochschule Rheinland-Westfalen-Lippe
Bochum Hochschule Bochum
Bochum Hochschule für Gesundheit
Bochum Technische Fachhochschule Georg Agricola für Rohstoff, Energie und Umwelt zu Bochum, Staatlich anerkannte Fachhochschule der DMT-Gesellschaft für Lehre und Bildung mbH
Bochum Evangelische Fachhochschule Rheinland-Westfalen-Lippe
Bochum Hochschule Bochum
Bochum Hochschule für Gesundheit
Bochum Technische Fachhochschule Georg Agricola für Rohstoff, Energie und Umwelt zu Bochum, Staatlich anerkannte Fachhochschule der DMT-Gesellschaft für Lehre und Bildung mbH
Bonn Hochschule der Sparkassen-Finanzgruppe
Brandenburg an der Havel Fachhochschule Brandenburg
Bremen APOLLON Hochschule der Gesundheits-wirtschaft GmbH

Name der Fachhochschule / UAS name
Bremen Hochschule Bremen, University of Applied Science
Bremen Hochschule für Öffentliche Verwaltung Bremen
Bremerhaven Hochschule Bremerhaven
Brühl Europäische Fachhochschule, Staatlich anerkannte Privathochschule
Brühl Fachhochschule des Bundes für öffentliche Verwaltung
Buxtehude Hochschule 21 (FH)
Calw SRH Hochschule für Wirtschaft und Medien Calw, Staatlich anerkannte Fachhochschule der SRH Hochschule Calw gGmbH
Coburg Fachhochschule Schloss Hohenfels GmbH, Staatlich anerkannte private Hochschule für Fachtherapien im Gesundheitswesen
Coburg Hochschule Coburg, Hochschule für angewandte Wissenschaften
Darmstadt Evangelische Fachhochschule Darmstadt
Darmstadt Hochschule Darmstadt
Deggendorf Hochschule für angewandte Wissenschaften, Fachhochschule Deggendorf
Dortmund Fachhochschule Dortmund
Dortmund International School of Management GmbH, Staatlich anerkannte private Fachhochschule
Dresden Evangelische Hochschule für Soziale Arbeit Dresden (FH)
Dresden Hochschule für Technik und Wirtschaft Dresden (FH)
Düsseldorf Fachhochschule Düsseldorf, University of Applied Sciences
Eberswalde Fachhochschule Eberswalde
Edenkoben Fachhochschule für Finanzen
Elmshorn FH Nordakademie, Hochschule der Wirtschaft
Emden Hochschule Emden/Leer
Erding Fachhochschule für angewandtes Management, Staatlich anerkannte private Hochschule
Erfurt Adam-Ries-Fachhochschule GmbH
Erfurt Fachhochschule Erfurt
Essen Hochschule für Oekonomie & Management gGmbH, University of Applied Sciences
Esslingen Hochschule Esslingen
Flensburg Fachhochschule Flensburg
Frankfurt/Main Fachhochschule Frankfurt am Main, University of Applied Sciences
Frankfurt/Main Provadis School of International Management and Technology, Staatlich genehmigte Hochschule
Freiburg Evangelische Fachhochschule Freiburg, Hochschule für Soziale Arbeit, Diakonie und Religionspädagogik
Freiburg Katholische Hochschule Freiburg gGmbH, staatlich anerkannte Hochschule
Freising Hochschule Weihenstephan-Triesdorf
Fulda Hochschule Fulda
Furtwangen Hochschule Furtwangen, Informatik, Technik, Wirtschaft, Medien
Gelsenkirchen Fachhochschule für öffentliche Verwaltung Nordrhein-Westfalen
Gelsenkirchen Fachhochschule Gelsenkirchen
Gießen Technische Hochschule Mittelhessen
Gotha Thüringer Fachhochschule für öffentliche Verwaltung
Göttingen Private Fachhochschule Göttingen
Güstrow Fachhochschule für öffentliche Verwaltung, Polizei und Rechtspflege
Hachenburg Fachhochschule der Deutschen Bundesbank
Hamburg Europäische Fernhochschule Hamburg GmbH, University of Applied Science
Hamburg Evangelische Hochschule für Soziale Arbeit & Diakonie
Hamburg Hamburg School of Business Administration (FH)
Hamburg HFH - Hamburger Fern-Hochschule gGmbH, University of Applied Sciences
Hamburg Hochschule der Polizei Hamburg
Hamburg Hochschule für angewandte Wissenschaften Hamburg
Hamburg Hochschule für Finanzen Hamburg
Hamburg International Business School of Service Management GmbH
Hamm Hochschule Hamm-Lippstadt
Hamm SRH Fachhochschule Hamm, Hochschule für Logistik und Wirtschaft

Name der Fachhochschule / UAS name
Hannover Fachhochschule für die Wirtschaft Hannover (FHDW)
Hannover Fachhochschule Hannover (FHH)
Hannover Kommunale Fachhochschule für Verwaltung in Niedersachsen
Heide Fachhochschule Westküste, Hochschule für Wirtschaft und Technik
Heidelberg- Wieblingen Hochschule Heidelberg, Staatlich anerkannte Fachhochschule
Heilbronn German Graduate School of Management and Law gGmbH
Heilbronn Hochschule Heilbronn, Technik - Wirtschaft - Informatik
Hildesheim Hochschule für angewandte Wissenschaft und Kunst Hildesheim/Holzminden/Göttingen
Hildesheim Norddeutsche Fachhochschule für Rechtspflege
Hof Hochschule für Angewandte Wissenschaften - Fachhochschule Hof
Idstein Hochschule Fresenius
Ingolstadt Fachhochschule Ingolstadt, University of Applied Sciences
Iserlohn BiTS Business and Information Technology School gGmbH
Iserlohn Fachhochschule Südwestfalen, Hochschule für Technik und Wirtschaft
Isny Naturwissenschaftlich-Technische Aka-demie Prof. Dr. Grübler gGmbH, Isny , Staatlich anerkannte Fachhochschule und Berufskollegs
Jena Fachhochschule Jena
Kaiserslautern Fachhochschule Kaiserslautern
Karlsruhe Hochschule Karlsruhe, Technik und Wirtschaft
Karlsruhe Karlshochschule
Kehl Hochschule Kehl, Hochschule für öffentliche Verwaltung
Kempten Hochschule Kempten
Kiel Fachhochschule Kiel
Kleve Hochschule Rhein-Waal Rhine-Waal University of Applied Sciences
Koblenz Fachhochschule Koblenz
Köln Fachhochschule Köln, University of Applied Sciences
Köln Katholische Hochschule Nordrhein- Westfalen
Köln Rheinische Fachhochschule Köln
Königs Wusterhausen Bildungszentrum der Finanzverwaltung, Fachhochschule für Finanzen
Konstanz Hochschule Konstanz Technik, Wirtschaft und Gestaltung
Köthen Hochschule Anhalt (FH)
Krefeld Hochschule Niederrhein (HN)
Landshut Hochschule Landshut
Leipzig Deutsche Telekom Hochschule für Telekommunikation Leipzig
Leipzig Hochschule für Technik, Wirtschaft und Kultur Leipzig (FH)
Lemgo Hochschule Ostwestfalen-Lippe, University of Applied Sciences
Lübeck Fachhochschule Lübeck, Hochschule für Technik, Wirtschaft, Bauwesen und Naturwissenschaften
Ludwigsburg Evangelische Hochschule Ludwigsburg, Hochschule für Soziale Arbeit, Diakonie und Religionspädagogik, Staatlich anerkannte Fachhochschule der Evangelischen Landeskirche in Württemberg
Ludwigsburg Fachhochschule Ludwigsburg - Hochschule für öffentliche Verwaltung und Finanzen
Ludwigshafen Fachhochschule Ludwigshafen am Rhein, Hochschule für Wirtschaft
Magdeburg Hochschule Magdeburg-Stendal (FH)
Mainz Fachhochschule Mainz, University of Applied Sciences
Mainz Katholische Fachhochschule Mainz
Mannheim Hochschule der Bundesagentur für Arbeit, Staatlich anerkannte Fachhochschule für Arbeitsmarktmanagement
Mannheim Hochschule Mannheim
Marburg Archivschule Marburg, Fachhochschule für Archivwesen
Mayen Fachhochschule für öffentliche Verwaltung, Zentrale Verwaltungsschule Rheinland-Pfalz
Meißen Fachhochschule der Sächsischen Verwaltung Meißen
Merseburg Fachhochschule Merseburg
Mittweida Hochschule Mittweida (FH), University of Applied Sciences
Moritzburg Fachhochschule für Religionspädagogik und Gemeindediakonie
Mülheim an der Ruhr Hochschule Ruhr West
München Fachhochschule für öffentliche Verwaltung und Rechtspflege in Bayern

Name der Fachhochschule / UAS name
München Hochschule für Angewandte Sprachen, Fachhochschule des SDI
München Hochschule München
München Katholische Stiftungsfachhochschule München
München Macromedia Fachhochschule der Medien
Münster Fachhochschule Münster, University of Applied Sciences
Neubrandenburg Fachhochschule Neubrandenburg
Neu-Ulm Fachhochschule Neu-Ulm
Nordhausen Fachhochschule Nordhausen
Nordkirchen Fachhochschule für Finanzen Nordrhein- Westfalen
Nürnberg Evangelische Fachhochschule Nürnberg
Nürnberg Georg-Simon-Ohm-Fachhochschule Nürnberg
Nürtingen Fachhochschule für Kunsttherapie Nürtingen (HKT)
Nürtingen Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen (HfWU)
Offenburg Hochschule Offenburg
Oranienburg Fachhochschule der Polizei des Landes Brandenburg
Osnabrück Hochschule Osnabrück
Ottersberg Fachhochschule Ottersberg, Staatlich anerkannte Fachhochschule in freier Trägerschaft für Kunstthera-pie/Kunstpädagogik und Freie Bildende Kunst
Paderborn Fachhochschule der Wirtschaft FHDW
Pforzheim Hochschule Pforzheim, Gestaltung, Technik, Wirtschaft und Recht
Pfungstadt Wilhelm Büchner Hochschule, Private Fernhochschule Darmstadt
Potsdam Business School Potsdam, Hochschule für Management (FH)
Potsdam Fachhochschule Potsdam
Regensburg Hochschule Regensburg, Hochschule für Technik, Wirtschaft, Sozialwesen
Reutlingen Hochschule Reutlingen
Reutlingen Theologische Hochschule Reutlingen, Staatlich anerkannte Fachhochschule der Evangelisch-methodistische Kirche
Riedlingen Fernfachhochschule Riedlingen
Rosenheim Hochschule Rosenheim
Rotenburg an der Fulda Verwaltungsfachhochschule in Rotenburg an der Fulda
Rothenburg/Oberlausitz Hochschule der Sächsischen Polizei FH
Rottenburg Hochschule für Forstwirtschaft Rottenburg
Saarbrücken Deutsche Hochschule für Prävention und Gesundheitsmanagement GmbH, Hermann Neuberger Sportschule
Saarbrücken Hochschule für Technik und Wirtschaft des Saarlandes
Saarbrücken Fachhochschule für Verwaltung des Saarlandes
Sankt Augustin Hochschule Bonn-Rhein-Sieg
Schmalkalden Fachhochschule Schmalkalden
Schwäbisch Gmünd Fachhochschule Schwäbisch Gmünd - Hochschule für Gestaltung, University of Applied Sciences
Schwäbisch Hall Fachhochschule Schwäbisch Hall, Hochschule für Gestaltung
Schwandorf Döpfer-Schulen, Private Fachhochschule
Schwerin Baltic College
Schwetzingen Fachhochschule Schwetzingen - Hochschule für Rechtspflege
Senftenberg Hochschule Lausitz
Sigmaringen Hochschule Albstadt-Sigmaringen
Stralsund Fachhochschule Stralsund
Stuttgart AKAD-Zentrale und -Fachhochschule Stuttgart
Stuttgart Duale Hochschule Baden-Württemberg
Stuttgart Hochschule der Medien
Stuttgart Hochschule für Technik Stuttgart
Stuttgart Merz Akademie, Hochschule für Gestaltung Stuttgart - Staatlich anerkannte Fachhochschule
Trier Fachhochschule Trier, Hochschule für Technik, Wirtschaft und Gestaltung
Ulm Hochschule Ulm, Hochschule für Technik, Informatik & Medien

Name der Fachhochschule / UAS name
Vechta Private Fachhochschule für Wirtschaft und Technik Vechta-Diepholz- Oldenburg gGmbH, Fachhochschule und Berufsakademie
Villingen-Schwenningen Hochschule für Polizei Villingen- Schwenningen
Wedel Fachhochschule Wedel
Weingarten Hochschule Ravensburg-Weingarten, Technik - Wirtschaft - Sozialwesen
Wernigerode Hochschule Harz (FH)
Wiesbaden Hochschule Rhein/Main
Wiesbaden Verwaltungsfachhochschule in Wiesbaden
Wildau Technische Fachhochschule Wildau
Wilhelmshaven Jade Hochschule, Wilhelmshaven/Oldenburg/Elsfleth
Wismar Hochschule Wismar, University of Technology, Business and Design
Wolfenbüttel Ostfalia Hochschule, Hochschule für Angewandte Wissenschaften
Worms Fachhochschule Worms
Würzburg Fachhochschule Würzburg-Schweinfurt, Hochschule für angewandte Wissenschaften
Wustermark Theologisches Seminar Elstal (FH), Staatlich anerkannte Fachhochschule
Zittau Hochschule Zittau/Görlitz (FH)
Zwickau Westsächsische Hochschule Zwickau (FH)

Table A1-4: Dropdown list of the institution names (UAS)
Source: Warnecke 2016, p. 241 et seqq., Deutscher Hochschulverband 2011, p. 355 seqq.

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Deutscher Hochschulverband (2012) Universitäten Deutschland, De Gruyter Sauer, München

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Appendix A2 Information related to HEIs (level 2)

Name of the HEI	founding year	age	third-party funding	basic funds	total budget
Albert-Ludwigs-Universitaet Freiburg	1457	65	158781	258584	417365
Alice-Salomon-Fachhochschule Berlin	1971	43	2281	10995	13276
Bauhaus-Universitaet Weimar	1910	65	13650	43024	56674
Bayerische Julius-Maximilians-Universitaet Wuerzburg	1582	65	106870	233838	340708
Bergische Universitaet Wuppertal	1972	42	28460	100946	129406
Beuth Hochschule fuer Technik Berlin	1971	43	7123	61044	68167
Brandenburgische Technische Universitaet Cottbus	1991	23	26166	59052	85218
Carl von Ossietzky Universitaet	1974	40	31780	103449	135229
Charité	1948	65	153513	188317	341830
Christian-Albrechts-Universitaet zu Kiel	1665	65	116411	263739	380150
Deutsche Hochschule fuer Verwaltungswissenschaften Speyer	1947	65	187	7724	7911
Deutsche Sporthochschule Koeln	1947	65	10581	31256	41837
Duale Hochschule Baden-Wuerttemberg	2009	5	4501	144278	148779
Eberhard-Karls-Universitaet Tuebingen	1477	65	151666	443812	595478
Ernst-Moritz-Arndt-Universitaet Greifswald	1456	65	42347	113429	155776
Europa-Universitaet Viadrina Frankfurt (Oder)	1991	23	6676	27736	34412
Fachhochschule Aachen	1971	43	10785	50267	61052
Fachhochschule Augsburg	1971	43	1299	23085	24384
Fachhochschule Bielefeld	1971	43	4082	40202	44284
Fachhochschule Bingen	1996	18	761	11998	12759
Fachhochschule Brandenburg	1992	22	3334	12963	16297
Fachhochschule Dortmund	1971	43	4502	49079	53581
Fachhochschule Duesseldorf	1971	43	3852	37728	41580
Fachhochschule Eberswalde	1992	22	5319	10776	16095
Fachhochschule Erfurt	1991	23	1752	24147	25899
Fachhochschule Flensburg	1969	45	2046	16680	18726
Fachhochschule Frankfurt am Main	1971	43	4168	49880	54048
Fachhochschule Gelsenkirchen	1992	22	5708	40567	46275
Fachhochschule Hannover (FHH)	1971	43	6420	42236	48656
Fachhochschule Ingolstadt	1994	20	1135	14927	16062
Fachhochschule Jena	1991	23	5040	25384	30424
Fachhochschule Kaiserslautern	1996	18	4310	32771	37081
Fachhochschule Kiel	1969	45	2632	27726	30358
Fachhochschule Koblenz	1996	18	2473	31022	33495
Fachhochschule Koeln	1971	43	18706	92173	110879
Fachhochschule Ludwigshafen am Rhein	1971	43	1015	16517	17532
Fachhochschule Luebeck	1969	45	3069	21031	24100

Name of the HEI	founding year	age	third-party funding	basic funds	total budget
Fachhochschule Mainz	1996	18	2260	24945	27205
Fachhochschule Merseburg	1992	22	2913	20852	23765
Fachhochschule Muenster	1971	43	17092	52798	69890
Fachhochschule Neubrandenburg	1991	23	1874	17074	18948
Fachhochschule Neu-Ulm	1998	16	174	12405	12579
Fachhochschule Nordhausen	1997	17	1573	9763	11336
Fachhochschule Potsdam	1991	23	2605	16354	18959
Fachhochschule Schmalkalden	1991	23	877	13913	14790
Fachhochschule Stralsund	1991	23	2793	16245	19038
Fachhochschule Suedwestfalen	2002	12	5363	45881	51244
Fachhochschule Trier	1996	18	7711	35026	42737
Fachhochschule Westkueste	1994	20	2082	7629	9711
Fachhochschule Worms	1996	18	1011	13430	14441
Fachhochschule Wuerzburg-Schweinfurt	1971	43	1723	38177	39900
FernUniversitaet in Hagen	1974	40	2521	55825	58346
Freie Universitaet Berlin	1948	65	114348	243896	358244
Friedrich-Alexander-Universitaet Erlangen-Nuernberg	1743	65	154972	378092	533064
Friedrich-Schiller-Universitaet Jena	1558	65	87973	205257	293230
Georg-August-Universitaet Goettingen	1734	65	149938	307001	456939
Georg-Simon-Ohm-Fachhochschule Nuernberg	1971	43	2241	48246	50487
Gottfried Wilhelm Leibniz Universitaet Hannover	1879	65	89608	221524	311132
HafenCity Universitaet	2006	8	3125	18907	22032
Heinrich Heine-Universitaet Duesseldorf	1966	48	55397	237716	293113
Hochschule Aalen Technik und Wirtschaft	1962	52	5826	25702	31528
Hochschule Albstadt-Sigmaringen	1971	43	1308	16159	17467
Hochschule Amberg-Weiden	1994	20	1400	14979	16379
Hochschule Anhalt	1991	23	4324	39099	43423
Hochschule Aschaffenburg	2000	14	2428	13043	15471
Hochschule Biberach	1971	43	2442	13927	16369
Hochschule Bochum	1971	43	2617	29952	32569
Hochschule Bonn-Rhein-Sieg	1995	19	6369	29284	35653
Hochschule Bremen	1982	32	8751	30773	39524
Hochschule Bremerhaven	1975	39	6443	8049	14492
Hochschule Coburg	1971	43	2765	21726	24491
Hochschule Darmstadt	1971	43	4262	63169	67431
Hochschule der Medien	2001	13	2538	23899	26437
Hochschule Emden/Leer	2009	5	1782	25458	27240
Hochschule Esslingen	1971	43	3064	42575	45639
Hochschule fuer angewandte Wissenschaft und Kunst Hildesheim/Holzminden/Goettingen	1971	43	5579	33788	39367
Fachhochschule Ansbach	1996	18	3277	11216	14493

Name of the HEI	founding year	age	third-party funding	basic funds	total budget
Fachhochschule Hof	1994	20	1262	14583	15845
Hochschule fuer angewandte Wissenschaften Hamburg	1970	44	8107	72605	80712
Fachhochschule Deggendorf	1994	20	3848	19069	22917
Hochschule fuer Forstwirtschaft Rottenburg	1971	43	668	4677	5345
Hochschule fuer Gesundheit	2009	5	93	6914	7007
Hochschule fuer Politik Muenchen	1950	64	0	615	615
Hochschule fuer Technik Stuttgart	1971	43	3571	22079	25650
Hochschule fuer Technik und Wirtschaft Berlin	1991	23	5772	54863	60635
Hochschule fuer Technik und Wirtschaft des Saarlandes	1971	43	2622	29746	32368
Hochschule fuer Technik und Wirtschaft Dresden	1992	22	3903	37117	41020
Hochschule fuer Technik, Wirtschaft und Kultur Leipzig	1992	22	5622	33840	39462
Hochschule fuer Wirtschaft und Recht Berlin	2009	5	3296	35272	38568
Hochschule fuer Wirtschaft und Umwelt Nuertingen-Geislingen (HfWU)	1972	42	2315	21437	23752
Hochschule Fulda	1974	40	3333	27464	30797
Hochschule Furtwangen, Informatik, Technik, Wirtschaft, Medien	1971	43	3111	33893	37004
Hochschule Harz	1991	23	2064	15700	17764
Hochschule Heilbronn, Technik - Wirtschaft - Informatik	1971	43	3304	40309	43613
Hochschule Karlsruhe, Technik und Wirtschaft	1878	65	6431	38035	44466
Hochschule Kempten	1977	37	2233	22111	24344
Hochschule Konstanz Technik, Wirtschaft und Gestaltung	1971	43	3274	28191	31465
Hochschule Landshut	1978	36	1201	18470	19671
Hochschule Lausitz	1991	23	9020	19695	28715
Hochschule Magdeburg-Stendal	1991	23	4831	30359	35190
Hochschule Mittweida	1969	45	5223	25955	31178
Hochschule Muenchen	1971	43	6584	84208	90792
Hochschule Niederrhein	1971	43	7547	53057	60604
Hochschule Offenburg	1964	50	3782	23152	26934
Hochschule Osnabrueck	1971	43	10896	63129	74025
Hochschule Ostwestfalen-Lippe	1971	43	9516	33364	42880
Hochschule Pforzheim, Gestaltung, Technik, Wirtschaft und Recht	1992	22	2096	32593	34689
Hochschule Ravensburg-Weingarten, Technik - Wirtschaft - Sozialwesen	1971	43	602	18019	18621
Hochschule Regensburg, Hochschule fuer Technik, Wirtschaft, Sozialwesen	1971	43	3804	38339	42143
Hochschule Reutlingen	1855	65	4533	30744	35277
Hochschule Rhein/Main	1971	43	3575	60721	64296

Name of the HEI	founding year	age	third-party funding	basic funds	total budget
Hochschule Rosenheim	1971	43	3799	22953	26752
Hochschule Ulm, Hochschule fuer Technik, Informatik & Medien	1960	54	1446	24487	25933
Hochschule Weihenstephan-Triesdorf	1970	44	3059	31319	34378
Hochschule Wismar	1991	23	6918	28378	35296
Hochschule Zittau/Goerlitz	1992	22	5935	26391	32326
Humboldt-Universitaet zu Berlin	1810	65	88494	106642	195136
Jade Hochschule, Wilhelmshaven/Oldenburg/Elsfleth	2009	5	3018	37497	40515
Johann Wolfgang Goethe-Universitaet Frankfurt am Main	1914	65	145813	282055	427868
Johannes Gutenberg-Universitaet Mainz	1476	65	93899	301772	395671
Justus-Liebig-Universitaet Giessen	1607	65	57012	253477	310489
Karlsruhe Institute of Technology	1825	65	158323	217021	375344
Leuphana Universitaet Lueneburg	1946	65	21045	50138	71183
Ludwig-Maximilians-Universitaet	1826	65	215200	466948	682148
Martin-Luther-Universitaet Halle-Wittenberg	1694	65	49404	193997	243401
Ostfalia Hochschule	1971	43	6498	45594	52092
Otto-Friedrich-Universitaet Bamberg	1979	35	30340	54149	84489
Otto-von-Guericke-Universitaet Magdeburg	1993	21	53901	130901	184802
Philipps-Universitaet Marburg	1527	65	59164	208979	268143
Rheinische Friedrich-Wilhelms- Universitaet Bonn	1786	65	146431	248104	394535
Rheinisch-Westfaelische Technische Hochschule Aachen	1870	65	291640	372813	664453
Ruhr-Universitaet Bochum	1962	52	105842	281584	387426
Ruprecht-Karls-Universitaet Heidelberg	1386	65	227078	318006	545084
Technische Fachhochschule Wildau	1991	23	6642	13432	20074
Technische Hochschule Mittelhessen	1971	43	4028	60198	64226
Technische Universitaet Bergakademie Freiberg	1765	65	53392	52226	105618
Technische Universitaet Berlin	1946	65	152902	222595	375497
Technische Universitaet Carolo-Wilhelmina zu Braunschweig	1877	65	76678	145808	222486
Technische Universitaet Chemnitz	1963	51	62472	80367	142839
Technische Universitaet Clausthal	1775	65	29723	46220	75943
Technische Universitaet Darmstadt	1877	65	116867	214399	331266
Technische Universitaet Dortmund	1968	46	63897	158701	222598
Technische Universitaet Dresden	1828	65	225002	202703	427705
Technische Universitaet Hamburg-Harburg	1978	36	40798	77832	118630
Technische Universitaet Ilmenau	1894	65	41550	56766	98316
Technische Universitaet Kaiserslautern	1970	44	50363	93971	144334
Technische Universitaet Muenchen	1868	65	311409	305369	616778
Tieraerztliche Hochschule Hannover	1778	65	12103	39923	52026
Universitaet Augsburg	1970	44	15603	86421	102024

Name of the HEI	founding year	age	third-party funding	basic funds	total budget
Universitaet Bayreuth	1970	44	36370	110036	146406
Universitaet Bielefeld	1969	45	57567	138130	195697
Universitaet Bremen	1971	43	88971	131600	220571
Universitaet des Saarlandes	1948	65	58465	224377	282842
Universitaet Duisburg-Essen	1972	42	105623	305624	411247
Universitaet Erfurt	1994	20	6874	38930	45804
Universitaet Flensburg	1946	65	3131	20691	23822
Universitaet Hamburg	1919	65	167210	368949	536159
Universitaet Hildesheim	1978	36	5164	29057	34221
Universitaet Hohenheim	1818	65	26962	100763	127725
Universitaet Kassel	1970	44	42293	138830	181123
Universitaet Koblenz-Landau	1990	24	15154	55583	70737
Universitaet Konstanz	1966	48	65612	87190	152802
Universitaet Leipzig	1409	65	103064	200032	303096
Universitaet Mannheim	1967	47	19791	83398	103189
Universitaet Osnabrueck	1970	44	15417	81889	97306
Universitaet Paderborn	1972	42	36567	104875	141442
Universitaet Passau	1978	36	8872	48309	57181
Universitaet Potsdam	1991	23	49677	111768	161445
Universitaet Regensburg	1964	50	60797	172978	233775
Universitaet Rostock	1419	65	48389	136086	184475
Universitaet Siegen	1972	42	25251	99619	124870
Universitaet Stuttgart	1967	47	161873	175815	337688
Universitaet Trier	1473	65	11747	73211	84958
Universitaet Ulm	1967	47	78333	197799	276132
Universitaet Vechta	1995	19	3781	24359	28140
Universitaet zu Koeln	1388	65	129274	335137	464411
Universitaet zu Luebeck	1973	41	9084	28285	37369
Westfaelische Wilhelms-Universitaet Muenster	1780	65	125872	351689	477561
Westsaechsische Hochschule Zwickau	1969	45	5037	34197	39234

Source: De Gruyter Saur, 2012. Handbuch Der Universitäten Und Fachhochschulen 2012: Deutschland, Österreich, Schweiz. De Gruyter; Statistisches Bundesamt (Federal Statistical Office), 2014. Subject-matter series 11, series 4.3.2: Monetäre hochschulstatistische Kennzahlen.2012, Wiesbaden.

Appendix A3 R&D-staff

DESTATIS
Statistisches Bundesamt

Startseite Zahlen & Fakten Gesellschaft & Staat Bildung, Forschung, Kultur Forschung & Entwicklung **Forschung und Entwicklung**

Forschung und Entwicklung

Personal für Forschung und Entwicklung 2012 nach Bundesländern und Sektoren -Vollzeitäquivalente-

Bundesland	Staat und private Institutionen ohne Erwerbszweck	Hochschulen	Wirtschaft	Insgesamt
Baden-Württemberg	14 466	21 045	100 375	135 886
Bayern	12 720	18 922	81 334	112 976
Berlin	11 132	9 611	11 669	32 412
Brandenburg	3 860	2 333	3 323	9 515
Bremen	2 074	1 854	2 142	6 071
Hamburg	2 960	3 913	7 337	14 210
Hessen	4 214	8 067	36 811	49 091
Mecklenburg-Vorpommern	2 134	2 419	2 252	6 805
Niedersachsen	7 864	10 863	28 059	46 787
Nordrhein-Westfalen	16 184	25 005	55 002	96 191
Rheinland-Pfalz	1 961	4 634	12 704	19 298
Saarland	1 086	1 457	1 672	4 215
Sachsen	7 232	8 432	11 708	27 371
Sachsen-Anhalt	2 506	2 822	2 733	8 061
Schleswig-Holstein	2 564	3 060	4 870	10 495
Thüringen	2 473	3 463	5 489	11 425
Deutschland[1]	95 882	127 900	367 478	591 261

[1] Einschließlich nicht regionalisierbarem Personal.

Quelle: Statistisches Bundesamt, Wiesbaden; Stifterverband, Wissenschaftsstatistik; Essen.

Source: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/*ForschungEntwicklung/Tabellen/FuEPersonalBundeslaenderSektoren.html (accessed June 1, 2015).*

Appendix A4 R&D-staff and number of professors

Federal State	Number of professors (2012)			R&D-staff (2012)
	University	UAS	Total	
Baden-Wuerttemberg	2615	3002	5617	100375
Bavaria	3157	2383	5540	81334
Berlin	1570	813	2383	11669
Brandenburg	455	392	847	3323
Bremen	283	204	487	2142
Hamburg	850	370	1220	7337
Hesse	1819	1088	2907	36811
Lower Saxony	2035	1260	3295	28059
Mecklenburg-Western Pomerania	475	300	775	2252
North Rhine-Westphalia	4636	2656	7292	55002
Rheinland-Palatinate	1027	838	1865	12704
Saarland	297	129	426	1672
Saxony	1203	721	1924	11708
Saxony-Anhalt	574	438	1012	2733
Schleswig-Holstein	597	355	952	4870
Thuringia	653	376	1029	5489

Source: R&D-staff: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/ForschungEntwicklung/Tabellen/FuEPersonalBundeslaenderSektoren.html; Number of professors: special evaluation done by the Statistische Bundesamt (Federal Statistical Office).