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Measuring the Regional “Third-Mission-Potential” of Different Types of HEIs

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1. Introduction

The influence of higher education institutions (HEIs) on national and regional economic and social development is a topic of special interest and prevalent object of studies and discussions in regional sciences.¹ Especially in knowledge based economies, the quality of the higher education system is of high importance for the success of the national innovation system. Furthermore, HEIs are considered to be key actors in regional innovation systems, as they offer regional companies the potential of knowledge transfer and hence encourage localised knowledge spillover effects by enriching the creative atmosphere of a region, and providing continuous access to research facilities and highly qualified human capital.

Traditional missions of HEIs comprise (1) the generation and accumulation of academic knowledge, and (2) the diffusion of knowledge via academic education. More recently, attention has also been drawn to the regional development role of university activities: the “Third Mission” of universities. These discussions centre on the high potential of the economic, innovative and social impact of HEIs on their surrounding regional areas, implying that HEIs might have a duty and mission to foster explicit engagement in regional development processes.

As the Third Mission is a comparably unexplored research field, important questions still need to be answered. As studies point out, the success of university knowledge transfer is spatially distributed unequally, with some regions being able to profit from knowledge spillover effects more effectively than others. The research aim of this article is to analyse an important influence factor on knowledge transfer success: the ‘fit’ between HEI and region. High complementarity of HEI’s focus in education and research with regional economic clusters and specialities might indicate a higher potential concerning the HEI’s regional engagement and Third Mission activities. Although it is mentioned in several studies as important parameter, the HEI-region-fit has not yet been thoroughly explored in empirical research.

Concentrating on the twofold structure of the higher education system in Germany, universities of applied sciences (*Fachhochschulen*) are generally considered to obtain a high focus on academic education and applied research, whereas universities (*Universitäten*) have a supplemental focus on basic research. The following article analyses the fit between German universities respectively universities of applied sciences and national employment on the one hand, and the HEI-industry-fit between HEIs and their surrounding region on the other hand. The article points out, to what extent HEIs of various types focus their educational offer to meet the needs of either the national or the regional labour market. Hence it points out their different potential for regional Third Mission activities and, more general, for knowledge transfer success between academia and industry.

JEL classification: I23 - Higher Education and Research Institutions

I25 - Education and Economic Development

Keywords: Knowledge Transfer, Third Mission, University-Industry-Fit

¹ Important corresponding studies e.g.

- international: Anselin et al. 2000, Varga 1998, Florida 2004, Reddy 2011, OECD 2011,
- with special focus on Germany: Fritsch et al. 2007, Hamm et al. 2012, Back / Fürst 2012, Spehl et al. 2006, Fromhold-Eisebith 1992, Rosenfeld et al. 2005, Schmoch 2011,

2. Theoretical Background

2.1 Knowledge Transfer between HEI and the regional innovation system

The activities of HEIs including research and development, tertiary education, and knowledge transfer, imply a high meaning and important role in national knowledge economies: „Universities are widely cited as critical institutional actors in national innovation systems“². Due to a number of well-known scientific studies³, it is furthermore widely accepted in academic research that HEIs are also a key competitive advantage on a regional level. HEIs are hence increasingly perceived as prominent actors in regional innovation systems that also have the potential to encourage societal and economic developments in the surrounding region.⁴ This article aims at pointing out especially the high importance of HEIs for their surrounding HEI region.

Traditional missions of HEI comprise (1) the generation and accumulation of knowledge (*provider of academic knowledge*⁵), and (2) the dissemination and diffusion of knowledge via tertiary education and support of young academics (*provider of academic education*⁶). Furthermore, the (3) “Third Mission” of HEIs is frequently discussed, which summarizes economic, social, and cultural contributions of HEIs, foremost to the regional society and private industry. Whereas a precise definition of the third mission is still missing in literature, and the general understanding of this concept also varies in different countries, multiple academic contributions focus on this broader area: “(i) the entrepreneurial university model, (ii) the regional innovation systems concept, (iii) the mode 2 of knowledge production approach, (iv) the engaged university model”⁷ and (v) the role as regional system builder.⁸ Concerning this paper, the third mission of HEIs is understood as a process of regional engagement and the interactive support of regional development processes based on a range of multiple contributions and cooperation of HEI and HEI-region. If HEIs engage in third mission activities, this also implies that the more traditional missions – the generation and accumulation of knowledge, and the dissemination and diffusion of knowledge via tertiary education – should be focused more on the surrounding regional environment, the HEI region. Cooperation and knowledge transfer processes should hence be oriented to regional actors, enabling a support of regional development processes.

The HEI region can benefit from a HEI to a crucial extent. The institution’s expenditure, but also the continuous consumption and spending of students and staff benefit local production, employment and economy. These impacts are summarized as expenditure effects and resemble the effects observed for any large expenditure-generating institution. Furthermore, HEIs are increasingly accepted as an important member of regional innovation systems, supporting and promoting regional innovation climate and efforts. The surrounding regions may profit from spill-over effects of HEIs distinguished research efforts, high public investments for research projects in future-oriented branches, and international network connections that enable contact to global knowledge flows for regional private industry. HEIs generally foster entrepreneurial activity of university members and graduates,

² Mowery / Sampat 2009, S. 212

³ Prominent literature includes Benneworth / Hospers 2007; Huggins/Kitagawa 2012; OECD 2007; Acs et al. 1999; Anselin et al. 1997, 2000; Varga 1998; Florax 1992; Uyarra 2008, Caniels/van den Bosch 2011; Pinheiro et al. 2012; Fritsch et al. 2007, 2008; Fritsch 2009

⁴ Acs / Armington 2004, p. 1

⁵ Caniels / van den Bosch 2011, p. 272

⁶ Caniels / van den Bosch 2011, p. 272

⁷ Tripl / Sinozic / Smith 2012, p.3

⁸ Caniels / van den Bosch 2011, p. 272

leading to a higher rate of spin-offs and business start-ups in the region.⁹ Finally, positive side-effects complete the widespread image of a modern HEI region, as e.g. socio-cultural impacts, and a changing city atmosphere that can be referred to as “creative buzz”. These effects are summarized as knowledge-based impacts and benefit the population, the general economic development and innovation systems in their regional environment to a high extent.¹⁰ Figure 1 gives an overview over supply- and expenditure-based effects stemming from HEIs.

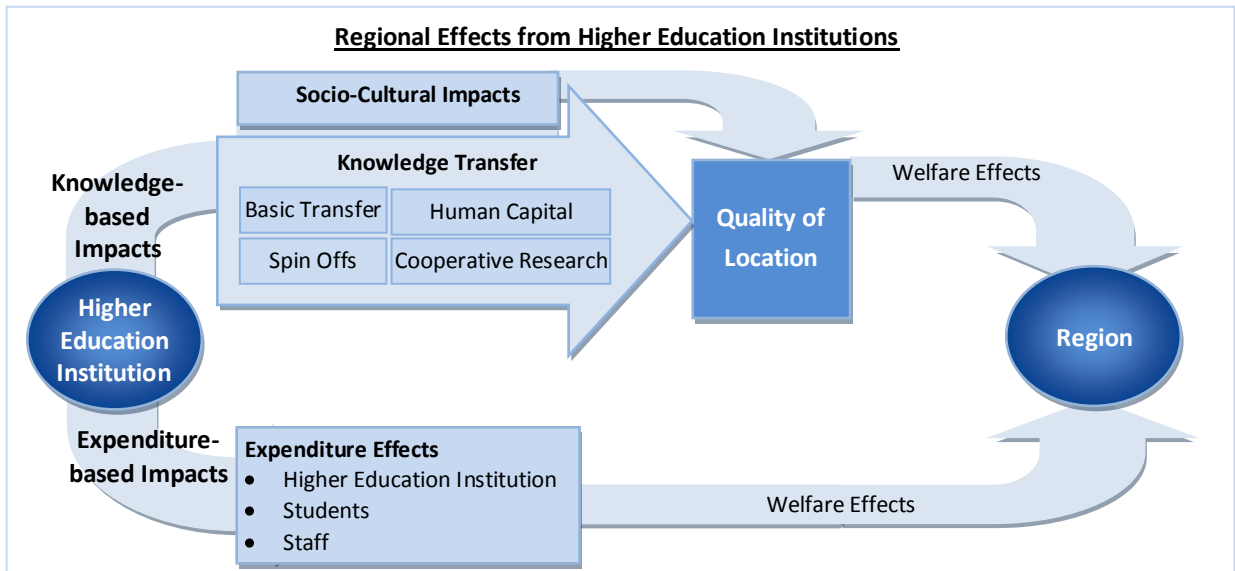


Figure 1: Regional Effects from Higher Education Institutions. Source: Hamm et al. 2012, p. 44

Although many scientific studies describe and empirically underline the potential of HEIs to influence economic and societal changes, not all regions are able to turn this potential into success. As described above, students and graduates may have no contact to local companies, start their careers elsewhere and thereby transfer HEI knowledge to other regions. Cooperative research and development activities between HEIs and industry actors may concentrate on supraregional companies from other areas. As Pinheiro et al. state: “The “rise of the regions” has not treated all regions equally - some thrived through possessing the potent blend or regional knowledge assets making them a ‘place to be’ in a particular industry, such as Silicon Valley, Cambridge in the UK, Paris in France or the Øresund in Scandinavia- universities feature centrally in the stories that are told about the rise and economic dominance of these places.”¹¹ But many policy makers in other regions surrounding HEIs face the challenge of copying these achievements and living up to the generally high expectations of regional private industry, important community actors and the general public.

Concentrating on (1) the generation of knowledge by research and development activities, the regional economic environment will benefit most from cooperative research activities between HEIs and local companies. These cooperative research activities encompass joint patenting and licensing of intellectual properties, contract research, joint research cooperation, or simply the use of university infrastructure by companies for industrial purposes. HEIs increasingly focus on conducting cooperative research activities with industrial partners, as the practical focus – especially in the German higher education system – is becoming more and more important. Nevertheless, some HEIs are

⁹ Egelin et al. 2002

¹⁰ Hamm et al. 2012, p. 45

¹¹ Pinheiro et al. 2012, p. 20

known specifically for their international network connections – academic literature underlines the importance of this ‘antenna-function’¹² to avoid lock-in-effects of innovation systems and achieve a connection to global knowledge flows. This means, HEIs may potentially focus on supraregional, external industrial partners instead of regional partners, either because they focus on an internationally oriented network strategy or simply due to a lack of suitable regional partners.

Concentrating on the second traditional mission of HEIs, (2) the dissemination and diffusion of knowledge via tertiary education, especially the highly-qualified graduates are of eminent importance on a regional micro level – for the firms located in the surrounding regions – as the graduates can effectively transfer and disseminate the knowledge and innovation generated and accumulated in the HEI into regional economy, networks, and enterprises.¹³ On a broader macro-level, graduates are one of the key competitive factors in terms of regional competitive advantages, as the availability of a well-educated work-force strengthens regional economy and furthermore attracts external companies. Human capital has traditionally been observed to be one of the most important resources of regions and one of the most important factors explaining economic growth.¹⁴ The proportion of highly-skilled workers holding a degree of tertiary education among the regional population is generally seen as a key indicator for economic growth potential and human capital endowment. Considering this background, the percentage of HEI graduates that remain in the HEI region may be critically important for a successful knowledge transfer process between a HEI and its surrounding region. Only if graduates remain in the HEI region, they form and enrich a highly educated labour force and support knowledge and innovation transfer from the HEI to the regional economy, networks, and enterprises.

Addressing the (3) third mission of HEIs, academic institutions are expected to contribute to societal and regional development processes. The process of regional engagement of HEIs is frequently discussed, and reflects expectations of academics, policy makers and general public – but developments and changes in higher education systems generally have a long-term perspective and are accompanied by frequent discussions and the exchange of different points of view. It has to be noted that not all HEIs have converged to see themselves as broader societal objectives, and the dissemination of third-mission-activities varies. This is understandable, as the benefit to individual HEIs in future oriented and monetary terms for some modes of third-mission-activities – particularly the support of (regional) spin-offs and patenting efforts¹⁵ – is clearly limited. But even considering different levels of HEI’s third-mission-activities, also a high resonance, absorption capacity and integration and cooperation willingness of the surrounding region is of high importance for the success of third-mission-activities.

As the success of all three prominent HEI-missions varies when different regions are compared, in the following chapter, potential factors of influence on knowledge transfer processes in general will be described and analyzed in more detail.

¹² Fritsch / Schwirten 1998, p. 253; Back / Fürst 2011, p. 2

¹³ Audretsch et al. 2010, p. 105

¹⁴ E.g. Mellander / Florida 2007, p. 2; Rodriguez-Pose / Vilalta-Bufi 2004, p.1

¹⁵ Trippel / Sinozic / Smith 2012, p. 21

2.2 Potential Factors of Influence on Regional Knowledge Transfer

The fact that not all regions benefit from their central universities to the same extent proves the existence of influence factors on knowledge transfer success. As every two-sided dynamic interaction process, knowledge transfer between HEI and regional industry can be influenced by a diverse range of influence factors. As pictured in figure 2, these influence factors can generally be divided into three groups:

- University-sided determinants influence the knowledge transfer intensity. For example, the HEI network and research strategy might focus on international connections, or the given financial resources might prevent the HEI to engage in supplemental transfer activities.
- In his well-known studies of university spill-over effects in the US, Varga pointed out: „The same university research expenditures were associated with dramatically different levels of innovation output depending on the concentration of high technology production, business service employment, and small firms.“¹⁶ Concluding, regional determinants influence the absorption capacity of the given knowledge transfer potential. Region-sided influence factors, as e.g. the local level of agglomeration, innovation and service orientation, and further regional economy characteristics play an important role in the knowledge transfer process.
- Intermediate determinants greatly influence the interaction of HEI and regional economy:
 - o There is a wide range of intermediary institutions and networks with the task to improve the interaction among HEI and industry actors.
 - o The „fit“ between the education and research focus of the central HEI and the regional distribution of retail and industrial branches is of eminent importance for regional knowledge transfer success.

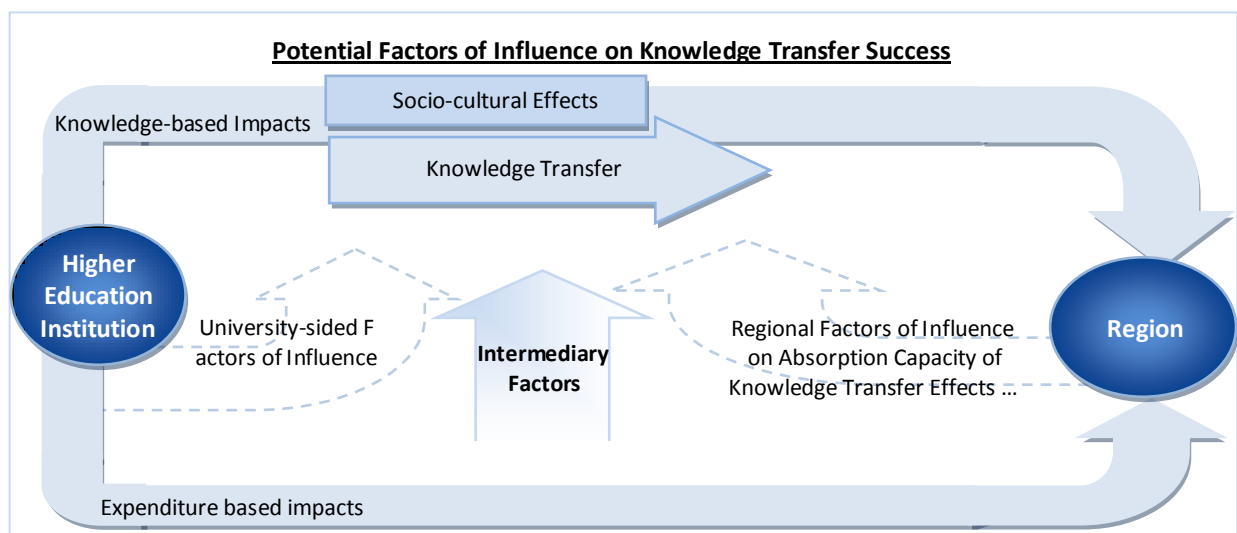


Figure 2 Potential Factors of Influence on Knowledge Transfer

¹⁶ Varga 1997, p. 124.

To underline the importance of a thematic congruence between the academic research and education fields of the HEI and the economic structure of the surrounding economic environment – which can be referred to as the HEI-region-fit – the article will again focus on the traditional HEI missions.

Considering the function (1) to generate and accumulate knowledge on the basis of research and development activities, contract research and other joint research activities, the success of this mission on a regional level depends on a similar thematic approach of industry and academia. Companies and scientists from universities can interact and learn from each other particularly well, when there is a high thematic overlap between private and public research activities. The process of interactive knowledge sharing is facilitated and cooperative research activities can be bundled. In addition, a university research focus that is similar to the regional structure of private industry leads to a better match of culture, norms and values of the active researching individuals.¹⁷ On the one hand, a high degree of thematic congruence of the research output of business and academia (e.g. patents, publications) suggest a high transfer potential between the HEI and the actors of regional economic environment.¹⁸ Accordingly, on the other hand, a disadvantageous situation will arise for knowledge transfer success between HEI region and HEI, if important HEI research and education focuses are not in balance with regionally strongly represented economic branches.¹⁹

For the success of the mission of HEIs (2) to disseminate and diffuse knowledge via tertiary education, a thematic congruence is necessary between education fields represented strongly at the HEI and the economical branches represented strongly in the economic environment. Thematic orientation of academic education on the demand of local employers is connected to the regional range of the knowledge transfer and supports the probability of graduates to find employment in regional companies. If HEI strategically align their educational efforts with regional employment demand, this strategy might help to reduce the extent of mobility of the region's HEI graduates. If HEI strategically align their educational focus on national or international labour demand, mobility after graduation might be an implication.

Addressing the third mission of HEIs as regional system builders and supporters of regional societal, economic, cultural, and innovative processes, the HEI-region-fit is of especially high importance. If there is no thematic overlap, and no suitable industry partners for cooperation can be found, the university will direct their research, education and third-mission-efforts to general societal needs and cooperate with supraregional, national, and even international partners more often. If the university research activities do not comply with the needs of the regional industry branches, and students graduate in fields that are not of importance for the companies in the surrounding regions, the benefit of the HEI to local private industry, policy makers and society is most probably very limited.

Summarized, a good fit between teaching and research areas of the HEI on one side, and regional private industry focus on the other side, highly influences, how high the chances of graduates are to accomplish their career entry in the regional labour market, how well academic and commercial researchers cooperate, and how well knowledge transfer potential can be absorbed by the regional economy. Thus, an empirical analysis of the "HEI-region-fit" might hold exceptional answers as to the question, why some regions are able to benefit from their central HEI more than other regions.

¹⁷ Cummings / Teng 2003

¹⁸ Fritsch / Slavtchev 2007, p. 14

¹⁹ Knappe 2006, p. 81.

2.3 Research Questions

The central research aim of this article is the development of an empirical measure of the “HEI-region-fit”, which empirically conceptualizes the congruence between the distributions of industry branches and activities of higher education in a considered institution of higher education. A comparable economic measure has not yet been developed in academic literature. A high HEI-region-fit might, among other factors (as was clarified in chapter 1.2), imply a high regional absorption potential for third-mission-potential. Concentrating on the manifold German system of higher education, the paper furthermore aims at a differentiation of the HEI-region-fit between universities of applied sciences (*Fachhochschulen*) and universities (*Universitäten*). Whereas universities of applied sciences are generally considered to possess a high focus on higher education as a direct preparation for career entry in the private industry, and get engaged mostly in application-oriented research, universities have a more general focus of education and on research, also engaging in basic research.

Although there is a wide range of different third-mission-models that are applied in various countries and discussed in various academic contributions, this paper points out the importance of two prerequisites for a high third-mission-potential that are in line with all mentioned concepts. First, most third-mission-concepts imply a focus of activities of HEIs towards their geographically surrounding environment, the support of development processes in the HEI region. Second, most third-mission-concepts imply a focus on economic processes, the support of and knowledge transfer to industry, the commercialization of academic contributions. Thus, as depicted in figure 3, both conditions are seen as part and prerequisite for a high third-mission-potential and are therefore empirically conceptualized in the following.

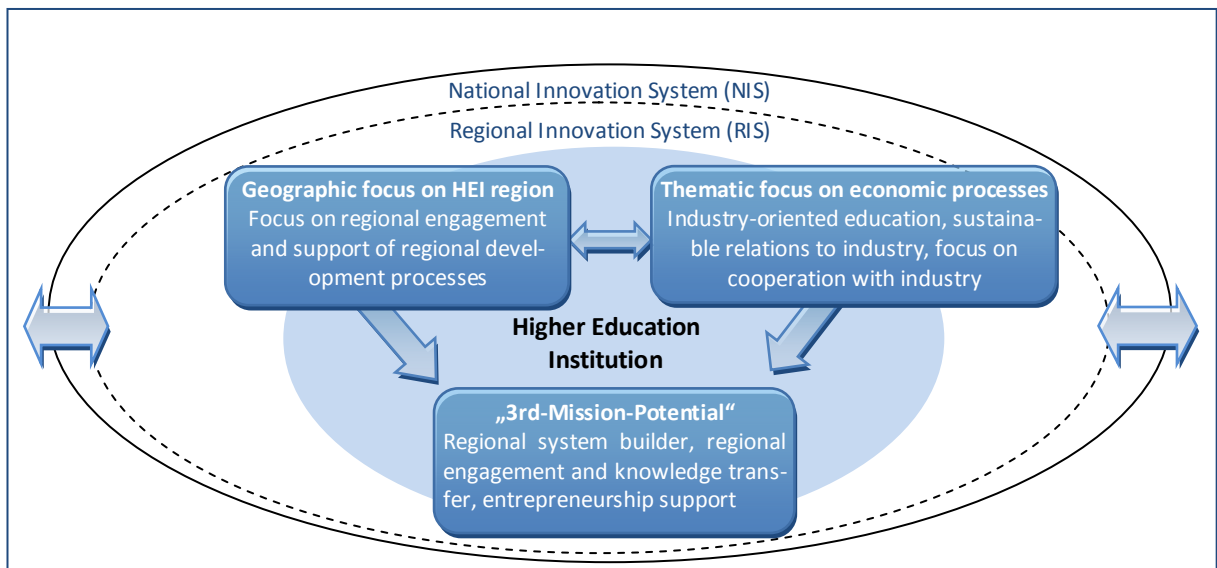


Figure 3: Potential for “Third-Mission-Engagement” of Higher Education Institutions

To analyze third-mission-potential, thus both aspects have to be part of an empirical examination. Considering the mentioned research aims, the paper aims at investigating the following central methodological research questions:

Q.1: The education activities of which type of HEI - universities of applied sciences (*Fachhochschulen*) or universities (*Universitäten*) - are more focused on private industry employment?

Q.2: The activities of which type of HEI are thematically better aligned with the structure of private industry employment in the geographical environment, the HEI region?

3. Empirical Analysis and Results

3.1 Focus on Industry-Oriented Education

Concerning knowledge transfer via industry-oriented education, one of the most important factors of success is the degree of how a HEI's educational curriculum is in line with the regional structure of economy. The higher the congruence of HEI curriculum and industry structure, the higher is the benefit of students (internships, part-time work) and graduates for employers. The success of knowledge transfer hence significantly depends on compliance of a HEI's educational curriculum 'supply' and regional employer's demand of workforce. Considering the traditional and politically supported task descriptions of German HEIs, it can be assumed that universities of applied sciences are more likely to adapt their curriculum to the demand of local companies than universities. That, in consequence, improves chances of highly qualified graduates of universities of applied sciences to find a job in the HEI region. Following the hypothesis that German HEIs develop their educational curriculum according to their traditional missions, by trend it can be expected that it is not one of the central targets of traditional universities to focus on industry-oriented education, but primarily to convey basic scientific skills, which first play a role on the national employment market.²⁰ Thus, it is to be assumed:

Hypothesis 1: The congruence between the structures of education of universities of applied sciences and industry employment is generally higher compared to the equivalent of universities.

To examine hypothesis 1.1, we analyze the congruence of data of German HEI graduates with data of employed academics in Germany. The higher the congruence, the better the 3rd-mission-potential is assumed to be. To gain information on employment figures, we analyzed the structure of employment in 2011 on the 3-digit-level, dissected by occupation groups, in NUTS-3-regions, which was obtained from the Federal Statistical Office²¹. Only occupations were included in the analysis, where more than 5% of employees own a third-level education degree. Furthermore, only employed academics were included in the analysis – the respective percentage in each occupation was obtained from the Federal Employment Agency.²² There is only employment subject to social security considered. The Number of graduates for 2011 was included dissected by thematic subject groups according to the classification of study fields of the Federal Statistical Office, considering the 4-digit level²³. Private universities, open (distance learning) universities, and higher education institutions with a very specialized focus (e.g. arts, *Pädagogik*- and *Verwaltungsfachhochschulen*) were excluded from the analysis.

²⁰ E.g. Fritsch et al. 2007, p. 79.

²¹ Federal Statistical Office (Statistisches Bundesamt): Beruf und Ausbildung. BAA 3.1.2 Erwerbstätige nach Berufsgruppen, ausgewählten Berufsordnungen und beruflichem Bildungsabschluss 2011. In: Mikrozensus 2011 – Bevölkerung und Erwerbstätigkeit – Beruf, Ausbildung und Arbeitsbedingungen der Erwerbstätigen in Deutschland, 2012.

²² German Federal Employment Agency (*Agentur für Arbeit, Deutschland*):Arbeitsmarkt in Zahlen – Beschäftigungsstatistik 2011. Sozialversicherungspflichtig Beschäftigte nach Berufsordnungen (3-Steller) und Qualifikation für Kreise und kreisfreie Städte. Special Statistical Analysis prepared for Niederrhein Institut for Regional and Structural Analysis, NIERS, 2011.

²³ Federal Statistical Office (*Statistisches Bundesamt*): Monetäre hochschulstatistische Kennzahlen – Einzelne Hochschulen. Special Analysis for Niederrhein Institute for Regional and Structural Research. Fachserie 11, Reihe 4.3.2. Wiesbaden, Ausgabe 2013.

The comparison of structures focuses on percentages and share values, not on absolute figures. On the basis of a developed distributional key index, educational study areas were associated with the thematically equivalent occupational fields provided by the basic classification of the German Federal Employment Agency. Thus, for example (i) the percentage of veterinarians in all academics employed in a considered geographical area is compared with (ii) the share of graduates of the study program "Veterinary Medicine" in the total number of graduates of a considered HEI.

To analyze, which type of HEI obtains a higher focus on industry-oriented education activities, figures 4 and 5 compare national employment shares of different professional groups with corresponding proportions of different types of HEI graduates. For the display of national employment structure, the analysis took into account employees with a university degree who are subject to social insurance contributions (only sectors with a share of academics > 5% were considered).

The comparison of the thematic focus of HEI curriculum and employment structure is carried out as a first step for national employment and the national figures of graduates of universities of applied sciences (figure 4) and universities (figure 5). Based on the figures, it is visually apparent that universities of applied sciences align the thematic focus of their educational curriculum to a higher extent to the industry-oriented employment structure than universities do. The congruence of the structure of graduates of universities of applied sciences with the national employment structure considering employees who are subject to insurance contributions (figure 4) seems to be distinctly higher than the congruence of universities and national industry employment (figure 5). Especially, the difference can be depicted in figure 5 due to a high dissimilarity between the proportions of graduates and the employees who are subject to social insurance contributions in the field of language and cultural studies.

However, a corporate task sharing in the higher education system can be identified. While study courses in the field of "language and cultural studies" and "human medicine, veterinary medicine, sports and health sciences" is almost exclusively part of the educational curriculum of universities, there are significantly more graduates at universities of applied sciences considering the thematic educational groups "agriculture, forestry and food sciences", "law, economic and social sciences" and "engineering".

Analyzing the first research question,

Q.1: The education activities of which type of HEI - universities of applied sciences (*Fachhochschulen*) or universities (*Universitäten*) - are more focused on private industry employment?

Summarized, it can be stated that according to visual measures, universities of applied sciences more intensively align their educational curriculum to the structures of private industry employment. Supplementary, the following chapter will provide further empirical measures to underline and empirically prove these visual impressions.

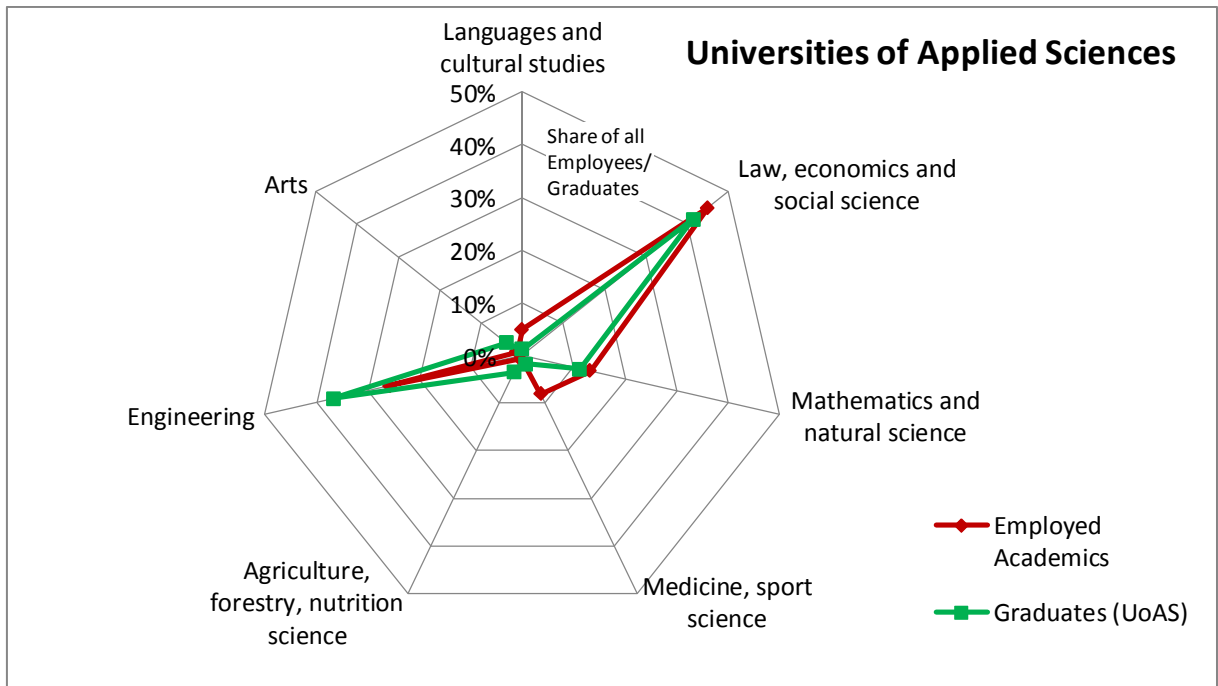


Figure 4 Matching of academic employment subject to social insurance contributions and teaching at public universities of applied sciences (n=100)

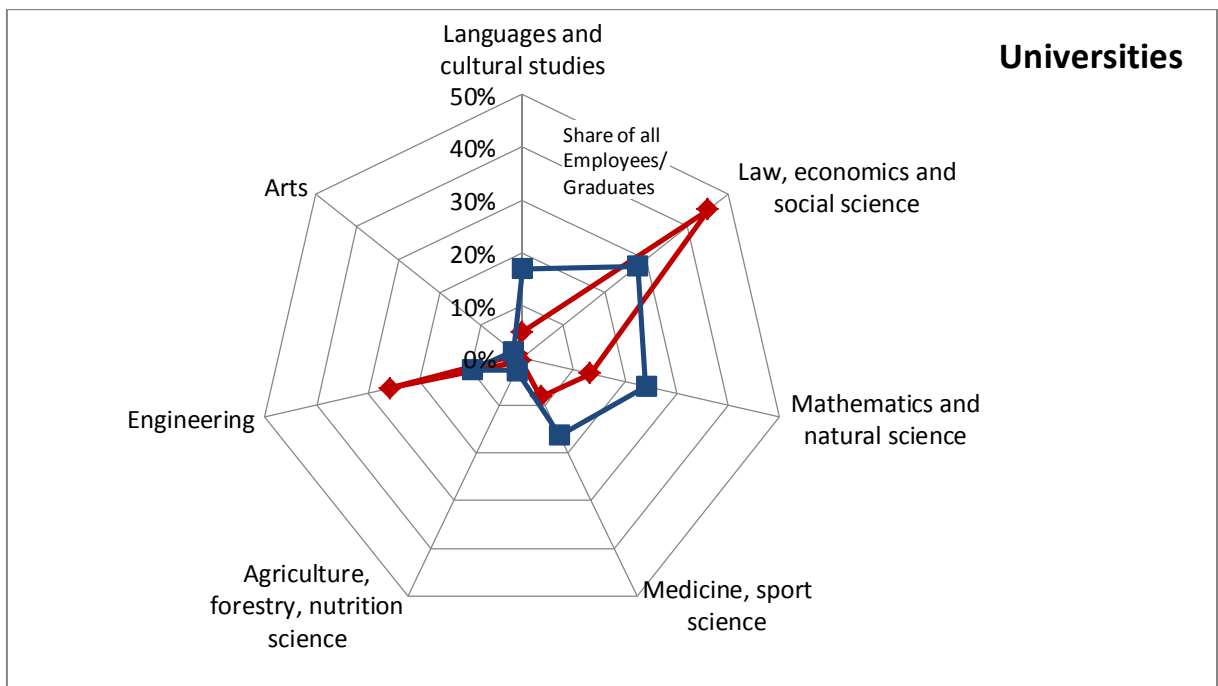


Figure 5 Matching of academic employment subject to social insurance contributions and teaching at public universities (n=80)

3.2 Focus on HEI region

In addition to the considerations of chapter 3.1, an empirically based comparison of individual HEIs with national employment structures, federal state's employment structures (NUTS 1), and regional (NUTS 1) employment structures is to be conducted, to empirically underline the answer on the first research question, and to analyze Q.2:

Q.2: The activities of which type of HEI are thematically better aligned with the structure of private industry employment in the geographical environment, the HEI region?

Considering the traditional and politically supported task descriptions of German HEIs, it is generally assumed that universities of applied sciences are more likely to engage in regionally oriented transfer activities²⁴ than universities. Universities of applied sciences engage in industry-connections more frequently, where the geographical distance to contact partners is an important influence factor. Universities on the other hand are known for their national and international network connections, and internationally oriented education and research strategy. Furthermore, the corporate task sharing in the German higher education system mentioned earlier implies that in some study areas, only universities are allowed to offer graduation programs, e.g. concerning medicine, law, and teaching degree programs. Therefore, universities are expected to cover national education demand in these study areas. Thus, it is assumed:

Hypothesis 2.1: In comparison to university structures, the education activities of universities of applied sciences are thematically better aligned with the specific private industry structure in the geographical environment.

Hypothesis 2.2: A special focus on regional employment structures can be identified for education activities of universities of applied sciences.

Hypothesis 2.3: A special focus on national employment structures can be identified for education activities of universities.

To analyze the posed research question Q.2, a "HEI-region-fit-index" has been developed. This index compares employment of graduates in the various sectors of a geographic unit (e.g. the HEI region²⁵) with the appropriate course specific numbers of graduates of located universities. The percentage deviations of all branches are summed and halved - the procedure for determining the HEI-region-fit coefficients is thus very similar to the approach known in regional economics to determine the specialization coefficient²⁶ of a region.

²⁴ Hamm et al. 2012, p.146; Fritsch et al. 2007, p. 79; Falk / Kratz 2009; Busch / Weigert 2010, p. 466

²⁵ The term "HEI region" is defined in this work as the NUTS-3 (German administrative form: *Kreis*), in which the HEI is located. If a university has several locations, these districts are cumulated to form the HEI region

²⁶ Giffinger et al. (2011): "You can determine the level of industry-specific specialization of subspaces of an entire room and investigate the structural one-sidedness or versatility of regions with the aid of specialization coefficient. This coefficient is defined as the sum of the deviations of the shares of branches in the investigated region from their shares in the total space."

To calculate the fit index of a certain HEI and a considered geographic unit, the following formula is to be applied:

$$(1) \quad FI_{hi} = 0,5 \times \frac{\sum_{j=1}^m Y_{ij}}{\sum_{j=1}^m Y_{ij}} - \frac{\sum_{j=1}^m X_{hj}}{\sum_{j=1}^m X_{hj}} \times 100$$

FI_{hi} = fit index of HEI h and considered geographic unit i

Y_{ij} = Employed academics in considered geographic unit i in occupation/academic field j

X_{hj} = graduates at the HEI h in the occupation/academic field j

m = industries/academic fields

We analyzed the structure of employment in 2011 on the 3-digit-level, dissected by occupation groups, in NUTS-3-regions²⁷. Only occupations were included in the analysis, where more than 5% of employees have a third-level education degree. Furthermore, only employed academics were included in the analysis.²⁸ There is only employment subject to social security considered. The Number of graduates was included dissected by thematic subject groups for 2011, according to the classification of study fields of the Federal Statistical Office, considering the 4-digit level²⁹. Private universities, open (distance learning) universities, and higher education institutions with a very specialized focus (e.g. arts, *Pädagogik*- and *Verwaltungsfachhochschulen*) were excluded from the analysis.

The resulting fit index can take a range of 0 (perfect match between employment shares and shares of graduates of considered HEI) to 100 (minimum compliance). As an example, in the following the fit index for Augsburg University (figure 6), respectively Augsburg University of Applied Sciences (figure 7) and their surrounding geographical unit (*district*) are calculated and visualized. Whereas the visualization in figure 6 and 7 cannot provide a clear clarification, which of the two HEIs education structures has a higher congruence with regional private industry, the fit index analysis enables a distinct comparison and differentiation. Considering the fit index coefficient, Augsburg University has a fit index of 56.65 with HEI region (district of Augsburg), whereas the fit index for Augsburg University of Applied Sciences is 48.04. Hence, there is a higher congruence between the educational curriculum of Augsburg University of Applied Sciences to the employment of academics in Augsburg – this difference is also visibly apparent in figures 6 and 7.

The fit index for the considered Augsburg University and Augsburg University of Applied Sciences can be calculated also in reference to the federal state's employment structure of the concerned federal state Bavaria (NUTS 1) and the national employment structure.

²⁷ Federal Statistical Office (Statistisches Bundesamt): Beruf und Ausbildung. BAA 3.1.2 Erwerbstätige nach Berufsgruppen, ausgewählten Berufsordnungen und beruflichem Bildungsabschluss 2011. In: Mikrozensus 2011 – Bevölkerung und Erwerbstätigkeit – Beruf, Ausbildung und Arbeitsbedingungen der Erwerbstätigen in Deutschland, 2012.

²⁸ The respective percentage per occupation was obtained from the German Federal Employment Agency (*Agentur für Arbeit, Deutschland*):Arbeitsmarkt in Zahlen – Beschäftigungsstatistik 2011. Sozialversicherungspflichtig Beschäftigte nach Berufsordnungen (3-Steller) und Qualifikation für Kreise und kreisfreie Städte. Special Statistical Analysis prepared for Niederrhein Institut for Regional and Structural Analysis, NIRS, 2011.

²⁹ Federal Statistical Office (*Statistisches Bundesamt*): Monetäre hochschulstatistische Kennzahlen – Einzelne Hochschulen. Special Analysis for Niederrhein Institute for Regional and Structural Research. Fachserie 11, Reihe 4.3.2. Wiesbaden, Ausgabe 2013.

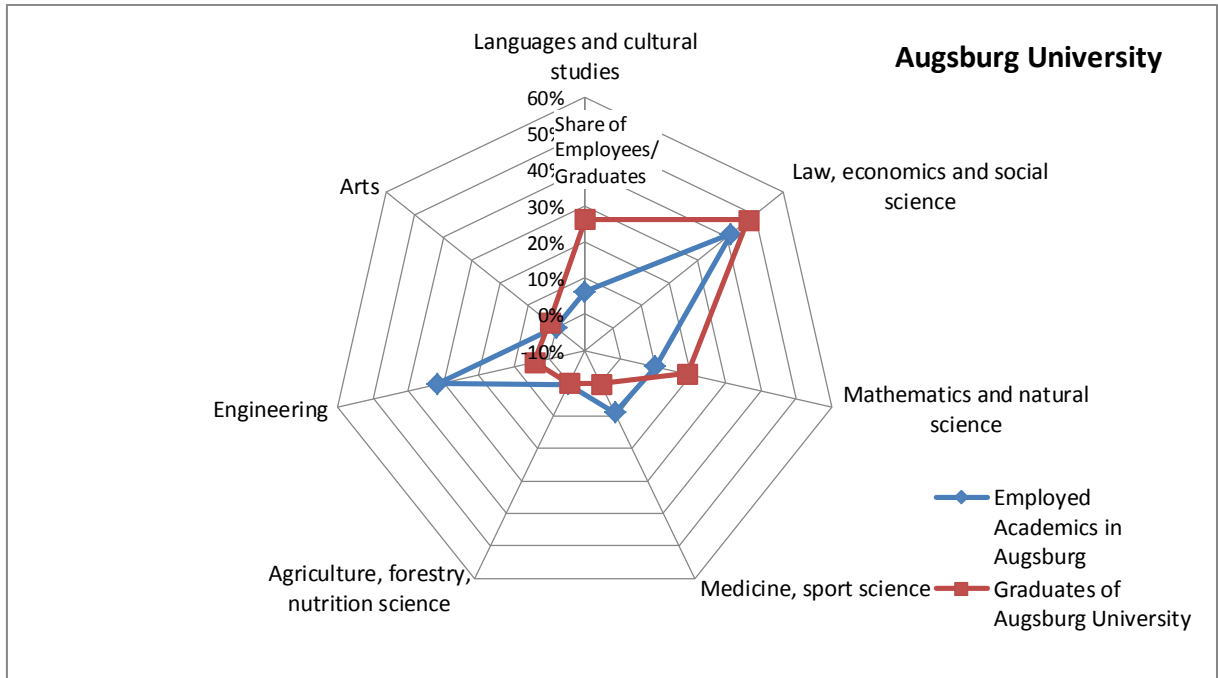


Figure 6 Matching of academic employment subject to social insurance contributions in the city of Augsburg and the educational structure at Augsburg University

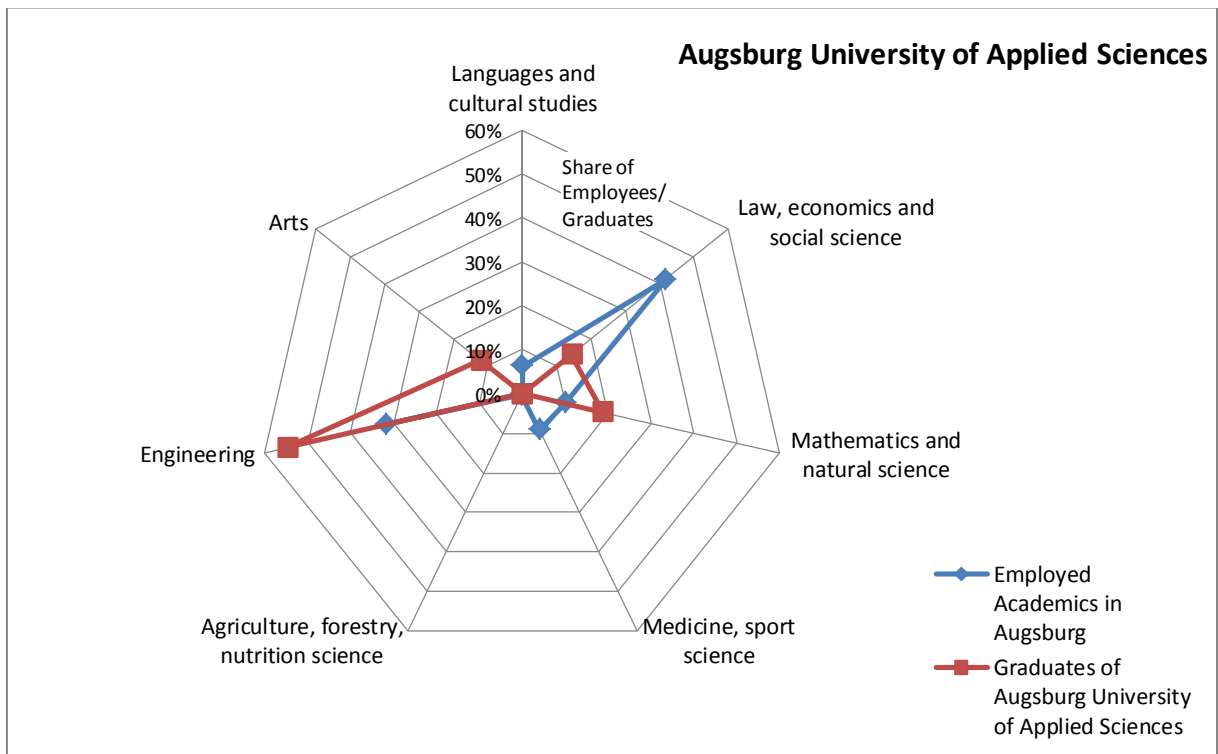


Figure 7 Matching of academic employment subject to social insurance contributions in the city of Augsburg and the educational structure at Augsburg University of Applied Sciences

To reach a conclusion for the identified research questions Q.1 and Q.2, fit indices for each HEI were calculated related to national employment, the respective federal state’s employment (NUTS 1) and employment³⁰ in the HEI region (NUTS 3). Then arithmetic means were calculated for the different

³⁰ The HEI region is defined in this work as the county in which the HEI is located. If a HEI has several locations, these counties are added to the HEI region.

types of HEIs. Table 1 indicates the resulting HEI-region-fit index for the different forms of HEI and the different geographic units, for which the index was calculated.

HEI-region-fit index to determine the fit between employment and the HEI's educational curriculum			
	Ø fit index		
	National level	Federal state level	Regional level
Universities of applied sciences (n=100)	52.43	52.78	53.78
Universities (n=80)	60.61	60.98	59.52
All HEIs (n=180)	56.06	56.43	56.33

Table 1 fit between employment and the HEI's educational offer

Table 1 illustrates that the average fit index for national employment structures and universities of applied sciences is 52.43 compared to the equivalent average fit index of 60.61 for universities. This implies that universities of applied sciences indeed show a higher average congruence to private industry employment structures than universities. Analyzing the situation on a regional level, a similar situation can be observed: education structures of universities of applied sciences exhibit on average a lower HEI-region-fit index – and hence a better “fit” with regional private industry employment structure – than universities. These findings further empirically underline the confirmation of Hypothesis 1, which implies that the congruence between the structures of education of universities of applied sciences and private industry employment is generally higher compared to the equivalent of universities. However, a special role can be claimed by technical universities as a part of the universities, which generally exhibit a rather private industry- and application-oriented research and education curriculum. Hence, also their fit-indices are very low compared to normal universities, indicating a better HEI-region-fit (53.49) that is comparable to universities of applied sciences.

Returning to the second identified research question:

Q.2: The activities of which type of HEI are thematically better aligned with the structure of private industry employment in the geographical environment, the HEI region?

In the review of the first research question clear indications were to recognize that the research hypothesis 2.1 even can be confirmed. The analysis of arithmetic means of the HEI-region-fit indices carried out in table 1 clearly implies that universities of applied sciences are thematically better aligned with the structure of the private industry in the HEI region which states that the education structures of the universities of applied sciences are more geared to the needs of the regional economy. The fit index on regional level is 53.78 for universities of applied sciences and 59.52 for universities. To be able to draw valid conclusions concerning this research question, further statistical tests have to be conducted to examine, if there is a statistically significant difference between the calculated HEI-region fit indices on a regional level for universities and universities of applied sciences. To be able to examine, if the differences are significant, the distributions of the indices are analyzed. Figure 8 exhibits a histogram, a Q-Q-Plot and further statistical information of the fit index between universities and HEI regions. Figure 9 illustrates the same information for the fit index between universities of applied sciences and HEI regions.

From the diagrams and statistics in Figure 8 and 9, it can be concluded that the fit indices for both HEI-types do not indicate a normal distribution, but a light skew to the right (positive skewness). The elongated tails at the right indicate that for both distributions, there is a certain number of specialized HEIs that offer study courses only in certain thematic areas and hence reach a very high fit index

coefficient. As the data do not indicate a normal distribution, and furthermore the Q-Q-plot proves that there are a few outliers for both HEI-types, the Kolmogorov-Smirnov-test was ruled out. To test for significant inequality of the given independent samples, the Levenes test and the Mann-Whitney U-test was chosen, the results being indicated in table 2. Both tests indicate that the null hypothesis could definitely be rejected, for the Mann-Whitney-U-test at a 0.003 significance level with $Z = -3$, which proves a significant difference between the two distributions.

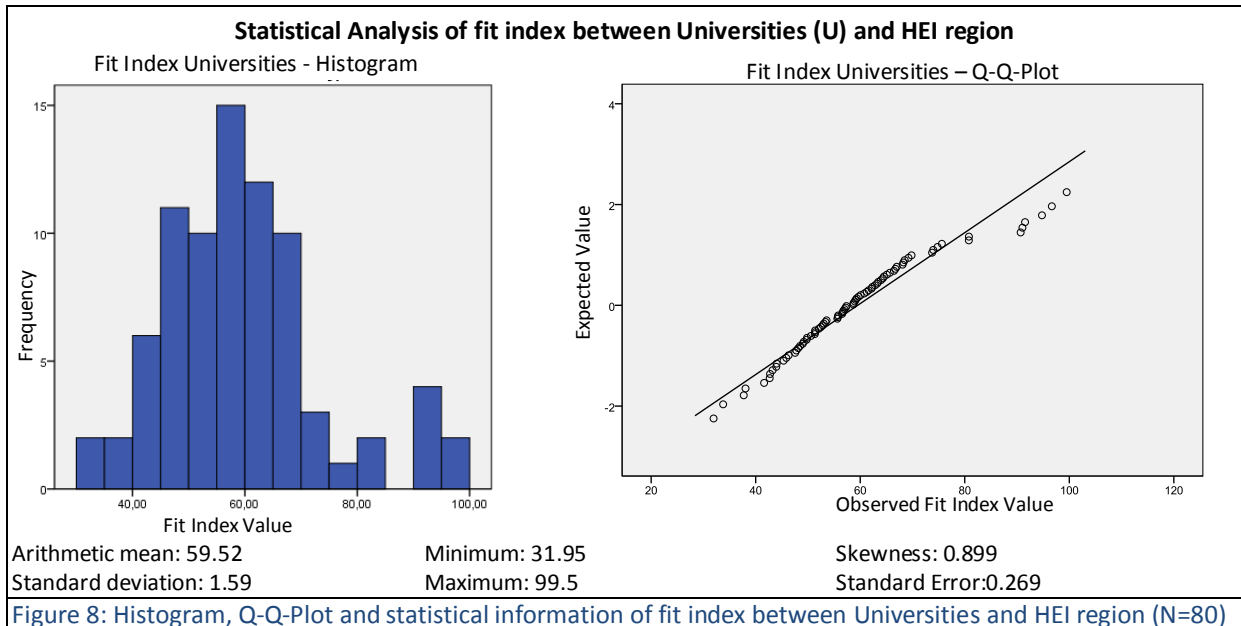


Figure 8: Histogram, Q-Q-Plot and statistical information of fit index between Universities and HEI region (N=80)

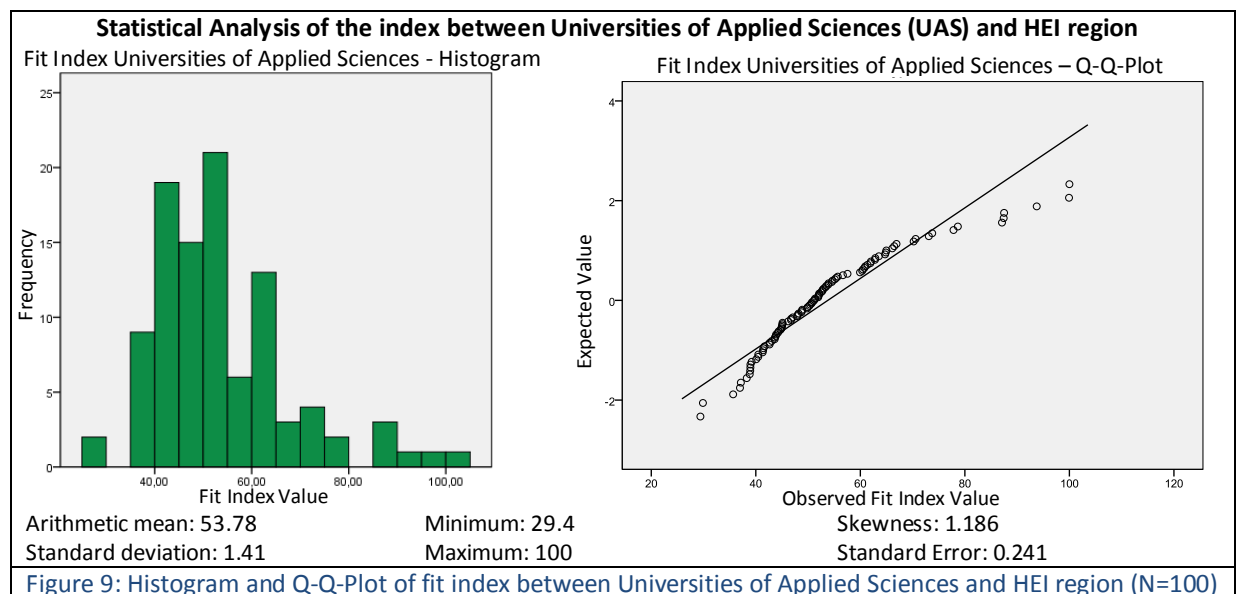


Figure 9: Histogram and Q-Q-Plot of fit index between Universities of Applied Sciences and HEI region (N=100)

Mann-Whitney-U-Test					
	N	Mean Rank	Sum of Ranks	Z	Significance (2-tailed)
Fit-index U	80	104.61	8369.00	-3.000	0.0003
Fit-index UAS	100	79.21	7921.00		

Table 2: Non-parametric Mann-Whitney-U test for the difference between fit-indices of universities and universities of applied sciences

Hypothesis 2.2 states that the educational structure of universities of applied sciences is especially targeted to the specific needs of the regional economy – in comparison to the other geographical levels. We test this hypothesis by comparing the fit indices of different geographical levels with each

other. In figure 10, the data from table 1 is presented graphically to illustrate the differences between the fit indices for different geographical levels. If H 2.2 was correct, we would expect universities of applied sciences to have the lowest fit index on the regional level, followed by the other geographical levels.

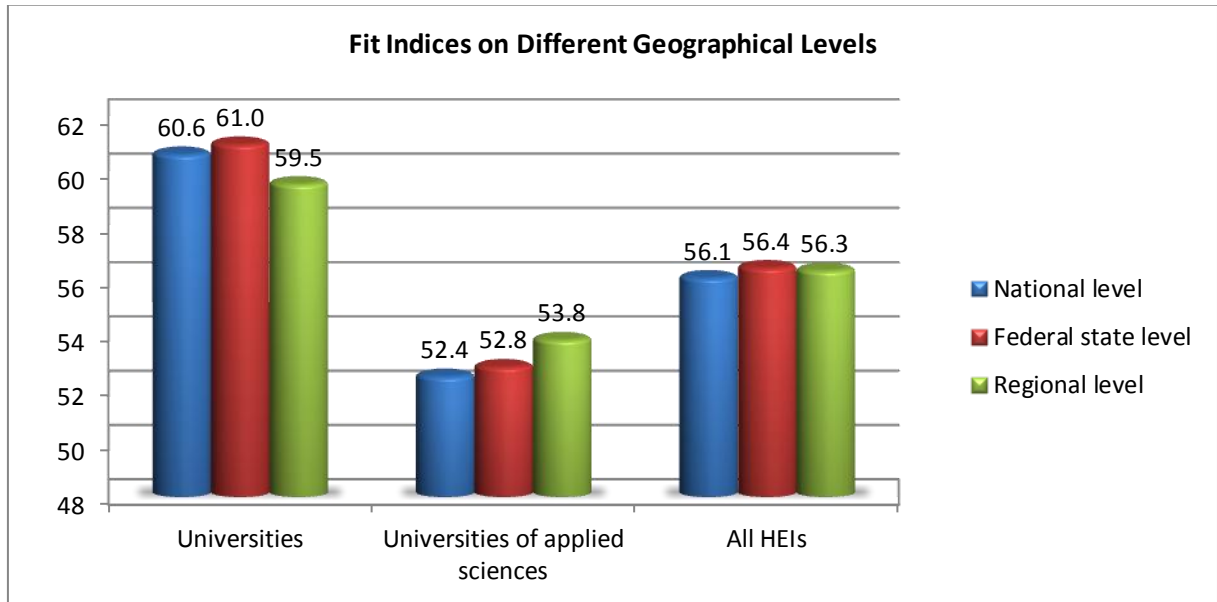


Figure 10: Comparison of industry-HEI fit-indices on different geographical levels

For universities of applied sciences, it is clearly visible that the fit index on national level is the lowest, followed by the federal state's and regional levels. The congruence between the structure of the educational curriculum of universities of applied sciences and private industry employment is hence highest considering the national level – which rejects the theory of a clear primary strategic focus on regional private industry needs. Thus, hypothesis 2.2 is not confirmed. For a strong focus on the special demand of the region namely would speak a relatively low value at a regional level. However, the difference between the geographic levels is very low. On the basis of the study at hand, it can therefore not be presumed that universities of applied sciences are not focusing the regional labour market demand, because probably the fit index would otherwise differentiate accordingly. What can be said, however, is - and this brings us to hypothesis 2.3 - that regarding the labour market, universities of applied sciences do not have a stronger regional focus than universities. Also, the assumption that the structure of the education activities of universities is rather aligned to the national and federal state's labour market structure could not be confirmed. In fact, the fit index on a regional geographic level has a slightly lower value than on federal state's and national level.

Finally, with respect to Research Question 2, it is to note that the education activities of universities of applied sciences (in comparison to universities) are more consistent with the structures of the regional labour market regarding private industry employment, but a special focus on the local demand for skilled workers is not to detect. To avoid confusion, it is to be summarized that universities of applied sciences based on each investigated geographical level have a higher congruence with the private industry employment demand than universities have, thus including the local level. Nevertheless, our investigation cannot detect a focus on the regional private industry.

Model Variation

To complement the analysis of the regional orientation of HEIs in the field of education, a variation of the developed model will be presented in the following. In the figures above - as already explained - only employees subject to social insurance contribution were recorded. But, ultimately, an innovation system doesn't only consist of private industry employees. Rather, the innovation system also requires supportive public institutions (e.g. schools, political establishments, governmental administrative offices), in which mainly civil servants work, who are not registered in the data base that was used in this article so far. Furthermore, entrepreneurs and self-employed persons are important members of a regions' innovation system and contribute to its innovative and economic performance. To comprehend the entire employment situation including these two groups, the share of self-employed professionals and civil servants has been added to the calculation of workforce structures. This was achieved by modifying the number of employees subject to social insurance contribution of each occupational field with a special multiplier. The multiplier is calculated according to the national share of self-employed persons and civil servants of all employees in the respective occupation.³¹ Thus, a 'self-employed and civil servants adaptation' of the numbers of employees subject to social insurance contribution was performed.

In comparison to figure 4 and 5, it becomes apparent in figure 11 that particularly the areas of language and cultural studies are more strongly represented due to the inclusion of the multiplier. Among other factors, this is likely to be due to the high number of teachers in this field, who are mostly not subject to social insurance contributions and have therefore not been included in calculations so far.

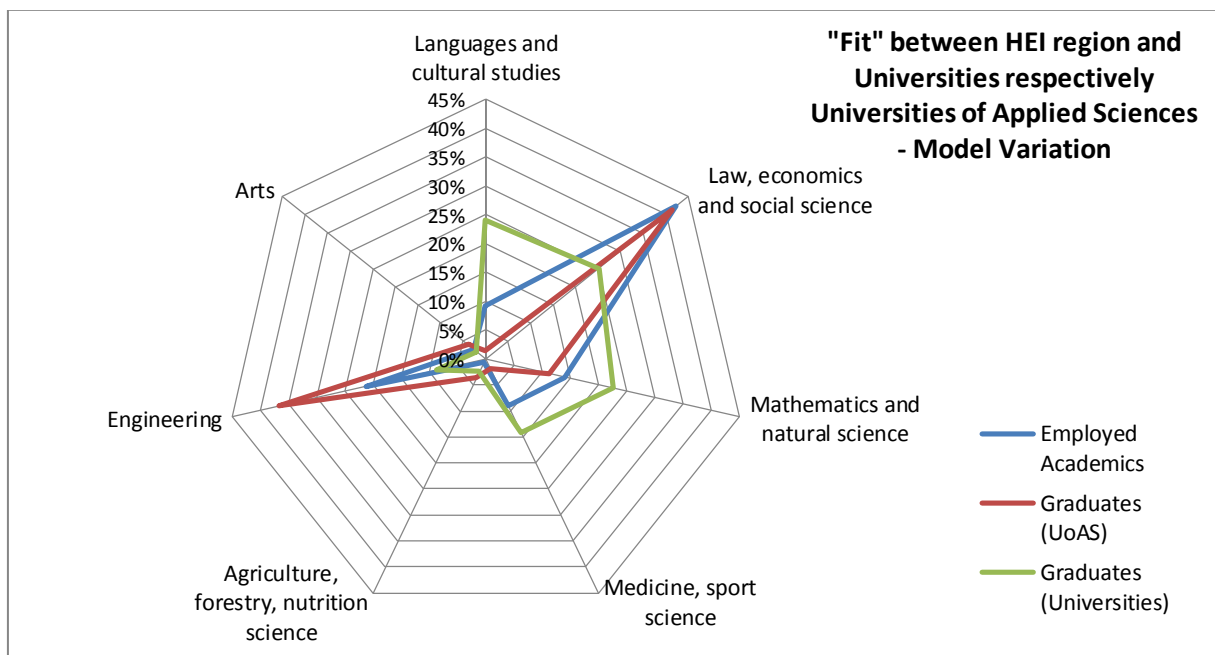


Figure 11: Matching of academic employment and educational curriculum at public universities of applied sciences and universities – Model Variation

³¹ Federal Statistical Office (*Statistisches Bundesamt*), 2012

The adapted construction of academic employment structures in turn has an impact on the comparison with the structures of the education activities of HEIs. Thus, the extension of the model with the numbers of self-employed and civil servants changes the values of the Fit Indices considerably, as the following figure 12 shows:

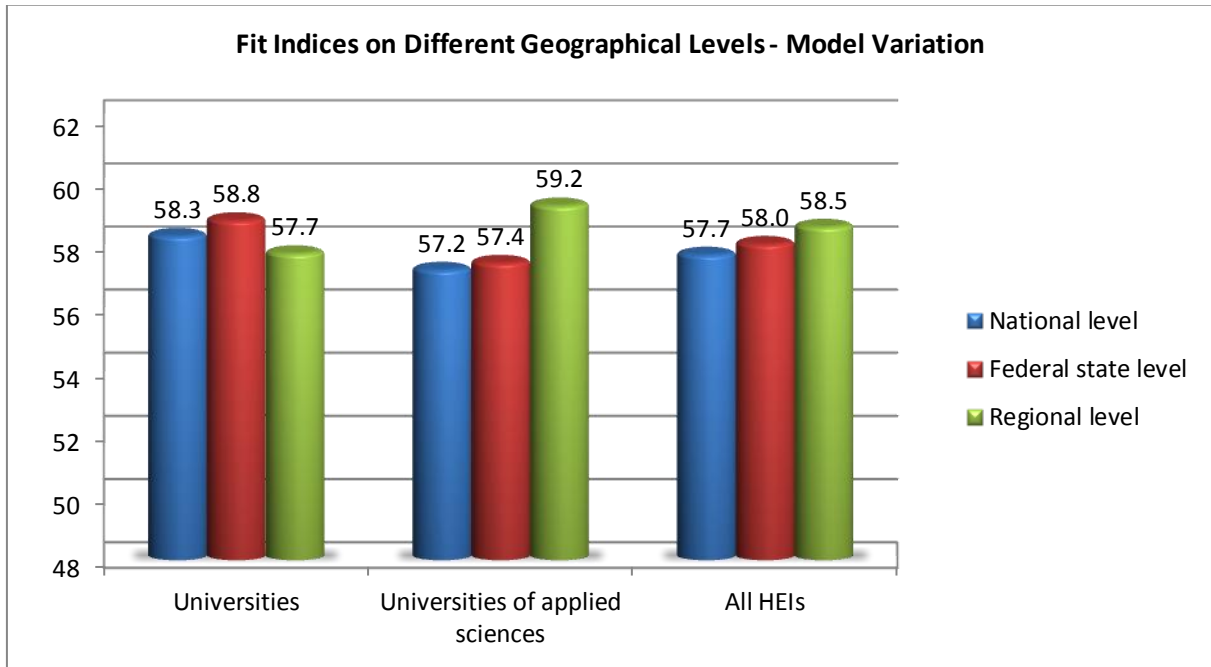


Figure 12 Comparison of fit-indices on different geographical levels – model variation (total employment)

Universities now indicate fit index values that are on a similar level to the values of universities of applied sciences. Surprisingly, the education activities of universities – based on the structure of total employment – are not less oriented on the regional labour market than education activities of universities of applied sciences. It should be considered here that the low fit index values of technical universities as part of the group of all universities improve the value of universities.

4. Summary and Conclusions

Whereas traditional missions of higher education systems encompass (1) the generation and accumulation of academic knowledge and (2) the provision of academic education, a rise of concepts for (3) Third-mission-activities can be observed. The different models examining third-mission-activities summarize economic, social, and cultural contributions of HEIs, foremost in cooperation with or in benefit for the regional society and private industry. The measurement approach presented in this work represents a tool to analyze the prerequisites for third-mission-potential.

To reach a high third-mission-potential, the classification given in this article considers two conditions that have to be fulfilled. First, the HEI should have a geographic focus on regional engagement and support of regional development processes. Secondly, the HEI should focus on private industry-oriented education, and cooperation and sustainable relations to industry actors. A HEI-region fit-index was developed to empirically analyze the congruence between the focus of a regarded HEI in

education and the employment structure of a considered geographic unit – either the HEI region (NUTS 3), the federal state's (NUTS 1) or national employment figures.

The article aimed at investigating two central methodological research questions:

Q.1: The education activities of which type of HEI - universities of applied sciences (*Fachhochschulen*) or universities (*Universitäten*) - are more focused on private industry employment?

Q.2: The activities of which type of HEI are thematically better aligned with the structure of private industry employment in the geographical environment, the HEI region?

For these research questions, the following hypotheses were developed based on literature analysis and political regulations:

Nr.	Hypothesis	Results
H 1.1	The congruence between the structures of education of universities of applied sciences and private industry employment is generally higher compared to the equivalent of universities.	Approval
H 2.1	In comparison to university structures, the education activities of universities of applied sciences are thematically better aligned with the specific private industry structure in the geographical environment.	Approval
H 2.2	A special focus on regional employment structures can be identified for education activities of universities of applied sciences.	Rejection
H 2.3	A special focus on national employment structures can be identified for education activities of universities.	Rejection

Table 2: Results of Hypothesis Testing

In summary, the identified research questions can be answered based on the calculations presented in this article.

Concerning Q1, visual measures combined with the calculation of fit indices (Table 1) and further statistical tests empirically confirm Hypothesis 1. The results prove that the congruence between the structures of education at universities of applied sciences and private industry employment is generally higher than the equivalent fit of universities and private industry. Universities of applied sciences hence tend to align their educational curriculum more intensively to the employment demand of the private industry than universities.

Research question Q2 aims at analyzing, which type of HEI is thematically better aligned with the specific private industry structure in the HEI region. Our results evidence a higher congruence between regional employment structures of private industry, and the educational structures of universities of applied sciences. The arithmetic means of the calculated indices differentiate considering the same geographical level; universities have a mean fit index with their specific HEI region of 59.5, the correspondent mean fit index for universities of applied sciences is 53.8. Concluding, according to the difference of arithmetic means, the average educational curriculum of universities of applied sciences fits better to the employment demand of their surrounding environment – the HEI region – than universities. Hypothesis 2.1 can thus be confirmed.

Nevertheless, the answer to the second research question is more complicated, as hypothesis 2.2 and 2.3 cannot be confirmed. It was hypothesized that universities of applied sciences focus especially on the employment needs of their direct geographical environment, the HEI region (H 2.2), and that for educational curriculum structures at universities, generally a higher congruence with federal state's and national employment structures than with regional employment structures of private industry (H2.3) can be detected. According to the analysis presented in this article, this is not the case. Comparing the fit index of universities of applied sciences related to national, federal state's,

and regional employment, the mean fit index coefficients are highest for the regional employment (\emptyset FI = 53.8), followed by the indices for federal state's (\emptyset FI = 52.8) and national employment (\emptyset FI = 52.4). These results actually indicate a slight focus on national employment. On the other hand, comparing the fit index of universities related to the three different levels of employment, the average fit index coefficients are slightly lower for national employment (\emptyset FI = 60.6) than for federal state's (\emptyset FI = 61) and regional employment (\emptyset FI = 59.5). These facts contradict the established hypothesis. An orientation or special focus to the particular labour market structures of the HEI region would mean that the average fit index value at the regional level is the lowest. This holds true - but only to a very small extent - only for the universities, not for universities of applied sciences. A special role can be claimed by the technical universities, which – similar to the universities of applied sciences – align their educational curriculum on the needs of technology-oriented industry.

Analyzing the total employment³² in a model variation, education activities of universities of applied sciences are not stronger geared to the structures of the regional labour market than education activities of universities. However, referring to the particular perspective of an individual HEI or HEI region – which primarily consider their own benefit and secondly a more general public benefit – a match of education activities and regional structure of private industry in terms of employment subject to social insurance contributions should be more important. The reason is that a large part of the occupational groups, which are not employees subject to social insurance contributions (e.g. teachers, doctors, administrative civil servants) are distributed on a federal state level by public authorities on the basis of allocation keys. This means, if a considered HEI concentrates on employment demand of regional private industry and thereby neglects educating doctors, politicians, teachers etc., a shortage or lack of these civil servants will nevertheless not occur as these professions are distributed based on an allocation key.

What our study also shows, is that there is a collaborative division of tasks in the German national higher education system. Analyzing some subjects, universities of applied sciences cover the national human capital demand; for other study areas, universities follow this task. It seems that universities of applied sciences offer an oversupply especially concerning the regional needs in the field of engineering. In the areas of languages and cultural studies, medicine / sports science and mathematics and natural science universities apparently rather teach according to national needs.

In the introduction, it was pointed out that a high correlation of the structures of regional education offer and the structures of the regional economy and the employees working there is an important requirement for HEIs to fulfil their tasks within the third mission. But, obviously, it is not the only task of HEIs to meet the regional employment needs of private industry. Of course there must be institutions or departments that align to national and international needs. The question, whether a regional or national focus is aimed for the individual cases need to be faced by governments and HEI administrations and other stakeholders in the context of positioning and profiling. Now, if a HEI aims at teaching for regional employment demand – thereby concentrating on third mission activities – one of the most important conditions is a certain orientation to the current employment structure.

³² Also including self-employed people, entrepreneurs, and civil servants who work in public institutions

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