The Role of Universities in Economic Growth: The German Situation

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Introduction

This paper is part of a broader study of the role of universities in economic growth in particular in developing countries. The following description of the German situation should be considered as an example for the situation in an advanced industrialised country. However, the German structures are not necessarily a suitable benchmark for developing countries, as the function of universities in the latter group may be quite different. Furthermore, the German university system is presently subject to far-reaching reforms, so that the structures will change within the next years.

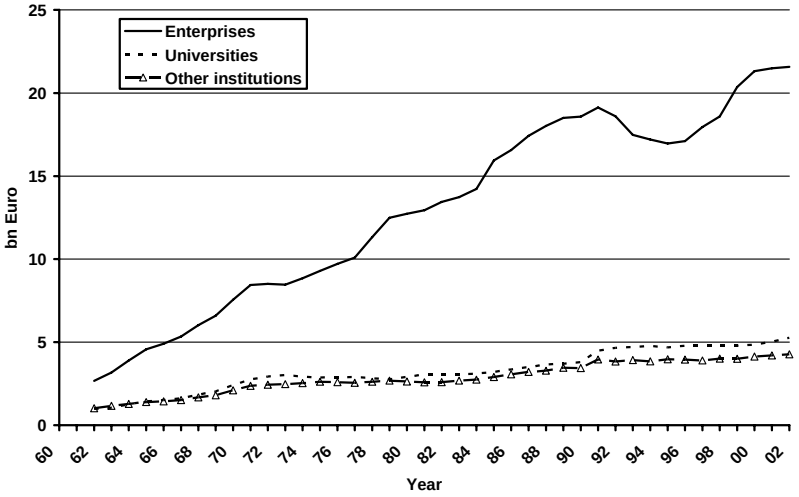
The paper starts with a description of the structures of German universities. In the second section it discusses the position of universities within the German research landscape. The next topic refers to the specific contribution of universities to societal issues. The paper will close by addressing some problems linked to the knowledge transfer at universities.

Basic Structures of Universities

The situation in Germany is characterised by tremendous increase of the R&D budgets of enterprises, universities and other research institutions since the 1960s (figure 1). This statement also applies to universities as illustrated in figure 2 in a more distinct way. In the graph of the development of the university R&D expenditures, the sharp increase between 1991 and 1992 may be striking. This is linked to the fact that until 1991 the universities of West Germany are considered exclusively, and with German unification, the universities of East Germany have been included since 1992.

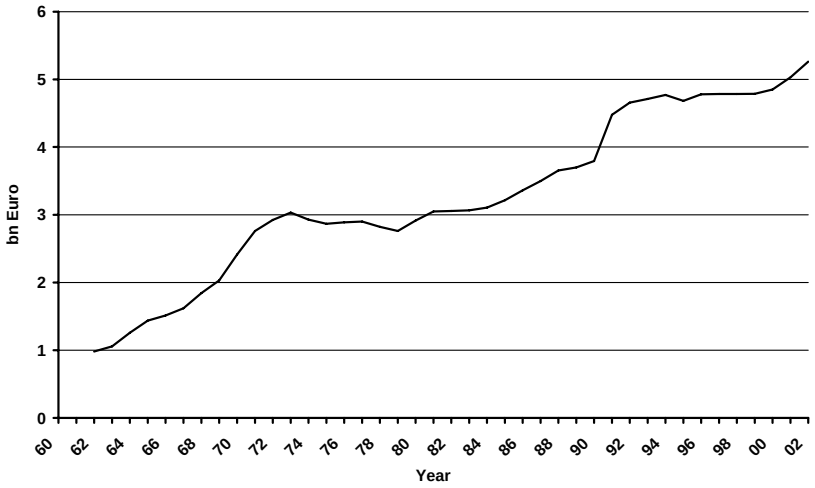
As to the contribution of the universities to the German economy, the main factor is the provision of a competent labour force. So in early years, teaching is by far more important than research with regard to economic growth. With the rise of the knowledge-intensive economy, the contribution of university research to economic performance becomes more relevant, but teaching still remains the most important element, in particular in the disciplines of engineering and natural sciences.

Figure 1: R&D expenditures of major organisational sectors in Germany (in real terms)



Source: BMBF (2004), BMBF (2000), BMFT (1993), own computation

Figure 2: R&D expenditure of German universities (in real terms)



Sources: BMBF (2004), BMBF (2000), BMFT (1993), own computation

The funding of public research in Germany has to been seen against the background of the federal system with a distinct division of labour between the federal states and the central government. Within this system, the federal states are responsible for education and thus for the universities. The states provide base funds to the universities which are used for teaching and research without a clear budgetary separation. Up to now, most universities have not established an accounting system which would allow for a

clear distinction of the activities which these base funds are spent on. In consequence, all available statistics on university research in Germany are based on estimates.[1] Despite these restrictions, some statements about the structures of German universities are possible.

The German university system is multi-facetted and consists of different types of high-level education institutions. An important type of institutions are (full) universities with a broad spectrum of disciplines, all in all 100, whereof 35 operate own clinics (Table 1). However, people generally do not consider the offer of clinical facilities as a major contribution of universities to society, as many other public and private institutions run clinics as well. So the major contribution of universities in the medical sector is the development and application of advanced medical treatment.

Table 1: Number of different types of high-level education institutions in Germany

Institution	**Number**
Universities	100
thereof	
with clinics	35
with engineering dpts.	17
Pedagogical schools	6
Theological schools	16
Art schools	52
Polytechnical schools	168
Administration schools	29
Total	**371**

Source: Hochschulrektorenkonferenz (HRK)

17 universities dispose of engineering departments. These universities, sometimes called technical universities, originally were pure engineering high-level schools, but increasingly integrated other disciplines and achieved the status of universities. But in most cases, the engineering departments are still dominant.

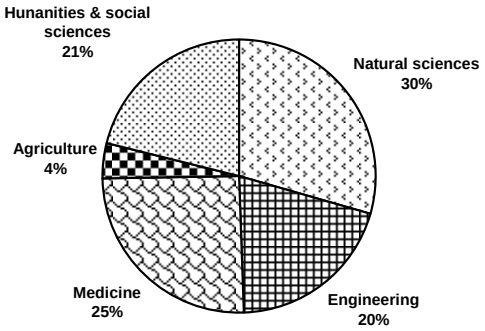
13 within the 100 universities are organised by private agencies, but these private universities still play a minor role, as they teach only about 0.45% of all students at universities. In most cases, the private universities are focussed on few disciplines, primarily in economics.

1 As a further problem, the statistics on universities are not available for recent years and stem from different, not completely consistent sources.

In addition to universities, 6 pedagogical schools, 16 theological schools with parochial agency, 52 art schools and 29 administrative schools can be counted among the high-level education institutions in Germany. With regard to their contribution to societal needs, the 168 polytechnical schools, sometimes called polytechnics or applied universities, have to be mentioned as relevant actors. Compared to full universities, their courses are less theoretical and more oriented on application. The average length of the course of studies at polytechnical schools is about three years compared to five to six years at universities. With reference to public agencies, the number of students in polytechnical schools represents about one third of those in full universities. The polytechnical schools are strongly oriented on teaching; their contribution to research is negligible, therefore the following description exclusively refers to full universities.

The present structure of university research is characterised by large shares of disciplines relevant for technological application, in particular natural sciences, engineering, medicine, and to a lesser extent, agriculture (figure 3). However, the share of about 20% of the humanities and social sciences is quite high by comparison with other industrialised countries.

Figure 3: Research expenditure at German universities by disciplinary field, 2001

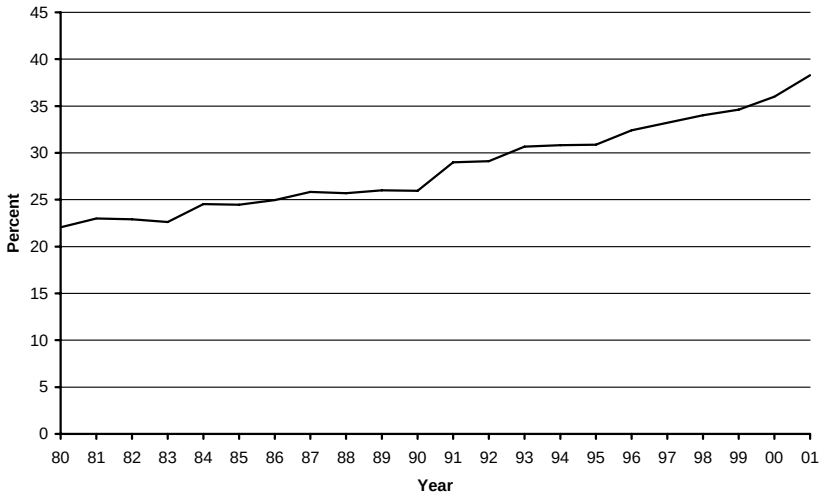


Source: BMBF (2004)

The most recent data for the funding structures of universities refer to 2001. In this year, about 43% of the total funds were spent for research and development (BMBF 2004: 197f). Within the university budget, external funds play an increasing role; they are primarily used for R&D activities. The share of external funds tremendously increased at the beginning of the 1980s and in particular during the 1990s. In the last

decades, the absolute level of base funds increased, in particular since about 1997. In the 'old', Western states the stagnation of base funds even began in 1996. Against this background, the increase of the total R&D budget, depicted in figure 2, is due to the growing relevance of external funds. The share of external funds within the total R&D budget increased from 22% in 1980 to 38% in 2001 (Figure 4), and it can be assumed that this share is about 45% in the present situation. This figure is an average value for all disciplines, so that in some disciplines of the natural sciences, it is even distinctly above 50% (Statistisches Bundesamt 2003). In consequence, the R&D activities of many disciplines heavily rely on external funding.

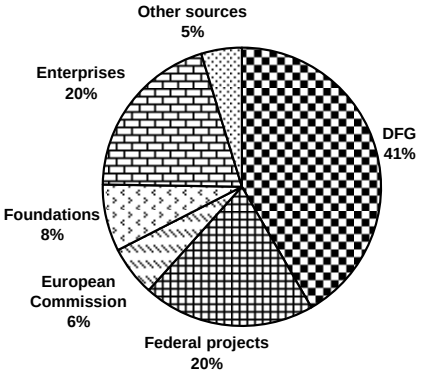
Figure 4: Share of external funds within the R&D budget of universities



Sources: BMBF (2004), BMFT (1993), HRK (1996), WR (1993, 2000a), Encarnaçao/Schmoch (1997), Schmoch (2003)

Reliable statistics for the sources of external funds are available but for 1997 (WR 2000). According to this, the largest share of the external funds is provided by the German Research Association (Deutsche Forschungsgemeinschaft, DFG), followed by projects of the federal government and research on behalf of enterprises (Figure 5). The share of the funding of the European Commission with reference to the total research budget of universities is still modest, but for some fields such as microelectronics, biotechnology or material sciences, its relevance is very high. As a general trend, the share of the funding of enterprises and of the European Commission is steadily growing. The increasing relevance of external funding implies an organisation of research in the form of projects with definite length and deliverables and of more explicit application aspects. Furthermore, the competition between universities for external funds is a major characteristic of the situation at universities in recent years.

Figure 5: Sources of external funds of German universities, 1997



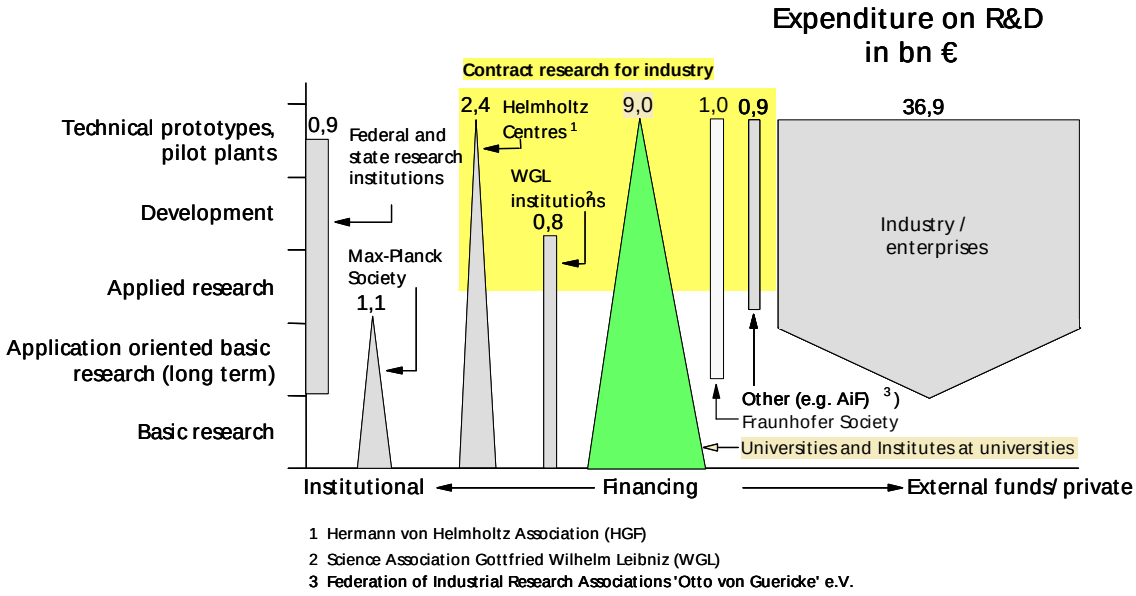
Source: WR (2000)

Interaction of Universities and Society

In the German research landscape, the universities are only one among a broad variety of public research organisations and private industrial enterprises. The tremendous increase of the R&D budget of universities since the 1960s also applies to enterprises and other research institutions (Figure 1). In particular, the enormous growth of the R&D activities of firms is striking, but a high share of their activities refers to experimental development. Nevertheless, firms represent the largest organisational sector in research. With the growing relevance of knowledge-based technologies, German firms substantially engaged in knowledge production and developed a considerable absorptive capacity.

Within the research institutions with public agency, the universities are only one among a broad variety of other research organisations. Therein, the most important ones are the Helmholtz Centres, the Max Planck Society, and the Fraunhofer Society (Figure 6). All non-university organisations taken together represent about 80% of the university research. Thus, there is also an explicit competition within the public research sector between university and non-university institutions. The high share of non-university institutions is again based on the division of labour between the central government and the federal states. Since the states are responsible for universities, the central government strives to get a higher relevance in research by supporting non-university institutions. In consequence, the non-university institutions are primarily funded by the central government.

Figure 6: Depiction of the German research landscape, 2002



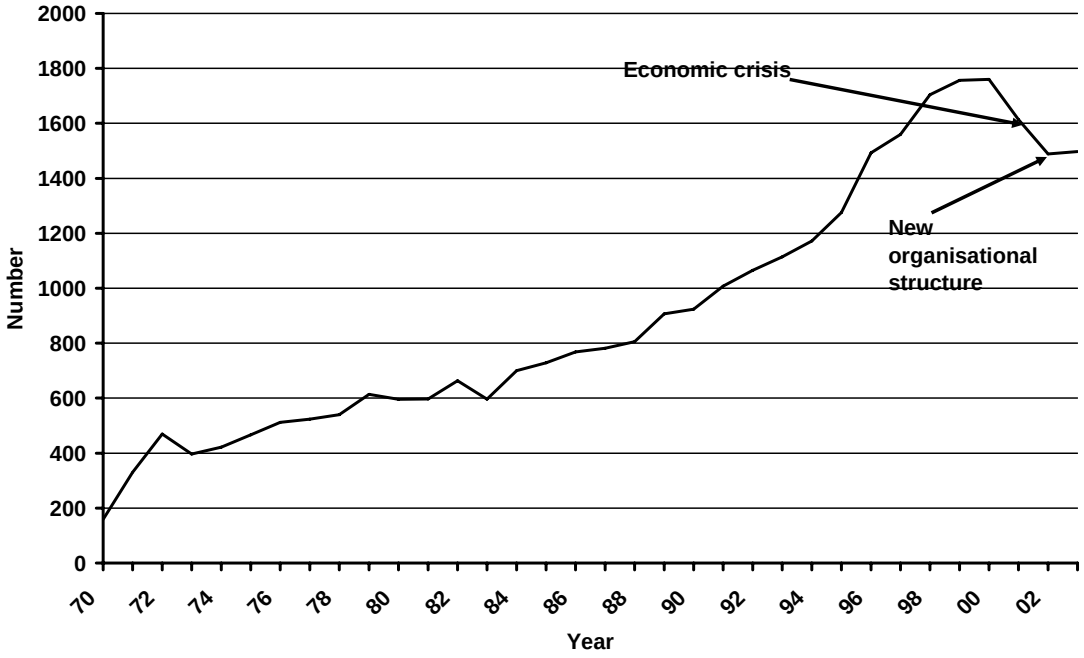
Source: Fraunhofer ISI, BMBF (2004)

As to their general orientation, the Max Planck institutes are engaged in excellent basic research and primarily rely on institutional funding. The institutional funding of the Helmholtz Centres is also quite high, but they have activities in applied research and development in addition to basic research. As third important organisation, the Fraunhofer Society has a distinct orientation towards applied research and is primarily financed by external funds, in particular from industrial enterprises.

Against this background, the universities have to define their specific role within this differentiated research landscape. Their performance is increasingly assessed by their contribution to technology, a requirement which is directly reflected in the steadily increasing number of patents generated by universities (Figure 7). The substantial decrease of patent applications in the 2001 is linked to the economic crisis at that time, in particular in high-technology sectors, and the decrease in 2002 to a new organisational structure of the transfer units at universities. But there are clear indications that patent applications of universities will rise again in the next years, as already visible in the slight increase in 2003.

The direct contribution of universities to technology as reflected in patent activities does not cover all technology areas, but is focussed on knowledge-intensive ones. Most of the patent applications have disciplinary backgrounds in chemistry and mechanical engineering. The institutional background of this focus is a specific strength of German industry in these sectors. In addition, universities provide patent applications in electrical engineering and in medicine at a medium level, in physics at a low level.

Figure 7: Patent applications of German universities at the German Patent and Trademark Office (Deutsches Patent- und Markenamt, DPMA)



Source: Database PATDPA (STN)

The application-oriented research activities of universities have to be assessed within the broader framework of industrial activities in Germany. In the present situation, German industry is substantially engaged in R&D-intensive goods. As the cutting rule, any sector or product group with an above average R&D-intensity of 3.5% is called R&D-intensive. As a further differentiation, we distinguish between high-level technology (3.5 to 8.5%) and leading-edge technology (more than 8.5%). Leading-edge technologies are cross-section technologies (for instance, biotechnology or electronics) and key factors for related product groups such as pharmaceuticals, computers, telecommunication equipment, scientific instruments, but also for uses in other branches. In addition, they are often subject to protectionism, such as in aircraft, aerospace or weapons technology. In high-level technology industry, there is still a need for above average R&D activities, too, but they are concentrated less in research, but more on experimental development. The German government strives for increasing the industrial activities in leading-edge products and therefore supports related R&D activities. In this context, universities are expected to play a ´substantial role.

The increasing societal expectation that universities should actively engage in knowledge and technology transfer leads to corresponding political expectations. Therefore a clear trend in favour of short-term results is visible, whereas long-term research is in-

creasingly neglected. Many political administrators have an insufficient understanding of the university focus on complex areas and are not aware that the contribution of universities to low and medium technology is and should be moderate. Furthermore, the user-needs are often insufficiently differentiated. Many small and medium-sized enterprises need technology solutions at a low and medium level; for these purposes, universities are not the appropriate partners. With regard to more applied needs of small and medium-sized enterprises, Fraunhofer Institutes are often the more appropriate partners compared to universities. Furthermore, the polytechnical schools with their distinct focus on applied topics should play a more important role, but still their infrastructure in terms of staff and technical equipment is insufficient for these purposes. However, some federal states have started initiatives to strengthen the role of polytecnical schools with regard to technology transfer to small and medium-sized enterprises.

As to the situation at the full universities, the requirement of an effective knowledge transfer increasingly comes into conflict with the organisational structures of a public institution characterised by low flexibility and long response times to external requests. As a reaction, many activities of technology transfer are organised not directly in the university, but in its close environment, for instance in private firms of professors or as public associations or foundations. One relevant form of these external activities is the so-called An-Institutes which are research centres located near the university, but which are legally independent of the universities. Based on co-operation treatments with the universities, the directors of the An-Institute are part-time professors at the universities in parallel. The An-Institutes generally get base funds from the federal states where they are located, but have to acquire the majority of their funds from external sources, similar to Fraunhofer institutes. As a rough estimate, the activities of An-Institutes in technology-related areas have a volume of about 1/3 of all Fraunhofer Institutes combined. But it is impossible to enumerate the technology transfer activities in the environment of the universities in a more precise way, due to the broad variety of organisational types and transfer mechanisms (Bierhals/Schmoch 2000). As a reaction to this trend, the universities try to build up new internal organisation structures in order to achieve a higher visibility in transfer.

In this context, a relevant arena of debate is a criticism in recent years as to the performance and flexibility of the research at universities (Schimank 2001, Krücken 2001, Wissenschaftsrat 2000b, Krull 2005). In particular, universities are blamed to distribute their funds in an egalitarian way and not on the basis of performance criteria, so that they cannot build up clear profiles. As a consequence of this debate, Germany is going to introduce assessment activities similar to the Research Assessment Exercise (RAE) in the United Kingdom. For instance, the German Research Association has established an institute for the research information and quality assurance (Institut für For-

schungsinformation und Qualitätssicherung, IFQ) which is supposed to assess all German public research institutions in about five years. In parallel, the German Research Council (Wissenschaftsrat) is starting a rating activity referring to disciplines with the aim to cover all relevant disciplines within the next five years. Many states and universities collect performance indicators with the aim to link the level of base funds to performance (Lesczensky/Orr 2004). However, the impact of these measures on the base funds is limited, so that in the perspective of the universities, the acquisition of external funds is more relevant. In the present situation, the research governance of the universities at the micro-level is dominated by the need of external funding.

A further relevant novelty is an agreement between the central government and the federal states to provide additional research funds to excellent universities (Eliteuniversitäten) selected in a specific competition. One effect of the presently ongoing selection procedure seems to be that the participating universities introduce new organisational structures implying the establishment of clearer profiles. So the resistance to reforms of many decades (Schimank 1995) maybe broken up due to the prospect of substantial additional funds.

Conclusion

To summarise, there is a trend to a too one-sided assessment of universities by their success in technology transfer. In the long run, the specific role of universities in basic research has to be adequately acknowledged. With regard to economic growth, a reform of teaching seems to be more relevant. It has to be taken into account that a large share of the graduates will not work in scientific organisations, but in enterprises. In this regard, the teaching in many disciplines can be improved considerably. Furthermore, the universities have to care for the reputation of the non-technical disciplines and to show their relevance for society. If they are not successful in this regard, the share of these disciplines will steadily decrease.

In general, the contribution of universities to society in Germany is primarily seen in the perspective of technology transfer. This discourse reflects the present focus of the public debate on the economic prospects of the German economy in the context of globalisation.

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