

STEERING AND FUNDING OF RESEARCH INSTITUTIONS

COUNTRY REPORT: GERMANY

Introduction

This report on the research system of Germany draws on the German response to the project questionnaire, and on data gathered during a visit to German institutions and agencies in Bonn, Cologne, Düsseldorf, Essen, Stuttgart and Munich in December 2001. The visit was organised by the German representative on the ad hoc Working Group.¹

This report begins by identifying the goals of the German research system, followed by an overview of the system structure. The main body of the paper reviews areas of current policy and practice.

Goals of German research system

Although Germany has an institutionally divided research system within which decision making is widely distributed, at federal governmental level it has a dominant Ministry – Education and Research (BMBF) – with respect to research policy making and funding. The research policy objectives of this ministry can reasonably be seen to define key directions for German research at the national level. Six objectives have been identified:

- Increasing investments in education and research – important for restoring and consolidating Germany's business efficiency and international competitiveness.
- Developing the research system – to reduce isolation, increase flexibility and create a sharper profile and stronger focus.
- Increase project funding – bringing more flexibility, more competition and more quality into research.
- Increasing joint activities between publicly funded research centres, higher education institutions and industry – improving innovation and developing a clearer and more efficient competition oriented profile.
- Increasing internationalisation – attracting more foreign students and more foreign researchers to Germany, promotion of experience abroad.

1. Details of the schedule of visits and meetings are given in the Annexe.

- Developing a science dialogue – a recognition that public support will be crucial to the continued public finance for increasingly costly research activities.

In addition to these broad goals of the BMBF, various federal and state bodies develop their own goals and priorities.

Overview of the German research system

The German science system is institutionally complex, serving a populous federated country with an advanced and diversified industrial economy. Germany has one of the largest research systems in the OECD. The large bulk of R&D in Germany is industry-based (63.3% GERD for 1999); higher education accounted for 15.5% and the public research institute sector (government and private non-profit) for 13.3% of GERD in 1999.

Business financed 65.5% R&D in 1999, with government financing 34.1% (of which 18.1% federal and 16.0% state and local government) and 0.3% private non-profit. Since 1989, states have increased the proportion of R&D they finance by 2%, and industry by 1%, while the federal government's share has decreased by 3%. Total expenditures grew over that ten-year period from EUR 33 094 million to EUR 47 363 million.²

Germany has a distinctive science system – a federal system with shared responsibilities between federal and state governments, institutionally divided within both the higher education and the public research institute sectors. Public funding for different aspects of research is organised in one of three ways: from federal sources (*e.g.* project funding); from state sources (*e.g.* institutional funding for higher education institutions, state R&D institutions); jointly from federal and state sources according to agreed formulae (*e.g.* institutional funding of public research institutes of national significance; project funding for universities; categories of research infrastructure). Figure 1 illustrates the structure of the German research system.

Higher education

German universities are a central node in the German research system comprising diversified and substantial units. In 1999, university expenditure on teaching and research was estimated at EUR 18.4 billion, of which EUR 7.9 billion on R&D. The higher education system includes a binary divide which separates universities – funded for research and able to offer research degrees – from other higher education institutions, including *Fachhochschulen*, which cannot accept doctoral students, and where research activities are relatively limited and generally rather applied in nature. Overall Germany has 82 university level institutions and 124 *Fachhochschulen*.³

Higher education institutions are established under state legislation, with base (institutional) funding allocations from state treasuries. Within the 16 different states, a number of different legal forms are found for higher education institutions, mostly either foundations or public-law corporations, and certain differences in mandates, for example in the research category, Baden Wuerttemberg has only universities, whereas Nordrhein-Westfalen, in addition to universities, has a technical university and several

2. Figures which were quoted in DM in source documentation have been converted to euros at the rate of 1 euro: 1.95583 DEM.

3. As listed on the website of the *Hochschulrektoren Konferenz* (www.hrk.de)

Universitaet-Gesamthochschule, (comprehensive universities combining university and *Fachhochschulen*) and a special single faculty university (*Sporthochschule*, Cologne). In some states, budgeting remains integrated to the state public service, denying higher education institutions full control over personnel and financial matters.

The German university has been seminal in the development of the modern research university, from von Humboldt's ideal vision of the unity of teaching and research as the basis for the establishment in 1810 of the new University of Berlin, to the development of practical organisational structures which subsequently became funding units within the decentralised university – Liebig's research laboratory at Giessen; and Neumann's research seminar at Koenigsberg (Clark, 1995). By the late nineteenth century the distinctive form of research practice in the modern German university was well established, with research organised around the research interests of each professor within his/her own institute, and research training through a close working relationship with a mentor over an extended period of time. German universities became international centres for a highly developed academic research culture, and influential on university models then developing in other countries, notably the US and Japan. By the late twentieth century, pressures of both student numbers and changes in modern scientific practice have forced fundamental rethinking about this established German pattern giving rise to several major reforms, discussed later in this paper.

The *Deutsche Forschungsgemeinschaft* (DFG), an autonomous non-profit association, provides the major source of project funding for university research. Established in 1920, it acts similarly to a research council in that most of its funds are competitively awarded following a process of peer review of applications. DFG is the key intermediate level funding body of national scope in Germany, and funds a broad range of research, mainly at universities. The DFG is jointly funded by the federal and state governments through formulae which varied by program until 2001. In 2002 a new formula was introduced with 58% of overall funding by the Federal government and 42 % of funding provided by the Federal states. In 2000 it received EUR 1.17 billion from government to support a variety of programs spanning individual grants, co-operation in research and research infrastructure. DFG represents the largest share of state funds under the joint funding arrangements. The DFG budget has grown strongly in recent years.

Public research institutes

Germany is unusual among OECD member countries in having maintained the size of its public research institute sector over the past 20 years, while in most other OECD countries this sector has been in retreat.

Public research institutes of national significance, and which are jointly funded by federal and state governments, are now organised into four large networks.

The *Max Planck Gesellschaft* (MPG) is a non-profit registered society conducting basic research in its own network of 81 institutes, concentrating on cutting edge and interdisciplinary research in the natural sciences, medicine, social sciences and the humanities. Its work is designed to supplement university-based research. MPG was established in 1948, succeeding the Kaiser Wilhelm Society (founded in 1911). Some 95% of MPG funds are from public sources. Core government funding for 2000 was EUR 0.87 billion, (an increase of 7.9% over 1999) and split on a 50:50 basis between federal and state sources.

The *Fraunhofer Gesellschaft* (FhG), founded in 1949, is a society focusing on applied research, largely in engineering and natural sciences, through its own network of 56 institutes, and working closely with industry. Core public funding for 2000 was EUR 310 million, on a 90:10 federal state basis. FhG's budget comprises 35% core public funding, 35% from industry (mainly under contract), and 30% project funding, mainly from public sources, but also from foundations.

The *Helmholtz-Gemeinschaft Deutscher Forschungszentren* (HGF) is an association comprising fifteen independent large scale research institutes covering a broad range of technical, natural science, engineering and biomedical basic and preventive research and pre-industrial development research. Formerly the big science centres (individually established from the 1950s onwards), they include large and costly public facilities, many of which are available for use by researchers in other sectors. When the HGF network was established in 1995, member institutes retained their separate identities. Currently subject based program (by contrast with institutionally based) management is being introduced to help establish a base for rationalising research activities within the network. HGF organises its research activities in six fields: structure of matter, earth and environment, aerospace (air and ground traffic), health, energy, key technologies. The HGF core budget forms the largest single item of public research funding, EUR 1.6 billion in 2000, split 90:10 between federal and state governments.

The *Wissenschaftsgemeinschaft Wilhelm-Gottfried-Leibniz* (WGL) is an association comprising 78 independent non-university institutes formalized, like HGF, into a network. Member institutes of WGL, which are generally small research and service oriented institutes whose R&D activities are of general supra-regional interest, continue to be funded separately, directly from government via the Blue List, a funding instrument agreed jointly between federal and state authorities. A small secretariat addresses concerns common to member institutes and the challenging task of raising the profile of the institutes as a new network. An internal evaluation process began in 2001 from which it is hoped ultimate efficiencies will emerge within the network. In 2000, the WGL institutes received EUR 0.61 billion public funding, mostly on a 50:50 federal state arrangement.

In addition to these four major networks, there are mission focused research institutes at both federal and state level.

Academies

Germany has several longstanding state based scientific academies, for example *Bayerische Akademie der Wissenschaften*. The Union of German Academies organises joint activities such as symposia and coordinates a research program which attracts joint federal and state funding, but on a relatively modest scale only (EUR 39 million for 2001). Most academy members hold university posts.

Joint Federal- State Governmental bodies

National policy co-ordination and policy advice are supported by two organisations which have been jointly established by the federal and state governments.

The *Bund-Laender-Kommission für Bildungsplanung und Forschungsfoerderung* (BLK) is the forum in which federal and state ministers and civil servants co-ordinate research policy and planning, and where agreement is reached on responsibilities and arrangements, including formulae, for the various jointly funded elements of the research system. Equivalent commissions exist for co-ordinating other spheres of federal and state policy and planning.

The *Wissenschaftsrat* (WR), or Science Council, established in 1957, is an independent policy advisory body whose members are appointed by the federal president, and which is mandated to advise the federal and state governments on all matters of higher education and research policy. It is the single key advisory body integrating the views of many stakeholders through its processes. Its members are divided between scientific and the administrative commissions (representatives from the science community in an individual capacity, and nominated representatives from the federal and state governments respectively),

and each working party involves members of both commissions. Having no funding role, the Science Council largely avoids conflict of interest problems.

Federal government

Federal research policy is within the portfolio of the Federal Minister for Education and Research. Following the re-designation of Berlin as the capital after reunification, the political and administrative elements of the research system have become more physically separated, with, to date, the bulk of most federal departments remaining in Bonn and the headquarters of most research agencies remaining in that vicinity. Within the BMBF, for example, some strategy responsibilities are now in Berlin, but the balance remains in Bonn.

R&D expenditure for 2000 within the federal government was:

Federal Ministry of Education and Research (BMBF)	EUR 5 539 million	(64.3%)
Federal Ministry of Defence (BMVg)	EUR 1 333 million	(15.5%)
Federal Ministry of Economics and Technology (BMWt)	EUR 787 million	(9.1%)
Other ministries	EUR 955 million	(11.1%)

Source: BMBF, 2000.

BMBF (*Bundesministerium für Bildung und Forschung*) is the key ministry responsible for direct federal contributions to both the higher education and the public research institute sectors, and for federal policy development towards both sectors. It is responsible for almost two thirds of the federal R&D budget.

In 2000, federal R&D expenditure by type of funding showed: project funding (42.8%); basic funding of institutions (44.8%), university related funding (4.6%), international co-operation (9%). Change over the previous ten years showed that the project funding proportion dropped by almost 11% from 53.6% in 1989, and basic funding of institutions rose by 9% from 35.6% in 1989, a trend set to continue. While this appears at variance with many other OECD countries where proportions of project funding are on the increase, the German authorities appear to be developing indirect mechanisms to encourage competitive allocation internally within each of the four networks of public research institutes. Federal project funding in Germany comprises project related financing, funds for research commissioned as departmental research and funding for defence research and development.

Research projects of BMBF and BMWt (*e.g.* in health research, new materials, oceans, biotechnology, environment) have, for a long time, been looked after by *Projekttträger*, a form of management organisation. Different categories of *Projekttträger* are licenced by the departments, and some are based at public research institutes (*e.g.* Deutsches Zentrum für Luft- und Raumfahrt (DLR), a member institution of the HGF, acts as a *Projekttträger* for some BMBF project fields). Thus, the federal departments remain at arm's length from the process of allocation of their project grant monies.

The balance of recipient groups of federal funding changed markedly over the 1990s in two respects: the proportion allocated to private non-profit organisations (including DFG, MPG, FhG) rose from 35.5% in 1989 to 47.6% in 1999; and support for the business enterprise sector dropped from 34.7% in 1989 to 25.3% in 1999 (other recipient groups remaining stable).

State government

In the German constitutional system the Federal states have the main responsibility for supporting R&D. Therefore they fund and promote research on their own as well as in co-operation with other Federal states

and the Federal government. State R&D funding is primarily directed at the higher education sector, including annual block grants for university research and teaching, and the state contributions to the DFG. States also contribute to the funding of agreed national level research institutes (MPG, FhG, HGF, WGL); to state and local government research performing institutions, and to business enterprises under research, technology and innovation funding programs. As discussed below, some states provide significant research funding to support their own institutions.

Foundations

The private non-profit sector provides less than 2% of German R&D funding, mainly from private foundations. While a small percentage, these funds nevertheless are important for performers of basic research, as they do not have the restrictions associated with public funds. The German foundation sector, although still small, has been growing in recent years. The *Stifterverband für die Deutsche Wissenschaft* is a charitable institution active nationally in promoting science, the humanities, research and education, including endowed chairs, academic prizes, and supporting new types of research co-operation between universities, business and public research institutes. Established in 1920, it works exclusively with private funds, including company and individual endowments, and manages a number of foundations. In the current climate where greater linkage between public research and industry is favoured, one could expect its views to be influential in policy making.

Review of Policies and Practices

In this section, areas of current research policy and practice are reviewed:

- Improving the overall structure of the research system.
- Improving the research performance capability of institutions.
- Increasing overall public funds available for research.
- Putting available funds to best use.
- Ensuring adequate and appropriate provision of researchers.

Improving the overall structure of the research system

The current reform process in Germany is the culmination of some 30 years of debate over perceived shortcomings in the system. Over the past ten years, extensive evaluation of Germany's higher education and research institute sectors has occurred. During the 1990s, the Science Council evaluated individual sections of the German academic system in connection with academic restructuring following reunification, it undertook a number of cross sectional surveys of specific research fields, and identified directions for future development in both higher education policy generally and research in higher education.

Federal and state ministers meeting in the forum of the BLK, in 1996 decided to commission systemic evaluations of the major institutions of the research system outside higher education. The Science Council undertook system evaluations of the HGF and WGL (Wissenschaftsrat, 2001); an international commission sponsored by BLK undertook a system evaluation of DFG and MPG (Internationalen Kommission, 1999); a BMBF commission evaluated the FhG. These major evaluations, as well as pointing directions within

each organisation, provided an important source of data for an overall review of the higher education and research system within Germany.

In 2000, the Science Council released its *Theses for the Future Development of the System of Higher Education and Research in Germany* which it sees as directions for the reform process over the next 10 to 15 years. The general thrust of these directions is that 'in institutional terms ...[the German system of higher education and research] is too inflexible and its contribution to the solution of problems in industry, society and politics is inadequate. Energetic reforms and financial support of a far higher order than is currently available are necessary' [p.6]. Three primary tasks essential to achieve these goals are: first, orienting the German system more towards possible applications for research and teaching; second, further internationalisation of the system; and third, making greater use of information and communication technologies. Success in these tasks is seen to hinge on implementing reforms in the following areas:

- Raising the profile of higher education institutions and concentrating on their most efficient areas.
- Increasing the mobility of academics and students.
- Achieving greater institutional competition (through more flexible funding arrangements) as a counter weight to the previous overemphasis on functional differentiation within the system.
- Making greater use of opportunities for co-operation among academic institutions as well as publicly and privately financed institutions.
- Increasing the self-organisational capacities of academic institutions (federal and state governments withdrawing as much as possible from control at the detailed level).
- Renewing the unity of research and teaching.
- Maintaining publicly financed higher education institutions as an open system based exclusively on aptitude and performance.
- Federal and state governments significantly increasing their financial contribution to the system, if Germany is not to fall behind in comparison to countries of comparable economic power.

(Wissenschaftsrat, 2000, pp.6 – 10).

The conclusions drawn from this evaluation process by the federal and state ministers in the forum of the BLK were summarised in five points:

- The German science system, in which the universities occupy a central role, needs to experience an increase in research quality and efficiency of operations.
- Research and science institutions must develop stronger profiles.
- Networking and internationalisation of the German science system must be pressed ahead with.
- Competition and co-operation inside the science system must be strengthened.

- The German science system needs to become more flexible.

(BLK, 2001).

A well-articulated and wide-ranging reform process has been initiated in Germany which involves all aspects of the research system. While several bodies participated in the review process and formulated policy directions, the carriage of initiating and following through the reforms largely lies with the BMBF. The progress of a number of specific reforms are discussed below.

Improving the research performance capability of institutions

Autonomy of the universities

The current reform of universities has been undertaken in two legislative phases. The 4th Amendment of the Framework Act for Higher Education was passed in 1998 bringing a number of areas of flexibility to higher education institutions (BMBF, 1999*b*). A second stage, the reform of the employment law in higher education and public research, was passed in 2002 (BMBF, 2001*b*).

A key issue at present is the status of research personnel, with moves under way to increase flexibility in conditions of employment, salaries and other structural arenas. The status of universities varies by state, according to local arrangements. In some states universities can take the form of foundations, in others corporations. But whatever the legal status, all state universities are bound by parity with civil service pay scales, and common restrictions on the academic posts which they can offer. There are moves underway at the national level, spearheaded by BMBF, to alter both of these, but progress is neither easy nor swift, given the number of stakeholders, the entrenched interests and different agendas being pursued, and the complexities of a very large federal system with numerous instrumentalities for policy and its implementation.

BMBF has taken the lead in proposing a package of changes to salaries to make them more flexible and to base them on performance rather than on seniority. For example, one component would include special remuneration from external money generated by researchers. The initial focus of the change was the enhancement of salaries at the professorial level, and as such, the Ministry of Finance was supportive, as were the state ministries as the employers, on the understanding that the change would prove ‘cost neutral’. Once the unions became involved, however, they were in favour of the proposal, but wanted the provisions to apply to all staff. As this was obviously no longer ‘cost neutral’, negotiations reached a stalemate in mid 2001. The way forward appears to be to bring the system forward in stages, first establishing a trial of the new proposal in a couple of institute networks. Over what period of time the experiment will last, how it will be evaluated, and how it may become generalised are not yet clear, but if the trial proceeds, it will represent an important break in the system. But given that it is likely that the two trial institute networks will be the most market-oriented, it is important that those two do not break away from the overall research system, and establish a dual pattern. Obviously, for the Ministry of Finance, this overall change could be seen to have implications beyond the research profession.

The aim of bringing greater flexibility into employment structure and conditions at universities also began by targeting the professors, but in this case they were seen as representing an authority which needed to be significantly curbed. German academic life is built on a unique and rather inflexible model, which revolves around the position of the professor. Professors are appointed at around the age of 40 after completing the *Habilitation*, a post doctoral thesis unique to Germany. With professorial appointment comes the directorship of an institute, and authority over several assistants, themselves with PhDs and maybe post

doc experience, and employed on five-six year contracts. These assistants essentially become part of the professor's research team, without the independence and available facilities to initiate and undertake research of their own. While there are a great many strengths in the German system, this restriction on enabling young highly qualified researchers between the ages of approximately 30–40 to pursue their own research interests places Germany outside the mainstream of academic career development internationally. It is seen to have led to the loss of many promising scientists, notably to the US, at the post doctoral stage.

A new position of junior professor has been created which, following a doctorate or post doc, provides a promising candidate a term appointment for three years, renewable once (thus a maximum of six years). For the period of his/her tenure, the junior professor has the independent right to teach and research, be provided with a grant for basic research equipment, and is not be part of the team of the professor. At the age of approximately 40, however, a junior professor must secure a professorship or look elsewhere for employment. Concurrently with this change, the restrictive and localised *Habilitation* has been abolished as the virtually mandatory requirement for appointment as a professor. The new pre-requisite for appointment to a chair will be a junior professorship from the year 2010, professional work or foreign scientific qualifications. The creation of this new system is a major step in bringing the German academic career path into closer alignment with academic career paths in the US and UK which are the systems acting as models for the major changes of the nineties in the Nordic and East European countries neighbouring Germany to the north and east. As discussed further below, changes under way in course structures at German universities are also moving towards incorporating the Anglo-American model.

The process of change is not yet complete and there is certainly not universal support for it, particularly among many professors who stand to lose their assistants. For example, in medical research, under the present hierarchical conditions, it is possible reliably to assemble large teams for research in particular areas. A possible consequence of the proposed change is that research groupings will become much smaller, and it will become more difficult to assemble large teams to work on long-term research. Criticisms and reservations notwithstanding, the BMBF has pressed forward with the change, and has already begun the process of providing the additional grants for research equipment to support junior professors. Some fifty universities have applied for the equipment grants, whose terms oblige them to guarantee the changes are university-wide. Following the passing of the federal Act, early in 2002, states have up to three years in which to make relevant changes in their own legislation.

A further area of needed change at universities is **improving institutional management**. Currently faculty deans are, in the main, elected, and their success generally depends very much on the personal quality of the individual. These elected deans have nothing like the power or support accorded appointed deans at major American or British institutions. It will be necessary to rethink university management arrangements in relation to the increasing complexity of research management roles, to say nothing of teaching and community service. However, the prestige of the German university and the force of long established practices mean that any reforms that are introduced will be the result of extensive debate and close analysis of a range of options.

The detailed impact of these changes needs to be seen at the state level where variations in consequent legislation can be expected. In Baden-Wuerttemberg the 1999 finance reform for higher education introduced performance indicators relating to both teaching and research, and a new independent quality assurance agency for higher education, *Stiftung Evaluationsagentur Baden-Wuerttemberg*, was established in 2000.

At another level, a number of institutions are affected by line budgeting requirements or their equivalent. Following recommendations in the systematic evaluation, the DFG has just succeeded in moving to block budgeting of funds received from the federal and state governments, in return for which their representatives participate in internal strategic funding decisions. As well the DFG has achieved a degree

of freeing up of personnel policy (gaining freedom to appoint up to 12.5% more staff, although no comparable increase in budget).

Autonomy within the institute sector

With minor exceptions the institute networks comprise institutions formally independent of government, and with a legal identity. But there is an important restriction which limits their independent action: that salaries equate with those of the civil service. In an environment where institutes are competing with industry and foreign institutions for top class researchers, they are unable to offer salaries higher than those of equivalent civil service levels.

The common response amongst institutes, as amongst universities which are equally affected, is to make the conditions of employment within these restraints as attractive as possible for prospective research staff. The FhG believes it can offer a less stressful environment, a more attractive working environment, and salaries which, for the first five or so years after graduation, are relatively comparable with those in industry. The MPG in fact draws researchers from universities, as it provides attractive working conditions in a research only environment. And because of its unique nature as a high quality research network focused at the basic end of the research spectrum and addressing selected topics at the cutting edge of knowledge, the MPG is also able to attract researchers internationally.

The MPG places a high priority on employing the right person, in an environment where mobility, particularly of senior staff, has been relatively low. Directors of institutes, who hold joint appointments as professors at a nearby university, tend to be appointed around the age of 40 and may therefore be in post for 25 years. As noted above, there are current attempts to change the restrictions on salary, which all of the institutes feel keenly.

Increasing overall public funds available for research

During the past ten years, budgets in all areas of German life have been severely strained by the massive effort of the reunification process. While general public spending has been kept at no growth, federal research budgets have increased. Since 1998, the federal research budget of BMBF has grown by some 15% overall through the regular process of parliamentary subventions. Also, in line with the decision to strengthen independent basic research, the budgets of both DFG and MPG have been increased by 16% since 1998.

State governments are also active in Germany in providing additional support for research institutions within their borders, actively building competitive advantage. The state of Baden Wuerttemberg has established a foundation, the *Landesstiftung Baden-Wuerttemberg*, with a capital stock enabling it to spend annually between EUR 51 – 77 million in support of educational, scientific and research activities. Legally it is a non-profit limited company, with the state of Baden-Wuerttemberg as sole shareholder. It is governed by a board whose chair is the state prime minister. In 2000, 35% projects granted were for research. This development, however, needs to be set against the background of a major funding crisis for the state's higher education sector which led to a considerable loss of positions in universities in return for an agreement on financial security, the so-called *Solidarpakt*, resulting in an effective shift in the balance of state higher education funding in favour of the *Fachhochschulen* sector (Ministerium, 2000).

Putting available funds to best use

Program funding and management

HGF institutes have historically been funded without reference to research performance, and a degree of overlap exists in research areas within the group. Annual budgets provided by the federal government and respective host state have primarily been determined by the cost of the institute's existing staff and equipment rather than by the content of research and relevant goals. Little incentive for co-operation and competition was evident. In September 2001 the federal government, states and HGF centres agreed on a new financing procedure allowing for priority setting for the HGF as a whole, and stimulating competition between the individual centres without affecting their legal independence (Catenhusen, 2001; Koester, 2001).

There is a genuine question of how best to fund and manage a grouping of diverse and independent institutes physically spread throughout the country. In the new approach, 80% of overall HGF funding is to be allocated to thematic programs for which member institutes will need to compete either singly or in collaboration. The new system will be introduced in several stages, beginning with health, transport and space research in 2003. Given the very particular nature of HGF institutions, unevenly spread among different fields, it is recognized that it will be far from an equal or perfect competitive process, but it is a mechanism which is expected, over a period of years, to lead to some rationalization of effort, and greater efficiencies in research within the network. (It is in fact a process which one member institute has operated internally for some ten years between its own several sites.) For the HGF, this is an important initiative which will be watched with interest, not least by the WGL, a much larger grouping of smaller institutes, but which equally faces questions of duplication, inefficiencies and scope for greater collaboration.

The *Fraunhofer Gesellschaft* is currently reshaping the way funding is allocated internally between the different institutes to increase competition and boost performance. The organisation is working towards an internal allocation to member institutes of approximately one third fixed budget, one third competitive internal programs, and one third performance related, taking into account revenues from industry.

Encouraging greater use of research outcomes

For any project funded now by the federal ministry (BMBF), a utilisation plan must be agreed. This is in recognition of the fact that a large amount of research has been completed without any particular use being considered, commercial or otherwise.

The idea of developing a utilisation plan requires a new mentality, a new orientation towards research planning on the part of most researchers, and new criteria on the part of the funder. While this development does not mean that applied research with clearly commercial outcomes will necessarily be favoured, it certainly indicates that there is an intent on BMBF's part to give preference to research which is purposive in socially relevant terms. It is, however, still early days in this reorientation. As yet this requirement does not extend to institutional or core funding – it relates only to project funding. Also, utilisation plans have so far had greater importance for companies in receipt of BMBF funding than for research institutions. For some of them publication of a book remains the extent of utilisation planning. Dissemination and uptake of research outcomes is an issue shared by many countries, and Germany's longer-term success will be of wider interest.

Changes have been made in patent law allowing universities to own all the results of research. The institution (not the individual) has exclusive rights, and it is free to do as it wishes with any profits. Patent offices have been established grouping together four-six universities each.

Co-operation between research performers

While at a formal level Germany's public research system is multiply divided both horizontally and vertically, there are a considerable and growing range of linkages between research performers, a trend strongly reinforced in the recent system evaluations. Co-operation tends to be discussed between higher education, institutes and industry on the one hand, and between higher education institutions on the other – less emphasis appears to be given specifically to co-operation between different elements of the institute sector. There are and have for a long time been a wide range of informal links between individual researchers and research teams through the normal process of interchanges within academic science communities. There are also formal structural linkages, as in joint appointments of institute directors as university professors, placement of research students in institutes, joint or co-operative research projects, joint use of expensive and/or large facilities, close location of facilities.

The Science Council report on higher education and research noted a number of co-operative arrangements, and argued for greater use of opportunities for developing synergies among academic and public and privately funded institutions.

Closer links between MPG and universities in relation to basic research have been growing, now given impetus by the recent evaluations. In 2000, MPG – 37 institutes were involved in 58 co-operative interdisciplinary special research fields with universities (supported by DFG). A new initiative in international research training is detailed below. A second initiative of considerable interest is the experimental development of *Max-Planck Forschungsgruppen an Universitaeten*, joint research groups at universities (MPG, 2001b). Drawing on the experience of establishing some twenty new institutes in the new states during the 1990s, MPG is establishing joint research teams with universities, located at the universities for a period of five years (the maximum period of a research contract, beyond which staff must be made permanent employees). At the end of that time, universities can take over the responsibility for and running of the centre or the centre can lapse. Three programs have so far been established on an experimental basis. This closer institutional co-operation between MPG and universities presents a major new direction for the MPG from its traditional and time worn pattern of collaboration from an institutionally separate base. Evaluation of this new development will be important to watch – it has the potential for creating powerful university-based research centres, but also the potential for raising questions about Germany's long-standing approach to institutional separation.

New forms of co-operation, particularly between universities and public research institutes and business enterprises, are also supported through private foundations such as the Stifterverband.

In certain fields, such as medicine, which benefit from the assembly of large research teams, research consortia are developing which might draw together groups from several universities and institutes within a local area. One such is based in Munich, and centred on the medical clinic at Ludwig Maximilian University's new Martinsried Grosshadern 100 hectare campus. The university is consolidating onto this site its facilities for biology, chemistry, pharmacy, medicine and the new gene centre; adjacent are MPG institutes for biochemistry and neurobiology, the institute for hematology of the National Research Centre for Environment and Health, and an innovations centre for biotechnology established by the Bavarian government. Munich has been recognised as one of three model regions in Germany for the enhanced development of biotechnology. This is an example of synergies developing from close location of complementary facilities in different sectors. In fact this grouping currently has twelve DFG funded Collaborative Research Centres, and four *Graduiertenkollegs* among a multitude of other research initiatives. It illustrates the way in which the emergence of this large node and research concentration reflects the convergence of consistent decision-making over a considerable period: a supportive and strategically oriented state government, university building opportunities, entrepreneurial researchers

utilising emerging funding opportunities, and funding bodies offering medium to long-term research support.

While the backbone of the research funding from the DFG remains its individual grants program, increasingly it is developing programs which favour co-ordinated research activities (collaborative research centres, priority programs, research units) and over longer time frames. From 1994, DFG funded an eight year centres of excellence program to boost higher education in the New Laender. Priority programs (SPP) fund supra regional co-operation generally for six years.

Following recommendations of the systemic evaluations, DFG moved towards a more strategic and proactive approach to funding. A significant development has been the establishment in 2001 of a new Large Research Centres scheme, going beyond the existing Collaborative Research Centres program. CRCs are currently funded at about EUR 1.5 million; the new centres will receive about EUR 5.1 million p.a. In DFG's view, this is a move designed to strengthen research in the university sector, and make it more competitive with the university sector in those countries not 'weakened' by an institutionally divided research sector. This development is a clear signal of intent to strengthen the universities which, despite the considerable quantity of research performed, do not currently have the overall reputation for research quality of the MPG which has produced several Nobel Laureates. The new Research Centres program aims at funding internationally visible cutting edge research, based on existing collaborative research priority areas. Up to six additional professors and their staff, as well as teams of junior scientists will be funded by a Centre, for a maximum period of twelve years, subject to satisfactory intermediate evaluations. Three have been funded to date (in the areas of: ocean margins/ marine geosciences, functional nanostructures, experimental biomedicine).

Research distribution and concentration

In a newly reunified country, there has been a national policy imperative over the last ten years to ensure an equitable geographic balance of research capacity in each of the states. By way of example, MPG, which is 50/50 federal state funded, has established twenty new institutes in the new states over this period to reach a distribution which is roughly proportional to the population distribution. As illustrated in the case of Munich, however, considerable forces for research concentration within states are operating, and a number of state governments are active in boosting research resources for institutions based in their territory.

While all German universities have a research charter, it is still the case that research is more highly concentrated in some institutions than others. Some 50% of DFG funds go to one quarter of the universities. In a knowledge economy, strong forces act toward research concentration, and it appears national level policy is moving to reinforce this. The *Stifterverband für die Deutsche Wissenschaft* is currently funding a study by the DFG to introduce a ranking of research universities in Germany a trend already well established in several other countries. This is seen as a continuing activity which may lead to a substantial program. Industrialists appear to have a strong interest in a better ranking, and an interest in improving the quality of research at universities.

Directing research to thematic priorities

In a system as large and institutionally diverse as Germany, it is not surprising to find a multiplicity of priority setting efforts relating to different contexts. The Science Council, during the nineties, undertook an extensive review of foresight recommending the use of research prospectation as an instrument of funding. A subsequent pilot study has applied this in particular fields. Recently, BMBF has revitalized the Futur program with extensive public participation, including a web-based dialogue, and is well down the track to

defining a set of five priority interdisciplinary problem areas of future relevance for one of its interdisciplinary program areas (BMBF, 2001a). The state of Baden-Wuerttemberg recently commissioned a study to identify research areas in which they had a strategic advantage, and plan to use these as priorities for future state level development (Roland Berger & Partner, 2000).

A 2001 workshop on establishing priorities in research funding co-hosted by the *Stifterverband*, the Science Council and the Confederation of German Industries revealed differing approaches to priority setting and strategic decision taking at an institutional level among the major public research performers, but overall an increasingly strategic orientation within organisations supporting and funding research (Winter, 2001).

There is an underlying tension between the recent system-wide approach to policy planning, and the long-standing belief in the scientific community in the importance of ‘absolute’ freedom in choice of research theme, which is particularly strong in Germany. Einhaeufl sees this tension as part of the process of replacing the post World War II social contract between science and society – giving science continuous financial support for free research in order to get useful knowledge for practical aims. We are still in transition to a new social contract, which will be shaped by the expectation that science contributes to the development of society and that science can only expect continuing and increasing funding when it is able and willing to introduce necessary internal reforms (Einhaeufl, 2001).

Ensuring adequate and appropriate provision of researchers

Policy measures relating to the development of human capital are largely focused on the question of opportunities for young researchers.

Besides the major changes to employment structures and salary arrangements discussed above, German universities are also undergoing radical reform in their degree structures. In 1998 changes offering the possibility of a BA/MA course sequence alongside the traditional *Diplom* were passed by federal parliament, with states having three years in which to make requisite alterations to their own legislation (BMBF, 1999b). These changes have not been uncontroversial, but by the end of 2001, some 500 courses had been registered on the new system, with particular interest being shown amongst *Fachhochschulen*.

Stage two of the reform process concerns the qualifications track of young scientists and professors. The present doctoral program is very lengthy, taking up to six-seven years to complete. The reform aims to shorten the program to 3-4 years, again bringing it into line with the Anglo-American pattern, and the emerging patterns in countries surrounding Germany to the east and north. As mentioned earlier, the *Habilitation* process, involving a post-doctoral thesis, is to be abolished as a requirement for a professorship.

As is clear, there is a strong emphasis within Germany on the promotion of young talent, and enabling young scientists to pursue independent research. The DFG has for a number of years been active in supporting this through particular programs, notably the postgraduate research groups, and the Emmy Noether fellowships, regarded by the BLK as one of the most important recent innovations of the DFG (BLK, 1999). The now well-established pattern of *Graduiertenkollegs*, research training groups first introduced in the early 1990s, make an important contribution to research training. The DFG limits its doctoral scholarships to students participating in research training groups. These groups are established for a limited period of time at universities, offering doctoral students the opportunity to undertake their research within the framework of a co-ordinated research program supported by several university faculty members. A systematically organised study program, most commonly interdisciplinary, accompanies research activities. International research training groups extend this program to co-operating with an

equivalent foreign group. The Emmy Noether program, available to junior scientists in all disciplines, is intended to foster independent scientific work at an early career stage. The program offers support for six years immediately following on a doctorate; it includes a research stay abroad and subsequent autonomous research activities in Germany linked with heading a career development group, and teaching activities consistent with preparation for the position of lecturer in higher education. In parallel, the MPG fosters young researchers, with independent junior research groups established alongside the normal departmental structure within many of its institutes (MPG, 1999).

Internationalisation is seen as another way in which Germany can both attract and retain high quality researchers. There is a concerted effort to encourage more foreign students to study at German universities to increase the importance of Germany as a player in the academic training market, including an increase in courses taught in English, and international campuses. At the same time there is a strong effort to create overseas study opportunities for German researchers. State bodies are also active, for example from 2001 the Baden Wuerttemberg scholarships have been created as an activity of the newly created foundation (*Landesstiftung B-W* discussed earlier), to promote international exchange among German students attending state universities and non-German students.

Over the past two years, to promote young academics, the MPG has established nineteen Max Planck International Research Schools involving 25 Max Planck institutes and more than 30 universities. Schools focus on selected groundbreaking interdisciplinary fields (*e.g.* bounded plasmas, earth system modelling, structure and function of biological membranes, polymer materials science). Half the doctoral fellowships offered are for foreign students and courses will be conducted largely in English, with degrees granted by the participating universities. Schools are financed by the partners and established initially for six years, with a possible extension for a further six years, dependent on evaluation.

Conclusion

In structural terms, for both higher education and public research institutes, an intermediary level between government and research groups is being crystallized where decisions are taken at that level about detailed allocation of funds for research activities using competitive procedures and performance criteria. In the case of universities, this intermediary level is an independent body which is funded jointly by state and federal governments, and which draws extensively on the broad scientific community in decision making.

In the case of the public research institute sector, the structure is still evolving with outcomes that are not entirely clear at this stage. For the two big unitary organisations, MPG and FhG, the process takes place at their central management level, through internally determined mechanisms. The HGF is in a transitory stage, developing a new centrally managed procedure for balancing the allocation to the independent member organisations between core and program funds. In the case of WGL no intermediary mechanism currently exists for allocation decisions within the network, although the current evaluation process clearly provides the basis on which such a mechanism may be built, and strong interest is being taken in the outcome of the HGF process.

Alongside this, systematic efforts are under way to increase the operational flexibility within all research performing institutions through changes in the permitted salary structures (breaking the nexus with civil service salaries) and enabling greater flexibility in appointing to positions. Systematic efforts are also under way to ensure researchers have adequate opportunity to pursue independent research activities at an early stage of their career. This is an evolving area, and outcomes and implications are unclear for the present. It is an important area if German institutions are to be able to compete for researchers on a reasonably equitable basis with industry and with overseas research institutions. It is important that

German universities, in particular, become more integrated into the increasingly mobile pathways of the international scientific career.

Research remains a priority area for government with preferential funding within the constraints of the current economic climate. State government is an active level for research policy and several states provide significant support to research, actively encouraging and assisting the location of new research facilities from both sectors.

The development of coherent policies and structural reform in a large, complex and institutionally divided national research system where strong traditions continue alongside numerous endeavours to shape new priorities and decision making procedures is not at all straightforward. Several clear patterns have emerged, pointing towards greater responsiveness, more flexibility, improved competitiveness, greater integration and co-operation across institutional boundaries, but within an environment that remains highly structured and regulated. While detailed decision taking remains widely dispersed within the country, consideration agreement and co-ordination on strategic directions for change has been achieved through initiatives taken within longstanding structures bringing together the major stakeholders of the German research system. The key structures of the German research system are of long standing – and there is no evident intent to alter any of these structures. What is evident, however, is a clear will to achieve a better articulation between the elements and to improve internal structures, to enhance efficiency and performance. A clear start has been made; the challenge now is to maintain both direction and momentum. The shifting balance as these forces interact will be of great significance in the quality and usefulness of the research outcomes.

ANNEX

ACRONYMS

BLK	Bund-Laender -Kommission für Bildungsplanung und Forschungsfoerderung
BMBF	Bundesministerium für Bildung und Forschung
DFG	Deutsche Forschungsgemeinschaft
FhG	Fraunhofer Gesellschaft
HGF	Helmholtz-Gemeinschaft Deutscher Forschungszentren
MPG	Max Planck Gesellschaft
WGL	Wissenschaftsgemeinschaft Wilhelm-Gottfried-Leibniz
WR	Wissenschaftsrat

Visits

3-7 December 2001.

Monday December 3, 2001

Peter Kaye, BMBF Z33, Bonn

Dr Baerbel Koester

Susanne Clobes

Susanne Sieger, BMBF Z23, Bonn

Dr Bruno Zimmermann, Deutsche Forschungsgemeinschaft, Bonn

Herr Brand, Bund-Laender-Kommission fur Bildungsplanung und Forschungsfoerderung, Bonn

Ludger Viehoff, Wissenschaftsgemeinschaft Gottfried-Wilhelm-Leibniz, Bonn

Dr Joerg Schneider

Tuesday, December 4, 2001

Petra Weyers, BMBF Z36, Bonn

Kornelia Haugg, BMBF Z22, Bonn

Dr Enno Aufderheide, Wissenschaftsrat, Koeln

Dr Rainer Lange

Dr Manfred Rebhahn, Ministerium fur Schule, Wissenschaft und Forschung des Landes
Nordrhein-Westfalen, Duesseldorf

Dr Ekkehard Winter, Stifterverband fur die Deutsche Wissenschaft, Essen

Wednesday December 5, 2001.

Dr Dirk Schueller, BMBF 311, Bonn

Dr Uwe Moeller, Deutsches Zentrum fur Luft- und Raumfahrt, Koeln-Porz

Dr Renate Fischer, Ministerium fur Wissenschaft, Forschung und Kunst des Landes Baden-Wuerttemberg,
Stuttgart

Susanne Ahmed

Thursday December 6, 2001

Dr Stefan Echinger, Max-Planck-Gesellschaft zur Foerderung des Wissenschaften, Muenchen

Dr Berthold Neizert

Dr Lothar Behlau, Corporate Planning, Marketing, Fraunhofer Gesellschaft, Muenchen

Friday December 7, 2001

Dr Peter, Dekan, Klinikum der Ludwig Maximilians Universitaet, Muenchen

Dr Wolfgang Simon

Dr Frank Christ

REFERENCES

- BLK (1998) Information on the Bund-Laender Commission for Educational Planning and Research Promotion, Bonn, BLK.
- BLK (1999) Bund-Laender Commission for Educational Planning and Research Promotion BLK. Focus points and results '99, Bonn, BLK.
- BLK (2001) Evaluation der gemeinsam gefoerderten Forschung in Deutschland, Entwurf von Thesen der BLK fur die Regierungschefs des Bundes und der Laender, Bonn, BLK, Mimeo.
- BMBF (1999a) Das 5. Europäische Forschungsrahmenprogramm, Bonn, BMBF.
- BMBF (1999b) Framework Act for Higher Education, Bonn, BMBF.
- BMBF (2000) Report of the Federal Government on Research 2000, Bonn, BMBF.
- BMBF (2001a) Futur: Information für den Innovationsbeirat, Bonn, BMBF, Mimeo.
- BMBF (2001b) A new employment law for the 21st century in higher education and public research, Bonn, BMBF, Mimeo.
- BMBF und BMWi (2000) Innovations Foerderung, Bonn, BMBF u. BMWi.
- Catenhusen, W-M (2001) Programme-oriented Financing of the German National Research Centres, 22nd Carnegie Meeting: UK, 30 Nov -2 Dec. 2001, Mimeo.
- Clark, B.R. (1995) Places of Inquiry, Research and Advanced Education in Modern Universities, Berkeley, Univ. of California Press.
- Deutsche Forschungsgemeinschaft (1998) Structure and Functions, Bonn, DFG.
- Einhaeufl (2001) 'What does 'basic research' mean in today's research environment?', Keynote address to the OECD workshop on 'Basic research: Policy relevant definitions and masurement.'"28-30 October, 2001, Oslo. Draft. mimeo.
- Internationalen Kommission zur Systemevaluation der Deutschen Forschungsgemeinschaft und der Max-Planck-Gesellschaft (1999) Forschungsfoerderung in Deutschland, Hannover, Internationalen Kommission.
- Koester, B. (2001) Research in Competition: Programme-Oriented - Funding Hermann von Helmholtz-Association of German Research Centers (HGF), Bonn, BMBF. Mimeo.
- LMU (1999) High Tech Campus Martinsried-Grosshadern, Munich, Ludwig-Maximilians-University.

Max Planck Gesellschaft (1999) Guide to the Max Planck Institutes 2000, Munich, MPG.

Max Planck Gesellschaft (2000) Research Perspectives 2000+, Executive Summary, Munich, MPG.

Max Planck Gesellschaft (2001a) Facts and Figures 2000, Munich, MPG.

Max Planck Gesellschaft (2001b) Forschungsperspektiven 2000+ - Neue Initiativen, Munich, MPG.

Ministerium für Wissenschaft, Forschung und Kunst, Baden-Wuerttemberg (2000) Strategien der baden-wuerttembergischen Forschungspolitik, Stuttgart, Ministerium.

Roland Berger and Partner (n.d.) Zukunftsinvestitionen in Baden-Wuerttemberg, Landesstiftung Baden-Wuerttemberg gGmbH.

WGL (2001) Die Leibniz-Gemeinschaft .. im Jahr 2001, Bonn, WGL.

Winter (2001) 'Time to take down the gates', Essen, Stifterverband für die Deutsche Wissenschaft. Mimeo.

Wissenschaftsrat (2000) Theses for the Future Development of the System of Higher Education and Research in Germany, Cologne, WR.

Wissenschaftsrat (2001) Systemevaluation der HGF – Stellungnahme des Wissenschaftsrates zur Helmholtz-Gemeinschaft Deutscher Forschungszentren, Cologne, WR.