UNITED NATIONS UNIVERSITY

UNU-MERIT

Universiteit Maastricht

Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments The "POLICY MIX" Project

Country Review Germany

Submitted by:
Christian Rammer, ZEW

March 2007

Introduction and Policy mix concept

The policy mix project

This report is one of the 31 country reviews produced as internal working papers for the research project "Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments" (Contract DG-RTD-2005-M-01-02, signed on 23 December 2005). This project is a research project conducted for DG Research, to serve as support for policy developments in Europe, notably in the framework of CREST activities. It does not form part of the ERAWATCH project, but the working documents are made available on ERAWATCH webpages for the purpose of steering a debate on the policy mix concept.

The "Policy Mix" project is run by a consortium of 7 partners:

- UNU-MERIT (The Netherlands), consortium leader
- Technopolis (The Netherlands)
- PREST – University of Manchester (United Kingdom)
- ZEW (Germany)
- Joanneum Research (Austria)
- Wiseguys Ltd. (United Kingdom)
- INTRASOFT International (Luxembourg).

Each country review is produced by an individual author, and provides expert's view on the policy mix in the country. This report is not approved by the Commission or national authorities, and is produced under the responsibility of its author.

The role of country reviews is to provide an exploratory analysis of the current policy mixes in place in all countries and detect the most important areas of interactions between instruments as well as new modes of policy governance that are particularly adapted (or detrimental) for the building of policy mixes. They provide analytical material for the analysis of the policy mix concept and its implementation in Europe. This material will be used as background for further reports of the project and for the construction of a tool for policy-makers (to be made available in late 2007 and 2008).

The policy mix concept

The country reviews are based on the methodological framework produced by the consortium to frame the "policy mix" concept. They have been implemented on the basis of expert assessments derived from the analysis of National Innovation Systems characteristics and policy mix settings, using key information sources such as Trendchart and ERAWATCH reports, OECD reviews, and national sources, among which the National Reform Programmes.

In this work, the "policy mix for R&D" is defined by the consortium as: **"the combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors."**

In this definition, policy instruments are: "all programmes, organisations, rules and regulations with an active involvement of the public sector, which intentionally or unintentionally affect R&D investments". This usually involves some public funding, but not always, as e.g. regulatory changes affect R&D investments without the intervention of public funds.

Interactions refer to: "the fact that the influence of one policy instrument is modified by the co-existence of other policy instruments in the policy mix".

Influences on R&D investments are: "influences on R&D investments are either direct (in this case we consider instruments from the field of R&D policy) or indirect (in that case we consider all policy instruments from any policy field which indirectly impact on R&D investments)".

Structure of the report

The report is structured along the following questions.

First, in section 1, and in order to place the policy mix in context, the general challenges faced by the National Innovation System (NIS) are analysed by the expert. The view is here not restricted to the challenges with regard to raising R&D investments, but rather encompasses all the conditions that directly or indirectly affect the functioning of the NIS and R&D expenditures. These context conditions are very important for the discussion of the relevance of the policy mix later on.

Second, the stated main objectives and priorities of R&D policy in the country are spelled out in section 2, as well as their evolution over the last ca. five years. This discussion is based on White Papers and official documents, i.e. on published policy statements. The reality of these objectives compared to actual working of policy instruments will appear in section 5.

The third section provides an expert assessment and critical analysis of a possible gap or convergence between the NIS challenges and the main policy objectives and priorities stated before.

Section 4 presents the policy mix in place, following the above definition, i.e. policy instruments affecting R&D activities in the private and in the public sector, either directly for instruments from the R&D policy domain, but also indirectly for instruments outside the R&D domain which are of particular relevance to R&D activities. A typology of instruments is used, to categorise the R&D-specific and non-R&D specific instruments. A short description of each instrument is provided: aim, nature, target group, budget.

Then, section 5 discusses whether there is a gap between the main policy objectives and priorities stated in section 2, and the instruments in place. This is done by

comparing the set of objectives with the set of instruments at work. When individual evaluations of programmes or policy instruments are available, their results are used if they shed light on contribution of these instruments towards the policy objectives.

Section 6 discusses the orientation of the policy mix, indicating priorities amongst various possible routes to increase R&D investments. Policy instruments are categorised under 6 different routes according to their relevance, and this categorisation is followed by a discussion on the range of instruments affecting each route, missing instruments, routes that are not addressed by instruments, possible redundancies or overlaps, etc.

Section 7 provides another view on the policy mix, focusing on the relative importance of each types of instruments. The aim is to get a picture of the policy mix, the balance between (sets of) instruments, and the relative weight between them.

From section 8 onwards, the review turns to the crucial question of policy governance. That section discusses the emergence of the policy mix through examination of the following question: how did the set of R&D policy instruments arrive? What is the rationale behind them, what was the driving force behind their establishment, and how is this evolving recently. A crucial question relates to the existence of some consideration of possible interactions when establishing new or suppressing existing instruments. The section tries to establish whether the policy design process is incremental or radical, analytical or non-analytical. From this, that section discusses if the policy mix is a "construct" or an "ex post" reality.

The next section, section 9, focuses on the governance of the system of R&D policy instruments take place. It examines the key question of interactions, i.e. whether there is a form of co-ordination between R&D policy and policy instruments from outside the R&D domain, and the existing mechanisms that favour or hinder such interactions.

The final section, section 10, deals with the core question of the policy mix concept: it endeavours to discuss interactions between policy instruments to affect R&D expenditure. The section discusses possible positive, neutral and negative effects of R&D policy instruments; both within the R&D policy domain, but also with instruments from other policy domains. In most cases, this takes the form of hypotheses rather than hard evidence.

Feedback welcome

Feedback on this report is gladly received. Individual country reports will not be updated but discussion on policy mixes is welcome during the timeframe of the study (2006-2008). Please send your comments to:

Claire Nauwelaers
UNU-MERIT
Coordinator of the "policy mix" project
c.nauwelaers@merit.unimaas.nl

1. National Innovation Systems Challenges

The stakeholder and policy debate in research policy in Germany centres around five major challenges that directly relate to features and shifts in the national innovation system:

- **Low share of cutting-edge technology sectors** (such as ICT, pharmaceuticals and aerospace/defence) in total value added. The vast majority of R&D expenditures in the business sector is taking place in medium- to high-technology sectors such as automobiles, mechanical engineering, chemicals and electrical engineering. In these sectors, a significant further increase in R&D intensity is rather unlikely. German companies are already at the forefront of R&D intensity in these sectors in international comparison. At the same time, other factors than innovation such as the utilisation of scale and scope economies in production, modernisation of production technology, cost efficiency and marketing play an increasingly important role and will attract funds for investment. A significant increase in total R&D intensity of the German economy will first of all depend on a significant increase in production shares of cutting-edge technology sectors. This challenge is difficult to cope with since policy can hardly change structural features of an economy. Nevertheless, public programmes such as the thematic R&D programmes (e.g. in the fields of biotechnology, ICT, nanotechnology, medical technologies, micro-system technologies, optical technologies) are intended to strengthen cutting-edge technologies and thus raise their share in value added in the long run.

- **Decreasing funding of public research**. While R&D expenditures in the public sector (universities and other higher education institutions - HEIs - and other public sector research establishments - PSREs) grew rather constantly form year to year until 2002, the recent development is showing negative rates of change. This is particularly due to cuts in funding by the Federal States (*Länder*), who are the primary financer of university research and account for almost half of institutional funding in the PSRE sector. Since the *Länder* intend to continue austerity programmes in order to reduce public debt, no revitalisation of R&D expenditures in the public sector may be expected for the years coming. What is more, a likely short-term increase in student figures as a result of shortening of secondary education curricular will absorb researcher resources for teaching at universities and may reduce the share of total spending at HEIs that is devoted to research. This challenge could be easily met by increasing public funding of research at HEIs and PSREs. The new Federal Government has announced steps in this direction ("6-billion-programme" for research). Whether the *Länder* governments will follow, is unclear, however.

- **Stagnating R&D expenditures in the SME sector**. The number of R&D performing SMEs is stagnating or even shrinking for some time now, and the SME's share in total R&D expenditures in the business sector is remaining low in international comparison. The most important obstacle today is financing, and the

uncertain market prospects of the domestic market in Germany. To meet this challenge, the Federal government has adapted some of its SME-target R&D programmes, e.g. a new financing instrument (mezzanine capital) within the ERP innovation programme. A new high-tech strategy to be announced in summer 2006 is expected to add new measures to improve financing for R&D in SMEs.

- **Funding restrictions to high-tech start-ups**. In the late 1990s and until 2001, a significant number of high-tech start-ups have been founded in Germany, most of them operating in fields of technology such as biotechnology, nanotechnology, optical technology, software and ICT where the German economy is lacking somewhat in international comparison. Many of these new firms show very high R&D intensities. Funding of R&D strongly rests on external funds such as venture capital (VC). As a result of the downturn of the German VC market after 2000, many of these high-tech start-ups are faced with financing difficulties, and a significant number had to close down. In response to this challenge, the Federal Government has introduced a new High-tech Start-up Funds in 2005 and re-launched its VC programmes.

- **Upgrading of skills**. While Germany's work force is characterised by a high average skill level compared to most other countries, there is an increasing gap in attained educational levels among the younger generation. Special concerns relate to a still rather low share of 25-29 years old persons with a higher education degree. Though the number of students has increased since 2000, there is a fear of upcoming undersupply with science and engineering graduates. Moreover, the traditional vocational training system is under permanent pressure to reform curricula in order to meet new skill demands. A further, more general worry refers to an increasing number of very low educated young people, missing some basic capabilities and knowledge needed in a modern society.

While the first challenge is prevailing for many decades, since it reflects a structural feature of the German economy, the other challenges have emerged after 2001/2002 (or in the 1990s with respect to skill level concerns). They have displaced some other challenges such as a shortage in high-qualified labour (and S&E graduates in particular), though the latter is very likely to re-emerge in the years coming.

Some stakeholders also argue that partnerships between business and academia can be improved, though the level of interaction in general is high, and HEIs receive a significant share of their total research funding from industry sources. Nevertheless, some types of institutions, e.g. among the federal R&D laboratories and large public R&D centres, show a rather poor record in technology transfer activities. And some groups of businesses, especially SMEs, tend to face difficulties when attempting to approach academia for research co-operation. Some say that universities are often reluctant to partner with SMEs and response to their specific needs.

In addition to these challenges specific to the German NIS, some generic challenges have emerged in recent years which concern all industrialised countries and which may have long term impacts on economy and society, including the NIS. Among these global challenges, the following are particular relevant to NIS:

- Globalisation

- Aging of society
- Climate change
- Emerging knowledge society

Globalisation is a big issue in public debate in Germany, and mostly connected with a fear of downward pressure on wages and loss of jobs. In the field of research policy, concerns relate to a perceived outsourcing of R&D to low-cost locations with a high potential of young, well-qualified researchers such as China, India and Eastern Europe. The main policy challenge here is to stronger embed German-based R&D activities of enterprises into innovation networks with other companies, academia and public administration, and to improve framework conditions for research in Germany with respect to regulation, funding and labour market. Another challenge is seen for the science system. Some stakeholders and policy makers observe a growing tendency of talented researchers to move to other locations, especially the USA. Globalisation is also regarded as an opportunity, however, in particular with respect to attracting high qualified people from abroad in order to countervail the upcoming shortage in human capital.

Aging of society is the main theme in German policy today, particularly in the field of social security policy (health, pension system, long term care insurance). Research policy did not take up this issue at the same intensity, but is aware of the potential consequences of aging on the research system. A particular challenge here refers to the large numbers of engineers and teachers who will retire within the next 10-15 years, and the resulting demand for human capital which seems difficult to satisfy at least in some disciplines.

Climate change, or to put it broader: environmental issues are at the very centre of research policy in Germany for three decades. Research in environmental technologies has been a priority since the 1970s. The government launched a large number of individual programmes on developing environmental technologies under the umbrella of thematic R&R programme. Many of these programmes were and are interrelated with environmental policy initiatives, e.g. cleaner production, sustainable transport, renewable energies, renewable primary products etc. Today, climate change is challenging research for renewable energies such as wind power, solar energy and fuel cell technologies, better understanding of climate changes, socio-economic consequences of climate change, improving measurement of climate.

To cope with the emergence of a "**knowledge society**" is a challenge for German research and innovation policy for many decades, too. The main challenges that result from this secular trend are manifold: First, it requires new approaches to learning and knowledge exchange. Continuous up-dating of previously acquired knowledge, life-long learning for workers, adopting firms and administrations to "learning organisations" and finding new modes of co-operation in education, training, research and innovation are new requirements in this respect to which research policy has to respond. Secondly, knowledge production is becoming key for competitiveness and calls for a shift of resources towards knowledge production activities. Thirdly, the emergence of the knowledge society is closely inter-linked with the development of new information and communication technologies that serve as generic technologies. Their rapid diffusion requires adaptations in infrastructure and skills, ensuring competition on markets and technological standardisation.

2. Objectives and priorities of R&D policy

R&D policy in Germany is mainly organised along the following objectives and priorities:

- Increasing R&D activities in the enterprise sector and the public sector. In 2010, 3% of GDP should be spent on R&D.
- Improving the quality of research performed in the public research sector and promoting excellence by increasing international co-operation, building up of competence centres, supporting graduate schools and strengthening links between HEIs and PSREs.
- Increasing the share of SMEs that perform R&D, the R&D expenditures of SMEs, and the use of public R&D results by SMEs.
- Developing new technologies and promising technology clusters. Special focus is currently laid on ICT, biotechnology, nanotechnology, fuel cell technology, medical and health technologies, optical technologies, micro-system technology, space and aircraft technologies, environmental technologies, energy technologies (e.g. wind power, solar power) and transport technologies.
- Stimulating the creation of new technology-based enterprises and the growth of young technology companies.
- Increasing the use and commercialisation of research results achieved at public research institutions, including a more intense co-operation between enterprises and academic institutions, a more efficient use of IPRs by public research institutions and the promotion of spin-offs from public research.
- Improving the education system at all levels in order to meet expected increases in the demand for highly qualified people - at HEIs this includes the shortening of study curricula through introducing a system of Bachelor and Master studies.
- Promoting R&D in the eastern *Länder* in order to contribute to the economic restructuring of eastern Germany - this especially refers to fostering regional clusters in R&D in order to make full use of complementary skills and competencies of the HEIs, PSREs, SMEs and large companies in the innovation system.

These priorities and objectives guide research policy at the federal level, but are also constitutive for most of the *Länder*. The state governments traditionally focus more on research in universities, including their links to the business world, and education-related research topics since these education (including higher education) is the prime responsibility of the state governments. Most of the larger *Länder* also attempt to foster research into new technologies, support R&D in SMEs and link research, innovation and value added in order to strengthen regional economic growth.

The objectives and priorities of German research policy have not changed significantly over the last five years, though, some shifts can be observed. Currently, promoting excellence at public research has become a main priority. Research for new technologies, especially in partnerships involving business and public research, is

still the single most important priority in German research policy. It is also in the centre of the "**High-tech Strategy for Germany**", the federal government's new research and innovation strategy for the coming years presented in August 2006. This strategy rests on the above mentioned objectives, but presents some shifts in priorities and, more important, the way policy is delivered. Particular emphasis was laid on the link between research results and market success. For the first time ever, the federal government has developed a comprehensive national strategy for all its ministries. All political sectors that affect R&D will be geared to a clearly defined goal. This strategy puts innovation policy front and centre in government activities.

The federal government summarises the High-tech Strategy's objectives and priorities in the following way:

- *Translate ideas into practice*: The High-Tech Strategy places innovation policy at the heart of government action. It is the first national strategy to show how Germany can become and remain a global leader in the most important cutting-edge technologies.
- *Create more freedom for new ideas*: This central policy thread has been woven into all parts of the High-Tech Strategy. More freedom for research and industry means that research findings will become products faster.
- *Foster and support good minds*: Germany wants to become the most research-friendly country in the world. To achieve this goal, we will foster and support talent and capability as early in life as possible and work to ensure that performance and accomplishments receive greater recognition.
- *No ideological blinkers*: We will be open and receptive to new technologies. In areas such as green biotechnology and security technology we will seek opportunities and market potential.
- *Goals for the markets of the future*: To create lead markets, the High-Tech Strategy has laid down clear-cut and developed a timetable complete with concrete activities for each of its targeted 17 cutting-edge fields.[1] Strategic partnerships will arise as a result of the close coordination between the players involved.
- *New ideas for SMEs*: Support for small and medium sized businesses and collaboration between science and industry take centre stage in the High-Tech Strategy. All funding instruments and political will be geared to this.
- *Push the strategy forward*: The "Research Alliance Industry-Science" will provide flanking support during the implementation of the High-Tech Strategy. The experts in the Research Alliance will issue regular reports to document the strategy's progress.

(Source: Federal Ministry of Education and Research: The High-tech Strategy for Germany, Berlin, http://www.bmbf.de/pub/bmbf_hts_lang_eng.pdf)

[1] These 17 fields are: Health research and medical technology; Security technologies; Plants – new paths for agriculture and industry; Energy technologies; Reliable, efficient, sustainable environmental technologies; Information and communications technologies; Automotive and transport; Aviation technologies; Space technology; Maritime technologies; Services – on the road to tomorrow's knowledge society; Nanotechnologies; Biotechnology; Microsystems technology; Optical technologies; Materials technologies; Production technologies.

The High-tech Strategy not only responds to most of the main challenges the German NIS is currently facing, but also reacts to some of the global challenges of globalisation, environmental change, aging, and the knowledge society:

- *Globalisation*: Making Germany more attractive as a location for research both in academia and in the business world is a key priority and may be seen as a response to the challenges of globalisation. Another key objective in science policy is also related to the process of globalisation, i.e. strengthening the internationalisation of the German science system. This includes increasing the inflow of top-level researchers from abroad, expanding bilateral and multilateral scientific co-operation, offering attractive return options to German researchers who moved abroad, and increasing the participation of German researchers in international programmes.

- *Aging*: Adopting the higher education system to cope with the aging of the society is a key priority in education policy that has significant impacts on the research system since a sufficient availability of well-trained young researchers is vital for any research system.

- *Climate Change*: Developing new environmental technologies and promoting their broad use is a key priority of federal R&D policy and is closely inter-linked with environmental policy both on the federal and *Länder* level.

- *Knowledge Society*: The federal government has launched several comprehensive programmes in recent years that attempt to better prepare Germany for the challenges of knowledge society. In 2003, a large "Information Society Germany 2006" was published, setting the priorities in this policy field. Associated to this programme is the 2002 thematic R&D programme on Information and Communication Technologies. Currently, the federal government is in the process of up-dating and revising these priorities, which will result in a new R&D programme, "ICT 2020".

3. Coherence between NIS challenges and R&D objectives and priorities

On a broad scale, policy priorities largely correspond with the challenges identified, i.e. one can find at least one policy objective that may be viewed as a response to each of the challenges discussed in Section 1. What is far more difficult to assess is whether the objective effectively addresses the critical processes underlying a particular challenge, and whether the amount of efforts put on responding to a particular challenge is sufficient with respect to the real effects on the German research system that may stem from this challenge. One may assume, for instance, over-emphasis on certain challenges that in fact have little effects on the R&D systems, while paying too little attention to those challenges that really make a difference.

Giving an assessment on the latter is heavily complicated by the fact that there is no reliable source of information on the likely impacts both in short- and long-term of a particular challenge on the German research enterprise. One is bounded to stakeholder views and expert assessments, which may be biased or idiosyncratic. For each of the five main challenges identified in Section 1, the following appraisal may be given:

- **Low share of cutting-edge technology sectors**: Tackling this challenge is at the heart of modern research policy in Germany, and even dates back to the 19th century science and technology policy efforts to put Germany at the forefront of technical progress. With the founding of the Federal Ministry for Nuclear Issues, the predecessor of today's Federal Ministry of Education and Research, the promotion of cutting-edge technologies was the main activity of this ministry and occupied a significant fraction of the federal government's budget. The new "High-tech Strategy for Germany" consequently follows this route and lists 17 fields (basically defined by technologies) that should receive priority funding within the next four years. The 3% R&D target adopted by the federal government can also be linked to this challenge. Since shifting economic structures towards cutting-edge technology sectors is key for maintaining Germany's prominent role in the world as a major source for new technology, the strong policy emphasis on this issue corresponds with the likely real importance of this challenge.

- **Decreasing funding of public research**: This challenge is basically the result of policy decisions, i.e. to reduce institutional funding for higher education institutions by the *Länder* governments. It is likely that lower basic funding reduces research resources available at this type of institutions. This is a threat for Germany's research capacities as a whole since HEIs are responsible for 55% of all public R&D expenditure. The federal government attempts to go against this trend by offering additional funding sources for basic research at HEIs and also PSREs, often as a bipartisan activity with *Länder* governments. The most prominent priorities in this respect is the Initiative for Excellence, that provides additional funding for (i) a few top-performing universities, (ii) excellence clusters in research, and (iii) graduate schools. Another main priority is the so-

called “Pact for Research and Innovation” that offers significant increases in funding for most PSRE sector organisations as well as for the German Research Foundation, the German pendant to the US NSF. With respect to this challenge, one is inclined to notice that the challenge has been recognised, but that the shift in priorities to tackle this challenge is insufficient, especially with respect to *Länder* activities, which are restricted by budget constraints of the state governments.

- **Stagnating R&D expenditures in the SME sector**: SMEs are a main target group of research policy measures addressing the business world, and have clearly gained in policy attention over the past 15 years or so. Today both the federal and the *Länder* governments run various R&D programmes targeting SMEs, offering grant funding, loans, venture capital and supportive infrastructure. The new “High-tech Strategy for Germany” lists a better framework for innovative SMEs as one out of five key cross-section activities (which complement the 17 technology specific priorities).

- **Funding restrictions to high-tech start-ups**: This challenge that came up after 2001, has led to clear policy responses in 2004 and following years. The federal venture capital programmes have been reformed substantially, introducing new measures such as the High-tech Start-up Fund and the EIF/ERP Umbrella Fund. Improving financing for high-tech start-ups is also one of five cross-cutting priorities of the “High-tech Strategy for Germany”.

- **Upgrading of skills**: Improving the education system at all levels in order to cope with the growing demand for high-skilled labour is a key priority of the federal government. At HEIs this includes the shortening of study curricula through introducing a system of Bachelor and Master studies. The “High-tech Strategy for Germany” lists “investment in people” as one out of five key cross-section activities.

Another key priority - and one of the cross-section activities mentioned in the “High-tech Strategy for Germany” - is improving and intensifying **industry-science links**. This priority reflects a demand by many stakeholder groups, though it is less clear from technology transfer indicators and international comparison and evaluation, whether Germany is really facing a big challenge in this particular area. Anyway, policy activities in this field are important for maintaining and further developing the ties between academia and the business world and making innovation processes and the transfer from research to the market more smoothly.

With respect to the four generic challenges identified, one can also observe a number of related policy priorities:

- **Globalisation**: Strengthening the international position of Germany in science and research is the fifth cross-section priority in the “High-tech Strategy for Germany”.
- **Aging**: The key response to this challenge refers to reforms in the education system in order to secure sufficient supply with high qualified labour when population is shrinking.

- **Climate Change**: Many of the technology fields addressed by the "High-tech Strategy for Germany" directly relate to environmental issues and climate protection. On this challenge, environmental and research policy often concur.
- **Knowledge Society**: Making Germany fit for the information age has been a main motive of many research and innovation policy initiatives of the federal government in the past 10 years, including various ICT programmes, the support for research on and in the service sector, and life-long learning initiatives.

4. Composition of the policy mix for R&D

The policy mix for R&D in Germany consists of instruments and measures from three different types of policy areas: the federal research (and innovation)[2] policy; the research and innovation policy instruments of the state governments; and instruments of other policy areas that have a markedly impact on R&D decisions and activities of firms and public institutions.

R&D policy instruments at the federal level

Table 1: Policy mix for R&D in Germany

Policy categories	Policy instruments: short description and target group
R&D Domain	
R&D policy generic	**Institutional Funding:** Each HEI or PSRE receives a certain fraction of their total expenditures as an annual lump sum. This "basic funding" is typically used to cover basic research activities, strategic research, infrastructure maintenance and various activities in the context of offering public services. The share of institutional funding varies among institutions and depends on the volume of research funds acquired from other sources (both public and private). The total volume of institutional funding for HEIs (including funding for teaching) by the *Länder* governments was €16.7 billion in 2003 (appr. 40% of this sum may refer to research). Total institutional funding of the four main organisations in the PSRE sector (Helmholtz Centres, Max Planck Society, Fraunhofer Society, Leibniz Association) by Federal and *Länder* governments together was €3.7 billion in 2004. **DFG:** The German Research Foundation (DFG) basically offers funding for research projects, competence centres in academic research and graduate colleges. The most important programme is the "single project funding": researchers from HEIs and most PSREs are qualified to submit proposals which will then be reviewed by peer review. A number of special DFG programmes offers funding for centres of excellence ("*Sonderforschungsbereiche*", "*Forschungszentren*", *Schwerpunktprogramme*"), graduate schools, mobility of researchers (both inward and outward), conferences, summer schools. The DFG is co-financed by the Federal and the *Länder* governments. In 2005, the DFG's budget was €1.35 billion. **FHprofUnd:** For Universities of Applied Sciences ("*Fachhochschulen*"), the Federal government and some *Länder* governments run separate R&D programmes that provide funding for individual research projects. The single most important one is the Federal programme for application-oriented R&D at Universities of Applied Sciences (now called "Research at Universities of Applied Sciences with Enterprises" - FHprofUnd). Its budget in 2006 is €10 million. **Non-Profit-Foundations:** There are a number of public, semi-public or private non-profit foundations that offer funding for academic research. At the *Länder*

[2] In Germany, there is no clear distinction between research and innovation policy, rather these two areas strongly overlap in terms of objectives, priorities, strategies and instruments. The thematic R&D programmes by the federal government may be used to illustrate this integrated approach: They typically combined elements of basic research funding for public institutions with industry-science link measures (including collaborative research, centres of excellence, clustering) and the commercialisation of new technologies. The Länder follow similar approaches with their technology programmes.

	level, the "*Landesstiftung Baden-Württemberg*" of the Federal State of Baden-Württemberg is the most significant example. Among the private foundations, the Volkswagen Stiftung, the Fritz-Thyssen-Stiftung and the Robert-Bosch-Stiftung are among those with the highest budgets for funding academic R&D. These foundations act similar to DFG. The amount of funding for R&D projects in 2004 was about €110 million. The annual volume of project funding for R&D at the Landesstiftung Baden-Württemberg is about €10-20 million. **Institutional Reform:** The institutional setting and organisation of HEIs and PSREs is subject to permanent reform aiming at improving efficiency and quality of research, increasing internationalisation and better linking public research institutions among each others and with other actors in industry and society. While reforms are manifold and typically specific to the varying challenges present at each particular institutions, some common features that may affect the volume of R&D expenditures at HEIs and PSREs in Germany may be identified: Increasing attention is paid to technology transfer activities, which is likely to increase the ability of public research to attract contract and collaborative research with industry and thus raise the available funds for research. Secondly, increasing international orientation and integration in international research networks provides additional access to foreign sources for research funding, first of all EU Framework Programme funding.
R&D policy sectoral	**IGF:** This programme is a type of indirect support to R&D activities of SMEs. The programme provides funding for R&D projects that are submitted by one of currently 102 Institutions for Industrial Collaborative Research (IfG). IfGs are sector-specific research institutions and part of an umbrella organisation, the AiF. R&D projects performed or co-ordinated by IfGs are intended to contribute to technical problems of SMEs and should help them in innovation activities. SMEs get access to the research results as long as they are member of the IfG that has performed or co-ordinated the project. IfGs often subcontract research activities to public research institutions though many of them have own research facilities and research staff. The IGF's annual programme budget is about €100 million. **Military Research Projects:** The Federal Ministry of Defence (BMVg) concludes contract research to enterprises and public research institutions in defence-related areas. These R&D contracts are distributed through the Federal Office for Military Technology and Procurement. Their total volume in 2005 was €0.85 billion, of which €0.5 billion went to enterprises.
R&D / Innovation policy – Linkage	**Thematic Programmes:** The Federal government runs a large number of thematic programmes that offer direct financial support to enterprises, HEIs and PSREs for conducting research projects. These programmes - similar to EU Framework Programmes - rest on calls to which applicants (typically consortia) can apply project proposals. These proposals will be evaluated by specialised agencies ("*Projektträger*"). Funding is provided by grants (up to 50% for enterprises, up to 100% for HEIs and PSREs). Thematic programmes typically consist of a framework programme which sets out the main rationale and objectives of funding in the particular thematic area as well the instruments to be applied, as well as a number of individual programmes. The latter typically run for 4 to 6 years, and their volume may vary from a few million Euro to several hundred million Euro. Individual programmes are typically published by a separate Directive ("*Richtlinie*") which sets out eligibility criteria, the type of R&D that may receive public funding, beneficiaries and other funding details. Sometimes, one programme contains of more than one Directive. Most programmes are open to enterprises and public research institutions, though some programmes may be restricted to public research only (e.g. in case of funding of young researcher teams). Co-operation among several actors in consortia is often required or at least preferentially treated, as is the participation of SMEs. The total volume of thematic R&D programmes in 2004 was roughly €2.2 billion, of which about €0.6 billion went to enterprises (all figures exclude R&D project funding for military research). **InnoRegio/Innovative Regional Growth Poles:** Both offer grant funding for collaborative R&D projects that involve enterprises and public research

	institutions in a number of pre-selected regional clusters (42 in total). Further activities under the framework programme refer to InnoProfile (funding for groups of your researchers from public research institutions, with a special focus on co-operation with enterprises from the region), centres for innovation competence (funding of centres of excellence at universities) and Innovation Fora (financial support for regional networks in their start-up stage). Total public funding for this framework programme is about €90 million per year (note that this amount is part of the total volume of thematic R&D programmes). **ProInno:** This programme is the single most important Federal R&D programme that is not focussed on specific technologies. The programme basically funds co-operative R&D projects. Co-operations may involve a group of enterprises, or enterprises and public research institutions. Another, though small, programme part offers funding to enterprises that start doing R&D, or re-enter R&D after a period of 5 or more years without in-house R&D activities. The programme offers grants of up to 50% for enterprises and up to 100% for public research institutions. Funding is based on proposals by enterprises (and public research institutions in case of such type of co-operation) which are evaluated by a project management organisation. Applications can be submitted at any time. In 2005, the ProInno programme had a budget of €157 million. **InnoNet:** This programme is a special type of funding for collaborative R&D that involves SMEs and public research institutions. The programme offers up to 85% of those costs of such a collaborative R&D project that occur at the side of the public research institutions. Funding is provided through a grant. The remaining part of the public research institutions' project costs (i.e. at least 15%) will have to be covered by the SMEs that participate in the project. SMEs also have to contribute at least 20% of the total project activities by own resources (i.e. research personnel). There is no direct flow of money from the government to SMEs. InnoNet projects require the participation of at least 4 SMEs and at least 2 public research institutions. The basic idea of the programme is to mobilise knowledge and research capacities at public research institutions for innovation activities of SMEs. The budget on InnoNet in 2005 was €17.5 million.
R&D / Innovation policy – IPR	**IPR regulation:** The regulation of intellectual property rights may affect research decisions of both public and private actors, although no flow of public funding for R&D is resulting from this type of policy instrument. The IPR system in Germany is long-standing (as in all other industrialised countries) and perceived to be effective. It should thus provide incentives to engage in R&D as it allows for private appropriation of returns from R&D activities. In 2002, the IPR regulation at HEIs was changed, resulting in a shift of ownership from individual researchers to the state. In practice, HEIs are today the owner of all IP resulting from research performed by HEI researchers and that has a potential to be patented. A separate network of technology commercialisation offices (similar to the US TTOs) has been established in order to effectively commercialise inventions. Assessing the effect of IPR regulation on the level of R&D expenditures in Germany is extremely difficult (as it is in any other country), and no data exist on this subject.
R&D specific financial and fiscal policy	**InnoWatt** ("Innovative Bearers of Growth"): This programme offers grants for R&D projects conducted by enterprises in Eastern Germany. Enterprises may submit proposals for R&D projects at any time. Proposals are evaluated by a programme managing institution. The programme's budget in 2005 was about €90 million. **Exist Seed:** This small measure offers seed funding (through grants) to students, graduates or researchers from HEIs who plan to establish a new venture. Funding should help them to develop a business plan and conduct other preparatory activities for market entry, including R&D. The programme basically covers personnel costs of the potential firm founders for up to one year and up to 3 founders, as well as some costs for consulting. The programme volume in 2005 was €13.5 million. **High-Tech Start-Up Fund:** This newly established VC fund offers VC to newly founded technology-based enterprises. The maximum amount of equity

	investment is €0.5 million per enterprise through a mezzanine shareholder's loan in exchange of 15% of the enterprise's shares. The loan has to be repaid within seven years, with a grace period of four years. The fund is intended to fill the gap left by the private VC market after 2000 when private VC companies stepped out of the seed stage segment. The funding by the high-tech start-up fund is likely to be used for R&D investments by the young firm. The fund has a total volume of €262 million, its annual amount of investment is likely to in the region of €50 million. **ERP Start Fund:** This fund offers VC investment to young technology-based enterprises (up to 5 years). VC funding is not ear-marked for R&D, but the enterprise must perform in-house R&D and develop new products or technologies. Public VC funding is tied to the existence of a private lead investor. There is no information available on the amount of annual investment in this programme. **ERP Innovation Programme**, loan variant: This programme offers loans to enterprises that develop innovative products and look for financing (a) further R&D activities and (b) the market introduction expenses for new products. The loan offered consists of a classical debt and a mezzanine variant. Mezzanine capital does not require liabilities whereas the classical debt part oes. The interest rates are slightly below typical market rates for such types of projects and enterprises. The loan may be up to 100% of R&D costs and up to 50% of costs of market introduction. There is no information available on the amount of annual investment in this programme.
R&D specific education policy	**Reform of HEI curricula** along the Bologna process **Graduate school programme** for PhD students
R&D specific employment policy	**ProInno:** Provides also funding for exchange of R&D personnel between enterprises and public research institutions.
Macroeconomic policy	Macroeconomic policy has certainly a significant impact on R&D investment by firms, since these typically require cash-flow funding, which is more likely available under prosperous economic conditions than in a recession phase. But there is no direct link from macroeconomic policy to R&D, and no macroeconomic policy measure has been designed in order to spur R&D.
Human Capital Domain	
Education policy	There are numerous programmes at the federal, the state and the municipal level that aim at improving standards and performance in the German education system at all educational levels and types of schools. These activities all together are intended to improve the skill level of workers and increase the inflow of well-educated young people into the university system and could thus improve the base for research. But non of these instruments outside higher education has an explicit link to R&D themes.
Employment policy	Employment policy in Germany focuses on reducing the high level of unemployment, which first of all affects low-skilled people. Instruments thus focus on basic training, opening a low-wage labour market, public employment measures, labour market deregulation etc. In 2001, when there was a fierce shortage in high-qualified worker, especially in the ICT sector, a special instrument, the so-called **Green Card**, was implemented in order to allow high-qualified workers form outside the EU to temporarily enter the German labour market. One may expect similar activities in case a similar situation occurs in the years coming.
Innovation Domain	
Innovation policy generic	Innovation policy cannot be separated from research policy in Germany. A typical innovation policy measure is the ERP Innovation programme (see above) which provides funding for a wide range of R&D and innovation activities, including pre-competitive research, but also the implementation of new process technologies.
Innovation policy sectoral	Sectoral innovation policy basically takes place through the thematic R&D programmes and associated activities, e.g. in the fields of training, standardisation, clustering etc.
Other policy areas	
Industry policy	There is almost no industry policy in the traditional sense, but support for

	domestic industry takes place through promoting research and innovation, e.g. through thematic programmes. Another activity concerns export guarantees (see below)
Trade	Export guarantees ("Hermes Bürgschaften") are offered to German enterprises to secure their exports against economic and political risks. They may also be used to spur exports of new technologies and could thus provide an incentive to conduct R&D for export market products. But promoting R&D is no explicit (nor implicit) goal of this measure.
Defence	The Defence Research and Technology Programme of the Federal Ministry of Defence has a volume of €430m in 2006. Defence related development is budgeted €555m in 2006. Further R&D funding sum up to €40m in 2006. Total defence related R&D funding (€1,140m in 2006) constitutes about 7% of total government funding of R&D (sum of federal and state governments). The business sector has received €650m of defence related R&D funding in 2006, which is more than a third of total federal R&D funding in the business sector. This figure increased in 2006 for the first time after six years of decline. Defence related funding is thus an important source for R&D in Germany, but clearly less significant than in other large economies such as the USA, France or the UK.
Consumer protection	No consumer protection measure is clearly related to R&D or has a distinct effect on R&D activities.
Health and safety	Research in health and safety sums up to more than €600m in 2006 and is funded primarily by the BMBF. This is an important source for R&D funding. Health policy (so-called "Health Reform", and on-going project for more than a decade), on the other hand, is clearly oriented towards cutting costs in the health system. Expenses for pharmaceuticals and for medical devices and instruments are one major target in this respect. There is especially pressure on substituting patent protected drugs by alternative generics. R&D performing pharmaceuticals regard this as disadvantageous for performing R&D in Germany.
Environment	Environmental policy is likely to have a positive impact on research and innovation in several industries. The **Renewable Energy Act** (ENE) and the Energy Supply Act (EEG) promote the introduction of new types of energy production by offering terminated and decreasing subsidies. This has positively affected the producers of wind energy machines and solar energy devices, including an increase in R&D in these areas. The EU regulation on the trade in emission certificates is an incentive for energy producer to research into ways of avoiding CO2 emissions through new energy production technologies.
Regional development	Regional development programmes such as Objective 1 and Objective 2 programmes under ERDF co-funding include instruments targeting on R&D and innovation. This is also true for other regional development programmes run by the *Länder*. The federal programmes in East Germany focus a lot on R&D funding (see InnoRegio/Innovative Regional Growth Poles above). There is no overview, however, on the magnitude of these instruments with respect to total R&D funding by governments in Germany. Rough estimations suggest that about a quarter to a third of total public R&D funding for enterprises is provided by the *Länder* (including ERDF programmes) and may thus fall under regional development. R&D funding for HEIs and PSREs by the *Länder* is generally not considered as part of regional development policy, but falls under science policy.
Competition	Competition policy is regarded by many stakeholders and experts as important to spur innovation in a market that long has been dominated by state-owned actors, such as telecommunication, rail transport, energy and postal services. Despite this widespread believe, only little hard evidence is available. Marginal prising policies by regulating authorities (e.g. in the telecommunication and energy markets) may rather result in a cut of investment, including R&D, since these expenses cannot be covered by marginal pricing.
Social security	There is not hint that any of the many social security measures is related to R&D or had a distinct impact on it.

R&D policy instruments at the *Länder* level

Each of the 16 Federal States in Germany run its own R&D programmes. These vary considerably in terms of volume, scope, funding mechanisms, eligibility criteria and target groups. No complete overview on the details (esp. the funding volumes) of these programmes is available. The programmes range from grant programmes for R&D projects and technology programmes to VC programmes, loans for technology diffusion and subsidies for employing young researchers.

The total volume of R&D funding by *Länder* programmes (i.e. outside the institutional funding of public research institutions) is not available, too. It may be estimated - based on various indications in the Federal Report on Research (BMBF 2006) - to amount close to € 1 billion, about half of this sum going to enterprises, the other half to HEIs and PSREs. Compared to the total volume of Federal R&D programmes (excluding DFG and non-profit foundations), which may be estimated at € billion per year, this is a significant but still

Though data on the volume of individual programmes are not readily available, it is fair to estimate that there is no single *Länder* programme in the field of R&D that - in terms of funding volume - comes close to any of the main Federal programmes. Nevertheless, some *Länder* programmes have a significant size, e.g. a biotechnology programme of the State of Baden-Württemberg (€9 million for a perennial period), an aviation research programme of the Free State of Bavaria (€7.7 million for a perennial period) or a micro-system technology programme of the State of Bavaria (€19 million within a ten-year period). The vast majority of *Länder* R&D programmes are of rather small size: the grant programme for collaborative R&D projects of the State of Hesse, to give just one example, awarded a total of €8 million within a ten year period (1996-2005), i.e. less than €1 million per year.

A special situation is Eastern Germany, where Federal States run significant R&D programmes that offer grants for R&D projects conducted by enterprises alone or in co-operation with public research institutions. In Saxony, these programmes provided funding of €0.75 billion within a 15-year period, i.e. €50 million per year on average. The Federal State of Saxony-Anhalt provided grants of €25 million in 2002 for R&D projects. The Free State of Thuringia spent about €20 million per year for a R&D grant programme that support co-operative research projects between enterprises and public research institutions.

Other policies that significantly affect R&D investment levels

There is no empirical information available in order to determine which other types of policy activities have a measurable effect upon the level of R&D investment by either public or private actors. The general debate on innovation obstacles and drivers for innovation in Germany in the past years suggests that the following policies might be of some relevance to R&D expenditure decisions:

1. Education policy: A shortage in high-qualified labour was reported to have significantly affected innovation activities of enterprises and - to a lower extent - research at public research institutions around the year 2000. There is no clear evidence that the level of R&D expenditures suffered from this lack of labour supply significantly, however. A policy responsibility for this shortage may be seen in the low share of tertiary education enrolment in

Germany, especially when it comes to S&T disciplines. Causes for this are often seen in a selective secondary education system which is likely to discriminate children from lower social classes, long duration of study and a high share of college dropouts.

2. Sector specific regulation: Some product or technology specific regulations are often mentioned as hindering research. The most often cited regulation in this respect is the Law on Genetic Engineering. Both industry and public research complain that this regulation impedes research and the use of research results, especially in stem cells research and plant technology (including pesticides and the like).
3. Competition policy: Liberalisation of a number of product markets that previously were dominated by state monopolies is regarded as a stimulus for innovation. Such markets are, for instance, telecommunication, rail transport, energy supply and postal services. The effects of liberalisation in these markets of total R&D expenditures in Germany are - if any - small since these sectors account for only about 2% of total business R&D expenditures.
4. Macroeconomic policy: There are a number of indications that the weak macroeconomic performance of the German economy, i.e. the low dynamics of domestic demand and investment both at the side of private households, governments and private enterprises, restrains decision to engage in innovation. This low dynamics may be attributed to a restrictive macroeconomic policy, putting much emphasis on low inflation and cuts in public investment, as well as a wage policy that results in income shifts from labour to capital. While low domestic demand may be a hampering factor for R&D and innovation in sectors that are strongly oriented towards the domestic market, this is rather unlikely for larger enterprises in the technology sector. They are heavily export oriented, thus low domestic demand may be of little relevance for their innovation decisions while they profit a lot from global market dynamics. Since this firm segment is responsible for the vast majority of business R&D expenditures in Germany, the effect of macroeconomic policy on R&D expenditures may be minor.

5. Coherence between main policy objectives and priorities, and policy instruments

There are no major gaps between the instruments in place, and the challenges and policy objectives, with one exception: While policy clearly has identified the decreasing share of R&D performing SMEs as a major challenge, and consequently adopted a change in this development as a main policy objective, only a few measures are in place that may help non-R&D performing enterprises to take up R&D activities. The ProInno programme consists of an element that targets this group, though the number of enterprises addressed by this sub-measure is fairly low. Within a 4.5 year period from Spring 1999 to Autumn 2003, only 491 projects received funding (see Kulicke et al. 2005: 33). Given the significant number of R&D performing enterprises - almost 30,000 SMEs in Germany from manufacturing and knowledge-intensive business services conduct in-house R&D on a permanent base (see Aschhoff et al. 2006) and another 50,000 SMEs are active in innovation without continuous R&D activities (see Rammer et al. 2006) - the quantitative effect of ProInno on stimulating SMEs to engage in R&D is low.

Other programmes are in principle open to non-R&D performers, though in practice it will turn out to be fairly difficult to receive funding from an R&D programme such as the Thematic R&D programmes, the regional cluster programmes in Eastern Germany, IGF, InnoWatt or military research contracts since all these programmes require a substantial technological capacity from the enterprises to be funded, which is difficult to built up without in-house R&D.

Although there is an on-going debate on whether to introduce an instrument that provided incentives to conduct R&D for a very large group of enterprises - such as a tax credit for R&D - no steps in this direction have been made. In the 1980s, the Federal Government has offered two types of indirect R&D instruments: a tax credit for R&D investment combined with a special tax allowance for R&D expenditures, and subsidies for the R&D personnel costs (both a volume and an incremental variant). Both type of measures ended around 1990. Today, policy makers fear low additionality of such indirect measures and focus on a general reduction in corporate tax rates while reducing the number of exemptions. The introduction of a tax incentive is thus perceived to thwart corporate tax reforms.

6. Policy mix instruments and target groups

The following table provides an overview on the different groups of actors relevant to increasing R&D investment in an economy that are targeted by the various instruments. The table consists of measure from the R&D policy domain only, because measures from other policy domains are too loosely related to R&D in order to make a clear assignment to R&D-related target groups.

The table shows that all routes are addressed by several measures. The two most important target groups are Route 6 (public sector) and Route 2 (R&D performing firms). A particularly important Route is No. 5 (co-operation with public sector institutions). This is the main direction of impact of thematic R&D programmes and a number of other R&D programmes (ProInno, InnoRegio/Innovative Regional Growth Poles, IGF, InnoNet). Limited attention is paid to Route 4 (foreign firms) as a target group in its own right. But German subsidiaries of foreign-owned companies can fully participate in all programmes.

Since about 20 years, high-tech start-ups are another important target group (Route 1), though their share in total R&D funds distributed by R&D policy instruments is low, which just reflects their limited resources for R&D due to their small size.

Table 2: Policy instruments and broad routes to increase R&D investments

Policy categories	**Policy instruments**	**ROUTE 1**: promote establishment of new indigenous R&D-performing firms	**ROUTE 2**: stimulate greater R&D investment in R&D-performing firms	**ROUTE 3**: stimulate R&D investments in firms non-performing R&D	**ROUTE 4**: attract R&D-performing firms from abroad	**ROUTE 5**: increasing extramural R&D carried out in cooperation with public sector	**ROUTE 6**: increase R&D in public sector
R&D Domain							
R&D policy generic	Institutional Funding						X
	DFG						X
	FHprofUnd					X	X
	Non-Profit-Foundations	(X)	(X)				X
	Institutional Reform						X
R&D policy sectoral	IGF	(X)	(X)	(X)		X	(X)
	Military Research Projects	X	X	(X)	(X)	X	X
R&D / Innovation policy – Linkage	Thematic R&D Programmes	X	X	(X)	(X)	X	X
	InnoRegio/Innovative Regional Growth Poles	X [a) b)]	X [a) b)]	(X) [a) b)]	(X) [a) b)]	X	X [b)]
	ProInno	X [a)]	X [a)]	X [a)]	X [a)]	X	X
	InnoNet	(X) [a)]	(X) [a)]			X	X
R&D / Innovation policy – IPR	IPR regulation	X	X	X	X	(X)	X
R&D specific financial and fiscal policy	InnoWatt	X [a) b)]	X [a) b)]	(X) [a) b)]	(X) [a) b)]		
	Exist Seed	X [d)]					
	High-Tech Start-Up Fund	X [a)]			(X)		
	ERP Start-Up Fund	X [a)]	X [a) c)]		(X)		
	ERP Innovation Programme		X		(X)		
R&D specific employment policy	ProInno	X [a)]	X [a)]	X [a)]	(X) [a)]	X	X

a) Size restriction
b) Restricted to specific regions (Eastern Germany)
c) Age restriction
d) Restricted to potential firm founders from HEIs (students, graduates, young researchers)
(X) not primary target group, but eligible for funding

7. Balance within R&D policy mix

In the following, we try to assess the different R&D funding instruments (except *Länder* R&D programmes). The criteria used are a) overall contribution to increase private R&D expenditures, b) impact on specific aspects of the NIS ore R&D performers, c) public attention/attention by policy makers, d) volume of public funding involved, and e) beneficiary of a shift in public funding.

Table 3: Assessment of 'importance' of R&D policy instruments

Instruments	Funding [1)]	Criteria				
		a	b	c	d	e
Institutional Funding	16.7 billion EUR [2)]		XX	XX	XX	
DFG	1.35 billion EUR		XX	XX	X	
FHprofUnd	10 million EUR [3)]		X			
Non-Profit-Foundations	110 million EUR [4)]		XX	XX		
Institutional Reform			XX	XX		
IGF	100 million EUR	X	X	X		
Military Research Project	850 million EUR	X			X	
Thematic Programmes	2.2 billion EUR [4)]	X	XX	X	X	
InnoRegio/Innovative Regional Growth Poles	90 million EUR [5)]	X	X	XX		
ProInno	157 million EUR	X	XX	X		
InnoNet	17.5 million EUR	X	X			
IPR regulation						
InnoWatt	90 million EUR	XX		X		
Exist Seed	13.5 million EUR	X		X		
High-Tech Start-Up Fund	50 million EUR [6)]	XX	X			
ERP Start-Up Fund		XX				
ERP Innovation Programme		XX	X			

1) figures for 2005 (empty boxes: no information available about investment in this programme)
2) figure for 2003 (only funding by Länder for HEIs)
3) figure for 2006
4) figure for 2004
5) included in funding for thematic programmes
6) amount of investment

8. Emergence of R&D policy mix

The current set of R&D policy instruments gradually evolved over time. There is no official information available on the rationale for the policy mix, but there are rationales for the introduction of each individual measure. Since some of these measures have been introduced long time ago, these rationales may be of little relevance to the current need of this programme. In order to understand the current set of R&D policy instruments in Germany at the Federal level, one also has to take into account the governance structure, in particular the type of division of labour in R&D policy among the Federal Ministry of Education and Research (BMBF), the Federal Ministry of Economics and Technology (BMWi) and the *Länder* governments.

Institutional funding of public research institutions out of state budgets has a very long tradition (actually going back to the foundation of Universities). It is the primary field of action of the Federal States and absorbs the vast majority of funds available for science and technology at the side of the *Länder* governments (more than 90% of total budget for science and technology).

The **DFG** was founded in 1951 but dates back to 1920, when the "Need Community of German Science" (*Notgemeinschaft der Deutschen Wissenschaft*) was established. The DFG was from its beginning state-financed and served as an instrument to provide additional funding sources for universities (and later for other public research institutions) besides institutional funding. Among the scientific community, this instrument of a peer review selection of academic research projects and centres of excellence is regarded as an effective and flexible tool. It is a major complement to institutional funding for financing basic research activities and involving young researchers. The DFG is financed jointly by the Federal and the 16 *Länder* governments based on a Framework Agreement in accordance with §91b of the German Constitution. A change in this legal setting would require acceptance of all parties involved.

Among the R&D policy measures in place today that are targeted - at least partly - at enterprises, the **IGF** programme is the oldest one. It was established in 1954 and running since then with little changes, though some amendments. The main rationale of this programme is to stimulate R&D that tackles technology needs typical for SMEs in a particular sector, the costs of such R&D activities being to high to be captured by individual SMEs alone. This collaborative approach to R&D in favour of SMEs developed out of the particular situation in the early 1950s when re-establishing and further strengthening the technological base of SMEs while coping with a lack of financial sources was a real challenge. From then on, a network of institutions developed: non-profit research institutions that organise and conduct R&D in specific sectors (IfGs), public research institutions that co-operate with them in R&D, and an umbrella organisation, the AiF, bringing together the IfGs and managing the programme (as well as some other programmes such as ProInno). The IGF programme is funded by the BMWi.

The **Thematic R&D Programmes** trace back to the foundation of the Federal Ministry for Nuclear Power in 1956, when the first thematic programmes to stimulate

research both by public institutions and private enterprises in areas of eminent public interest. During the 1960s, these thematic programmes advanced from energy technology to areas such as information technology, material technologies, technologies in physics and chemistry, biotechnology etc. The Thematic R&D Programmes are the single most important type of R&D funding in Germany since the 1960s, apart from institutional funding for public research institutions. From the beginning, the main rationale for this type of instrument was the need of public funding for the development of new cutting-edge technologies which is characterised by high uncertainty, high spillovers, high funding needs and rather long periods until commercial application. A main feature of these programmes is the focus on collaborative research in consortia that bring together large companies, SMEs and public research institutions. Owing to the typical duration of 4-6 years of each individual thematic programme, redesigning and prioritising is a permanent process. Consequently, despite their long tradition, the programmes contain a number of new elements, including the processes to select technologies and define new areas of cutting-edge technologies and the way collaborative research can be designed and conducted. Thematic R&D Programmes have traditionally been at the centre of BMBF activities in research policy. In recent years, an increasing number of programmes have been moved to the BMWi, especially after the Federal Elections in 2005.

The **ProInno** programme goes back to a programme for promoting R&D collaborations by SMEs which started in 1981 (called FoKo). This programme had a rather low volume until 1993. From 1994, funding volumes increased considerably, and since 1998, ProInno is the most important R&D programme for SMEs (apart from the Thematic R&D Programmes which show a slightly higher annual volume of R&D funding for SMEs). Funding R&D co-operations is rather popular in German R&D policy since this type of public intervention is perceived to be less exposed to critics on likely market distortions resulting from public interventions (compared to subsidies for single firm projects). The ProInno programme was initially developed and implemented by the BMBF, but moved to BMWi's responsibility in 1998.

The **InnoNet** programme is a small programme that developed out of the experiences made with the predecessor of the ProIno programme, FoKo, and some other perceived challenges. The programme focuses on collaborative R&D projects that primarily involve research at public research institutions, while SMEs focus on development activities close to market introduction of new products. The programme is also intended to direct research at public institutions more towards the technology needs of SMEs. In order to offer a flexible framework for funding such types of projects, InnoNet was launched in 1999. Owing to its specific requirements - collaborative R&D that involves at least four different SMEs and two different public research institutions - and funding mechanisms - there is only public funding available for the public institutions, while SMEs have to contribute own resources - overlaps with other programmes are low. InnoNet is a BMWi programme.

The **InnoWatt** programme, targeting enterprises in Eastern Germany, was established since the early 1990s, but conceptually prolonged a similar, though small programme to support R&D in West-Berlin that was offered by the Federal Government for a long time prior to 1990. The main rationale of this programme was first the need for technological upgrading of enterprises in Eastern Germany. For this purpose, some

other programmes were offered in the early 1990s too, though more focussing on process innovation and near-to-market product innovation activities. Another motive for this programme was to provide funding sources for a larger number of non-profit R&D enterprises in Eastern Germany ("*gemeinnützige Forschungs-GmbHs*"). These enterprises have evolved out of R&D laboratories of combinations in the GDR economy, or sector specialised research institutes. They offer R&D services for other (for-profit) enterprises in their particular sector. In recent years, the programme increasingly focuses on supporting R&D as a way to gain and maintain international competitiveness of East German enterprises. In the mid 1990s, this programme also consisted of a sub-measure that provided subsidies to R&D personnel costs, but this sub-measure ended in 2002. Funding of R&D projects conducted by East German enterprises and by "*gemeinnützige Forschungs-GmbHs*" was a BMWi activity from the very beginning.

The other programmes that target beneficiaries in Eastern Germany (**InnoRegio**, **Innovative Regional Growth Poles**) are rather new and evolved after 1999. A main impulse for starting these programmes came out of the innovation systems literature, that stresses the role of networks among actors in a (regional) innovation system for a possible market success of technologies and innovations. Given the specific situation in Eastern Germany - a rather large public research infrastructure, but only few and predominantly small enterprises with R&D capacities - merging technology capacities from public research with R&D activities in the enterprise sector was perceived as an important way to improve the technological performance of the Eastern German economy. What is more, regional innovation networks should also contribute to achieving a critical mass in research in particular fields of technology. Regional cluster programmes are administered by the BMBF.

The **ERP Innovation Programme** is another long-standing R&D programme. It is managed by the state-owned bank KfW. This bank offers a large number of loan programmes to SMEs and individuals in fields of public interest, such as environmental investment programmes, international development programmes, infrastructure programmes and loan programmes for students to finance their studies. Among this set of loan programmes, the ERP Innovation Programme is a rather small one (currently less than 200 projects per year). The ERP programme focuses on (market) introduction stages of the innovation processes, though loans for R&D activities are offered, too. Within the concert of Federal research and innovation policy measures, the ERP Innovation Programme is located at the near-to-the-market end of the innovation process and primarily provides financing for fixed investment for introducing new products or implementing new processes. Similar programmes are offered by many Federal States, too. The main financing source for the ERP programme is the ERP (European Recovery Programme) Fund, but additional money for financing investment failures and subsidised loans is provided by the BMWi.

The **High-tech start-ups fund** is an example of a measure that was introduced in response to a clear challenge, the retreat of private VC companies from provide financing sources for seed stage investment in technology firms. In order to offer VC financing for very early stages, the Federal government established a new fund, basically funded from Federal sources (plus some funding by four large private companies), that is entitled to invest into newly founded technology enterprises. By doing this, the government departed from its previous policy principle, i.e. to offer

public VC investment only in addition to investment by a private lead investor. This was done under the so-called BTU programme (see below). Until 2000, this policy proofed to be effective and contributed to a dynamic development of the German VC market. The contraction of the market form 2001 onwards changed the situation fundamentally, however. In 2001, the government introduced a new measure for seed financing, the BTU Early Stage programme. But this programme had only a very small volume and was targeted on pre-entry stages of spin-offs from public research. The high-tech start-up fund as well as other Federal VC programmes are in the responsibility of the BMWi.

The **ERP start-up fund** is the predecessor of the BTU programme. This programme goes back to the late 1970s, when the Federal government initiated the first initiatives for funding technology-based start-ups. Its main rationale was to provide funding to young enterprises that have good ideas and technological capabilities, but lack in finance resources. Access to private funding is restricted due to high information asymmetry and low investment volumes. Over the time, public funding for technology-based start-ups was oriented towards VC instruments, in order to develop a liquid market for private investment in such enterprises. In this context, a set of instruments ranging from seed funding for start-ups and co-investment to guarantee and re-financing programmes were established.

The **Exist Seed** programme emerged from a sub-measure of the Exist programme, an initiative to promote entrepreneurship in higher education. The Exist programme initially (i.e. until 2006) was restricted to selected regions. As Exist Seed turned out to be a highly demanded in these regions, the measure was offered to all HEIs in Germany. Since it focuses on individuals that plan to start-up a new enterprise, there is little overlap with other R&D programmes. The Exist programme was implemented by the BMBF, but moved to BMWi in 2006.

The current **IPR regulation** dates back to the 19th century and has been adapted regularly since then. The system is well established and perceived to be effective. The main rationale for IPR is - as anywhere in the world - to offer inventors the opportunity to exclusively appropriate the economic returns of their inventions for a certain period of time, i.e. to restrict to volume of spillovers from new knowledge and technologies. IPR regulation is in the responsibility of the Federal Ministry of Justice.
Institutional reform of public research institutions is an ongoing process since each organisations needs to adapt its internal procedures and structures, and its external relations from time to time to cope with changes in their environment. Both the *Länder* governments and the Federal ministries are engaged in this process which concerns both HEIs and PSREs. The link of such reform with R&D policy is manifold: reforms should contribute to an increased quality of research, increase the utilisation of scale and scope economies through co-operation, improve the access to and transfer of knowledge and technology, and should increase efficiency of research, often by cutting costs.

Summing up the emergence of the set of R&D policy instruments in place today in Germany, one gets the impression that each individual measure has been implemented in the light of a specific challenge or need for this measure, but with little direct consideration of potential co-actions with other, already existing programmes. After a programme has been established, it tends to run for a long time, though regular

adaptations in response to changes in challenges, needs and user requirements take place.

In 2001, the BMWi conducted a "systemic evaluation" of its R&D programmes (ProInno, InnoNet, IGF, InnoWatt) in order to improve the joint effects of these programmes (see Blum et al. 2001). The evaluation expert group proposed a number of recommendations to avoid overlapping of programmes, to learn from the other programmes' experiences, and to target the underlying market failures more directly by each of the programmes. As a result, a redesign to each of the four programmes took place (which also took into account the results of programme evaluations of ProInno, InnoNet and InnoWatt). Nevertheless, each of the four programmes kept its main orientation and structure, and all four programmes are still running.

9. Governance of the policy mix

Each programme is managed by a separate administering agency, so-called "*Projektträger*". These are either public, semi-public or private institutions. There are about 30 such agencies at the Federal level, and at least the same number at the level of Federal States. A large number of them is specialised on specific fields of technology. Most of these originated out of large public research centres that are engaged in research in the respective fields of technology.

While "*Projektträger*" are responsible for managing the programme (e.g. information of potential beneficiaries, assessing proposals, project control, administrative handling of public project funding), the strategic development of policy measures takes place at the responsible ministries, though in close co-operation with "*Projektträger*" and other experts.

There is no formally established co-ordinating body that brings together all of these actors in German research policy. Nevertheless, co-ordination takes place through various mechanisms:

- Co-ordination between research policies of the Federal and the *Länder* governments takes place in joint commissions as well as via informal co-operation at parliamentary level. The *Bundesrat*, the second chamber of the parliament, consists of representatives of the *Länder* governments and has to endorse many laws passed by the first chamber, the *Bundestag*. Formal co-ordination in the field of research and education takes place within the BLK ("*Bund-Länder Kommission"*: the Joint Commission on Education Planning and Research Promotion). This is a permanent body for discussing all questions of education and research promotion of common interest to the Federal Government and *Länder* governments. It submits its recommendations to the Prime Ministers of the *Länder* and to the Federal Chancellor. There is an ongoing debate on redesigning responsibilities between the Federal and the *Länder* level through constitutional reform.

- In the field of science, both the Federal and the *Länder* governments are advised by the "*Wissenschaftsrat"* (Science Council). It is an advisory body that aims to draw up recommendations on the development of higher education institutions, science and the research sector (as regards thematic priorities and institutional structures), and also on the establishment of new universities. The Science Council also directs and carries out evaluations of academic institutions as well as evaluations of Germany's performance in research fields (e.g. economics, mechanical engineering). The Science Council offers a large number of studies and data on its homepage, though almost all of it is only available in German.

On the level of individual policy fields within research policy, co-ordination mainly takes place on an ad-hoc basis among experts from BMBF and BMWi and most often some *Länder* ministries within a certain thematic area. Moreover, in the course of implementing new or adapting existing measures, units from other Federal Ministries (such as Federal Ministry of Finance) may be consulted (according to the relation of their activities to the intended new measure) and are invited to comment on them.

Workshops, expert hearings and external reports and reviews support this co-ordinating process. In 2004 and 2005, informal co-ordination was also supported by the "Partner for Innovation" initiative. During the course of 13 working groups, policy makers and stakeholders came together to develop a joint Action Programme for each of the 13 thematic areas. This activity will be continued under the new Innovation and Growth Council which has been established in May 2006 by the Federal Chancellor. The more informal way of co-ordination is commonly seen as more flexible and efficient than a formalised approach as the latter may cause more bureaucracy and more cumbersome decision making processes.

10. Interactions among policy instruments in place

Analyses of interactions among research policy instruments are extremely rare in Germany. The most prominent example is a systemic evaluation of a set of R&D programmes in 2001 (Blum et al. 2001). However, this analysis is restricted to four programmes with rather similar basic rationales - i.e. funding of R&D co-operation in order to overcome classical disincentives to co-operate, such as high transactions costs, information asymmetries about potential co-operation partners, and high costs of governing IPRs of collaborative research results - and does not take into account the interactions with all other R&D programmes in place.

For all other R&D policy instruments, no evidence on likely positive or negative interaction effects on other instruments is available. Given this lack of information, one depends on speculations and some theoretical reasoning:

- Among a number of R&D policy instruments, one could expect a positive interaction effect as a result from a kind of "succession effect": This will occur when a programme stimulates R&D activities in a specific group of actors, or in a specific field, or of a specific type, which is a kind of precondition for the effective working of another instrument. This may be illustrated by the following example: Increase in institutional funding for HEIs in association with institutional reforms that promote the transfer orientation of research at HEIs, this will produce a higher potential, including a better quality, of spin-off projects. A programme that assists such projects (such as Exist Seed) will work more effective and produce a higher number of promising spin-offs. This may positively influence programmes that provide early stage funding for technology enterprises (such as the high-tech start-up fund). If these programmes produce a higher number of high-tech start-ups, technology programmes (such as the Thematic R&D Programmes) or programmes that support R&D co-operation with public research (such as ProInno, InnoRegio or InnoNet) will profit from a larger and better prepared target group, allowing them to focus on high-quality projects and thus generate higher leverage effects. If these programmes are successful in creating new technologies, programmes that focus on support for commercialisation and market introduction of new technologies (such as the ERP Innovation Programme) will have premises to be successful. A similar effect may be postulated in case of programmes that stimulate enterprises to enter into R&D activities, or conduct R&D in a more intense, more effective or more sophisticated way (which could partially be the case with the ProInno and InnoWatt programme), thus preparing these enterprises for more challenging R&D activities typically to Thematic R&D Programmes.

  Table 4 indicates those pairs of R&D policy instruments for which such type of positive effect is likely to occur, by "+".

Table 4: Assessment of potential effects of an increase in activity of a particular R&D policy instrument on the effect of other R&D policy instruments on the level of R&D expenditures in Germany

	effect upon è	A	B	C	D	E	F	G	H	I	J	K	L

	ê increase in activity												
A	Institutional Funding		-	-	+/-	-	-	-	0	+/-	+/-	0	0
B	DFG	-		+	0	-	-	-	0	-	-	0	0
C	Reform of HEIs/PSREs	-	0		+	+	+	+	0	+	+	0	0
D	Thematic Programmes	-	-	+		0	0	0	0	0	+	+	0
E	InnoRegio/Inn. Reg. Gr. P.	-	-	+	0		0	0	0	+	+	+	0
F	ProInno	-	-	+	0/+	0/+		0	0/+	0	0	+	0
G	IGF/InnoNet	-	-	+	0	0	0		0	0	0	+	0
H	InnoWatt	0	0	0	+/-	-	+/-	0		0	0	+	0
I	Exist Seed	0	0	0	+	+	+	+	+		+	+	0
J	High-tech/ERP Start-up F.	0	0	0	+	+	+	+	+	0		+	0
K	ERP Innovation Progr.	0	0	0	0	0	0	0	0	0	0		0
L	IPR regulation	0	0	+	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+	

+: potentially positive effect; -: potentially negative effect; ±: effect may be either positive or negative

- There are potential negative effects, too. These may occur for example between two programmes that are substitutive in nature (in terms of the type of R&D activity they address), but one programme offering more attractive conditions for the beneficiaries. Such a situation might be the case between the InnoWatt programme and the InnoRegio/Innovative Regional Growth Poles programmes: InnoWatt targets SMEs in Eastern Germany and offers grants for R&D projects. Form an enterprise perspective, InnoRegio offers the same, but demands co-operation with public research institutions and other enterprises. Since the latter is likely to implicate higher transaction costs, it is fair to assume that enterprises will prefer InnoWatt (since the subsidy ratio is practically equal in both types of programmes). An increase in funding volumes of InnoWatt may thus crowd out demand for InnoRegio.

  Another type of negative effects concern the R&D orientation that is associated with a specific R&D policy instrument. DFG funding to HEIs and PSREs, for instance, involves typically basic research activities which are evaluated against the number of publications in international, top-ranked refereed journals. Research that can be successful in this respect is often little application oriented in nature, and thus of little relevance to most enterprises. Increasing DFG funding may shift research activities of public research institutions towards pure scientific research and make them a less attractive, or even less qualified partner for R&D co-operation with enterprises. This may negatively affect all programmes that focus on such types of R&D activities. The same holds true in the opposite case of increasing funding for application-oriented research, will may reduce the capacities for pure scientific research at public institutions, and consequently the demand for pure research grants - or at least the quality of the proposals submitted.

  A similar case is with institutional funding: increasing this source of finance is likely to reduce engagement of public research institutions in acquiring funding

from third parties. Higher institutional funding may, on the other hand, increase the scope and quality of research, which may be advantageous for some other programmes such as technology programmes or spin-off programmes, since it increases the quality of research conducted in public institutions.

Increasing funding for public research institutions through project-based programmes may have negative effects on the level of institutional funding, at least in the current situation of institutional funding of HEIs and PSREs in Germany: since public budgets are under pressure, increased availability of project-based funding may be used as an occasion to cut institutional funding.

- This points to a likely interaction between financial R&D policy instruments and reforms at public research institutions: Since the latter intends to increase external co-operation and raise competitive research, reforms tend to support the effectiveness of project-based R&D programmes by putting pressure on public research institutions to make more use of these funds and to engage more seriously in this type of research, including transfer activities to enterprises.

  No clear statements can be made on the interaction between financial R&D policy instruments and strengthening IPR regulation since these effects will depend on the direction of changes in IPR regulation. Extending IPR regulation in the public sector by assigning IP to the institution (instead of the researcher) will support some of the goals of institutional reform. At the same time, it may complicate R&D co-operation with enterprises because more complex negotiations about IPRs between the public research institution and the enterprise is demanded, which may have negative impacts on the effectiveness of R&D co-operation programmes, e.g. through adverse selection. Widening the scope of IPRs on new fields of technology or processes, or expanding the protection period may help large enterprises that dominate in the market and have resources available for an effective IPR management, while small enterprises may suffer from increased competition by large enterprises over their IP. Programmes that focus on market introduction stages of R&D processes (such as the ERP Innovation Programme) will be likely to profit form a re-enforced IPR regime since this makes it more likely that enterprises with new products (and IPRs on the underlying technologies) will fully appropriate the economic returns from their innovations.

- An extremely difficult area of likely policy mix effects concerns the interaction of R&D policy instruments and other policy areas. Only for some instruments, some potential effects can be identified more or less clearly. One example is financial regulation with respect to investment funds and the taxation of losses and profits from investments in other enterprises on the one hand, and VC programmes on the other. While some regulations that aim at restricting the shift of profits and losses among firm conglomerates in order to save corporate taxes may be wise in their own right, they may have negative effects for some investment models in the VC business. Such regulations may thus reduce private VC investment in technology enterprises and may harm the effectiveness of programmes aiming at developing a liquid private VC market for early stage investment in technology enterprises.

  In the field of macroeconomic policy, there are some speculations on how taxation, interest rates, inflation, public debt and public spending structures, wage

policy etc. may affect R&D expenditures, but no robust findings on the policy effects exist. What is quite clear is that a dynamic macroeconomic environment, i.e. raising demand for goods and services will spur investment decisions, including decisions to invest into R&D. Los corporate taxes will increase the internal funds of enterprises available for investment and could thus raise R&D investment. Whether there is a positive net effect on R&D expenditures will depend on the way the government deals with reduced tax income out of corporate taxes. If this would result - in the most simple and extreme case - in equivalent cuts of public R&D budgets, the net effect will surely be negative. If reduced tax income is compensated by higher taxes from other sources or by debt or by savings in not R&D-related public expenses, net effects could be positive. This example should just illustrate that simple policy mix conclusions can not be derived in this area.

11. References

Aschhoff, B., T. Doherr, B. Ebersberger, B. Peters, C. Rammer, T. Schmidt (2006), Innovation in Germany. Results of the German Innovation Survey 2005, Mannheim: Centre for European Economic Research

Belitz, H., H. Berteit, F. Fleischer, A. Stephan (2001), Staatliche Förderung von Forschung und Entwicklung in der ostdeutschen Wirtschaft - Eine Bilanz, in: *DIW-Wochenbericht* 35/2001, 537-544

Belitz, H., O. Pfirrmann, R. Eschenbach (2002), *Wirkungsanalyse zur Maßnahme "Förderung von innovativen Netzwerken - InnoNet" - Funktionsfähigkeit des Förderinstruments*. Berlin: DIW

Blum, U., H. Berteit, U. Draugelates, A. Kleinknecht, W. Leonhardt, W. Ruhrmann, H. Scheibner, M. Weck (2001), *Systemevaluation der Wirtschaftsintegrierenden Forschungsförderung - Endbericht der Evaluierungskommission*. Berlin: BMWA

BMBF (2006a), *Bundesbericht Forschung 2006*, Berlin: Federal Ministry of Education and Research

BMBF (2006b), *The High-tech Strategy for Germany*, Berlin: Federal Ministry of Education and Research

BMBF, BMWA (2001a), *Informationsgesellschaft Deutschland*, Berlin: Federal Ministry of Education and Research and Federal Ministry of Economics and Labour

BMBF, BMWA (2001b), *Wissen schafft Märkte. Aktionsprogramm der Bundesregierung*, Berlin: Federal Ministry of Education and Research and Federal Ministry of Economics and Labour

BMBF, BMWA, (2004) *Innovationen und Zukunftstechnologien im Mittelstand - High-Tech Masterplan. Eine Initiative der Bundesregierung im Rahmen von "pro mittelstand"*, Berlin: Federal Ministry of Education and Research and Federal Ministry of Economics and Labour

BMWA, BMBF (2002), *Innovationspolitik - Mehr Dynamik für zukunftsfähige Arbeitsplätze*, Berlin: Federal Ministry of Education and Research and Federal Ministry of Economics and Labour

BMWA, BMBF (2003), *Innovationsförderung. Hilfen für Forschung und Entwicklung*, Berlin: Federal Ministry of Education and Research and Federal Ministry of Economics and Labour

BMWA, BMBF (2004), *Informationsgesellschaft Deutschland 2006. Aktionsprogramm der Bundesregierung*, Berlin: Federal Ministry of Education and Research and Federal Ministry of Economics and Labour

Bührer, S., R. Bierhals, T. Heinze, A. Hullmann, T. Studer, R. Erlinghagen, C. Lang (2002), *Die Kompetenzzentren der Nanotechnologie in der Frühphase der Bundesförderung: Ein Bericht der begleitenden Evaluation*. Karlsruhe: Fraunhofer-ISI

Bundesregierung (2006), *Neue Impulse für Innovation und Wachstum. 6 Milliarden Euro-Programm für Forschung und Entwicklung*, Berlin: BMBF

Czarnitzki, D., T. Doherr, A. Fier, G. Licht, C. Rammer (2002), *Öffentliche Förderung der Forschungs- und Innovationsaktivitäten von Unternehmen in Deutschland*, Mannheim: ZEW (= Studien zum deutschen Innovationssystem Nr. 17-2003).

DIW (2001), *Wirksamkeit der Programme zur Förderung von Forschung, Technologie und Innovation für die Entwicklung der ostdeutschen Wirtschaft*, Gutachten in Kooperation mit der SÖSTRA GmbH in Berlin im Auftrag des BMWi. Berlin

DIW (2004), *Evaluation der Maßnahme "Förderung von innovativen Netzwerken - InnoNet". Wirkungsanalyse*. Berlin: Deutsches Institut für Wirtschaftsforschung

Edler, J., P. Boekholt, H.-M. Binder (eds.) (2001), *Internationalisierungsstrategien in der Wissenschafts- und Forschungspolitik: Best Practices im internationalen Vergleich. Studie für das Bundesministerium für Bildung und Forschung (BMBF). In Zusammenarbeit mit Technopolis BV,* Amsterdam. Karlsruhe: Fraunhofer-ISI

Eickelpasch, A., I. Pfeiffer (2004), InnoRegio: Unternehmen beurteilen die Wirkung des Förderprogramms insgesamt positiv. *DIW-Wochenbericht* 23/04

Fier, A. (2002), *Staatliche Förderung von industrieller Forschung in Deutschland - Eine empirische Wirkungsanalyse der direkten Projektförderung des Bundes*, Baden-Baden: Nomos (= ZEW Wirtschaftsanalysen 62)

Fier, A., D. Heger, K. Hussinger (2005), Die Wirkungsanalyse staatlicher Förderprogramme durch den Einsatz von Matching- und Selektionsmodellen am Beispiel der Fertigungstechnik, in: Engel, D., *Mittelstandsfinanzierung, Basel II und die Wirkung öffentlicher und privater Kapitalbereitstellung*, Veröffentlichung des Round Table Mittelstandes Bd. 5, Berlin

Koschatzky, K. V. Lo (2005), *Innovationspolitik in den neuen Ländern. Bestandsaufnahme und Gestaltungsmöglichkeiten*, Stuttgart: Fraunhofer IRB Verlag

Kulicke, M., J. Görisch, T. Stahlecker (2002), *Erfahrungen aus EXIST - Querschau über die einzelnen Projekte*, Bonn: BMBF

Kulicke, M., S. Bührer, V. Lo (2005a), *Untersuchung der Wirksamkeit von PRO INNO - PROgramm INNOvationskomeptenz mittelständischer Unternehmen. Modul 1: Einschätzung der Ergebnisse des Programms PRO INNO*. Stuttgart: Fraunhofer IRB Verlag

Kulicke, M., S. Bührer, V. Lo (2005b), *Untersuchung der Wirksamkeit von PRO INNO - PROgramm INNOvationskomeptenz mittelständischer Unternehmen. Modul 2: Analyse von in den Jahren 2001/2002 abgeschlossenen FuE-Kooperationsprojekten*. Karlsruhe: Fraunhofer-ISI

Legler, H., B. Gehrke (2006), *Bericht zur technologischen Leistungsfähigkeit Deutschlands 2006*. Berlin: BMBF

Meyer-Krahmer, F. (2001), The German Innovation System, in: P. Larédo, P. Mustar (eds), *Research and Innovation Policies in the New Global Economy. An International Comparative Analysis*, Cheltenham, Northampton: Edward Elgar, 205-252

Rammer, C., W. Polt, J. Egeln, G. Licht, A. Schibany (2004*), Internationale Trends der Forschungs- und Innovationspolitik. Fällt Deutschland zurück?* Baden-Baden: Nomos (= ZEW Wirtschaftsanalysen Band 73).

Schmoch, U., G. Licht, M. Reinhard (eds.) (2000*), Wissens- und Technologietransfer in Deutschland*, Stuttgart: Fraunhofer IRB Verlag

Stifterverband (2006), FuE-Datenreport 2005/06. *Forschung und Entwicklung in der Wirtschaft. Ausgewählte Tabellen und Grafiken zum Bericht über die FuE-Erhebungen 2003 und 2004*, Essen: Wissenschaftsstatistik gGmbH im Stifterverband für die Deutsche Wissenschaft