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Analysis of policy mixes to foster R&D investment and to contribute to the ERA

Germany

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Executive Summary

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. The report aims at supporting the mutual learning process and the monitoring of Member States efforts. The main objective is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals, with particular focus on the national R&D investments targets and on the realisation and better governance of the European Research Area. This report is building on the analytical country reports 2008 and on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

Germany has a highly developed and well functioning research system. Measured in terms of R&D expenditure, it has the largest research system in the EU with €61.4 billion per year (2007). It contributes significantly to EU resource mobilisation, being responsible for more than 27% of aggregate EU-27 R&D expenditure. R&D intensity (measured as a percentage of GDP) stood at 2.53% in 2007, which is significantly above the EU average of 1.83%. This share is fairly stable since many years. Political responsibility for research policy and funding is shared between the Federal Government and the 16 state (Länder) governments.

The need for Germany to position itself at the forefront of scientific and technological progress in order to foster future prosperity and competitiveness has always been emphasised in policy documents. “Pressing ahead with information society and innovation”, which includes the strengthening of R&D and the 3% target in relation to GDP by 2010, is one of the six reform priorities of the National Reform Programmes 2005-2008 and 2008-2010. This priority further covers the strengthening the education system and the promotion of innovation. The main focus of the growth strategy in the last five years has been on structural reforms in particular of the labour market in order to face the upcoming challenges and demographic changes.

The German research and innovation system is characterised by a substantial level of R&D investment and the share of business is high and increasing. However, the systems stability and maturity make it difficult to surmount the current 2.5% R&D intensity and to reach the national commitment to the 3% target, both on the public and the private side. The main barriers are the difficulties encountered to implement significant budget increases due to co-ordination problems and constrained public budgets, a stable medium-high tech dominated structure of private knowledge demand, a below EU average financing of new R&D performers which becomes problematic in this context and, human resource bottlenecks that limit the R&D capacities of firms and other research actors.

Enhancing the mobilisation of public resources is regarded as an important challenge for the German research system, which has been increasingly addressed since 2006. However, significant increases are complicated to agree and organise in a federal

system with distributed responsibilities and have also been hampered by general government budget constraints in particular at the states' level, as acknowledged in the National Reform Programmes.

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Difficulty of significant budget increases due to co-ordination problems and constrained public budgets	Significantly increased volume of federal financial resources, facilitated by a government budget close to balance in 2008, and commitment of states to sustained increases, but public resource mobilisation remains insufficient to meet the 1% Lisbon target. Recently, R&D has only benefited to a limited extent from the economic recovery programmes.
Below EU average financing of new R&D performers	After reorganisation of instruments, the new law on venture capital tries to improve framework conditions, but effects may be limited.
Stable less high tech oriented structure of private knowledge demand	High Tech Strategy attempts to address this issue, but still follows to a large extent a "strengthening the strengths" approach. The profile of the R&D measures in the recovery package is largely fitted to sustain the current knowledge demand structure.
Human resource limits to increasing R&D capacities of firms	Implementation of recent human resource related measures like the Pact for Higher Education and the Qualification Initiative might come too late to fully circumvent this bottleneck

The policy mix has contributed to significant resource increases, although the extent of the leverage on private R&D is uncertain and probably limited. The main components are targeted at increased and excellent public R&D, enhanced public-private R&D collaboration and the increase of R&D in existing firms. For reaching 3% in 2010, further increases by more than €6bn each in 2009 and 2010 would be needed, which are currently not in sight neither on the public nor on the private side. With regard to the reasons for this insufficient progress, significant increases of R&D investments of the states appear to be particularly problematic, although recent improvements have been noticed. However, no particular imbalance in the policy mix could be identified. It should be noted that some of the barriers, in particular those related to the structure of knowledge demand, are difficult to address by policies.

Main policy risks relate to limited leverage effects of recent policies, e.g. of the new law on venture capital, a too slow progress in human resource related improvements and a status quo bias of the R&D related measures in the economic recovery package which stabilises the current structure of private R&D demand dominated by medium-high tech manufacturing, which accounts for nearly two thirds of BERD. Correspondingly, the share of high-tech manufacturing in BERD is lower than the EU average, and a further risk is seen in the shrinking number of firms in R&D-intensive sectors and the rise of imports of R&D-intensive inputs in certain fields such as ICT, electronics and media.

Enhancing European and international collaborative research is one of the political targets of the German Federal Government and is understood as a crucial factor of success for all appropriate actors.

The increased importance of the European Research Area for national policies is acknowledged by research policy makers, e.g. in the High-Tech Strategy and the Internationalisation Strategy. German research institutes and companies are

mobilised and encouraged to actively participate in the European Framework Programmes, with support and information provided.

	Short assessment of its importance in the ERA policy mix	**Key characteristics of policies**
Labour market for researchers	• Human resources are playing an increasingly important role within public R&D related policies. • There is a wide range of inward and outward mobility initiatives in Germany to increase international linkages.	• Policy focus on attracting excellent foreign students and researchers. • A number of initiatives have been set up to take this into account: e.g. in the NRP 2008-10, in the Pact for Research and Innovation, and the Immigration Act as a supporting measure. • In the NRP 2008-10 there are measures of the Länder included, which are aimed at promoting the mobility of researchers.
Governance of research infrastructures	• Germany operates a significant number of large infrastructures open to worldwide cooperation, mainly through its Helmholtz Research Centres.	• Several projects of the ESFRI-roadmap are being coordinated by Helmholtz centres. International cooperation is recognized to be a decisive factor in conducting research at the highest level and to produce results of global significance.
Autonomy of research institutions	• The German Länder have strong competences in science policy, especially with regard to the financing and governance of public universities.	• Since they finance the bulk of the public universities' expenses, their overall influence on higher education is considerable.
Opening up of national research programmes	• Increasingly important, with focus on improved international collaboration in research and ensuring that Germany becomes a leading research location.	• International collaborative research work is one of the political targets of the German Federal Government and is understood as a crucial factor of success for all appropriate actors. • Germany is heavily involved in most ERA-related partnerships and actions and German research actors are participating in all ERA initiatives.

Germany is heavily involved in most ERA-related partnerships and actions and German research actors are participating in all ERA initiatives. Furthermore, Germany is heavily involved in existing international infrastructures, often as founding member, although an explicit strategy on infrastructures remains to be developed. Also several projects of the ESFRI-roadmap are being coordinated by German research institutions and supported by policy makers.

Historically Germany was – and by and large remains – among the attractive labour markets for researchers in Europe. In addition, policy attention to remain an attractive labour market for German and foreign researchers has grown in recent years. Beyond some steps to remove formal constraints like the restrictions for labour migration for nationals from new EU Member States and third countries, concrete policy measure and regulations to promote attractiveness for non-national researchers are still rare. Although until recently an explicit policy strategy has been lacking, the German policy mix contains a range of elements with regard to the opening up and co-ordination of research programmes. Due to its size and the philosophy to influence European initiatives, Germany participates strongly in multilateral joint initiatives like ERA-NETS or Art. 169. Bilateral initiatives which go beyond traditional mobility-oriented bilateral co-operation measures centre on neighbour countries like France, Austria and Switzerland.

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1 Introduction

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs.[1] This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. For the period 2008 to 2010, this focus is confirmed as main policy challenge and the need for more rapid progress towards establishing the European Research Area, including meeting the collective EU target of raising research investment to 3 % of GDP, is emphasised.

A central task of ERAWATCH is the production of analytical country reports to support the mutual learning process and the monitoring of Member States' efforts in the context of the Lisbon Strategy and the ambition to develop the European Research Area (ERA). The first series of these reports was produced in 2008 and focused on characterising and assessing the performance of national research systems and related policies in a comparable manner. In order to do so, the system analysis focused on key processes relevant for system performance. Four policy-relevant domains of the research system have been distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The analysis within each domain has been guided by a set of generic "challenges", common to all research systems, which reflect possible bottlenecks, system failures and market failures which a research system has to cope with. The analysis of the ERA dimension still remained exploratory.

The country reports 2009 build and extend on this analysis by focusing on policy mixes. Research policies can be a lever for economic growth, if they are tailored to the needs of a knowledge-based economy suited to the country and appropriately co-ordinated with other knowledge triangle policies. The policy focus is threefold:

- An updated analysis and assessment of recent research policies.
- An analysis and assessment of the evolution of national policy mixes towards Lisbon R&D investment goals. Particular attention is paid to policies fostering private R&D and addressing its barriers.
- An analysis and assessment of the contribution of national policies to the realisation of the ERA. Beyond contributing to national policy goals, which remains an important policy context, ERA-related policies can contribute to a better European level performance by fostering, in various ways, efficient resource allocation in Europe.

[1] COM(2007) 803 final, "INTEGRATED GUIDELINES FOR GROWTH AND JOBS (2008-2010)", http://ec.europa.eu/growthandjobs/pdf/european-dimension-200712-annual-progress-report/200712-annual-report-integrated-guidelines_en.pdf

2 Characteristics of the national research system and assessment of recent policy changes

2.1 Structure of the national research system and its governance

Measured in terms of R&D expenditure, Germany has the largest research system in the EU. It spends €61.42 billion per year (2007)[2] on R&D. It contributes significantly to EU resource mobilisation, being responsible for more than 27% of aggregate EU-27 R&D expenditure. R&D intensity (measured as a percentage of GDP) stood at 2.53% in 2007, which is significantly above the EU average of 1.83% (see also Table 8 in section 3.4). This share is fairly stable since many years.

Main actors and institutions in research governance

Due to the federal structure of the German political system, political responsibility for research policy and funding is shared between the Federal Government and the 16 state (Länder) governments (see figure 2 below). Most importantly, the states have the constitutional right to legislate on education, including universities, and they apply a range of programmes in research and in innovation policy. As a consequence, nearly 50% of public R&D expenditures are financed by the states.

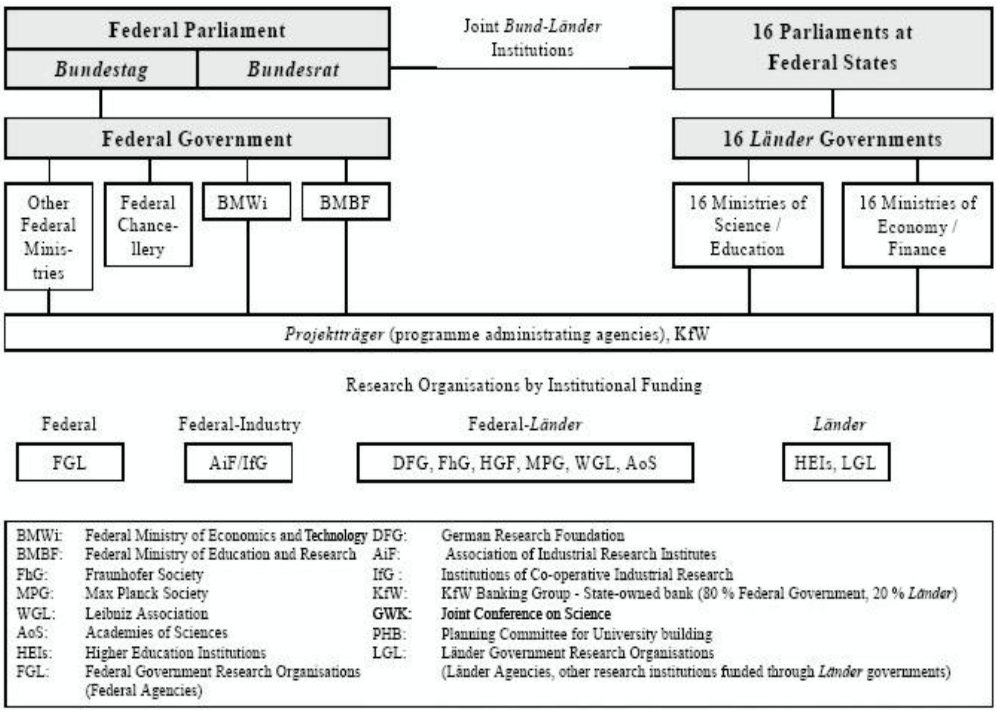
At the Federal level, the BMBF (Federal Ministry of Education and Research) has the main responsibility for research policy. The BMWi (Federal Ministry of Economics and Technology) is responsible for technology policy and some areas of R&D policy. Its current remit comprises not only SME-oriented indirect measures and energy research, but also aerospace and transport research, business R&D and patent issues. Each sectoral ministry has its own research institute(s). The German Parliament has a permanent Committee on Education, Research and Technology Assessment and has to approve the research budget. At the state level, responsibility is usually shared between the science and education ministry and the economics ministry. The main body for coordination of research policy between federal and state governments is the Joint Science Conference (GWK).

Unlike in other countries, there is no strategic policy council to coordinate research and/ or innovation policies. Some aspects of the work of a strategic council for research policy are performed by the German Science Council (Wissenschaftsrat), a joint institution with representatives from both federal and state levels, whose main function is to evaluate and advise on the development of higher education institutions, science and the research sector.

The Deutsche Forschungsgemeinschaft (German Research Foundation, DFG) is the central funding agency for fundamental research in Germany, complementing the institutional funding for basic research with project-type funding. Most publicly funded R&D programmes are administered and managed by a range of implementation agencies (“Projekttraeger”), which are mostly located in large research centres. The central concern of the German Federation of Industrial Research Associations "Otto von Guericke" (AiF) is the promotion of applied R&D for the benefit of small and medium-sized enterprises.

[2] If not referenced otherwise, all quantitative indicators are based on Eurostat data.

Figure 1: Overview of the governance structure of the German research system



Source: ERAWATCH Research Inventory,
http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=35&countryCode=DE&parentID=34

Main research performer groups

Private R&D performers are responsible for 69.9% (2007) of the German R&D expenditures. An important part comes from multinational enterprises. Private R&D performers are politically often represented by the "*Stifterverband für die deutsche Wissenschaft*" (an association of mainly private science-funding bodies).

The nearly 350 universities form the backbone of the German public research system (ERAWATCH Research Inventory, 2008), performing 16.2% (2007) of R&D if measured in expenditures. The German Rectors' Conference (HRK) is the umbrella organisation.

In addition, there are four important private not for profit non-university research organisations institutionally funded by the governments:

1. The MPG (Max Planck Society) currently maintains 80 institutes, research units, and working groups mainly in the field of basic research.
2. The FhG (Fraunhofer Society) offers scientific and technical expertise on the market for research and development services, in particular for SME.
3. The HGF (Helmholtz Association) is Germany's largest scientific research community. It shall perform research which contributes substantially to answering the major challenges facing science, society and industry.
4. The WGL (Leibniz Society) is working at the interface of problem-oriented basic research and applied research.

Another relevant block of public research performers consists of Government agencies and institutes performing research, which have organised themselves under the umbrella of "AG Ressortforschung". All public or publicly funded research organisations together perform 13.9% (2007) of the total R&D.

2.2 Summary of strengths and weaknesses of the research system

The analysis in this section is based on the ERAWATCH Analytical Country Reports 2008 which characterised and assessed the performance of the national research systems. In order to do so, the system analysis focused on key processes relevant for system performance. Four policy-relevant domains of the research system have been distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The analysis within each domain has been guided by a set of generic "challenges", common to all research systems, which reflect possible bottlenecks, system failures and market failures a research system has to cope with. The Analytical Country Report 2008 for Germany (Nill and Grablowitz, 2009) can be found on the ERAWATCH web site.

Table 1: Summary assessment of strengths and weaknesses of the national research system

Domain	Challenge	Assessment of system strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	Well established justification in terms of preserving economic competitiveness through S&T did not prevent declining share of R&D expenses in general budget
	Securing long-term investment in research	Stable mechanisms to ensure long-term research funding, but multi-level negotiations for increases are time-consuming and require political majorities difficult to achieve
	Dealing with barriers to private R&D investment	The two-thirds share of private R&D funding, sustained by multinational firms, meets Lisbon objectives
	Providing qualified human resources	Functioning mechanisms for the provision of a strong human resource base for R&D with slowly expanding S&T graduate basis and increased attractiveness of research careers
Knowledge demand	Identifying the drivers of knowledge demand	Demand signals from classical industries well perceived by policies, but demand signals outside of these or international demand signals not well addressed
	Co-ordinating and channelling knowledge demands	Strong R&D programme basis enables a flexible response to changes in demand
	Monitoring demand fulfilment	Well established evaluation mechanisms
Knowledge production	Improving quality and excellence of knowledge production	Mechanisms in place to enhance scientific excellence of public research through DFG and Science Council. However, the rigidity of the public research system, which is strongly geared towards traditional scientific disciplines, makes it difficult to adapt to cross-cutting opportunities
	Improving exploitability of knowledge	Strong focus on research closely linked to the economy's strengths
Knowledge circulation	Facilitating circulation between different research sectors	High profile of knowledge circulation measures
	Profiting from international knowledge	Number of measures and institutions in place to ensure access to international knowledge
	Enhancing the absorptive capacity of knowledge users	Broad R&D base in the private sector ensuring good absorptive capacity, but weak dynamics with regard to new private research performers and S&T graduates

Germany has a highly developed and well functioning research system. In each of the main domains there are strong system responses to the domain challenges (see also the summary assessment table). Very often the responses take the form of quite stable institutional arrangements, such as the role of the German Science Foundation and the German Science Council in enhancing quality and excellence of knowledge production, or the Fraunhofer Society and the AIF in enhancing knowledge circulation to the economic sector. Any remaining weaknesses are mostly related to the adaptation and enhancement of the changes being put in place, whether this is the extent of increases in financial resources or addressing signals of cross-cutting new demand and new scientific opportunities. They are partly a reflection of the strength of the established system responses.

The governance structure reflects the high level of development and differentiation of the German research system (see also the related positive appraisal of the German innovation governance by INNO-Policy TrendChart, 2007). The only area in which system weaknesses are closely related to the governance structure as such is the complicated co-ordination of resource mobilisation in a federal system with shared responsibilities.

2.3 Analysis of recent policy changes since 2008

The contribution of research and research policies to Lisbon goals (as well as to other societal objectives) goes beyond the fostering of R&D investment. It is therefore important to also analyse how other remaining shortcomings or weaknesses of the research system are addressed by the research policy mix. The focus of the section is on the analysis of main recent policy changes which may have a relevant impact on the four policy-related domains.

2.3.1 Resource mobilisation

Table 2: Main policy changes in the resource mobilisation domain

Challenges	Main Policy Changes 2008/2009
Justifying resource provision for research activities	• Create a stronger leverage in terms of employment and economic growth via the production and distribution of knowledge • Meet the agreed 3% goal of EU's Lisbon strategy
Securing long term investments in research	• Implementation and enhancement of the "Six Billion Euro Programme for R&D" in the 2009 Federal budget
Dealing with uncertain returns and other barriers to private R&D	• Implementation and enhancement of the "Six Billion Euro Programme for R&D" in the 2009 Federal budget • Support of private R&D by economic recovery programmes • Law on Venture Capital
Providing qualified human resources for R&D	• By promoting top-class university research within the framework of the Initiative for Excellence, the Federal Government is aiming to establish internationally visible research beacons in Germany

The "Six Billion Euro Programme for R&D" for the period 2006 to 2009 continues to be implemented and has been enhanced in the government budgets for 2008 and 2009. What can be indeed observed is that after a period of stagnation in real terms, federal public R&D funding has increased significantly, both for institutional and

project funding. One expected impact is the mobilisation of additional R&D investment from business. To this end, parts of the additional budget are to be channelled into industry, in particular SMEs (for details see sections 3.3 and 3.4).

The two economic recovery programmes of October 2008 and early 2009 provided additional resources for R&D, too, although they constitute a minor part of the total programmes (for details see section 3.4).

Another measure which may leverage *private R&D* is the Law on the Modernisation of Framework Conditions for Private Equity of end of June 2008 (see section 3.3.2).

2.3.2 Knowledge demand

Table 3: Main policy changes in the knowledge demand domain

Challenges	Main Policy Changes 2008/2009
Identifying the drivers of knowledge demand	• Increasing global competition and decreasing importance of Germany as regards the production of scientific results and innovations in some sectors • Weak links between (basic) research and innovation / innovative companies
Co-ordinating and channelling knowledge demands	• Implementation of High-Tech Strategy, e.g. Master Plan Environmental Technologies
Monitoring demand fulfilment	• The implementation of the High-Tech Strategy will be reviewed on a regular basis

The most notable recent policy initiative with implications for R&D demand articulation remains the implementation of the federal government's High-Tech Strategy, launched in August 2006 (for more details see section 3.3 and Grablowitz and Nill, 2008). Recent examples of thematic measures implemented are:

- the "Master Plan Environmental Technologies" jointly prepared by research and environment ministries and adopted by the Government in November 2008, focusing in a first step on water, resources and climate change, and
- the Innovation alliance "Lithium Ion Battery" concluded early 2009 for which 360m shall be provided by 60 private and academic partners, supported by 60m public funds from the second economic recovery programme.

2.3.3 Knowledge production

End of July 2008 principles of a new "freedom of science law" targeted at public research organisations have been presented by BMBF. The aim is to move towards global budgets, to give more freedom to MPG, HLG and FhG in using the money in order to keep best scientists and increase efficiency and to reduce the necessary approval stages for co-operations. However, no agreement on a law has been reached yet; therefore a step-wise approach is chosen with the aim of implementing steps which are feasible without law already in the 2009 government budget and its implementation procedures. The success of this endeavour remains to be seen.

Subsequent to a positive interim assessment, federal and states' science ministers have agreed in 2008 to extend the Pact for Research and Innovation until 2015. In the Pact they commit to sustained resource increases for public research organisations of 5% per year in exchange for reforms. The monitoring report 2008

highlights visible progress on reducing the segmentation of the science system and increasing co-operation with universities (GWK, 2008b). It should be noted, however, that no independent evaluation of the Pact has been conducted so far. The main research policy objectives for the period 2011 to 2015 are a dynamic development of the science system, performance increases through networking, new strategies for international co-operation, sustained partnerships between science and economy and the acquisition of the best talents for German science.

It has also been decided by the federal and states' heads of government in October 2008 to continue the "Initiative for Excellence", which is mainly targeted at the quality of research at universities (see also section 3.3.1 and 3.3.2). An agreement was reached in June 2009 on an additional budget of €2.7bn to span until 2017.

As part of the German High-Tech Strategy, a new "Clusters of excellence" (Spitzencluster) initiative is being implemented by the Federal Ministry of Education and Research. The competition is open to all scientific and technological fields in order to single out Germany's top cutting-edge clusters for awards and contribution to funding. Three competition rounds are foreseen, in each of which up to five clusters are selected. The funding shall include €60bn by the BMBF, €40-50bn by the *Länder* and at least €60-90bn by industry (GWK, 2008a). This shall enable these clusters to boost their profile, eliminate impediments to their strategic development and grow into internationally attractive centres. In August 2008 the first five clusters have been selected in a two step process out of 38 applications:

- Forum Organic Electronics in the region Rhine-Neckar
- Cool Silicon – Energy Efficiency Innovations from Silicon Saxony
- Solar valley Middle Germany
- Aerospace cluster region Hamburg
- Biotechnology cluster "cell and molecule based medicine in the region Rhine-Neckar" (see www.spitzencluster.de for more details)

The focus in the selection process of an independent committee led by the president of the new German Academy of Technology Sciences was on strengthening and better commercial utilisation of existing strengths, including substantial financial contributions by the private sector. Hence it is not a surprise that the first five winners are rather clearly linked to established innovation fields. A second round was started in January 2009 which shall lead to the selection of up to five clusters early 2010.

Table 4: Main policy changes in the knowledge production domain

Challenges	Main Policy Changes
Improving quality and excellence of knowledge production	• Principles for a new law on and first steps towards more freedom for public research organisations • Agreement on extension of Pact for Research and Innovation and Initiative for Excellence
Ensuring exploitability of knowledge production	• Implementation of Cluster of Excellence initiative

2.3.4 Knowledge circulation

In February 2008 the "Strategy of the Federal Government for the internationalization of science and research" was adopted (BMBF, 2008a, for details see section 4.5). New measures proposed include improving mobility of young researchers, improving co-ordination of national, regional and international research programmes in

complementary areas, and the promotion of the definition of an aligned and coordinated research agenda in international organisations. The strategy shall be evaluated by independent experts every three to five years. Another characteristic is regional and thematic focusing of strategies and measures. The country under focus from 2008 onwards is India. Two important topics of bilateral co-operation are nanosciences and environmental technologies.

Since July 2008 there is a "Central Innovation Programme for SMEs" (ZIM) of the BMWi (for a detailed analysis of the rationale see Rammer, 2008). It is intended to be the core programme for open market-oriented technology support for firms of the *Mittelstand* (with up to 500 employees) and replaces existing SME programmes like InnoWatt and ProInno. It runs until end of 2013 and covers co-operation between SME and research organisations, network projects between SME and single projects. To channel resource increases of €0,9bn as part of the second recovery programme, which nearly double the programme volume (BMBF, 2009), for a period of two years the ZIM has also been opened for firms up to 1000 employees. It remains to be seen to which extent this simpler funding tool can also attract new SME into research which is one of the intentions.

Further it is worth mentioning with regard to the enhancement of absorptive capacity that since early 2008 there is a new framework of the federal Government for lifelong learning, the "Qualification Initiative Advancement through Education". One of its initiatives targets at attracting more women into science and engineering professions. However, competencies for lifelong learning are mainly with the Länder and the social partners, which has limited effectiveness up to now (INNO-Policy TrendChart, 2007). The initiative can only be appraised when implementation steps are specified. Political agreement with the Länder on the main general goals and their contributions has been reached in October 2008. In March 2009, federal grant-based support for achieving non-academic qualifications ("Meister-BAöG") has been enhanced.

Table 5: Main policy changes in the knowledge circulation domain

Challenges	Main Policy Changes
Facilitating knowledge circulation between university, PRO and business sectors	• Implementation of Cluster of Excellence initiative (see 2.3.3) • Central Innovation Programme for SMEs
Profiting from access to international knowledge	• Federal Government strategy for the internationalisation of science and research
Absorptive capacity of knowledge users	• Central Innovation Programme for SMEs • Federal Qualification Initiative

2.4 Assessment of main policy-related opportunities and risks related to knowledge demand and knowledge production

Following the analysis in the previous section, this section assesses whether the recent policy changes respond to identified system weaknesses and take into account identified strengths.

It is worth noting that despite the increased funding volume, public resource mobilisation seems to fall short of the German 3% Lisbon target for 2010. Given the described barriers to private R&D, it remains to see if the public funding increase intended to leverage private R&D and public-private R&D collaboration will lead to further increases (for a detailed analysis see sections 3.3 and 3.4).

In the domain of knowledge production, new initiatives like the Clusters of Excellence rather strengthen existing strengths of the German system. It remains to be seen if the positive interim assessment of results of the Pact for Research and Innovation with regard to responses to the problem of segmentation ("Versäulung") stabilises so that also this rather soft implementation process would turn into a policy opportunity.

Table 6: Summary of main policy related opportunities and risks

Domain	Main policy related opportunities	Main policy-related risks
Resource mobilisation	• Increased volume of federal resource mobilisation through implementation of the "Six billion Euro programme"	• Public resource mobilisation remains insufficient to meet the Lisbon target • Private resource mobilisation might not respond to increased incentives to the extent anticipated
Knowledge demand	-	-
Knowledge production	• Further strengthening of exploitability of knowledge by additional cluster approaches	-
Knowledge circulation	• Internationalisation strategy provides framework for benefiting from international knowledge	• Policy measures too strongly oriented on knowledge circulation towards established firms

Recent policies tackle all three knowledge circulation challenges and further strengthen existing strengths. Despite new measures tackling also absorptive capacity, it is still unclear to which extent they are able to address the main weakness with regard to increasing the private research base (see section 3.3).

3 National policy mixes towards the Lisbon R&D investment goals

The aim of this chapter is to deepen the analysis of national policy mixes with a focus on public and in particular private R&D investment. The Lisbon strategy emphasises an EU overall resource mobilisation objective for 2010 of 3% of GDP of which two thirds should come from private investment. R&D investment is seen as important yardstick for the capacity of an economy to turn the results of science and research into the commercially viable production of goods and services and hence knowledge into growth. Corresponding investment policies are mainly pursued at national level and determined with a national focus.

The chapter is structured around five questions:

1. What are the specific barriers in the country that prevent reaching the Lisbon goal? What barriers exist in the country to prevent reaching the specific targets, particularly related to the private sector R&D investments?
2. Given the above, what are the policy objectives and goals of the government that aim to tackle these barriers?
3. What Policy Mix routes are chosen to address the barriers and which specific instruments and programmes are in operation to implement these policies?
4. What have been the achievements in reaching the above mentioned R&D investment objectives and goals?

5. What are the reasons for not reaching the objectives, adaptation of the goals?

The chapter aims to capture the main dimensions of the national policies with an emphasis on private R&D investment. The chosen perspective of looking at investments in R&D is the concept of Policy Mixes. The analysis and assessment follows a stepwise approach following the five questions mentioned above.

3.1 Barriers in the research system for the achievement of R&D investment objectives

Enhancing the mobilisation of public resources is regarded as an important challenge for the German research system (BMBF, 2006, Rammer, 2007), which has been increasingly addressed since 2006. However, significant increases are complicated to agree and organise in a federal system with distributed responsibilities and have also been hampered by general government budget constraints in particular at the states' level, as acknowledged in the National Reform Programmes (Bundesregierung, 2005, 2008).

The performance of the system with regard to the overcoming of barriers to private R&D is often viewed as strength of the German research system (e.g. BMBF, 2006). The only area in which Germany appears to perform increasingly below EU average is the availability of early-stage venture capital, of which the share in GDP has continuously declined between 1999 and 2006, then only reaching 0.011% (INNO-Policy TrendChart, 2008). While for established sectors, this has been compensated by the strength of other innovation financing mechanisms, this does not hold for new sectors. And in fact the main challenges referred to with regard to business R&D (e.g. Rammer, 2007) tend to be related to the structure of private R&D demand and to limits to the increase of absorptive capacity.

Private R&D demand continues to be dominated by medium-high tech manufacturing, which accounts for nearly two thirds of BERD. The even increasing orientation of private R&D demand towards the automotive sector, which according to Stifterverband (2008) provides 39.6% of private R&D (2007), is perceived as a weakness in the light of the expected growth in demand in other areas of the world and possible future relocations of production (BMBF, 2006). Correspondingly, the share of high-tech manufacturing in BERD is much lower than the EU average, and also rather stable. A further risk is seen in the shrinking number of firms in R&D-intensive sectors and the rise of imports of R&D-intensive inputs in certain fields such as ICT, electronics and media (BMBF, 2006). The share of BERD performed in the service sectors - which was 9.4% in 2006 - is growing but still among the lowest in the EU. This may be due in part to limited outsourcing from the manufacturing sector.

Absorptive capacity of knowledge users is a traditional strength, but its weak dynamics with regard to new private research performers and S&T graduates may constrain additional private resource mobilisation. While S&T graduates have increased recently, for some time the total number of SMEs conducting their own R&D on a permanent basis has been stagnating or even shrinking (Rammer, 2007).

3.2 Policy objectives to address the above barriers to R&D investment and recent policy changes

The current German coalition government, comprising the Christian Democratic and the Social Democratic parties, has given high priority to achieve the target of R&D

expenditure reaching 3% of GDP by 2010. It has confirmed this goal in the National Reform Programme (Bundesregierung, 2005) and its continuation 2008-2010. The contribution of the states to achieve the goal was confirmed in a joint declaration of Federal level and the states (GWK, 2008a). There is no explicit public/ private split of the investment goal, although the existing one third/ two third split is implicitly assumed to continue in the NRP 2008-10 (Bundesregierung, 2008). Neither is there an explicit further split of the 3% target into subsequent investment objectives. Some orientations are given by the three priorities of the "Six Billion Euro Programme for R&D" of 2006 which covered central government's budget increases 2006 to 2009:

- Strengthening those advanced technologies with the broadest application potential and increase R&D in areas of potential future markets,
- Increasing the performance of the German science system and the international attractiveness of Germany as a location for R&D,
- Strengthening innovative capacities of SME.

Changes in National Reform Programme regarding the role of research in the broader economic growth strategy

The German National Reform Programme 2008-2010 is mainly a continuation of the 2005-2008 programme. This main thrust is also expressed in its title "Building on Success – Continuing with the Reforms for More Growth and Jobs". It retains its six reform priorities, one of which being "pressing ahead with information society and innovation", which includes the strengthening of R&D, the strengthening of the education system and the promotion of innovation. The programme focuses rather on implementation than on discussing or changing the growth strategy. The main economic justification is rather defensive and builds upon the need to strengthen its R&D position to meet the economic challenge of increasing global competition.

The 3% target has been welcomed by all relevant stakeholders and in a number of expert analyses. The need for overcoming the stagnation trend with regard to public R&D investments has been highlighted and seems adequate in the light of the barrier analysis. The implicit German policy goal of an increase of private R&D investment to 2% of GDP and the focus on new markets and innovative capacities is in line with the barriers identified. However, its ambition goes beyond addressing the main system weaknesses. For reaching this objective, the mentioned structural limits will become more binding and it may be difficult to implement policy responses which provide sufficient leverage. BMBF (2006) and EFI (2008) highlight in particular the additional human resource needs. According to BDI/ Deutsche Telekom Stiftung (2008), the number of graduates would even need to double in 2010.

3.3 Characteristics of the policy mix to foster R&D investment

This section is about the characterisation and governance of the national policy and instrument mix chosen to foster public and private R&D investment. While policy goals are often stated at a general level, the policy mix has a focus on how these policy goals are implemented in practice. The question is what tools and instruments have been set up and are in operation to achieve the policy goals? The following sections will each try to tackle a number of these dimensions.

3.3.1 Overall funding mechanisms

Increases in R&D investment shall mainly be reached by an extension of existing instruments. Taken all public funding sources, the dominant instrument to fund public R&D is block funding. For universities, it is provided at regional level by the 16 states (*Länder*) and amounts to around €7bn. In recent years, in some states, parts of the block funding for universities was distributed against a set of performance criteria which include also research performance criteria. A major change is that since 2006 additional funding by federal government and the states of nearly €2 billion for university research is channelled in a competitive way according to excellence criteria, with both an institutional funding stream for 9 universities and a project-based stream for clusters of excellence (see below).

For the non-university public research system, the federal and the state levels coordinate joint block funding via the GWK. The total amount of this joint block funding (which includes also administration expenses) is about €4.3 billion (planned 2008). Block funding for government research institutes is provided by the federal ministries.

Additional competitive project funding for public basic research (beyond the Initiative for Excellence) of about €1bn is provided through the German Research Foundation.

Competitive project funding is the main mechanism to fund collaborative research of the public and private research sector in support of economic and societal objectives. This is mainly provided at federal level, and reached in the 2008 BMBF budget around €1 billion. Another billion is channelled through the BMWi. One important partial exception to this mainly competitive funding is the joint funding with industry of collective industrial research under the umbrella of the German Federation of Industrial Research Associations "Otto von Guericke" (AiF), which is often underpinned by the support of sector-specific R&D institutions.

Hence also for the support of private R&D, direct funding is the dominant mode. An increasing share of 40% (2006) of the €1.85 bn public funding is provided by the Ministry of Defence (BMBF, 2008b), mainly via R&D contracts. Other public support for industrial R&D mainly takes the form of grants for collaborative research in programmes of the Research Ministry (23%) and the Ministry of the Economy, here also including indirect R&D support for SME and new firms (31%, with shrinking volume between 2003 and 2006). In some of the *new Länder*, European Structural Funds play an important role in project-based support programmes and infrastructure for business R&D and innovation (ERAWATCH Network, 2007).

Taken together, in 2007 about 46% of federal R&D expenditures went on project funding. About 92% is direct project funding, supporting specific research areas (ERAWATCH Research Inventory, 2008). This mirrors that Federal German research and technology policies have preserved a mission-oriented element and thematic focus in the way they set priorities and fund research. The basic approach, as expressed in dedicated research programmes, is technology-oriented. Areas focused on include ICT, life sciences, microsystems, nanotechnology, optical technologies, materials and production technologies, energy and sustainable development.

The distribution between thematic areas has been rather stable over time. However, the "High-Tech Strategy" of 2006 signals already in its name an acknowledgement of the structural change dimension of policies to increase R&D investment, which is conceptually complemented by the attention drawn to the demand side of high technologies. Also research-based clusters as prominent and reinforced

implementation instrument point in this direction, because they may in the longer term contribute to changes in specialisation. However, a closer analysis reveals some limits with regard to implementation. Although space and ICT belong to those areas which receive most of the funding, funding of the thematic areas is still to a significant extent geared towards medium-high tech areas like energy or transport. Knowledge intensive services appear for the first time asan innovation field on its own, but its €50m budget is still quite limited. It remains to be seen to what extent changes in specialisation patterns are fostered. Also the new cross-thematic "clusters of excellence" competition has in the first round selected rather established technology fields (see section 2.3.3).

3.3.2 Policy Mix Routes

The “Policy Mix Project” identified the following six ‘routes’ to stimulate R&D investment:

1. promoting the establishment of new indigenous R&D performing firms;
2. stimulating greater R&D investment in R&D performing firms;
3. stimulating firms that do not perform R&D yet;
4. attracting R&D-performing firms from abroad;
5. increasing extramural R&D carried out in cooperation with the public sector or other firms;
6. increasing R&D in the public sector.

The routes cover the major ways of increasing public and private R&D expenditures in a country. Each route is associated with a different target group, though there are overlaps across routes. The routes are not mutually exclusive as, for example, competitiveness poles of cluster strategies aim to act on several routes at a time. Within one ‘route’, the policy portfolio varies from country to country and region to region depending to policy traditions, specific needs of the system etc.

Route 1: Promoting the establishment of new indigenous R&D performing firms

The INNO Policy TrendChart report (2008) clearly illustrates the significant amount of existing measures to promote start ups as well as the fast growth of young small firms both at the federal and the Länder level. At the federal level, many of them are managed by the “*Kreditanstalt für Wiederaufbau*” (KfW), which acts as the government's main capital provider. After a collapse of the Venture Capital (VC) market in the early 2000s, federal VC programmes were substantially redesigned in 2004/2005, including the introduction of an umbrella fund (EIF/ERP Fund) which invests in private VC funds specialised in early-stage funding, and the "*High Tech Gründerfonds*” which offers VC investment independent of private lead investors. The latter is a public-private partnership which has a budget of €272 million over five years 2005 to 2009 (for further details see INNO Policy TrendChart, 2008). Complementary elements introduced in the last years are the support of academic spin-offs, in particular through the country-wide extension of the EXIST programme, and specific conditions and the option for individual funds for new firms within thematic fields programmes under the "SME innovative" programme 2007. According to BMBF (2009), the support volume of positively evaluated projects has been €200 million and (only) 50% of its beneficiaries receive support for the first time.

Recent measures focused more on creating a favourable regulative environment that stimulates start-up activities. A new Law on Venture Capital has been introduced in 2008 as part of the Law on the Modernisation of Framework Conditions for Private Equity. It aims at improving tax regulations for investments into young technology companies and the financial situation of business angels. Changes in the Equity Participations Act (UBGG) shall further enhance the financing of SMEs with equity capital by loosening the existing provisions and by adapting them more efficiently to practical needs. The Experts Commission for Research and Innovation (EFI), an advisory body composed of six international experts and created in March 2007, highlights that the availability of venture capital is constrained by general corporate tax legislation and has assessed the new law as being too restrictive in its provisions to allow for substantial improvements (EFI, 2008, 2009).

Route 2: Stimulating greater R&D investment in R&D performing firms

In Germany, this route is closely linked to route 5, i.e. public-private collaboration. Most federal project-oriented resources can be attributed to this route. In the framework of the High-Tech Strategy, additional resources have been provided, e.g. more than €2 billion to increase collaborative thematic R&D programmes of BMBF and €1.2 billion for BMWi programmes, both thematic ones like Aerospace and energy and horizontal programmes, in particular to support SMEs. One expected impact is the mobilisation of additional R&D investment from business. A certain confirmation is provided by a survey by Rammer et al. (2007). Also at regional level there are many measures to stimulate private R&D investment which might primarily benefit existing R&D performers, often co-financed by European Structural Funds.

Also human resource policies like the Pact for Higher Education and the Qualification initiative may stimulate greater R&D investment in R&D performing firms (see below).

Route 3: Stimulating firms that do not perform R&D yet

Few specific measures are in place at federal level to stimulate R&D investment by non-R&D performing firms. Those that have been in place, like the former ProInno programme of the BMWi, reached only a limited number of firms and had a low quantitative effect (Rammer, 2007). A renewed discussion of tax incentives for R&D, which are seen as possible instrument, is fostered by the Expert Commision for Research and Innovation, among others (EFI, 2008), but has not led to tangible results yet.

The new simplified “Central innovation programme for SMEs” which integrates a number of prior programmes (see section 2.3.4 and, for a detailed analysis, Rammer, 2008) also targets "not-yet-R&D-performers" explicitly.

Route 4: Attracting R&D-performing firms from abroad

Attracting foreign R&D performers has been seen as a historical strength of the German system due to its large market and excellent research infrastructure. Many foreign affiliates conduct research in Germany[3]. There are no specific policy

[3] They often also produce in Germany, therefore their importance is only partly reflected in the measured share of R&D expenditures financed from abroad of 3.7% (2005), of which more than two thirds go to the private sector (Statistisches Bundesamt, 2008).

measures targeting this route, nor does the tax system contain specific incentives for R&D which would work in this way - but policies under routes 5 and 6 do indirectly.

Route 5: Increasing extramural R&D carried out in cooperation with the public sector

Fostering public-private collaboration in R&D is one of the cornerstones of the German research policy mix. External R&D expenditures of firms are significant, they are estimated at around €10bn[4] (Stifterverband, 2008). Many federal project-oriented resources, in particular of the BMBF, can be attributed to this route. In the framework of the High-Tech Strategy, more than €2 billion additional resources have been provided to increase collaborative R&D programmes. The additional resources provided follow mainly a "strengthening the strengths" approach and cluster approaches are increasingly supported both at federal and regional level, with the "Spitzencluster" competition being only the most recent example (see 2.3.3). Many of the networking oriented research and innovation policy instruments in particular the new Länder are significantly co-financed through European Structural Funds (see e.g. ERAWATCH Network, 2007). Another relatively recent measure aims at incentivising PROs to conduct research for SME. The "Research Grant" (*Forschungsprämie)* implemented in early 2007 has been complemented in October 2007 by a "Research Grant Two" for private not-for-profit research institutions.

Route 6: Increasing R&D in the public sector

The policy mix element on increasing R&D in the public sector is strongly influenced by the strong competencies of the states in this domain, in particular for funding universities. Correspondingly it results from negotiations between both levels and rests on two main elements which have both recently been extended (see 2.3.3):

- The “Initiative for Excellence” agreed in July 2005, aiming to support cutting-edge research at universities to create "beacons of science" with international visibility. It provides additional funding by federal government and the states of nearly €2 billion until 2011. It is channelled in a competitive way according to excellence criteria, with both an institutional funding stream for 9 universities and a project-based stream for interdisciplinary and inter-institutional academic clusters of excellence (for details see Grablowitz and Nill, 2008).
- In the Pact for Research and Innovation, federal and the states' governments agreed in June 2005 to increase the budget of each of the four main public research organisations and the DFG 2006-2010 by 3% per year. In turn, the organisations committed to increase their performance along several dimensions and to submit yearly progress reports.

[4] This number includes also R&D performed abroad.

Assessment of the importance of policy mix routes and their balance

Table 7: Importance of routes in the national policy and recent changes

Route	Short assessment of the importance of the route in the national policy	Main policy changes since 2008
1	To promote the establishment of new, domestic R&D performing firms has received considerable policy attention. However, the attention may still not live up to its importance in achieving further R&D investments, given that new firms are often the carrier of radical innovation and the opening up of promising economic fields. Here the importance of the link to innovation policy in the policy mix is obvious, and weaknesses with regard to the provision of venture capital remain relevant.	The main recent policy change is the Law on the Modernisation of Framework Conditions for Private Equity. However, the extent of its effects remains to be seen and has been contested by experts. In addition, the terms for small loans of up to €50.000 for new entrepreneurs and SME by the KfW have been improved January 2008. The "KfW Startgeld" may be beneficial for knowledge-intensive services.
2	Although most instruments targeted at private R&D cover several routes, strengthening of R&D investment by R&D performing firms is still the dominant one. Also the additional resources provided confirm this by following mainly a "strengthening the strengths" approach.	The resource increases of the new unified ZIM programme as part of the second fiscal stimulation programme focus on strengthening R&D in existing firms. The Qualification Initiative addresses some of the human resource bottlenecks which may constrain growth of R&D.
3	Against the background of an increasing high-tech focus, and taking also account of the high level of R&D intensification achieved (over 70% of all enterprises are according to CIS engaged in innovation activities), the lack of instruments to foster R&D of non-R&D performing firms does not seem to constitute a relevant gap.	The new ZIM programme addresses this route, too. Its direct implications for R&D investment are still limited.
4	There is no specific policy focus on attracting R&D performing firms from abroad, given that this has not been a relevant problem yet.	-
5	Strengthening public-private collaboration remains one of the cornerstones of the policy mix. Grant-based competitive funding for collaborative R&D has been assessed as highly effective (BMBF, 2007b, OECD, 2006). Also the distribution of additional resources since 2006 confirms this priorisation.	Implementation of the "cluster of excellence" programme (see section 2.3.3) Additional support of collaborative mobility research as part of the second German recovery programme
6	Increasing public sector R&D has been quantitatively the most important route, channelled through the Initiative for Excellence and the Pact for Research and Innovation.	Federal budget increases 2008 and 2009 Prolongation of both initiatives agreed.

The importance of education and innovation policies

The main channels of influence of the broader education policies and non-R&D innovation policies on R&D investments are

- the higher education policies by the states, which heavily influence both human and financial R&D capacities and hence in particular route 6 but also route 2,
- the innovation financing policies already analysed in relation to route 1 and 2
- policies relating to qualification of the workforce which are mainly a regional competence, too (e.g. the Qualification Initiative mentioned in section 2.3.4).

For co-ordination mechanisms between research, education and innovation policies, horizontal and vertical co-ordination have to be differentiated. At the federal level, the first two policies are under the responsibility of the BMBF; here the main challenge is vertical co-ordination which takes often the form of pacts as described above. Innovation policy is the responsibility of the BMWi. Given that it is also responsible for much of the business-related R&D, some interactions are institutionally easy to address, while others require co-ordination between the two ministries.

The High-Tech Strategy of the federal Government, which was jointly developed by BMBF and BMWi, aims at co-ordinating research and innovation policy, partly including also other policy domains. As main element it reframes the technology-oriented thematic R&D support mechanisms in 17 targeted "innovation fields" for which also market and framework conditions are being addressed (for details see Grablowitz and Nill, 2008). There is no direct co-ordination with the states, but they often try to complement federal initiatives (ERAWATCH Network, 2007).

Elements of an increased articulation between research and education policy can be found in the Initiative for Excellence, which includes also Graduate Schools as main elements, and in the Pact for Higher Education concluded in 2007 (for details see Nill and Grablowitz, 2008). The latter attempts to ensure higher education places for the increasing number of students, and is bolstered by additional federal money for university R&D infrastructure. It also includes a commitment by the Länder to foster partnerships between higher education institutions and business. Early June 2009 it has been extended until 2015.

Other policies affect R&D investment in two ways. First, many other ministries also have sectoral research programmes and institutes. These include the ministry of defence, the ministry of the environment, the ministry of transport, building and urban affairs and the ministry of food, agriculture and consumer protection, contributing together to about 20% of federal R&D resources. They mainly affect route 2 (in particular defence) and route 6 (targeted public research). Coordination of the various targeted R&D activities in the different ministries is limited (see also Edler and Kuhlmann, 2008). There are formal procedures in place under the overall responsibility of BMBF, but their effectiveness beyond simple information exchange appears to be limited. Second, some policies like the feed-in-tariff for renewable energy are also an incentive to conduct development activities.

3.4 Progress towards national R&D investment targets

To reach the German 3% Lisbon target for 2010, an additional investment of 16 to 24 billion Euro is estimated as being necessary in comparison to 2005 (GWK, 2008a). Latest available data from official statistics for Germany in total is for 2007 and confirms an increase of public and private R&D expenditure from €55.7bn (2005) to €61.2bn and a slight increase of R&D intensity to 2.53% (see table 8). Of this additional 5.5bn only 1.2bn were spent by the government.

Table 8: R&D investment indicators for Germany

	2005	2006	2007	EU-27	
				Average	Year
GERD (euro million)	55739	58872	*61240*	*226120*	**2007**
R&D intensity (GERD as % of GDP)	2,48	2,54	*2,53*	*1,83*	**2007**
GERD financed by government as % of total GERD	28,4	27,8	**na**	*34,2*	**2005**
GERD financed by business enterprise as % of total GERD	67,6	68,1	**na**	*54,5*	**2005**
GERD financed by abroad as % of total GERD	3,7	3,8	**na**	*9,0*	**2005**
GBAORD (euro million)	17221	17608	*18405*	*87639*	**2007**
GBAORD as % of general government expenditure	1,64	1,67	*1,73*	*1,55*	**2007**
BERD (euro million)	38651	41148	*42840*	*144089*	**2007**
Business sector R&D intensity (BERD as % of GDP)	1,72	1,77	*1,77*	*1,17*	**2007**
BERD financed by government as % of total BERD	4,5	4,5	**na**	*7,2*	**2005**

Notes: - Values in italics are estimated or provisional,
- **na**: not available

Source: DG Research, data source: Eurostat

With regard to recent trends, three main funder groups have to be differentiated:

- Federal public R&D funding is expected to further increase from 10.1bn (2007) to €11.1bn (2008) and is planned to further increase in 2009 according to BMBF data, e.g. for BMBF by around 0.65 bn. This includes further resource increases beyond the Six Billion Euro Programme. As part of the second recovery package of early 2009, additional federal 1.4bn for R&D in 2009 and 2010 have been made available. While these numbers are impressive, it has to be noted that the GERD estimates of the Statistical Office for 2005 had reported significantly lower baseline federal R&D investment (€7.6 instead of 9.0bn); hence the budget appropriation data may not always translate immediately or fully into R&D investments.
- After a period of stagnation and even decline, R&D funding by the states has started to increase again since 2006. It is estimated to have again slightly increased from €8.0 (2006) to 8.3bn (2007) (GWK, 2008c). More recent data is not available; work on the improvement of statistics is underway. One of the many areas proposed for the spending of additional €10bn provided by the federal level for regional and municipal investments as part of the early 2009 economic crisis recovery package is R&D. For example, the state of Berlin, which provided €0.55bn (2006) for R&D will provide additional €0.14bn for R&D in the years 2009 and 2010.
- Additional planned private R&D funding between 2007 and 2009 has been estimated as €5.8bn (Stifterverband, 2008). It should be noted that the estimates include funding abroad and are based on a survey conducted in the first half of 2008, hence before the start of the financial and economic crisis. In earlier periods business R&D investment reacted quite strongly to changes in the economic situation. EFI (2009) expects significant cuts in private R&D spending, in particular due to negative impacts on car industry and on venture capital provision. To counter this trend the first recovery programme contained an additional billion of euros for increasing innovation credit programmes and venture capital channelled through the KfW. The second programme provides additional €0.9bn for the support of private R&D and €0.5bn for mobility research.

The policy mix has contributed to these significant further increases, although the extent of the leverage on private R&D is uncertain. There are indications of a role of the High Tech Strategy and its support to collaborative and private R&D.

Nevertheless it should be noted that direct federal government funding of business expenditures for R&D has been constantly decreasing in relative terms and only accounts for 4.5% of BERD (2006). In all sectors except Aerospace it is below 10%, and hence of limited importance for mobilising business R&D resources. Taken together, the increases do not reach the extent deemed necessary by GWK (2008a). On the basis of planned data it is estimated by a recent study that R&D intensity will only increase slightly to 2.57% 2008 (BDI and Deutsche Telekom Stiftung, 2008). For reaching 3% in 2010, increases by more than €6bn each in 2009 and 2010 would be needed, which are currently not in sight neither on the public nor on the private side. Under the current context of economic downturn, EFI (2009) assesses the 3% objective as unreachable.

The reasons for this insufficient progress, if compared to government objectives, are explained in table 9 below. No particular imbalance in the policy mix could be identified. It should be noted that some of the barriers, in particular those related to the structure of knowledge demand, are difficult to address by policies.

Table 9: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Difficulty of significant budget increases due to co-ordination problems and constrained public budgets	Significantly increased volume of federal financial resources, facilitated by a government budget close to balance in 2008, and commitment of states to sustained increases, but public resource mobilisation remains insufficient to meet the 1% Lisbon target. Recently, R&D has only benefited to a limited extent from the economic recovery programmes.
Below EU average financing of new R&D performers	After reorganisation of instruments, the new law on venture capital tries to improve framework conditions, but effects may be limited.
Stable, less high tech oriented structure of private knowledge demand	High Tech Strategy attempts to address this issue, but still follows to a large extent a strengthening the strengths approach. The profile of the R&D measures in the recovery package is largely fitted to sustain the current knowledge demand structure.
Human resource limits to increasing R&D capacities of firms	Implementation of recent human resource related measures like the Pact for Higher Education and the Qualification Initiative might come too late to fully circumvent this bottleneck

To summarize, the expected impact of policy changes since 2008 is limited, partly due to the limits of direct funding increases, and partly to the limited scope of many of the recent measures, e.g. with regard to direct funding of private R&D. Project-oriented funding of BMBF in the core areas relevant for private R&D has increased in 2008 and the planned 2009 budget from €0.99 (2007) to €1.25bn (plan 2009). Relevant BMWi R&D and innovation funding has increased from €0.92 (2007) to €1.16bn (plan 2009) and has been further boosted by the second economic recovery programme. The agreed extension of the main initiatives seems at least to ensure a long term steady resource increase of public R&D, also beyond 2010.

4 Contributions of national policies to the realisation of the European Research Area

ERAWATCH country reports 2008 provide a succinct and concise analysis of the ERA dimension in the national R&D system of the country. This chapter further develops this analysis and provides a more thorough discussion of the national contributions to the realisation of the European Research Area (ERA). An important background policy document for the definition of ERA policies is the Green paper on ERA (European Commission, 2007) which comprises six policy dimensions, the so-called six pillars of ERA. Based on the Green Paper and complementing other ongoing studies and activities, this chapter investigates the main national policy activities contributing to the following four dimensions/pillars of ERA:

- Developing a European labour market of researchers facilitating mobility and promoting researcher careers
- Building world-class infrastructures accessible to research teams from across Europe and the world
- Modernising research organisations, in particular universities, with the aim to promote scientific excellence and effective knowledge sharing
- Opening up and co-ordination of national research programmes

In the ERA dimension, the *wider context of internationalization of R&D policies* is also an issue related to all ERA policy pillars and is normally present in the dynamics of national ERA-relevant policies in many countries.

4.1 Towards a European labour market for researchers

Human resources mobility, and the free flow of researchers with the EU, is one cornerstone of the ERA.

Historically Germany was – and by and large remains - among the most attractive labour markets for researchers in Europe, due to excellent research infrastructures, renowned research institutions and a high remuneration level. There is also a wide range of inward and outward mobility initiatives in Germany to increase international linkages. Nevertheless, concerns about brain drain, in particular to the US, have grown. Also Switzerland and UK attract a number of German researchers. Policy attention to the issue has grown accordingly. As an example the DAAD (German Academic Exchange Service) has established the service GAIN to support German scientists working in the USA return to Germany.[5]

The temporarily declining number of graduates in science and engineering has also been an issue, although a continuous increase can be observed since 2002, reaching a total of 95.180 (2006) which is a net increase of 13.000 compared to 1998. The comparatively low percentage of women among science graduates is also mentioned as problem.

Germany is the first country to put forward a proposal to adapt its higher education qualifications to the European Qualifications Framework. The German qualification framework proposal, launched on 10 March 2009, aligns the higher education qualifications of its federal states to make German qualifications more easily

understandable and transferable within the European Union (European Commission, 2009).

4.1.1 Policies for opening up the national labour market for researchers

The Lisbon convention on the recognition of qualifications has been ratified by Germany. It regulates the validation of studies, certificates, diplomas and degrees obtained in other EU countries and with a number of non-member states.

The actual validation of these foreign academic degrees is a task of each "Länder", and not centralized at the federal level. Therefore an easier and less bureaucratic way of validation is currently being asked for by the Ministerpräsident of Lower Saxony, Christian Wulff (Focus, 2007), in order to attract more specialists from abroad.

Human resources are playing an increasingly important role within public R&D related policies and a number of initiatives have been set up to take into account associated issues such as the "Initiative for Excellence" (see section 3.3.2), which, for instance, will provide funding for 40 graduate schools for junior scientists. The "Pact for Higher Education 2020" (see section 3.3.2) will offer a growing number of students more favourable conditions for their studies and research. Eleven organisations in Germany are fostering highly talented students, currently assisting 0.7% of all university students with the aim of increasing this figure to 1%. In order to meet its needs for highly skilled workers including researchers, Germany needs an inflow of scientists and specialist workers from other countries. Thus, in early 2005 the Immigration Act came into force, which will be supplemented by the implementation of the European Union's Third-Country Researcher Directive that facilitates the residence permit process for research institutes hiring researchers from other countries (ERAWATCH Research Inventory, 2009).

Also the action programme “Labour Migration helping to ensure there is an adequate supply of skilled workers in Germany” (Beitrag der Arbeitsmigration zur Sicherung der Fachkräftebasis in Deutschland) of 16 July 2008 is removing barriers to the immigration of highly-qualified and highly-skilled persons to Germany to meet the demands of the labour market. For academics from the new EU Member States it will now be completely opened. Also for academics from third countries the labour market will be opened, although there will still be the "Vorrangprüfung", which first makes sure that no German researcher would be suited for the post (BMI, 2008).

Opening-up of recruitment of permanent research and academic positions to non-nationals and the availability of short term contracts for foreigners

In the National Reform Programme 2008-10 (Bundesregierung, 2008) there are measures of the Länder aimed at promoting the mobility of researchers, amongst others by enabling foreign nationals to be appointed civil servants, although no further information on the implementation status was provided.

To increase the number of international professors at German universities (currently 8 %), the Alexander von Humboldt Professorship and other measures from the foundation with the same name have been started. These are for example programmes for postdoctoral researchers, Programmes for junior research group leaders, programmes for experienced researchers and programmes for internationally recognised cutting-edge researchers like the mentioned professorship (Humbold Foundation, 2009).

National initiatives provide incentives for the opening up of universities, e.g. funding programmes in which a premium is awarded for projects meeting international cooperation criteria, specific programmes for developing such partnerships etc. They act as framework conditions for opening up of universities (ERAWATCH Network, 2009).

Availability of permanent research posts for young doctoral holders

Following a career path at university is very difficult for young doctoral holders, since the typical researcher career follows a very rigid pattern. Short term contracts are the norm, and permanent positions as independent researcher are rarely available. This represents an obstacle for the recruitment of well qualified young researchers. In order to avoid a brain drain, especially to the US, measures like a career track for post-docs (Juniorprofessor) have been established. However the implementation has fallen short of expectations and since the maximum duration of a series of temporary contracts was limited to 12 years, there was still a big uncertainty for this group of researchers. In April 2007 a new law on temporary contracts in science entered into force, which makes the application of these time limits more flexible. In addition to these regulations, a widening range of Federal research programmes contains measures which are specifically focused on supporting promising groups of young researchers.

Improved qualification and support for junior researchers in public research organisations are also an element of the Pact for Research and Innovation. The latest (2008) Government monitoring report confirms that visible improvements have been reached, but suggests that more efforts should be made to attract talented and well qualified foreign scientists (GWK, 2008b). So far, only one fifth of the university teachers receive permanent positions (Bonner Presseblog, 2008).

Remuneration policies

According to an EC (European Commission, 2007b) report on the remuneration of researchers in the public and private sectors, the average total annual salary of a researcher in Germany was €56,132 in 2006, exceeding the EU-25 average of €37,948, and placing Germany among the highest paying countries for researchers[6]. However, when considering the cost of living, the position of Germany deteriorates with the average salary decreasing to €53,358, while the average EU-25 salary improves to €40,126. Nevertheless, this still keeps Germany in the range of countries with high remuneration level (€40,000-60,000). However, researchers' salaries in Germany are still far behind those in the US (€60,156 or €62.793 when considering the cost of living).

Another characteristic of German system is that while entry point salaries are usually low, a significant increase in remuneration throughout a researcher's career is usually expected, providing a powerful incentive. Hence, Germany ranks tenth among the EU-25 and Associated Countries based on the salary of younger researchers (0-4 years of experience), but rises to seventh based on the remuneration of experienced researchers (more than 15 years in the research profession). This increase represents an impressive increment of 217.91% during the researcher's career.

Compared to the salaries paid by private enterprises the salaries are still considered to be low and the rather rigid remuneration system of the "Tarifrecht" (law of the public sector) to be too rigid to attract excellent researchers (Spiegel online, 2006).

[6] Along with Austria, Belgium, Denmark, Ireland, Luxembourg, and the Netherlands.

In a reform of the salaries of professors (Professorenbesoldungsreformgesetz) in 2002 limited performance components were introduced to go beyond the frame of the "Tarifrecht".

4.1.2 Policies enhancing the attractiveness of research careers

Furthermore, the initiatives reported above and in ERAWATCH Network (2009) provide several accompanying services for graduates, lecturers, professors, young and senior scientist to gain international experience or to work in trans-national research projects. The initiatives intend to stimulate an increasing number of young academics to gain international experience. Moreover, the initiatives are thought to make Germany one of the main attractive places to study and to research for people from abroad. The overall guideline and motivation is trans-nationality within the core of Europe.

Only two organisations have signed the Charter for Researchers (the German Rectors' Conference and the Alexander von Humboldt Foundation). This is a very small percentage of German organisations, although the German Rectors' Conference (HRK) is representing all universities of Germany. It has not only signed the Charter for Researchers, but also the Code of Conduct for the Recruitment of Researchers. In the opinion of the HRK, most of the goals set out in the Charter have already been implemented in Germany or are even part of the German tradition in science and research. Yet the universities point to the great obstacles which the lack of the portability of pension rights has on the mobility of researchers between the public and private sectors[7].

Researcher-friendly social security and pension systems

In order to protect the social security rights of persons moving within the European Union the Regulation EEC No 1408/71 applies.

European researchers are usually part of the German pension scheme and there are Social Security Agreements ("Sozialversicherungsabkommen") with a number of countries. Contributions to the statutory pension scheme ("Rentenversicherung") are deducted from salaries at source. The employer is responsible for paying half of the contribution towards pensions, the employee the other half. Employers register their employee with the respective health insurance provider ("Krankenversicherung") who then automatically forwards the registration to all the other social security providers.

Promotion of women

Only 39 % of PhDs and 15% of the professors are women in Germany: this is a very low figure compared to other EU countries.

One of the main differences between men and women are the times when women leave their workplace to take care of children. There are a number of general measures aiming at the reintegration of women in the labour market which also apply to researchers:

- In general both men and women can take advantage of the "Elternzeit", the possibility to leave your work for up to 3 years (this can be split between the parents) with a guarantee for you workplace afterwards.

[7] See Euraxess: http://www.eracareers-germany.de/en/index.htm

- "Erziehungsgeld" is a reimbursement that is paid up to two years to support financially the parent not working.
- Affordable and high quality child care, particularly for children under the age of three, is an important support for the career of parents. There is a gap here, but Germany is expanding its offer.
- The equality-oriented initiative "Prospects for Re-entering the Workforce" announced by the Federal Government offers measures to help women who have a career break to raise a family to re-enter the workforce successfully.

With regard to the specific measures for researchers, the following is worth mentioning:

- The national reform programme 2008-2010 (Bundesregierung, 2008) contains as part of the Qualification initiative a programme for women professors: around 200 professorships for women are being funded jointly by the Federal Government and the Länder through start-up financing. Similar measures are currently already in place in a range of Länder, e.g. Berlin.
- Another part of the national Qualification initiative is the initiative MINT. Here a group of partners from public enterprises, industry and the state have signed a national pact in order to use the potential of women for the professions in natural sciences and technology facing the future lack of skilled workers. A memorandum has been signed by the partners on 17 June 2008 (BMBF, 2008c).
- The promotion of the advancement of women in researcher careers is also one element of the Pact for Research and Innovation concluded in 2005 between the Federal and the state Governments and the main German research organisations. The monitoring report 2008 points out that progress in this area is very slow, however (GWK, 2008b). The report suggests that state and Länder need to reflect on specific support and incentive mechanisms and sanctions which go beyond voluntary agreements.

There are also initiatives from the universities to enhance gender equality. The Ruhr-Universität Bochum (RUB) wants to give every fourths professorship to a woman. This is part of the equal opportunity concept 2008. The goal is to improve the representation of women especially in natural sciences in al levels, especially the top level. So far 14.4 % of professors are women at the RUB.

4.2 Governing research infrastructures

The analysis of infrastructures differentiates by type of infrastructure (inter-governmental, transnational, and national) because of their distinctive governance modes and commitment levels. Recent developments at transnational level with the implementation of the first phase of ESFRI road-map infrastructures[8] prompted national policy-makers to discuss and design novel strategies for the country in terms of areas of specialisation for the research infrastructure of the country associated with strategies for location of the new infrastructures.

Germany operates a significant number of large infrastructures, mainly through its Helmholtz Research Centres. It is also heavily involved in existing international infrastructures, often as founding member. Currently, Germany is enhancing its

[8] ftp://ftp.cordis.europa.eu/pub/esfri/docs/esfri-roadmap-report-26092006_en.pdf

research infrastructure. Germany's National Reform Programme 2008 – 2010 (Bundesregierung, 2008) highlights the agreement to provide the Federal Länder with just under € 1 billion a year until 2013 for the further development of the infrastructure at institutions of higher education and research buildings at universities. The Federal Länder will also be investing in state-of-the-art ICT facilities at universities. Resources for research and education building infrastructures have been significantly increased as part of the second economic recovery programme.

Policy objectives and strategies to access intergovernmental European infrastructures and Germany's financial contribution

International and European infrastructures in Germany are important as well as infrastructures in other European countries, which run with the involvement of Germany to ensure a first-rate and competitive research. Hence Germany takes an active part in all international organisations providing research infrastructures which are financed and operated jointly with partner states. Germany often belonged to the founding members of common infrastructure. Some of these infrastructures emerged from bilateral relationships between Germany and France. An example is the joint intergovernmental research infrastructures Institut Laue-Langevin ILL. European and international coordination is becoming increasingly important.

With regard to the financial contribution, BMBF Institutional funding for large international research facilities (excluding ESA) is about €200 million; this is supplemented by project funding. The largest part of BMBF funding goes to the European Laboratory for Particle Physics CERN. Germany is also a member of the ITER consortium for the fusion research reactor. According to the BMWi budget 2008, contributions to IAEO and ESA amounted to €600 million. The GBAORD share of intergovernmental infrastructures reaches hence around 4%.

Strategies to participate in transnational infrastructures, areas of specialisation and approved road-maps by research area

The Strategy of the Federal Government for the Internationalization of Science and Research, presented in February 2008, gives importance to Germany's participation in European and international infrastructures (BMBF, 2008). However, an explicit policy strategy or roadmap is still under development.

Several projects of the ESFRI-roadmap (European Strategic Forum for Research Infrastructures) are being coordinated by Helmholtz centres, the association of 15 German state research centres which operate giant equipment and complex infrastructures. Projects with German participation and joint coordination include the construction of the European X-Ray Laser Project XFEL, the particle accelerator FAIR (Facility for Antiproton and Ion Research) and the experimental nuclear fusion reactor ITER.

For example, XFEL is being built at the DESY site in Hamburg-Bahrenfeld with European participation. More than 40 % of the cost are to be contributed by the European partners.

Also the Max-Planck Society holds transnational common institutes with the CNRS in Grenoble, the "Hochfeld Magnetlabor"; the Institut für Radioastronomy IRAM together with CNRS and IGN, Spain, a German-Spain Centre for Astronomy in Calar Alto, Spain and ISL a French-German Research Institute coming from the armament field.

Opening-up of large national infrastructures or scientific technological platforms to foreign access

Many of the existing large national infrastructures are open to foreign access. Worldwide cooperation is the key to achieving outstanding scientific results and fostering innovation. For this reason, the Helmholtz Association uses funding from its Initiative and Networking Fund to specifically strengthen its international component. The German internationalisation strategy also highlights the importance given to the international infrastructures based in Germany. As mentioned, some of the most recent large infrastructure projects of the Helmholtz-Association like XFEL and FAIR are built with European participation and hence open to it.

International cooperation is a decisive factor in conducting research at the highest level and to produce results of global significance. The Helmholtz centres contribute to this internationalisation of science by establishing international strategic alliances, fostering scientific cooperation and networking with national and international partners in universities and companies.

A modern research infrastructure with large-scale facilities – many of which are unique worldwide – is one of the factors making the Helmholtz Association an attractive research partner. In 2006, over 3700 guest researchers from all over the world took advantage of the research opportunities it provides – an indication of the Association's function as a point of crystallisation for global research projects, particularly in the field of large-scale experiments, whether they involve observing and investigating worldwide climate change or basic research in physics (Helmholtz Association, 2009).

Moreover, Germany along with its European and international partners operates outstanding technological research facilities, such as the German-Dutch Wind Tunnels, the European XFEL or FAIR. These research facilities are indispensable for the creation of ERA, especially since they enable the implementation of highly sophisticated European and international research projects (ERAWATCH Network, 2009).

4.3 Research organisations

As described in section 2.1, Germany is organised federally and education is in the responsibility of the regions ("Länder"). Therefore no statement concerning all of Germany can be made.

The German Länder have strong competences in science policy, especially with regard to the financing of public universities. Since they finance the bulk of the public universities' expenses and regulate their governance structures, their overall influence on higher education is considerable. Moreover, they significantly contribute to the financing of the non-university public research organisations and the institutes located in the particular region. The share of institutional funding that they have to contribute to the financing of public research activities depends on the type of organisation and the status of the institutes.

Research organisation funding and governance at regional level, carried out within the German Bundesland Baden-Wuerttemberg

Research activities are rather unevenly spread among the German Bundesländer. Most German research activities are performed in a few key Bundesländer, most prominently, Bayern, Baden-Württemberg, North Rhine-Westphalia and, less notably,

Lower Saxony and Hessen. In contrast to the economically comparable Land of Bavaria, Baden-Württemberg has for instance not developed a central RTDI policy document. The basic principles and targets of RTDI policy were fixed in the current government's coalition agreement after the most recent elections in 2006 and have six main aims:

- to secure and develop international excellence in research;
- to further develop science–business cooperation
- to improve science–business know-how and technology transfer;
- to enhance the innovative capacity and willingness of Baden-Württemberg's businesses, particularly the numerous SMEs;
- to create performance incentives for leading research activities;
- to provide thorough training and to improve the options for future scientists.

Locally, the Ministry of Science, Research and the Arts is responsible for the basic principles of research policy, while the Ministry of Economic Affairs is responsible for implementing measures around technology policy, with a great deal of importance attached to the themes of education and further education.

For next to a decade the Ministry of Science, as one of the first ministries in a federal state to do so, has been distributing funding to universities on a competitive basis in the context of the "Forschungsschwerpunktprogramm".

Particular to Baden-Württemberg is the "Landesstiftung Baden-Württemberg" a foundation with capital of €2.4b raised by privatisation which supports projects in the fields of education, science and research with an annual budget of €50–70m. Due to legal constraints, however, it is not able to support applied, market-oriented research.

The necessary complement is thus partially provided by the now nationally active Steinbeis-Foundation, an institution dedicated to providing innovation related consulting and to enabling technology transfer to enterprises, which was set up and is still headquartered and very active in Baden-Württemberg.

RTDI policy in Baden-Württemberg aims to focus on the development of certain Technology-Clusters, e.g. in the areas of automotive development, production technology, fuel cell research and renewable energies. Broader direct support programmes for SMEs, however, have had to be limited due to fiscal constraints (ERAWATCH Research Inventory, 2009).

4.4 Opening up national research programmes

Research programmes are increasingly becoming important tools in the construction of the ERA. They can be an expression of non-formalised national policies towards Europeanization through their coordination modes and openness to non-nationals and non-residents.

National R&D funding programmes in Germany are increasingly open for foreign participants, on the ground that international research cooperation is beneficial for the quality and outreach of research activity. The modalities range from mere acceptance of foreign partners in research projects, without any explicit selection criterion nor funding associated, to the establishment of compulsory participation of foreign research performers and allocation of a substantial share of the funds to the latter. Domestic funding allocated to foreign partners is not compulsory to define a

programme as “open” but its presence is a good proxy for the actual degree of openness. Programmes covered here include those addressing public or private research performers, or a combination of the two (ERAWATCH Network, 2009).

In Germany, technology-open and technology-specific funding both refer to the same instruments like those supporting entrepreneurship (capital stock, coaching and consultancy for special start-up needs), see section 3.3.

The national funding programmes intend to strengthen the competitiveness and innovation activities of SME. They therefore provide a certain degree of openness. In principal, the openness towards partners from abroad is allowed as long as no national partner is available. In many cases additional funding is granted to support extra expenses for the co-ordination of international projects (ERAWATCH Network, 2009).

Germany's strategies for the opening-up of national research programmes

Until recently, strategies for the opening up of research programmes were often driven by funding agencies, of course with the support of the Ministry for Research. One example is the German Research Foundation (Deutsche Forschungsgemeinschaft) who is supporting the building of a European System of research funding, e.g. via the European Research Council, and the reform of the funding instruments of the European Science Foundation, thus working for a stronger self organised science in Europe. This stronger international perspective is one of the commitments made as part of the Pact for Research. DFG is also member of Eurohorcs.

Also strongly driven by the funding agencies, Germany has developed the strategy of participating in most ERA-NETs. Germany is involved in 55 ERA-NETs (see Annex), and there is a National Contact Point for the overall coordination of ERA-Nets. The biggest benefits for German programme owners are the mutual-learning process, the exchange of ideas, views, concepts and receiving perspectives from outside.

The policy framework for research programmes provides certain tools to go steps in the direction of opening, such as the general option to subcontract foreign partners if no national expertise is available and the general openness to European partners as long as nothing else is stated, but implementation is programme specific.

The recent internationalisation strategy of February 2008 goes further and highlights the potential in international collaborations for Germany and wants to use it as an evaluation criterion for project proposals. The aims should be a 20 % participation of foreign partners in BMBF-funded projects. (BMBF 2008, p. 23) This would mobilize additional EU funds and include know-how that is not available in Germany. Germany is also making contributions to Europe through the European Science Foundation (ESF)[9].

Also joint programming is used as strategy element where appropriate.

Germany participates in all of the current Article 169 initiatives:

- EDCTP "European and Developing Countries Clinical trials Partnership" (80 M€ for research into prevention of HIV/AIDS, tuberculosis and malaria in Africa plus

[9] 2008 Total Contribution from German Member Organisations into ESF General Budget: € 1 385 098 - i.e. 18.71% of the total contributions received from Member Organisations (ESF e-mail, 5.5.09)

the contribution from the European Commission of 40 M€, to be matched by European Member States and third parties)

- Bonus 169 (Baltic Sea research) with an estimated budget (excluding EC contribution) of 50 - 75 M€ and requested EC contribution 100 M€,
- AAL "Ambient Assisted Living" (budget of 600 M€ planned)
- EUROSTARS (which will provide financial support to market-oriented research projects initiated and driven by R&D performing SMEs)
- and EMRP (on metrology).

Traditionally Germany, Austria and Switzerland are working together under the DACH, an Interreg IIIA project, which focuses on cross-border cooperation in planning. Three principles facilitate transnational research projects: 1. "Lead agency principle", which states that a joint research project has to be applied for only at the main agency, the others follow the decision. 2. "Money follows scientist", which states that a scientist can move to another country, taking current project funding with him. 3. "Money follows cooperation line", which enables transnational funding in the framework of scientific co-operations.

There are also intensive bilateral relationships between Germany and France covering the domain of R&D. There are regular meetings and efforts to increase bilateral co-operation between similar institutions in selected fields. One example is the Theseus programme which started in 2005 as a bilateral industry-initiative between Germany and France, by now 30 research institutions universities and companies have joined and cooperate closely to develop new technologies for the automatic searching and processing of ICT data. The main themes addressed in the latest joint paper by the two governments in March 2006 are transport, genomics, nanotechnologies, cancer research and environmental sustainability (Auswärtiges Amt and Ministère des Affaires étrangères, 2006). Legal and other barriers to the melting of funds and differences in the institutional structure of the research systems make implementation a challenging task.

4.5 National ERA-related policies - a summary

Enhancing European and International collaborative research is one of the political targets of the German Federal Government and is understood as a crucial factor of success for all appropriate actors. Another emphasized political objective is the integration of European countries to the European Research Area. This strategy is implemented by several bilateral agreements with European countries on different levels. The agreement may cover common research targets or the unification of research institutes under a common roof. The main initiatives are “customised” to the benefit of the integrated countries.

Research institutes and universities have a great responsibility in the field of internationalisation, as they run several initiatives, awards and exchange services in order to foster the inflow of foreign researchers, the backflow of native researchers ("repatriates"), and the outflow of young scientist to gain experience abroad. The efforts in this field have been encouraged by two key acts of the Federal Government: the 22nd amendment of the Federal Training Assistance Act and the opening of the labour market towards graduates from abroad.

The increased importance of the context of the European Research Area for national policies is acknowledged by research policy makers, e.g. in the High-Tech Strategy. On the level of activities, Germany is heavily involved in most ERA-related partnerships and actions and German research actors are participating in all ERA initiatives. Care is taken by the German government to ensure that national priorities are sufficiently reflected in European programmes. However, the increased importance is only partly reflected both in public debates as well as in the "Strategy of the Federal Government for the internationalization of science and research" adopted in early 2008 (BMBF 2008a, for details see Nill and Grablowitz, 2009). The strategy recognises the changing international landscape and related challenges but has a markedly national and global focus. Its four main objectives are:

- Improving international collaboration in research and ensuring that Germany becomes a leading research location
- Making use of innovative potential by ensuring that German firms increasingly collaborate with the internationally leading high-tech regions and research centres
- Further developing the scientific collaboration with developing countries in order to improve education and research in those countries
- Assuming global responsibility for addressing the problem of global change, securing the energy supply, reducing poverty and controlling pandemics and contributing to the long-term international research agenda in the relevant scientific and technological areas

The European dimension and related opportunities are rather superficially covered. This may be due to both the size and the performance level of the German research system, which belongs to the leading systems in Europe and constitutes alone more than one quarter of the EU research area when measured in R&D inputs.

A European strategy is mentioned as important element which needs further development and specification. The stated objective is "to become a motor of European strategy development in research and innovation policy" (BMBF, 2008a, chapter 6.1) and five general guiding principles are set out. These include the strengthening of basic research, a clear focus of support instruments on performance and excellence, improvement of competitiveness, the increase of effectiveness of European co-operation with third countries and a better linkage of German research policy with European measures. Historically Germany was – and by and large still is - among the attractive labour markets for researchers in Europe and policy attention to remain an attractive labour market for German and foreign researchers has grown in recent years. There are some steps to remove formal constraints like the restrictions for labour migration for nationals from new EU Member States and third countries. The dominant policy mode in the field are pacts and voluntary agreements, e.g. in the field of enhancing careers of women researchers, the support of young doctorate holders from foreign countries. An increasingly used instrument is the specific professorships, be it for foreign scientists or for women.

Germany is heavily involved in existing international infrastructures, often as founding member. Although it operates a significant number of large infrastructures, mainly through its Helmholtz Research Centres, an explicit strategy on infrastructures remains still to be developed. Several new infrastructures covered by the ESFRI roadmap (e.g. XFEL, FAIR) are located in Germany, for which international co-operation is explicitly sought.

Although until recently an explicit policy strategy has been lacking, the German policy mix contains a range of elements with regard to the opening up and co-ordination of research programmes. The main rationale continues to be the access to complementary foreign knowledge while avoiding too strong openness to the unpaid transfer of knowledge to other countries. Correspondingly, there is a case-to-case approach towards the opening up of the national research programmes. Due to its size and the philosophy to influence European initiatives, Germany participates strongly in multilateral joint initiatives like ERA-NETS or Art. 169. Bilateral initiatives which go beyond traditional mobility-oriented bilateral co-operation measures centre on Neighbour countries like France, Austria and Switzerland.

Table 10: Importance of the ERA pillars in the ERA policy mix and key characteristics

	Short assessment of its importance in the ERA policy mix	Key characteristics of policies
Labour market for researchers	• Human resources are playing an increasingly important role within public R&D related policies. • There is a wide range of inward and outward mobility initiatives in Germany to increase international linkages.	• Policy focus on attracting excellent foreign students and researchers • A number of initiatives have been set up to take this into account: e.g. in the NRP 2008-10, in the Pact for Research and Innovation, and the Immigration Act as a supporting measure. • In the NRP 2008-10 there are measures of the Länder included, which are aimed at promoting the mobility of researchers.
Governance of research infrastructures	• Germany operates a significant number of large infrastructures open to worldwide cooperation, mainly through its Helmholtz Research Centres.	• Several projects of the ESFRI-roadmap are being coordinated by Helmholtz centres. International cooperation is recognized to be a decisive factor in conducting research at the highest level and to produce results of global significance.
Autonomy of research institutions	• The German Länder have strong competences in science policy, especially with regard to the financing of public universities.	• Since they finance the bulk of the public universities' expenses, their overall influence on higher education is considerable.
Opening up of national research programmes	• Increasingly important, with focus on improved international collaboration in research and ensuring that Germany becomes a leading research location.	• International collaborative research work is one of the political targets of the German Federal Government and is understood as a crucial factor of success for all appropriate actors. • Germany is heavily involved in most ERA-related partnerships and actions and German research actors are participating in all ERA initiatives

5 Conclusions

5.1 Policy mix towards national R&D investment goals

The German research and innovation system is characterised by a substantial level of R&D investment and the share of business is high and increasing. However, the systems stability and maturity make it difficult to surmount the 2.5% R&D investment/ GDP “wall” and to reach the national target of 3%, both on the public and the private side. Main barriers are the difficulty of significant budget increases due to co-ordination problems and constrained public budgets, a stable medium-high tech dominated structure of private knowledge demand, a below EU average financing of new R&D performers which becomes problematic in this context and, in perspective of 3%, human resource limits to increasing R&D capacities of firms.

The policy mix has contributed to significant resource increases, albeit the extent of the leverage on private R&D is uncertain and probably limited. For reaching 3% in 2010, further increases by more than €6bn each in 2009 and 2010 would be needed, which are currently not in sight neither on the public nor on the private side. With regard to the reasons for this insufficient progress, significant increases of R&D investments of the states appears to be particular problematic, although recent improvements have been noticed. However, no particular imbalance in the policy mix could be identified. It should be noted that some of the barriers, in particular those related to the structure of knowledge demand, are difficult to address by policies.

Main policy risks relate to limited leverage effects, e.g. of the new law on venture capital, a too slow progress in human resource related improvements and a status quo bias of the R&D related measures in the economic recovery package.

5.2 ERA-related policies

Beyond increasing R&D investments in tune with the 3% goal of the EU's Lisbon Strategy, the Federal Government's research policy explicitly supports the ERA. The increased importance of the context of the European Research Area for national policies is acknowledged by research policy makers, e.g. in the High-Tech Strategy and the Internationalisation Strategy. German research institutes and companies are mobilised and encouraged to actively participate in the European Framework Programmes, with support and information provided. At the administrative level, the ERA initiative has led to increased transnational collaboration mainly in the form of participation in ERA-Net. Furthermore, there are initiatives that financially support the establishment of contacts between established networks and clusters in Germany and similar clusters across Europe. These clusters should contain participants from industry and public research organisations (ERAWATCH Research Inventory, 2009). Also, several projects of the ESFRI-roadmap are being coordinated by German research institutions and supported by policy makers.

Although Germany is heavily involved in existing international infrastructures, often as founding member, an explicit strategy on infrastructures remains to be developed. Beyond some steps to remove formal constraints on researchers' mobility like the restrictions for labour migration for nationals from new EU Member States and third

countries, there is still room to develop concrete policy measures and regulations to promote attractiveness for non-national researchers.

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List of Abbreviations

AiF	Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von Guericke" (German Federation of Industrial Research Associations)
BERD	Business Expenditures on R&D
BMBF	Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
BMWI	Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
CERN	European Organization for Nuclear Research - European Laboratory for

	Particle Physics
DAAD	Deutscher Akademischer Austausch Dienst (German Academic Exchange Service)
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
EFI	Expertenkommission Forschung und Innovation (Experts Commission for Research and Innovation)
ERA	European Research Area
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
FhG	Fraunhofer-Gesellschaft (Fraunhofer Society)
FP	European Framework Programme for Research and Technology Development
GWK	Gemeinsame Wissenschaftskonferenz (Joint Science Conference)
HGF	Helmholtz-Gemeinschaft Deutscher Forschungszentren (Helmholtz Association)
HRK	Hochschulrektorenkonferenz (German Rectors' Conference)
ILL	Institut Laue-Langevin
ISL	Institut Franco-Allemand de Recherches de Saint-Louis
MPG	Max-Planck-Gesellschaft (Max Planck Society)
NRP	National Reform Programme
PRO	Public Research Organisations
R&D	Research and development
SF	Structural Funds
S&T	Science and technology
VC	Venture Capital
WGL	Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (Leibniz Association)
ZIM	Zentrales Innovationsprogramm Mittelstand (Central Innovation Programme for SMEs)

Annex: ERA-NETs with German participation

There are 55 ERA-NETs with German participation.

ERA-NET name	Start date	End date	id_tag
ACENET	01/09/2004	31/08/2008	FP6
AirTN	01/01/2006	31/12/2008	FP6
AirTN – FP 7			FP7
ALLIANCE-0	01/10/2004	30/09/2007	FP6
ASPERA	01/07/2006	30/06/2009	FP6
ASPERA-2			FP7
BIODIVERSA	01/01/2005	30/04/2009	FP6
BIOENERGY	01/10/2004	31/05/2008	FP6
BONUS	01/10/2005	30/09/2009	FP6
CIRCLE	01/02/2006	31/01/2010	FP6
CORNET	01/11/2004	31/10/2008	FP6
CORNET II	1/3/2008	1/3/2010	FP7
CRUE	01/12/2003	30/11/2007	FP6
ECORD	01/03/2004	29/02/2008	FP6
ei			FP7
EMIDA			FP7
ENR2			FP7
ENT II			FP7
ERA.Net RUS			FP7
ERA-AGE	01/04/2005	31/03/2009	FP6
ERABUILD	01/01/2004	31/12/2008	FP6
ERACOBUILD			FP7
ERA-ENVHEALTH			FP7
ERA-IB	01/10/2004	30/11/2008	FP6
ERA-Instruments			FP7
ERA-NET ROAD	01/01/2004	31/12/2007	FP6
EraSME	01/05/2005	30/04/2008	FP6
EraSME2	1/10/2008	1/10/2010	FP7
ERA-SPOT	01/10/2004	30/09/2008	FP6
ERASysBio	01/12/2003	30/11/2007	FP6
ETB-PRO			FP7
ETRANET	01/07/2006	30/06/2010	FP6
EuroNanoMed			FP7
EU-SEC II			FP7
FENCO	01/09/2004	31/08/2007	FP6
HY-CO	01/04/2005	31/03/2008	FP6
ICT-AGRI			FP7
iMERA-Plus			ERA-NET plus
INNER	01/06/2005	31/12/2010	FP6
MARTEC	01/02/2005	31/01/2009	FP6
MATERA	01/01/2004	31/12/2007	FP6
MNT ERA-NET	01/03/2005	29/02/2008	FP6
MNT-ERA.NET II			FP7

NanoSci-E+			ERA-NET plus
NanoSci-ERA	01/03/2007	28/02/2011	FP6
NET- HERITAGE			FP7
NEW OSH ERA	01/04/2006	31/03/2010	FP6
NORFACE	01/01/2004	31/12/2008	FP6
NuPNET			FP7
PV-ERANET	01/10/2004	30/09/2008	FP6
RURAGRI			FP7
SUSPRISE	01/01/2004	31/12/2007	FP6
WOODWISDOM-NET	01/01/2004	31/12/2007	FP6
WoodWisdom-Net 2			FP7

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Abstract

The main objective of the ERAWATCH Policy Mix Country reports 2009 is to characterise and assess in a structured manner the evolution of the national policy mixes in the perspective of the Lisbon goals, with a particular focus on the national R&D investments targets and on the realisation and better governance of the European Research Area. The reports were produced for all EU Member State and six Associated States to support the mutual learning process and the monitoring of Member and Associated States' efforts by DG-RTD in the context of the Lisbon Strategy and the European Research Area. The country reports 2009 build and extend on the analysis provided by analytical country reports 2008 and on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

This report encompasses an analysis of the research system and policies in Germany.

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