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Recommendations on German Science Policy in the European Research Area

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Preamble

Science is, and has always been international. It thrives on the free exchange of findings and methods, but also on the unhindered access to a varied range of research topics and infrastructures. "Internationalization" is the process of further transformation experienced in science through recent decades. Intrinsically scientific, social and ecological challenges, which can be met only on a global scale, became accompanied by political and economic interests and, due to globalization, rapidly increasing international competition. As a result, the internationalization of science is now driven not only by science itself, but increasingly also by political intention. |[1]

The report "Recommendations on the Internationalization of Science Relations" [Empfehlungen zur Internationalisierung der Wissenschaftsbeziehungen], presented by the German Council of Science and Humanities [Wissenschaftsrat] as early as 1992, focused on issues of studying abroad, foreign students and cooperation between universities, and on the perspectives of research funding at European level. |[2] The fact that the Council is addressing this topic afresh is due to the ever more dynamic formation of the dimensions and outlines of the European Research Area (ERA) associated with progressing European integration. |[3] With the establishment of this paradigm by the European Council and the European Commission began a stronger process of Europeanization, which is distinct from the general process of internationalization of science relations as it is molded, to a much greater extent, by political framework conditions. |[4] Therefore, the Council of Science and Humanities decided to investigate the

|[1] Cf. Chapter A.I and A.II.

|[2] The Council argued for further deepening of science internationalization in its „Theses for the Future Development of the System of Higher Education and Research in Germany“ [Thesen zur künftigen Entwicklung des Wissenschaftssystems in Deutschland] (pp. 22-27), published in 2000.

|[3] The number of EU Member States, which at the time of the Recommendations of 1992 stood at twelve, has risen to 27 by the accessions of 1995 (Austria, Sweden, Finland), 2004 (Estonia, Latvia, Lithuania, Malta, Poland, Slovenia, Slovakia, Czech Republic, Hungary, Cyprus) and 2007 (Bulgaria and Romania), with more countries expected to join in the future.

|[4] For a more detailed definition, see Chap. A.II.1.

consequences of the Europeanization of science through the emerging European Research Area for the function and significance of the national science system and national science policy, and to derive recommendations for the national actors. Since the process of Europeanization is interacting with the wider process of internationalization (cf. Chap. A.I), the role of German science policy in the European Research Area can be considered only in the context of the latter process. In doing so, existing conflicts of objectives and interests as well as opportunities have to be taken into account. In keeping with the national mission of the German Council of Science and Humanities, issues concerning the development of European science policy and the European Research Area as such are regarded as secondary for the present recommendations.

These recommendations, in contrast to those of 1992, primarily and specifically deal with issues of science and research policy, disregarding the development of the European Higher Education Area in connection with the Bologna Process and the cooperation between science and industry in the area of innovation. |[5] The Council of Science and Humanities reserves the decision to comment on those issues for future recommendations. The present ones are intended to outline options for the relation between the national system of higher education and research (science system) and the European Research Area, regarding the dimensions that are relevant for the process of Europeanization (research promotion and financing, institutions and research infrastructures, mobility and career paths). The addressees are the German federal and state [Länder] administrations, universities and science organizations, as the central representatives of German science policy and interests in Europe, and the specialist scientific associations as the forum and public presence of their respective disciplines.

The recommendations were prepared by a working group appointed by the Council of Science and Humanities in July 2007, which took up its tasks in January 2008. The working group included members from outside the Council, to whom the Council feels particularly obliged. Also, our thanks are due to the scientific and political experts from Germany and abroad, who made themselves available for discussions and hearings to share information and experiences. The Council of Science and Humanities passed the present recommendations on July 2, 2010.

|[5] Cf. most recent (without explicit reference to Europeanization): Wissenschaftsrat (2007).

Summary

The extent of international scientific cooperation has increased strongly over the past decades. At the same time, due to the emergence of new actors, such as China, India and Brazil, international competition in science has intensified. Reacting to these developments, the European Union expanded its research funding activities and strengthened its claim to shape European science policy, ultimately expressed in the paradigm of the European Research Area.

The present recommendations of the Council of Science and Humanities are based on the conviction that the European Research Area must be backed by strong science [systems] in the Member States of the European Union. Therefore, the first task is to ensure the necessary conditions for maintaining and expanding a well-differentiated and rich scientific landscape in Germany. This is a challenge, primarily, for federal and state [Länder] politics in its framework-setting function and in its capacity as an essential paymaster of science.

Secondly, to keep sustainable the existing national research facilities and funding organizations, it is vital for them to become more open towards the European Research Area and participate in a formative role in its development. In the future, national actors in science and politics should always take into consideration the conditions within, and the effects on the European Research Area, when making important, strategic decisions. Furthermore, effective agenda-setting at European level requires an enhanced ability to join forces and act together, professionally.

With regard to research funding, the Council sees great opportunities in a European Research Area where the individual actors operate autonomously, to a large extent, and which is enlivened by the plurality and competitiveness of the funding options on offer. Overlaps between funding offers at national and European level allow a precise fit of funding and sustain a degree of competition between the funding instruments, which can result in their optimization. Therefore, the Council argues for continuity in European joint funding and a long-term perspective and wider, formative scope for the European Research Council (ERC), and even more flexibility for the national funding bodies, e.g. the German Research Foundation (DFG). The Council welcomes the aspiration of the

DFG to retain a broad spectrum of funding projects and cooperate with European partner organizations in its commitment to high standards in review procedures and the facilitation of transnational cooperation.

The Council for Science and Humanities would emphasize the importance of big research infrastructures in shaping the structure of the European Research Area. The Council supports the European Commission in its intent to make research infrastructures easier to access for users from other Member States by allowing them to contribute to the respective operating costs. To preserve Germany's status as a location of outstanding international research infrastructures, her position in the decision-making processes concerning new European research infrastructures must be strengthened by the establishment of a national road map process, in which any funding measures for the widest range of projects would be weighed against each other in a forward-looking, transparent and science-led process. In this, each field of science must be able to assert its needs appropriately, and scientific as well as societal criteria must be taken into consideration.

The European Research Area is a space of increasing mobility for all scientists involved. This presents great opportunities for science, which profits from open exchange. Consequently, the Council of Science and Humanities argues that, rather than allowing short-term migration balances to occasion protectionist measures, mobility should be welcomed and the focus should be on enhancing the attractiveness of scientific institutions in Germany and Europe.

For individual universities and research institutions this means that they will develop their own strategies for internationalization, explore possibilities of strategic alliances with partners abroad, and support their scientists in international collaborations. Apart from their own efforts, they will require support from federal and state [Länder] agencies, which should allow them a wider scope of action in the implementation of their strategies for internationalization. Apart from these institutionalized forms of cooperation, the universities and non-university research establishments should continue to offer the freedom for scientists to choose partners for discipline-specific, temporary and discontinuous, international scientific exchange.

In the Council's view, the doctorate and postdoctorate phases as the periods of highest mobility are of crucial importance. Postdoctoral scientists, in particular, still suffer excessive career insecurity in Germany. Reliable career perspectives within the science system, such as tenure-track positions, transparent and speedy appointment procedures, but also better support for dual-career couples and a more family-friendly working environment can be crucial factors for making science more attractive as a professional occupation.

The present recommendations are guided by the vision of Germany as a strong science location, open towards Europe, and a European Research Area that is open to the world. As a space of exceptionally funded and facilitated scientific exchange and joined-up human and financial resources, it will effectively invigorate European science in competition with an increased number of international rivals.

A. Motivation and subject

A.I INTERNATIONALIZATION AND GLOBALIZATION: NEW CHALLENGES FOR SCIENCE AND SCIENCE POLICY IN EUROPE

Science has always been international in its constitution (cf. Chap. A.II.2); but the process of internationalization of science has accelerated continuously through the past decades. For instance, the proportion of scientific publications jointly authored by scientists from several countries has more than tripled to about 22 % from 1985 to 2007. The contribution of transnational collaborations in the area of inventions (patents with owners from two or more countries) as a share of the total number of inventions worldwide nearly doubled (from less than 4 % in the period 1991-1993 to 7.3 % from 2004 to 2006). EU Member States cooperate mostly with each other, but rather less on a global stage as the United States, while e.g. Japan and Korea are less active internationally, overall. |[6]

The dynamics of this development is attributable not only to technical conditions such as, most notably, the facilitation of global communication by digital media, but also to a number of reasons that are immanent to science (cf. Chap. A.II.2). New motors of the internationalization of science also arise from the changed relationship between science and society. There is a broad consensus that global, social and ecological challenges (e.g. climate change, energy supply, ageing populations) can only be mastered globally through collaborative efforts of nations and scientific expertise worldwide. Moreover, the scientific issues in some fields are beyond the economic capacities and scientific expertise available to individual nations and require joined-up financial and human resources. |[7]

|[6] On these and other indicators for the internationalization of research and technology, see also: OECD (2009e), p. 109ff. – For cooperation within Europe, the EU's Framework Programmes serve as crucial motors (see Chap. A.III.1.a).

|[7] For instance, for the development and operation of ITER, the International Thermonuclear Experimental Reactor, the EU cooperates with the US, India, Japan, China, South Korea and Russia.

Not only do individual scientists cooperate in the course of this internationalization, but national institutions, too, have become actors in this development, some of them supporting their respective activities by explicit strategies for internationalization. | [8]

Another essential factor for the rapidly increasing importance of an internationally positioned science sector is the worldwide development towards science-based societies, with knowledge as the central resource for innovation and securing wealth. Growth and wealth are based, to an ever larger extent, on products and services from knowledge-intensive segments of the economy, which are exposed to growing international competition, at the same time. | [9] As a result, the corporate private sector and politics have become strong external motors of internationalization. | [10]

So, for a number of quite diverse reasons, the internationalization of science relations is in the shared interest of science itself, the economy, society and politics. As a consequence, science policy departs from its traditional function, which was, essentially, to enable researchers to cooperate with other experts worldwide, and increasingly pursues its own strategic interests in such cooperation, ranging from strengthening the country as a (science) location to contributing to the resolution of global challenges (and, in the process, retaining a strong position in matters of foreign policy). In Germany, for example, the growing importance of this strategic dimension is reflected by the Federal Government's publication, in 2008, of a strategy for internationalization in science policy, with the following four principal objectives: strengthening research co-

| [8] In this regard, the initiatives of the German federal and Länder administrations are most notable, cf. the „Strategie der Bundesregierung zur Internationalisierung von Wissenschaft und Forschung“ [Federal Government's Strategy for the Internationalization of Science and Research] (2008); see also Wissenschaftliche Kommission Niedersachsen (2002). The Länder discussed their strategies for internationalization in spring, 2009, and decided to sound out possibilities for cooperation between each other and with the federal administration. Essentially, the Länder support the internationalization of their [scientific] institutions through appropriate incentive structures (consideration of internationalization indicators in target agreements and performance-related resource allocation) and scholarship schemes (cf. GWK (2009c)). – On the internationalization of the universities, see Teichler (2007), Brandenburg, Knothe (2008). – An overview of the respective activities of the research funding and operating organizations DFG, FhG, HGF, Leibniz-Gemeinschaft and MPG can be found in the explanations accompanying the “Pact for Research and Innovation” at the website of the Joint Science Conference (GWK): http://www.pakt-fuer-forschung.de/index.php?id=312 [last downloaded: 2010-04-12]; see also GWK (2009a), p. 7 and pp. 23-26, and the description of the internationalization activities of DFG, FhG, HGF, MPG and the Leibniz-Gemeinschaft in Edler (2007), Annex, pp. I-L. Explicit strategies for Europe are operated by the German Research Foundation (cf. DFG (2009)), the Fraunhofer-Gesellschaft (2002 and 2007, unpublished) and the Hochschulrektorenkonferenz [German Rectors' Conference] (2009).

| [9] Cf. Beck (1997).

| [10] For the relevant political initiatives at European level, see Chapter A.II.3 and Schütte (2008), pp. 14-16.

operations with the best in the world; accessing international potentials for innovation; strengthening the long-term cooperation with developing countries in the fields of education, research and development; assuming international responsibility and mastering global challenges. This strategy is accompanied by a science-oriented "foreign policy", highlighting the importance of science for policies concerning international security and development, bilateral relations between nations, foreign culture and education and, not least, as an instrument to promote Germany as a location. |[11] The state [Länder] governments too have been paying more attention to internationalization in the areas of research and higher education.

As a valuable resource, knowledge and, therefore, scientific personnel have become objects of global competition. This makes the creation of science areas a sensible proposition, insofar as they can boost the competitiveness of the cooperating members: "An evolving multi-polar world-economy is leading to multiple centers of science – the United States, the European Union, Japan, China, Russia and possibly India." |[12] That Europe finds herself under pressure in this competition, despite her distinctive strengths, is demonstrated by a range of indicators.

The European region is particularly strong in the training of young scientists and scholars. In 2005, about 100,000 individuals in Europe (within the EU27) successfully completed a doctorate – almost double the USA figure (53,000). Of these, more than 24,000 graduated in Germany and 16,000 in the UK: these two countries alone produced 40 % of the new doctorate holders in the EU27. |[13] Regarding the promotion rates, Germany comes top in Europe, both per head of population and in terms of doctorates per number of university graduates. |[14]

For the number of scientists |[15] per 1,000 working population, Europe managed a moderate increase over the past ten years (EU27: from 5.5 in 2002 to 6.4 in 2007), but is still ranking clearly behind Japan (11.0 in 2007) and the United States (9.7 in 2006). Korea, for comparison, achieved continuous growth in this

|[11] The strategy was presented by the German Federal Foreign Office as a policy focus in 2009. See also Schütte (2008).

|[12] Hollingsworth; Müller; Hollingsworth (2008).

|[13] European Commission: STC key figures report 2008/2009 (2008), herein p. 59.

|[14] In 2004, for every 100 non-doctorate university graduations (= ISCED 5), there were 11.77 doctoral degrees completed, compared to the EU27-average of 2.73, which is still higher than the USA figure, 2.37; cf. BMBF (2008a), p. 48, tables 2 and 3. A high promotion rate in Germany is found even disregarding certain courses that are normally completed with a doctorate, such as Law or Medicine (see also footnote 17).

|[15] According to the Frascati Manual, item 301, "researchers" are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned.

respect, from 6.4 to 9.5. With a ratio of 7.3 scientists per 1,000 working population in 2007, Germany stands mid-table in the European rankings, with Finland (16.1) and Sweden (10.6) at the top. |[16] So in Germany, in particular, there is divergence between a remarkable contribution to the training of young scientists and the ability to properly integrate this new blood in the domestic science system. |[17] Regarding the share of the total number of scientists worldwide, Asia (41.4 %) is now the unchallenged leader, followed by Europe, contributing 28.4 % overall. US scientists make up another 20.3 %. |[18]

In terms of the number of scientific publications |[19], Europe was at the top in 2006, with a share of 37.6 %, followed by the United States with 31.5 %. However, the percentage of publications from Asian countries is growing rapidly and eroding the leadership of Europe and USA: China more than doubled her share from 3.8 % in 2000 to 8.4 % in 2006, while India and South Korea registered significant growth as well (2.9 % each in 2006), resulting in a combined growth of China, India, Japan and South Korea in their share of publications from 16.9 % in 2000 to 22 % in 2006. |[20] Regarding the number of publications in relation to public investment in R&D, the USA beat Europe as a whole, although individual countries in Europe (Switzerland, Sweden and Finland, especially) have been doing significantly better than the USA. Germany, with a higher proportion of public expenditure on research and development, produces fewer publications than the United States, but still registers a result slightly above the EU average, according to this indicator. In this, one has to take into account that additional private funds are invested in the United States. Such funds are not available to a comparable extent in Germany. |[21] According to data for the decade from 1999 to 2009, the United States also lead with regard to their share of the 10 % of the most-cited publications and in the ranking by the number of citations (USA: approx. 44,700,000 citations, with Germany taking second place with about 9,407,000 citations). Measured by citations per publication, Switzerland takes the top slot with 15.73, in front of the United

|[16] OECD (2009a). Also Table A.2 in the Annex of this document.

|[17] This even holds true when taking into account that not every holder of a doctoral degree wishes to remain permanently in the science system, and it remains true when disregarding the high incidence of promotions in subjects such as Medicine, for which, in Germany, a doctorate is regarded as the initiating, professional qualification. The Council of Science and Humanities already issued critical statements in this respect at several occasions (Wissenschaftsrat (2002), p. 69; specifically concerning Medicine: Wissenschaftsrat (2004a), p. 75 and 97).

|[18] UNESCO Institute for Statistics (2009), p. 1.

|[19] Analysis based on data from Thomson Scientific CWTS, University of Leiden, Eurostat and OECD; covering publications in refereed, international journals. On the use of citation indicators, cf. King (2004).

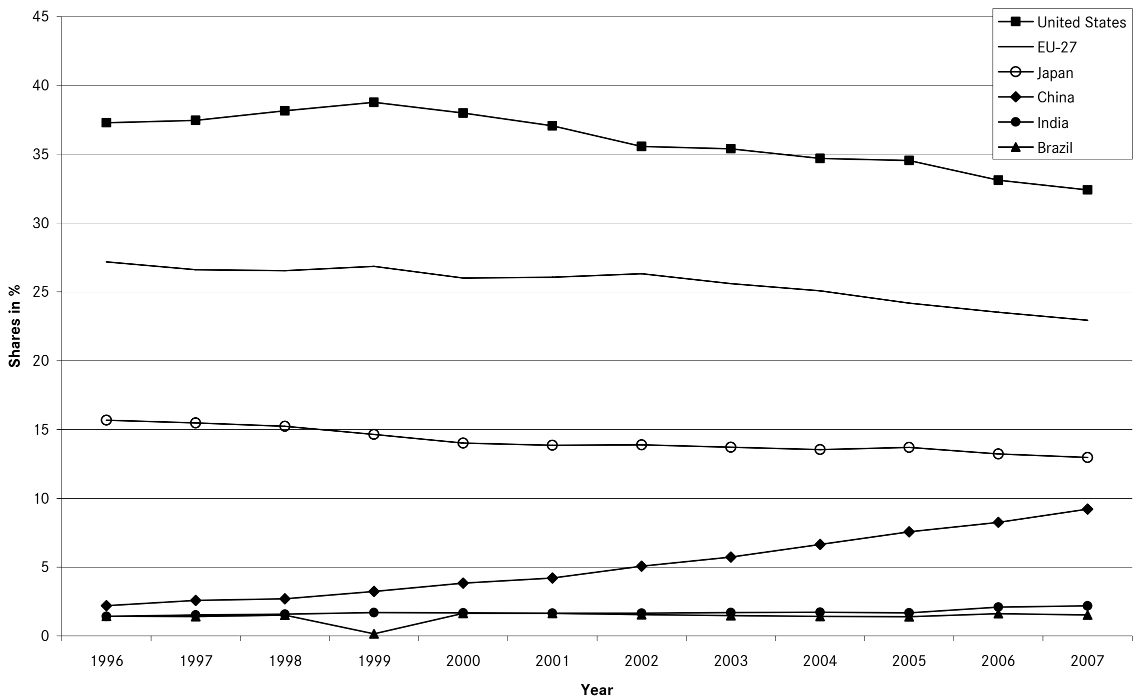
|[20] European Commission: STC key figures report 2008/2009 (2008), herein p. 61f.

|[21] Ibid., p. 62f.

States (15.02); in this ranking, Germany is far behind in 11th position (12.28 citations per publication). |[22] These indicators' significance may not be beyond dispute but, overall, they allow a valid comparison between the science systems, which in turn feeds back into the respective systems.

The changed global situation becomes particularly obvious when considering the volumes of finance invested in research and development: China, for example, significantly strengthened her R&D investments (to US $ 86.8 bn. in 2006), as did India (to US $ 23.7 bn. in 2004). Overall, the share of non-OECD nations in research and development (R&D) investment worldwide has reached 18.4 %, whereas that of the USA, Europe and Japan is now in decline. |[23]

Figure 1: Percentage shares of global R&D investment (1996-2007)



Source: The OECD Innovation Strategy: Getting a Head Start on Tomorrow

This finding is supported by an analysis of triadic patents |[24] as an indicator for innovation potential and successful technology transfer: Even if the United States still remain in front, her share has gone into decline, as is the case for the European Union. At the same time, the share of some emerging countries (espe-

|[22] Thomson Reuters: Essential Science Indicators (as of December 2009); cf. Table A. 2 in Annex. For a detailed discussion of the German performance in terms of bibliometric indicators, cf. Schmoch; Qu (2009).

|[23] Cf. OECD (2008a), p. 21.

|[24] Triadic patents are registered in the two foreign markets of the Triade regions USA-Europe-Japan, in addition to the respective domestic market. They usually represent inventions of high technical and economic impact and reflect the international orientation of the registering companies.

cially China, India and Korea) has risen significantly between 1995 and 2005, though starting from a low level. |[25]

Moreover, Europe's distinctive strength, which lies in a wide range of universities performing at a good level in teaching and research, cannot hide the fact that, when it comes to top-level research, the European universities lack international profile. This is what German politics reacted to with the paradigmatic change introduced by the Excellence Initiative established in 2005 |[26]. It was also highlighted by the research rankings by Shanghai Jiao Tong University, published annually since 2003, even if in those rankings non-university research facilities are not taken into account. In 2009, the TOP 20 include 17 higher-education institutions in the US, but only two universities in Europe (Oxford and Cambridge) and one in Japan (University of Tokyo). The highest-ranking German universities are LMU Munich (55th), TU Munich (57th) and the Heidelberg University (63rd). Still, in terms of the number of universities among the TOP 500, Germany is ranked equal second with the UK, behind the USA. Regardless of any conceivable criticism |[27] of the Shanghai Ranking, one cannot fail to note that the trend of the results is actually reflected by other indicators, too. For instance regarding breakthrough achievements in basic research, Europe has clearly lost ground against the US. While in the early part of the twentieth century the list of Nobel Prize winners was led by European scientists, this most prestigious award is now dominated by researchers from the United States. |[28]

|[25] Cf. OECD (2009b), p. 170f. and Table A. 2 in the annex of this document.

|[26] The Excellence initiative – as stated by the then chairman of the Council of Science and Humanities, Karl Max Einhäupl in a press release of 2006-01-20 – supports an "eagerly awaited paradigmatic change in the German higher-education system, by which we finally depart from the idea of homogeneity and acquaint ourselves with the concept of diversity".

|[27] For instance, the significance of the ranking is limited by the fact that, due to the choice of indicators, the focus and priority is on the performance in physical sciences, life sciences and mathematics, as the indicators are unsuitable for an appropriate assessment of achievements in social sciences and humanities. Other criticism relates to its failure to allow for country-specific structures of the science system, its mixture of historic and current performance indicators, and its systematic preference for publications in English.

|[28] For comparison: Between 1901 and 1932, 35 Germans were awarded the Nobel Prize, against only eight USA citizens (not including the Nobel Peace Prize and the Nobel Prize for Literature). Between 1966 and 2006, on the other hand, there were 216 US-American and 16 German new Nobel laureates; in 2007 to 2009, 18 researchers working in the US (nine of them born in other countries) and four Germans received such an award (http://nobelprize.org/nobel_prizes/lists/all/ [last downloaded 2010-04-12]).

The previous chapter outlined the areas of concern that have arisen from the internationalization of science, global challenges and the process of globalization. Before the central fields of action in the course of Europeanization are described (Chap. A.III), this chapter presents an inspection of the technology-driven dynamization of international cooperation, on the one hand, and the politics-driven Europeanization, on the other, based on precise definitions. The description of the general internationalization of the sciences is complemented by a brief consideration of different aspects of internationality and internationalization in exemplary disciplines.

II.1 Definitions

As the internationalization of national science institutions is progressing, it is also becoming the subject, increasingly, of strategy papers and discourses. |[29] In these, one sometimes finds a notable degree of indeterminacy and vagueness in the definition of terms and concepts. |[30] Therefore, the outline of the historical development of the internationalization of science and the Europeanization of science policy, which affect the relation between the nation and science, is preceded by some notes of definition.

Internationalization

Internationalization can be understood as the process of increasing transnational activities, in which national institutions provide the legal framework, forms of organization or financing to initiate transnational cooperations. In contrast to this, the term globalization implies the idea that national borders and systems are of diminishing relevance. |[31] The present recommendations assume the view that, while national science systems will remain important, especially on the institutional level, the national reference frame for the scientific activities carried out, and the scientific results produced in them will be progressively extended to become international, so that the process can be properly described as internationalization. However, this terminological definition is not intended to deny the existence of globalization phenomena. |[32]

|[29] Cf. Edler (2007).

|[30] See also Teichler (2003), herein p. 21.

|[31] Cf. Teichler (2003), p. 20; Kehm (2003), p. 7, with further literature on the internationalization of the university sector.

|[32] As, in this case, recourse is primarily made to the system of scientific institutions, this does not contradict the conclusion by Stichweh (2003) with regard to the entire science system – thus using another

Distinct from the process of growing international cooperation in science, there is, firstly, the fundamental internationality of science, which constitutes a precondition and a consequence, at the same time, of internationalization. |[33] The internationality of science is mainly based on the claim of universality of scientific statements. Due to this claim, the validity of scientific statements is invariable in exchange between persons, as well as in space and in time. For the same reason, the cooperation between researchers is international, in principle, and resists the drawing of borderlines. Secondly, a distinction must be made between internationalization and internationality as the actual condition of an institution in regard to international activities |[34], reflected e.g. by the number and percentage of foreign personnel, collaborations with institutions abroad, and international co-publications.

Europeanization

In contrast to the essentially science-driven process of internationalization (cf. Chap. A.II.2), the process of Europeanization is influenced much more significantly by political conditions (cf. Chap. A.II.3). This process is associated with the concept of the European Research Area, which has been guided, primarily, by the model of the European Economic Area and the Single Market, and is accompanied by the creation of European institutions. In this context, institutions installed centrally at European level need to be differentiated against intergovernmental institutions, which were established predominantly on the basis of science projects, bottom-up, as it were. Consequently, the emergence of such institutions, founded in a variable geometry |[35] is less the result of Europeanization than of a process of internationalization (albeit at European level).

II.2 Internationalization of science

Historical development of the nationality and internationality of science

While scientific activity in the medieval and early modern eras usually ranged across borders – not least because Latin was used as the language of science –,

definition of the system – that “there is no evidence anymore for any plurality of science systems […] in the present world” (p. 6).

|33 Cf. the first sentence of the Council’s recommendations of 1992: „Internationalität ist Teil des Wesens von Wissenschaft“ [internationality is an essential characteristic of science]. (p. 5).

|34 Also in Brandenburg; Knothe (2008), p. 10.

|35 In the EU context, the term “variable geometry” is used to describe a model of differentiated integration, with provisions for various levels of participation of individual Member States in measures at European level.

scientific education and research became institutionalized and funded nationally due to the rise, and at the instigation of nation states in the late eighteenth and early nineteenth century. |[36] Especially the major nations developed national science cultures, accompanied by the growing importance of national languages as the media of scientific communication. Politicians and the public increasingly expected proof for the "usefulness" of science, putting it in a functional context with the nation state. Thus there occurred two fundamentally opposed processes in the eighteenth and nineteenth centuries: differentiation of science into disciplines, on the one hand, which favored transnational communication, and nationalization of scientific communication and of the forms of organization of science, on the other. |[37] In the first half of the twentieth century, World War I, national socialism, especially by its ejection and, later, murder mainly of Jewish scientists, and World War II unleashed by the national socialists broke the free, international exchange of knowledge in Germany. This interruption still affected the performance and reputation of the German science system long after the end of the war. Subsequently the revived scientific relations contributed, to a considerable extent, to the process of European integration and the German participation in it |[38], while the Cold War continued to put restrictions on free international, scientific exchange. This phase could be considered as of the past only towards the end of the twentieth century.

At the beginning of the twenty-first century, the sciences are still funded and institutionally organized mostly at national level (see also Chap. A.III.1 on this point). In Germany, the Federalism Reform of 2006 strengthened the competences of the federal states [Länder] in the science sector, even if research funding remains a joint responsibility according to Art. 91b of the German Constitution [Grundgesetz] |[39], so that research funding and certain framework conditions are a matter for both national and regional governments. |[40] Nation states are still in competition with each other, although the reference frame of the sciences has become more and more global, regarding their topics, media, re-

|[36] Seminal in Stichweh (1991), who describes the centuries-long history of slow nationalization and territorialization of the European university, and; Vosskamp (1991). On the history of universities, cf. Rüegg (1993-2004); Moraw (2008). On graduation (e.g. the introduction of "state" graduation exams) and issues concerning the validation of preconditions, Hammerstein (2007).

|[37] Cf. Crawford; Shinn; Sörlin (1993); on the relation between the sciences and the nation, cf. Jessen; Vogel (2002), herein p. 34.

|[38] Note e.g. the initiatives for the foundation of intergovernmental research facilities, such as the establishment of CERN in 1955, and of EMBL or ESO (see Chap. A.III.2.a).

|[39] Cf. Hacker; Gaul (2007).

|[40] Generally, the regions in Europe, which can be conceived as transnational entities, have have grown in importance over the past decade (e.g. Basle-Strasbourg-Freiburg).

sources, career paths and reputations |[41]. For many science topics, international cooperation is essential for creating competitiveness. This in turn has the effect, especially in math, physical sciences and life sciences and in many engineering and economy-related disciplines, that national science languages receded more and more in favor of English as the common language of research communication (cf. Chap. B.I.).

Dimensions of the internationalization of science

In the internationalization of science and research, one can distinguish between the topical or epistemic, the institutional and the science-policy dimensions. |[42]

Internationality or internationalization can relate to the topics, but also to the methods or cultures of the disciplines as such. For instance, the humanities and social sciences often deal with issues that are defined at a cultural and, thus, national level, as well as with comparisons between different cultures and nationalities, entailing the explicit reflection of the national dimension of the topic. In contrast, the subjects of the natural and engineering sciences are usually free from national characteristics, in some cases to such an extent that they can be called universal (with varying degrees of internationality, see below). Internationalization can also give rise to conflicts between the scientific and scholarly traditions. In the humanities, for instance, the Anglo-Saxon tradition, according to which this class of disciplines is are defined through their institutional structure and the societal mission associated with them, has come to dominate, while the German tradition, guided by the more theoretical and abstract concept of "Geisteswissenschaften" [the arts], is feared to loose out against the former. |[43]

The institutional dimension of science internationalization includes e.g. the forms of organization, institutions, programs, career patterns and forums of publication of the sciences. Concerning such forms of organization and institutions, internationalization may also mean formal, international organization, e.g. as European institutions. At the same time, there is progressing internationalization of those institutions, too, that remain formally bound to the nation state – as for instance the universities, the German Research Foundation (DFG), the Max Planck Society (MPG), the Helmholtz Association (HGF) or the Fraunhofer-Gesellschaft (FhG) –, but may have to consider international frameworks when defining their tasks and strategies, and must refer to such condi-

|[41] As stated in Bogdandy (2007), herein p. 72f.; cf. also Teichler (2003), p. 21.

|[42] The legal dimension regarding science is not considered here; on that point, cf. Lindner (2009).

|[43] Cf. Mittelstraß (1997).

tions, even if that involves establishing their own institutes and facilities abroad. |[44]

The internationalization of science policy is another dimension insofar as it creates supranational science-policy actors (especially at European level), on the one hand, and forces national and regional science politics to consider European or international developments in their decision making (see Chap. A.II.3).

Science-immanent driving forces of internationalization

Apart from the genuine interest of researchers, who appreciate the positive effects of cooperation with other experts worldwide on the creation of knowledge and the quality and productivity of research, the increasing internationalization of science is also essentially attributable to the changing nature of scientific knowledge-creation as such, described by Gibbons et al. (1994) as the transition from "Mode 1 to Mode 2 of knowledge production". According to their argument, there is a development away from research anchored in disciplines, conducted at universities and driven by science, to transdisciplinary research, with a stronger focus on problem solving and social challenges, which it approaches by forming temporary networks. This transition would be accompanied by ever faster scientific production. |[45] Even if the traditional disciplinary core still constitutes a basis for the new, rather interdisciplinary research practices, the emergence of scientific fields such as life sciences, material sciences and computer sciences led to considerable changes in scientific production.

It is mainly the knowledge interests of the individual researcher what determines their preparedness, in principle, to enter international cooperations. This is further driven by the fact that the increasing subdisciplinary differentiation of the sciences, which in turn leads to ever more specialization of scientific topics, makes it more and more likely that the few world experts in the respective field cannot be found in any single, national environment. |[46] The exchange with such experts has become much easier due to the development of new me-

|44 Several German-model universities were founded in other countries in recent years, with German universities involved as partners, such as the German University in Cairo (GUC) or the German Jordanian University (GJU) in Amman. Regarding non-university research facilities, there are e.g. the international activities of the Fraunhofer-Gesellschaft, which operates affiliated organizations in Austria, Portugal and Italy, a contact office for European issues in Brussels, six Fraunhofer Centers in the US, as well as Representative Offices in Japan, China, Indonesia, Korea and the United Arab Emirates. More recently, the Max Planck Society, too, established a new foreign outpost, the Florida Institute in the US. Apart from that, the establishment of a new Institute for Comparative Procedural Law is imminent in Luxembourg, and there will be an institute in Shanghai.

|45 Gibbons; Limoges; Nowotny et al (1994).

|46 Cf. Stichweh (2003), p. 23, with further literature.

dia and capabilities for real-time communication across all borders. Another motor for internationalization is the emergence of scientific topics (see also the typology below) of global reach and interdisciplinary character (e.g. migration studies, climatology, biodiversity research, population ageing) that cannot be treated appropriately within a national scope. Finally, technical progress and the possibilities thus opened for research at ever larger research infrastructures, and the rising costs involved create pressure towards internationalization. This is reflected by the emergence of a road map for large research infrastructures at European level (European Strategy Forum on Research Infrastructures (ESFRI), cf. Chap. A.III.2.B). Furthermore, large research infrastructures can only be realized if other countries beyond Europe also contribute to their funding and operation (e.g. the European Organization for Nuclear Research (CERN) or the International Thermonuclear Experimental Reactor (ITER), see Chap. III.2.a). And last but not least, a high level of internationality has come to be regarded as a seal of quality, which can influence funding decision, adding another, financial incentive to above-mentioned science-immanent motors of internationalization.

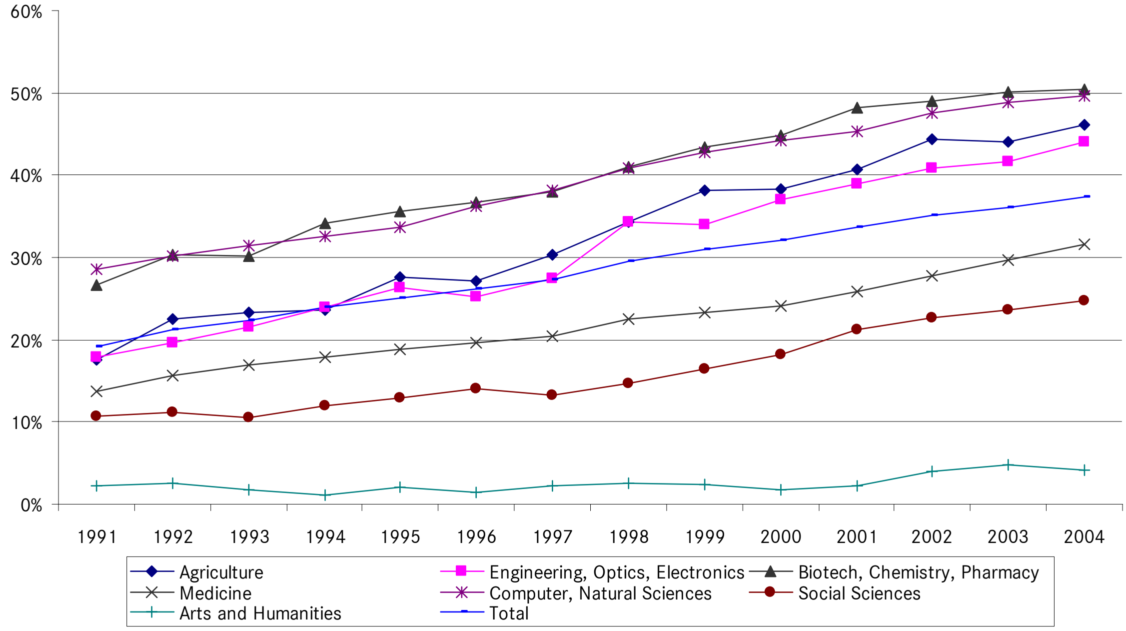
Internationalization and internationality in different scientific fields and disciplines

The progressing internationalization of science presents itself quite differently for individual scientific fields and disciplines, as regards the central parameters of internationality (scientific issues, language and publication media, career paths, reputation, resources, quality standards, cooperations). There is a wide spectrum, ranging from highly internationalized areas, essentially organized in clusters with globally operating specialist communities and standardized methods, internationally accepted customs of publication and binding quality standards, to disciplines that remain rather multilingual, individualized and specific to certain national and cultural characteristics. |[47] As, on the one hand, adequate treatment of every individual discipline is neither intended nor possible within the scope of the present recommendations, but, on the other, discipline-specific factors determine the degree of internationalization to a large extent, a heuristic typology of different levels of internationalization is developed in the following. The variations established therein show that a recommendation demanding “more internationalization” would fail to do justice to the special features of the scientific disciplines and fields.

|[47] Regarding the internationality and internationalization in different scientific fields and disciplines, cf. Schütte (2008), pp. 122-183, with contributions on the internationalization of the humanities (by Peter Strohschneider), jurisprudence (Dieter Grimm), sociology (Friedhelm Neidhardt), physics (Ulrich Schollwöck), chemistry (Katharina Kohse-Höinghaus), life sciences (Martin Korte) and engineering sciences (Friedrich Pfeiffer); MPG (1997) with contributions on engineering sciences by Dagmar Schipanski, on humanities by Jürgen Mittelstraß, on biomedical research by Francois Kourilsky, and on physics by Richard Brook.

Firstly, even a very general classification of scientific fields reveals significant variations in the percentage share of international co-publications |[48]:

Figure 2: Share of international co-publications among all publications as per faculty, 1991-2004



Source: Redrawn from Edler 2007 (p. 80), based on Social Science Citation Index/Science Citation Index

The share of international co-publications has grown significantly across the faculties, except for the humanities, where individual authorship remains the dominant mode of publishing. |[49] The highest degree of internationalization is found in the fields of biotechnology, chemistry, pharmacy, and in natural sciences and computing sciences, where about 50 % of all publications in 2004 were by co-authors from several countries. |[50]

Secondly, when using the proportion of foreign scientists and scholars in different subject groups at German universities (following the systematics of the public statistics) as an indicator for the internationalization of human resources, one finds wide variations between the subject groups. The percentage share of

|[48] Edler (2007).

|[49] According to OECD data, the proportion of published papers by international, scientific co-authors worldwide stood at 21.9 % in 2007, which is three times the percentage in 1985 (OECD (2009e), p. 114). The growing importance of international co-publication, compared to other forms of publication, is evidenced by figure A.1 in the annex.

|[50] The wide divergence of publication modes is also confirmed in the summary analysis of all indicators of internationalization considered in the study (mobility in both directions, international cooperation, use of knowledge generated internationally). In this, the highest level of internationalization was found in natural sciences and computer sciences, the lowest in the humanities and social sciences (Edler (2007), p. 101). See also AvH (2009a); DFG (2005).

foreign academics is highest in the subjects of the natural sciences and mathematics (13.0 % in 2008), compared to the rather low proportion in law, economics and social sciences (4.6 %, see table below).

Table 1: Academics employed in sciences and arts at German universities, 2008: percentage of foreigners in the subject groups*

Subject group/ origin	Scientists/ scholars total	Percentage of foreigners total**	Foreigners (EU)	Foreigners (other European)	Non-European foreigners
Language and cultural studies	39.304	10,7 %	6,3 %	1,4 %	3,0 %
Sports	2.606	1,7 %	1,1 %	0,1 %	0,5 %
Law, economics and social sciences	44.523	4,6 %	2,4 %	0,8 %	1,4 %
Math, natural sciences	53.068	13,0 %	5,4 %	2,7 %	4,9 %
Human medicine/ health sciences	53.838	8,1 %	4,2 %	1,3 %	2,7 %
Veterinary medicine	1.695	7,7 %	3,7 %	1,5 %	2,4 %
Agricultural sciences, forestry and nutrition science	5.371	6,6 %	2,3 %	0,9 %	3,4 %
Engineering science	39.703	9,2 %	3,2 %	1,7 %	4,3 %
Arts, art sciences	16.188	10,6 %	5,1 %	1,8 %	3,8 %
Central facilities (exc. clinical facilities)***	17.383	13,3 %	7,3 %	1,6 %	4,3 %
Central facilities of university hospitals	1.090	3,9 %	1,8 %	0,7 %	1,3 %
Total	**274.769**	**9,4 %**	**4,5 %**	**1,6 %**	**3,3 %**

* The nationality of academic and research staff has been recorded by the German Federal Statistical Office since 2005; ** incl. stateless/unresolved; *** the "central facilities" category includes university administration, the library, the university data center, central science facilities, language labs, etc.

Source: Federal Statistical Office: Fachserie 11, Reihe 4.4, Tab. 13

The subject group math and natural sciences also plays an outstanding role in terms of foreign scientists funded by science organizations to work in Germany, hosting more than half of all foreign researchers funded in this way |[51] and, conversely, registering the largest number (a third of the total for all subject groups) of researchers working abroad with support of funding organizations. |[52]

Even if these selected indicators do not reflect every facet of internationality, they illustrate the existing divergence between scientific fields internationalized to different degrees. This could also be demonstrated by pointing to the existence or non-existence of international publishing organs, specialist professional associations or quality standards.

The varying degrees of internationalization are attributable to a number of factors. First of all, there are the different knowledge objects of the respective scientific fields: The higher degree of internationalization of the natural sciences follows from the universality of nature as a research subject *per se*, whereas the humanities and social sciences deal with context-dependent social and cultural

|[51] DAAD (2009).
|[52] DAAD (2009), p. 84.

phenomena. |[53] For instance, the predominantly national orientation of jurisprudential research lies in its association with the national legal system. However, the growing importance of supranational, international and comparative law and the considerable export of law have given rise to a process of internationalization in jurisprudence, too. Similarly, in medicine, where close links to the respective national health system can set limits to internationalization in some areas, in others the need for large cohorts of patients necessitates transnational cooperation. In the same context, the different linguistic conditions of the sciences also play a significant role: While English has become the primary language of science in the natural sciences and life sciences, this process cannot progress to the same level in research disciplines that are characterized by a specific language (cf. Chap. B.I.).

The above-mentioned variations in the reach of the knowledge object are again reflected in the different publication places used by individual fields of science: While for the natural sciences, international publishing organs enjoy the best reputation, the main publication places for literature studies and jurisprudence are national in character. |[54] The forms of institutionalization as well as the history of the disciplines also have their effect on their national or international orientation. This is most notable in the relatively young, hybrid fields, e.g. bioinformatics, which only recently began institutionalizing themselves and, therefore, are still relatively independent of national traditions and forms of institutionalization.

Another important motor of internationalization, apart from the reach of the knowledge object, is the volume of human resources and instrumentation required for the respective research. In certain areas of basic scientific research, there exists a clear correlation between the necessary division of labor and the degree of research internationalization. This becomes particularly obvious where research requires large infrastructures, which necessitate international cooperation due to their requirements of finance and human resources. The prime example for this case is physics with its highly international, specialist communities and associations with their shared demands for large infrastructures. |[55] Similar setups are found in fields such as molecular biology, immunology and neurosciences, where research requires large networks, laboratories

|[53] Even so, the methods and thought patterns applied in the natural sciences also show cultural characteristics and are thus not independent of context.

|[54] AvH (2009a), p. 6.

|[55] International research infrastructures have been created since the mid twentieth century, such as CERN, the world-leading research center for particle physics, ESO, the astronomy and astrophysics observatory founded in 1962, the European Synchroton Radiation Facility (ESRF) and the ILL institute for neutron research.

and international databases. The international Human Genome Project, for instance, which from 1990 to 2003 pursued the complete decryption of the human genetic material, involved researchers and institutions all over the world.

The intensity of their coupling to other subsystems of society also affects the degree of internationalization of individual scientific fields. If this coupling largely consists of cooperative relations with the regional or national economy, this – as far as it entails a high degree of exclusivity concerning intellectual property exploitation – can hold back the process of internationalization, whereas cooperations with global industrial corporations can have the opposite effect.

In conclusion, the diverse levels of (institutional) internationalization can be described as a result of different knowledge dynamics. Starting from (and simplifying) appropriate, science-sociological approaches |[56], one can form categories that allow describing certain determinants of knowledge dynamics: Science topics differ in their need for complementary cognitive or institutional competence, i. e. regarding the extent to which human or material resources in addition to the intellectual capabilities of the investigator are required for researching the subject. |[57] The investigative horizon of the research project determines its reach (which is narrower, e.g. for a study of the Low German language than for the research of general, physical laws of nature). The more complementary competence is required and the more universal the investigative horizon of the research project, the higher will be its level of internationality. A third category comprises the internationality of personnel, with the distinction between internationalization by way of German scientists and academics staying abroad (outward dimension) and internationalization by foreign researchers working in Germany (inward dimension). Regardless of these categories, though, it should be noted that all fields of science and scholarship are subject to a general tendency towards internationalization.

II.3 Europeanization of science policy

Within the continuously increasing internationalization, special significance belongs to Europeanization as a process strongly influenced by political framework conditions. |[58] Europeanization follows from the traditional scientific as-

|[56] For the description of knowledge dynamics (especially in the "new sciences"), Bonaccorsi (2008) proposes the dimensions "rate of growth", "degree of internal diversity" (trend towards convergence vs. trend towards divergence) and "complementarity" (need for additional technical, cognitive or institutional resources); Whitley (2000) starts from the categories "dependency" and "uncertainty".

|[57] As Bonaccorsi is able to show by the proportion of industry partners (table 3 in his article), computer sciences, for instance, require much more additional competence than particle physics.

|[58] Here and in the following, the terms "Europe" and "European" primarily refer to the European Union.

sociations established within Europe, but is essentially based on the decision by the European Council to create a European Research Area (ERA) as the mainspring of Europeanization, following the example of the European Economic Area. The European Research Area is closely linked to the central theme of the European Higher Education Area promoted within the so-called “Bologna Process”. Its goal is the “creation of the European area of higher education as the key way to promote citizens’ mobility and employability and the Continent’s overall development”. |[59]

The following is a description of the Europeanization of science policy, referring exclusively to the European Research Area, followed by an outline of its consequences for national science policy.

Historical development of a European science policy

Initial efforts towards a common research and technology policy started as early as 1957 (treaty establishing the European Atomic Energy Community (EURATOM)). The breakthrough for European research funding was reached only in 1984, with the passage of the First Framework Programme for Research and Technological Development, which joined up the EU activities in this area. Since then, the Framework Programmes constituted the main instruments of research funding by the European Union, with the initial objective to strengthen the scientific and technological foundations of industry in the Union. Common research funding is subject to the general European principle of subsidiarity, meaning, according to Art. 5 of the Treaty on European Union (TEU), the European Union may become active in areas outside its exclusive competence only if and insofar the aims of the measures under consideration cannot be achieved adequately at Member State level and joint action promises demonstrably better results.

With the Reform Treaty of Lisbon |[60], signed by the Member States in 2007 and effective since December 2009, the European Research Area is explicitly established as an objective of European research policy, and research policy (TITLE XIX, Art. 179-190 TFEU) is defined as an area of “shared competence”. In future, the Union and the Member States shall together pursue further development of

|[59] From the Bologna Declaration of the education ministers of European countries (including non-Member States of the EU) of June 19, 1999, printed in: HRK (2004), p. 7ff.

|[60] Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007, ABl C 306 of 2007-12-17.

the European Research Area in dual competence, by which the European Union also obtains the competence to issue regulatory acts. |[61]

The Framework Programmes for Research and Technological Development (FPs) of the European Union have been the main instruments of research and technology funding in Europe since the implementation of the FP1 (1984-1987). Through a series of upgrades, extensions to areas of funding, and continuous budget increases (cf. Chap. A.III.1.A), the Framework Programme has become the biggest research funding scheme in the world.

The significant step-up of funds from the Sixth to the Seventh Framework Programme happened in the context of the so-called Lisbon Strategy of the European Union of the year 2000, aiming to make Europe the "most competitive and dynamic knowledge-based economic area in the world". |[62] Strengthening knowledge and innovation was intended to be an important contribution to the achievement of this aim. To this end, an increase of investments in research and development to 3 % of the gross domestic product (GDP) by the year 2010 (Barcelona Target) was adopted. |[63] The Lisbon Strategy (also known as Lisbon Agenda) is based on the premise that the competitiveness of the European area of science and innovation can only be sustained if the countries of Europe focus more strongly than before on cooperation and open borders, while maintaining competition within the area (in analogy to the concept of the European Single Market). In this way, the Europeanization of science policy keeps following European economic policy, which it has served for a long time, and still does.

The concept of the European Research Area

The concept of the European Research Area was originally coined by Ralf Dahrendorf, the first European Commissioner for Research, in the early 1970s. However, it only developed major impact when Research Commissioner Philippe Busquin released a Communication from the European Commission, "Towards a European Research Area", in January 2000, in preparation for the Lisbon summit (and the imminent expansion of the EU). His comments were occasioned by a comparison of Europe against the United States and Japan in terms of several R&D indicators, which turned out rather unfavorable for Europe. The fragmentation of research funding and structures in Europe was identified as

|[61] According to Art. 4 Para. 3, exercise of the Union competence does not prevent the Member States from exercising their own competences. For the first time, the union is also given a competence for space flight (Art. 189).

|[62] Council of the European Union (2000), p. 2.

|[63] Since this 3%-target is an essential element of the Lisbon Strategy for Research, it is also often referred to as the 3%-Lisbon Target.

the main cause of this weakness: “The European research effort as it stands today is no more than the simple addition of the efforts of the 15 Member States and the Union. This fragmentation, isolation and compartmentalization of national research efforts and systems and the disparity of regulatory and administrative systems only serve to compound the impact of lower global investment in knowledge.“ |[64]

Therefore it is a central aim of the concept, which was backed by the European Commission at Lisbon, to structure the European research landscape and to better coordinate the national research policies and funding programs in Europe in order to achieve optimal benefit for the economic and social development of the European Union. Again, science policy clearly serves economic and political objectives. |[65] The concept comprises three interconnected aspects: 1) a European “single market” |[66] for research, where researchers, technology and knowledge can cross borders without restrictions, 2) effective, Europe-wide coordination of national and regional research activities, programs and strategies, and increasingly 3) initiatives implemented and funded at European level. |[67]

With this concept of a European Research Area, anchored in the Lisbon Strategy, and by means of the Open Method of Coordination |[68], the way was carved for the establishment of a comprehensive European research policy, which, by European Commission Communication, was conveyed to the Seventh Frame-

|[64] European Commission (2000), p. 8.

|[65] Cf. European Commission (2000): “In Europe, however, the situation concerning research is worrying. Without concerted action to rectify this the current trend could lead to a loss of growth and competitiveness in an increasingly global economy. The leeway to be made up on the other technological powers in the world will grow still further. And Europe might not successfully achieve the transition to a knowledge-based economy.” (p. 4).

|[66] The appropriateness of the Single Market-analogy for the realm of science is not undisputed, though, since the Single Market, according to Article 126 TFEU (ex Article 14 TEC), is supposed to be a national market on a larger scale, in which a specifically German market ceases to play a central role. Thus, due to the factual and desired continuance of national science systems, the analogy is misleading. On this issue, see also v. Bogdandy (2007).

|[67] European Commission (2000), p. 27: “The European research area should be an area where the scientific capacity and material resources in Member States can be put to best use, where national and European policies can be implemented more coherently, and where people and knowledge can circulate more freely; an area attractive both to European researchers and to the best researchers from third countries and built on respect for the common social and ethical values of Europeans and their diversity.“

|[68] The so-called “Open Method of Coordination” (OMC) was developed by the EU as an instrument of mediate policy coordination in the 1990s. It was formally introduced under the Conclusions of the Council of the European Union of Lisbon in March 2000, and of Gothenburgh in June 2001 as a new, complementary policy instrument of the EU. In this, the Council formulates intended outcomes and guidelines, whose attainment at national level will be subjected to mutual inspection through transnational monitoring, which is indicator-based in most cases. Essentially, the coordination process promoted by OMC evolves beyond clearly defined legal foundations and thus beyond the treaties.

work Programme. [69] With new instruments aiming to join up national and European research funding resources, the Seventh Framework Programme (as well as FP6, in parts) supports the coordination of funding schemes according to the ERA concept (cf. Chap. A.III.1.b). In 2007, Research Commissioner Janez Potočnik presented a Green Paper offering a progress assessment and suggestions for new orientations of the European Research Area. [70] Subsequently, after extensive consultations the latter were further specified as five concrete, political initiatives concerning the career paths and mobility of researchers, research infrastructures, knowledge-sharing, shared program-planning and international cooperation in the field of science and technology. [71]

The Commission and the European Council have claimed for themselves an extended, formative role in research politics, for instance by seeking to influence the employment conditions of researchers in Europe by the publication of the – legally non-binding – "Charter for Researchers" in 2005. [72] Regarding the creation of institutions at European level, the establishment of the "European Institute of Innovation and Technology" (EIT) in 2008 was a relevant development (cf. Chap. A.III.2.a).

The ERA concept and the EU initiatives mentioned so far set off a dynamics of consultation about conditions of a common research area, even if the EU, for want of legally binding instruments to actually implement the concept, depended on the voluntary participation of the Member States. In this way, in recent years, the idea of a European Research Area served as guidance for the development of the national research policies in a common direction, although de-facto integration of those policies has not taken place so far.

Effects on national and regional science policies

The development of the European Research Area and its governance, combined with the strengthening role of the European Union as a funding source for research and an actor in science and higher-education policy – or, more precisely, research policy – is changing the context for the German federal and state [Länder] administrations to define their own science policy strategies. European policy strategies, in turn, are set in the wider context of federal and state [Länder] activities concerning internationalization.

[69] European Commission (2004); European Commission (2005a).

[70] European Commission (2007a).

[71] The initiatives are presented together in: European Commission (2009a).

[72] Cf. Lindner (2009), p. 12, pointing to the "tendency of the commission to compensate for the lack of competences of its own in the realization of the European Research Area by measures that generate factual, political obligation without being legally binding."

Consequently, national science policy is caught between two different aims: to create an appropriate framework for supporting science in its efforts towards internationalization and, at the same time, properly take into account the national interests addressed at science policy from other fields of politics.

The science sector expects national policy measures enabling optimal adaptation of scientific institutions to European as well as international structures and framework conditions, with the focus of institutional coordination, too, shifting from national states to transnational level. The question how university and non-university institutions are positioned and integrated at international level is becoming more and more important. Europeanization and internationalization always comprise domestic and external components: National and regional levels interact with the EU, just as national research institutions interact with each other and with supranational, intergovernmental institutions. |[73]

However, science also fulfills functions in other fields of politics, e.g. where winning and retaining a highly qualified workforce are the issues. |[74] In this case, science's traditional disinterest in national borders conflicts with national economic interests, |[75] a situation that science policy is asked to resolve in a functionally adequate way.

Apart from these conflicts of objectives (between national and European interests, as well as between different political fields), national science policy is experiencing tensions between the interests of excellence funding and mass funding and between competition and cooperation, both nationally and within Europe. For instance, it must address the possibility, which has already been indicated in certain statements of European functionaries, that European funding agencies might claim for themselves the responsibility for excellence funding, implicitly demoting national funding to the rank of a basic or mass funding source. Similarly, there are signs that the politically intended enablement of cooperation between science institutions from several Member States could make some kind of complementarity (entailing the development of different focus areas) an obvious strategic option, leading to more pronounced differentiation in another respect. The resulting processes of de-differentiation and differentiation, of harmonization and competitive distinction affect the internal relations between European countries as well as their relations to the outside world, especially the US, Southeast Asia and India.

|[73] On the already existing, very diverse configurations of such interaction, cf. Larédo; Kuhlmann (2007).
|[74] Since the present recommendations are primarily concerned with the "policies for science" angle, issues of "science for politics" will not be considered in the following.
|[75] Cf. Etzkowitz (1993).

These conflict areas for the nation with regard to its interests within Europe are reproduced in the relations of the European Research Area to the outside world: By supporting internal cooperation, the ERA naturally tends to privilege these internal relations over external ones, even if this is essentially against the logics of science, which would seek cooperation with appropriate partners, independent of their location or nationality. So there is a conflict of interest at European level, too, between the necessary sensibility for internal European political interests and the interests of science, which naturally transcend the European area. Therefore the EU formulated an initiative to shape international scientific relations in fall 2008, which goes beyond the involvement of partners from all over the world in the Framework Programmes and pursues the objective to coordinate the foreign science policy strategies of the Member States.

As fields of activity, research funding and financing, institutions and research infrastructures, mobility and careers are of central importance for the future shape of the European Research Area and the role of the national actors in it.

III.1 Research funding and financing

The field of research funding and financing in Europe is characterized by a high degree of differentiation, involving a large number of actors and programs, and complexity. Therefore, the following chapters aim at giving an overview of the actors and financial flows involved.

Public investment in research and development in Europe rose from about 49 bn. Euros in 1995 to more than 75 bn. Euros in 2006, equivalent to an increase in real terms by 11.8 %. Averaged over the years 1995 to 2006, 87 % of the resources were allocated nationally, about 6.5 % intergovernmentally and another 6.5 % through the European Union. |[76] Considering the significant growth of resources, the share of EU funding in it increased only moderately (from 6.07 % in 1995 to 7.02 % in 2006), because in the same period – also in the context of the 3 %-target of Barcelona (cf. Chap. A.II.3) – national, public R&D investment, as well as funds allocated at intergovernmental level registered similar increases. |[77] Consequently, there was only a minor shift towards supranational (on EU level) and intergovernmental resource allocation (from 12.25 % in 1995 to 13.87 % in 2006).

For these reasons, public research funding in Europe, regardless of considerable EU resources invested in research and development through the Framework Programme for Research and the Structural Funds programs, is still organized and financed predominantly at national level. However in recent years, the European Commission has taken efforts, both within the Framework Programme and by other initiatives, to boost Europe-wide cooperation between the funding levels (see below).

|[76] See tables A. 3 to A. 5 in Annex. — The data on intergovernmental research funding do not cover project funds, which are allocated through bilateral or multilateral programs run by national funding organizations; such data are not available yet.

|[77] In Germany, for instance, public R&D spending increased from € 15.7 to € 17.3 bn. during the period in question, representing a real-terms rise from € 15.9 bn. to € 16.3 bn. – Available data only cover spending to 2006. From 2007, investments were stepped up significantly under the Seventh Framework Programme.

In the following, the financial flows and research funding instruments are described in terms of the diverse public actors responsible for financing. |[78] Research funding through private institutions (e.g. charitable foundations) or the private sector are not considered at this point.

III.1.A Research funding by the European Union

The European Union is funding research and development through the Framework Programmes for Research and the Structural Funds. |[79]

Framework Programmes for Research

The Framework Programmes for Research are the EU's principal instrument for research funding. Over the past decades, their resources have grown continuously, reflecting the growing aspirations of the EU in the field of research and science politics (cf. A.II.3). Resources expanded most significantly in the step-ups to the Fourth and Seventh Framework Programmes |[80]:

Table 2: EU funding through Framework Programmes for Research |[81]

Framework Programme	FP1	FP2	FP3	FP4	FP5	FP6	FP7
Term	1984-1987	1987-1991	1990-1994	1994-1998	1998-2002	2002-2006	2007-2013
Funds in bn. Euro	3,3	4,4	6,6	13,2	15,0	17,5	53,3

Source: BMBF: "Das 7. EU-Forschungsrahmenprogramm", p. 6

The Seventh Framework Programme is the first to run for a term of seven years (2007-2013), with a financial volume of about 53.3 bn. Euros, which, at present prices, exceeds the budget of the Sixth Framework Programme by 63 %. |[82] It is divided into four specific programs: Cooperation (32.4 bn. Euros), Ideas (= Euro-

|[78] Research funding in Europe could also be represented systematically in terms of funding objectives (e.g. science-driven funding vs. society-driven vs. business-driven funding). However, as neither the distinctions between the objectives are absolutely clear-cut, nor the instruments applied at different levels uniquely attributable to specific objectives, differentiation according to actor levels was preferred for this purpose.

|[79] Apart from the Framework Programme and the Structural Funds, the European Union is funding research through the Competitiveness and Innovation Framework Programme (CIP), whose overall budget for the term 2007-2013 amounts to € 3.6 bn. It mainly addresses small and medium-sized enterprises (SME), supports innovative activities (including environmental), provides improved access to funds and offers services in support of businesses.

|[80] The clear increase from FP3 to FP4 is due to the accession of Austria, Sweden and Finland.

|[81] A table showing the real-term annual increases is included in the Annex (Table A. 6).

|[82] This increase means that EU project funding is growing faster than national project funding in Germany (see Chap. A.III.1.c).

pean Research Council, 7.5 bn. Euros), People (Marie Curie Actions, 4.8 bn. Euros) and Capacities (incl. Research Infrastructures, 4.1 bn. Euros). The "Cooperation" program, as the core element of the Framework Programme, is further subdivided into nine topical priorities |[83] for promoting transnational cooperation. Apart from that, the Framework Programme includes funding of the Joint Research Center (1.7 bn. Euros) |[84] and "Euratom" (2.8 bn. Euros). |[85]

Regarding the research-policy implications of the Seventh Framework Programme, the Joint Technology Initiatives and the establishment of the European Research Council (ERC) are of principal importance.

The Joint European Technology Initiatives (JTI), newly introduced with the Seventh Framework Programme for Research, are committed to the principle of cooperation. They represent public-private partnerships, i.e. projects in which the public and private sectors cooperate with each other, |[86] reflecting the growing tendency of the European Union to support larger, business-driven link-ups between science and the economy, with their administrations sourced out to executive agencies. It is anticipated that the Joint Technology Initiatives will strongly influence the topical planning of the Framework Programmes in the future. |[87] Due to the long-term, contractual commitment of national funding resources, this instrument of EU funding will also have lasting effects on national funding programs.

The idea to establish a European Research Council (ERC) arose from a broad, European debate about the promotion of basic research in Europe, and was im-

|[83] (1) Health, (2) Food, Agriculture and Fisheries, and Biotechnology, (3) Information and Communication Technologies, (4) Nanosciences, Nanotechnologies, Materials and New Production Technologies, (5) Energy, (6) Environment (incl. Climate Change), (7) Transport (incl. Aeronautics), (8) Socio-economic Sciences and the Humanities, (9) Security and Space.

|[84] The Joint Research Center is a Directorate-General of the European Commission, consisting of seven research institutes in five EU Member States (Belgium, Germany, Italy, Netherlands and Spain), with a payroll totalling 2,700 employees. It performs demand-guided science and technology support for the conception, development, implementation and monitoring of EU policies.

|[85] Euratom = Research and training in the field of nuclear energy; the specific program for the implementation of the Seventh Framework Programme for Euratom includes the areas of fusion energy, nuclear fission and radiation protection.

|[86] Each Joint Technology Initiative is adopted on the basis of Article 187 TFEU (ex Article 171 TEC) or of the decision on the specific programs according to Article 182 par. 3 TFEU (ex Article 166 para. 3 TEC).

|[87] The establishment of the first four Technology Initiatives was agreed by the Council for Competitiveness of the EU in November 2007 and approved by the EU Parliament in December of the same year. The focus areas of the Joint Technology Initiatives are embedded computing systems (ARTEMIS), nanoelectronics (ENIAC), innovative medicines (IMI) and clean air transport (CLEAN SKY). The initiatives are designed to run from 2007 to 2017, with allocated funding within the Seventh Framework Program (2007-2013) totaling € 2.67 bn. Since then, two more Technology Initiatives, "Hydrogen and Fuel Cells" (FCH) and "Global Monitoring for Environment and Security" (GMES) were agreed.

plemented through the “Ideas” part of the Seventh Framework Programme. |[88] The ERC supports “frontier research” through an investigator-led, competitive process unbound by pre-defined themes, applying criteria of scientific quality only, and not demanding transnational European cooperation. The ERC grants are intended to enable excellent researchers to pursue their science-driven research interests.

The ERC organization includes a President, the Scientific Council and the Board. The Scientific Council defines and decides the strategic direction for the work of the ERC. It is chaired by the President of the ERC. Based on the strategy defined by the ERC, the European Commission approves its work program and authorizes its implementation. The administration of the funding programs is carried out by an executive agency of the Commission, which is responsible only for the “Ideas” program. The legal implementation follows the Commission’s proposal, whereas national science organizations had pleaded for maximal or even complete autonomy of the ERC vis-à-vis the Commission. In a report on the interim evaluation of the ERC from July 2009, a high-level expert panel recommended streamlining of the governance structure of the ERC, as well as an assessment of its implementation within two years. Should it turn out the recommendations cannot be implemented within the established model of an executive agency, the expert panel recommends abolishing it in favor of a structure as set out in Article 187 TFEU (ex Article 171 TEC), |[89] by the Eighth Framework Programme. |[90]

The budget of the ERC for the entire term of the Seventh Framework Programme amounts to 7.5 bn. Euros. Presently there are two funding lines: Starting Grants for outstanding young scientists and Advanced Grants for established investigators. The Starting Grants aim to support young, postdoctoral researchers (usually two to ten years, in exceptional cases up to 14 ½ years post-

|88 The German Council of Science and Humanities was involved in this process, too. The Council advocated the establishment of an appropriate funding agency at European level (cf. Wissenschaftsrat (1993)).

|89 According to Art. 187 TFEU (ex Article 171 TEC), “the Union may set up joint undertakings or any other structure necessary for the efficient execution of Union research, technological development and demonstration programmes.”

|90 Vike-Freiberga, V. (Chair) et al (2009), herein p. 27. Apart from that, the panel notes that the ERC convincingly managed to recruit independent, excellent researchers as referees and, with their help, carry out valid assessments of applications for the two funding lines, exclusively guided by quality criteria. It is emphasized, especially, that the program was not subjected to any political influence. The report also points out that the establishment of the ERC for the promotion of basic research has been, and still is of crucial importance for the European Research Area and the EU Framework Programme, and should become a permanent element of Union funding, growing in volume and importance.

promotion) to establish their independent research teams. |[91] Applications are invited through a bottom-up process, meaning without any restrictions concerning research topics or areas of science and scholarship. Funded researchers receive between 100,000 and 400,000 Euros per year for a maximum of five years. The Advanced Grants funding line addresses experienced researchers, who can be awarded up to 3.5 mil. Euros over five years. Within the term of the Seventh Framework Programme, about 1/3 of the budget are allocated for the Starting Grants, and 2/3 for the Advanced Grants, equivalent to about 300 Starting Grants and 400 Advanced Grants awarded per year.

Structural Funds

The European Union also funds research and development through the Structural Funds scheme, whose purpose is to strengthen the economic and social cohesion within the EU. Over the period 2007-2012, the EU provided resources amounting to about 347.4 bn. Euros for the Structural Funds and the Cohesion Fund |[92]. These monies are invested in projects supporting the EU objectives "Convergence" (282.8 bn. Euros = 81.5 % of total volume), "Regional Competitiveness and Employment" (55 bn. Euros = 16 % of total volume) |[93] and "European Territorial Co-operation" (8.7 bn. Euros = 2.5 % of total volume), which must be co-financed by the Member States or regions, respectively. |[94] The distribution of funds is decided by the countries, based on "Operational Programmes". Since the beginning of the current funding period (from 2007), the EU Structural Funds have increasingly served the Lisbon Targets, and have been used under growth-oriented aspects. Therefore, a large portion of funding is planned to flow into investments for innovation and knowledge. |[95] The Framework Programme and the Structural Funds are to be used in a complementary fashion, as far as possible, taking into consideration possible synergy

|[91] For the first call for applications in 2007, the relevant time window was two to nine years post-promotion.

|[92] This amounts to approx. one third of the EU budget.

|[93] The Convergence funds are reserved for regions lagging behind in their development (in Germany, that would be the "new Länder" and the region of Lüneburg, although some of these regions are classed as "phasing out"). Funds for Regional Competitiveness and Employment may also be used outside the disadvantaged regions. Under this objective, the "old Länder" of Germany, except for the Lüneburg region, are eligible for funding. See also the respective maps at: http://ec.europa.eu/regional_policy/atlas2007/index_de.htm [last downloaded 2010-04-12].

|[94] Concerning these figures, cf. European Commission (2007b), S. 37f.

|[95] According to this appropriation requirement, 60 % of the Structural Fund resources allocated to the Convergence objective and 75 % of the "Regional Competitiveness and Employment" allocation should be used for tasks creating growth, with more and better jobs, and promoting innovation and the growth of a knowledge-based economy.

effects for R&D funding. |[96] The principal instruments for implementing the cohesion policy in the funding period 2007-2013 are the two EU Structural Funds ERDF |[97] (European Regional Development Fund) and ESF (European Social Fund). |[98]

Advice structures for EU research funding in Germany

Coinciding with the increased volume of the European funding resources, a well-differentiated advice system for European research funding became established. Most notably, at national level there are the national contact points (NCP), which take care of specific areas of the Framework Programme and advice applicants. |[99] These advice offices are funded by the relevant departments of the German Federal Government and work in close consultation with these departments. They are usually located with executing agencies, which in turn belong to one of the major research institutions, e.g. Forschungszentrum Jülich or the German Aerospace Center (DLR). A special feature within the NCP network is the EU office of the German Federal Ministry of Education and Research (BMBF) for the Framework Programme for Research (EUB), where a number of different NCP are bundled. This office undertakes various cross-sectional activities for the BMBF and serves as the initial contact point in matters of the Framework Programme. The federal states [Länder], too, operate their own EU advice structures, offer information about EU research policies through their agencies at Brussels, and facilitate contacts with members of the European Commission and the European Parliament.

Apart from the NCP, the "European Liaison Office of the German Research Organizations" [Koordinierungsstelle EG der Wissenschaftsorganisationen (KoWi)]

|96 The Commission has published a "Practical Guide" based on the CREST guidelines for coordination of the Framework Programme for Research and the Structural Funds: European Commission (2007b).

|97 The ERDF offers direct financial support for businesses' (especially small and medium-sized enterprises) investments in the creation of long-term employment, infrastructures, especially in connection with research and innovation, telecommunications, environment, energy and transport; financing instruments (capital risk funds, regional development funds) in support of regional and local development and for the advancement of cooperation between towns and regions; technical support measures.

|98 The European Social Fund serves to improve the employment situation in the European Union. Monies from this fund are allocated under the "Convergence" and "Regional Competitiveness and Employment" objectives. The fund supports projects of the Member States in the following areas: adaptation measures for workers and enterprises – lifelong learning schemes, development and propagation of innovative systems of work organization; access to employment for job seekers, the unemployed, women and migrants; social integration of disadvantaged people and combating discrimination in the job market; strengthening of human capital through reform of education systems and networking between education establishments. – Apart from ERDF and ESF, there is also a Cohesion Fund, which, however, only applies to countries at a wealth level below 90 % of the EU average and therefore is irrelevant for Germany.

|99 http://www.forschungsrahmenprogramm.de/nks.htm [last downloaded 2010-04-12].

with offices in Brussels and Bonn specializes in advising the universities. KoWi offers general information about research funding by the EU, advice concerning the application for such funds and the implementation of projects under the Framework Programme, and targeted, strategic advice for universities about combining national and European funding facilities. It also conducts training events for contract and project management.

Representation of national institutions in Brussels

KoWi supports the German Research Foundation (DFG), the German Rectors' Conference (HRK), the Alexander von Humboldt Foundation (AvH) and the German Academic Exchange Service (DAAD) in representing the interests of German university research vis-à-vis the European institutions. The interests of the universities are attended to by the federal state [Länder] agencies in Brussels, where the HRK, too, is running its own liaison office. Individual universities are also planning to open such offices. Apart from that, several German science organizations, such as the Helmholtz Association of German Research Centers (HGF), the Max Planck Society (MPG) and the Fraunhofer-Gesellschaft (FhG) keep offices in Brussels.

III. 1.B Transnational research funding in Europe

There exist various instruments and organizations for the funding of transnational cooperations of variable geometry in Europe: first those which the European Union has established with the aim to coordinate national research funding programs (European Research Area Networks (ERA-Nets), ERA-Nets+, Article 185 Initiatives); then the EU's newly proposed Joint Programming. Furthermore, there exist measures for coordination at intergovernmental level (European Cooperation in the Field of Scientific and Technical Research (COST) and European initiative for market-oriented research and development (EUREKA)) as well as bilateral agreements between Member States. Increasingly, the national funding organizations also launch initiatives to strengthen transnational cooperation.

Coordination of national funding programs through EU instruments and initiatives

Initiatives serving to coordinate national research policies and to link or open up national and regional funding programs have grown in importance in recent years. Following this approach, ERA-Nets (European Research Area Networks) were originally developed for the Sixth Framework Programme. They address government departments and research funding organizations that shape or manage national and regional schemes (e.g. DFG, executing agencies, etc.). At their core, there are measures such as the systematic exchange of information, the development of best practice-models, the implementation of joint calls for project proposals or the development of their own funding programs. Under the

Sixth Framework Programme, 71 of these networks were funded from a budget of 183 mil. Euros |[100] The ERA-Net activities are developed further through ERA-Net+ |[101].

On the basis of Article 185 TFEU (ex Article 169 TEC) |[102], the Union may support joint research programs of Member States ('variable geometry'). Under the Sixth Framework Programme, the possibility to jointly conduct national research programs on that basis was used only in one case. |[103] Under the Seventh Framework Programme, four other Article 185 Initiatives have been initiated so far. |[104]

By supporting these initiatives, the EU Commission endeavors to make Framework Programme funding work towards a degree of coordination of national research policies. This is based on its assessment that research funding in Europe is characterized by fragmentation and lack of efficiency in the use of resources, which were to be redressed (cf. Chap. A.II.3). In July 2008, the European Commission proposed to transform research funding in Europe through the new strategic approach of Joint Programming, "to boost Europe's ability to address major economic and societal challenges the resolution of which depends critically on research." |[105] This approach is intended to encourage the Member States to cooperate and coordinate their public research programs. The Com-

|[100] Overall, 38 countries participate in the networks, including the EU Member States, eight associated countries and five other countries. German participation, compared to the other European countries is strongest, both in regard to projects and consortium partners and to institutions with coordination functions: At least one institution from Germany is involved in 61 of the 71 ERA-NETs. Cf. Horvat (Chair) et al (2006); cf. also European Commission, Research Directorate-General (2006), p. 10.

|[101] As a special incentive to implement joint programs, ERA-Net projects that establish a joint funding pool are to receive additional financing by the Commission (top-up funding for joint calls for proposals).

|[102] Article 185 TFEU (ex Article 169 TEC): "In implementing the multiannual framework programme, the Union may make provision, in agreement with the Member States concerned, for participation in research and development programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes." The initiatives according to Article 185 TFEU are legislative acts, meaning the participation of the Union in research and development programs of several Member States is decided by way of the codecision procedure according to Article 294 TFEU (ex Article 251 TEC). This procedure involves the EU Commission, the European Parliament and the Council.

|[103] This was a joint project in clinical research for the development of vaccines and therapies for HIV, malaria and tuberculosis.

|[104] These are: Ambient Assisted Living (AAL), Baltic Sea Research (BONUS), the European Metrology Research Programme (EMRP) and an initiative to join up national research activities with SME involvement (EUROSTARS). Cf. http://cordis.europa.eu/fp7/art169/ind_169_en.html [last downloaded 2010-04-12].

|[105] European Commission (2008a), p. 8. As relevant challenges, the Communication cites "sustaining Europe's prosperity in the face of increased global competition; dealing with the needs of its ageing population and the challenges of immigration; and stimulating sustainable development, especially in the context of climate change, securing the supply of energy, preserving human and environmental health, ensuring food quality and availability as well as safeguarding citizen security." (p. 3).

mission is of the conviction that “in areas of strategic importance for the whole or a large part of Europe, the fragmentation of public research programming leads to sub-optimal returns.” Also, “unnecessary duplication” of efforts should be avoided, transnational pooling of data and expertise as well as cross-border researcher mobility facilitated, and horizontal policy coordination made possible. |[106]

In the course of the consultations of the European Commission on this matter, Germany and other Member States, as well as research organizations and the Federal Council of Germany [Bundesrat], presented considerable concerns about possible violation of the subsidiarity principle (cf. Chap. A.II.3) and issues of the integration of specialist scientific associations and funding programs of the research organizations. These concerns resulted in modifications to the original proposal, insofar as the Member States would be in charge of shaping, while the Commission is tasked with supporting the process of defining appropriate themes. |[107] As a first step, the research activities in the field of neurodegenerative diseases are to be joined up through a pilot initiative. |[108] It should be noted that by this a political concept is established, which is not accompanied by a EU funding initiative, but will mainly affect the national research programs by allowing the coordination of national funding initiatives along certain thematic lines, self-determined by the Member States.

The definition of other themes is left to a high-level working group of the Member States, constituted as a CREST forum based on wide consultation. Subsequent to the proposals of that group, the Council adopted the following themes in December 2009: |[109]

a) agriculture, food security and climate change,

b) health, food and prevention of diet-related diseases,

c) cultural heritage, climate change and security.

More themes for Joint Programming are meant to be named before the end of 2010. The above-mentioned high-level working group is also tasked with developing guidelines for a common framework for the Initiatives, including peer review-procedures, foresight activities, evaluation methods, financing of transnational research activities, use and optimal dissemination of research results,

|[106] Ibid., p. 4. The Communication cites, as pilot models, the European Strategic Energy Technology Plan and the European Strategy for Marine Research.

|[107] Council of the EU (2008b).

|[108] Cf. European Commission (2009b).

|[109] Council of the EU (2009).

and protection of intellectual property rights. A proposal to this end is to be presented by June 2010.

Intergovernmental cooperations in Europe

At intergovernmental level, there exist two long-standing, open coordination measures, COST and EUREKA, for application-oriented, cooperative projects |[110] shared by universities, research establishments and the private sector. They form a coordination framework for European cooperation of national research activities in science and technology. Both are characterized by a bottom-up approach and are open to all topics.

COST |[111] is an intergovernmental institution founded in 1971, with currently 35 member states plus Israel as a cooperating state. Today it is mainly funded by the EU, through the Seventh Framework Programme. Its office in Brussels is provided by the European Science Foundation (ESF). The COST programs primarily serve to set up networks of scientific institutions for the purposes of major research projects. Apart from that, COST fulfills the role of an initiator to the European research landscape, integrating as full members European countries other than the EU Member States and dedicating itself to topics, whose coordination at European level has not yet been established sufficiently, or which cannot be accommodated within the joint programs of the EU. |[112]

EUREKA, established in 1985, is an intergovernmental initiative for application-oriented research in Europe, offering a framework for transnational cooperation projects between industry and the science sector. |[113] Presently, the network includes 38 member countries and the European Union. EUREKA does not operate a central research funding budget. Its projects are financed at national level, according to varying rules in the individual member countries. In contrast to EU research funding, which is increasingly focused on large projects and collaborations, EUREKA concentrates on stronger funding of smaller projects with shorter project periods and fewer participants. Consequently, the EUREKA projects are particularly aimed at small and medium-sized enterprises. |[114]

|[110] See footnote 68.

|[111] COST = Coopération européenne dans le domaine de la recherche scientifique et technique. Cooperation under COST was the beginning of coordinated cooperation in research and development in Europe. New themes are generated by the members.

|[112] Topical focus areas for funding include biomedicine, molecular life sciences and nutrition/food technology, but also chemistry and molecular science and technology.

|[113] Businesses, research centers and universities are offered opportunities and support for cooperation in the development of innovative products and services.

|[114] The more than 700 current projects share a total budget of € 1.3 bn. The largest group of participants are SMEs (about 2/5), with big corporations, non-university research institutions and universities contribut-

Apart from these intergovernmental programs, there are numerous bilateral agreements on joint funding of research and development between Member States of the European Union. |[115]

Cooperation between national funding bodies

National research funding bodies cooperate in the European Science Foundation (ESF). The ESF, established in 1974, is an umbrella organization of currently 80 national funding bodies and research establishments. Its purpose is to enhance scientific cooperation, especially in basic research, in Europe. |[116] Its activities range from organizing workshops and conferences, through consulting about science issues and formulating visions for the future in specific scientific fields (so-called "forward looks") and management of external programs (e.g. COST, see above), to transnational programs for the funding of cooperative research with a European dimension. ESF payments to the respective funding initiatives amounted to nearly 36 mil. Euros in 2007. This finance is provided *à la carte* (i.e. on a voluntary basis) from the member organizations.

EUROHORCs (European Heads of Research Councils) was established in 1992. Being the common voice of the organizations funding and operating research institutions in Europe, it is primarily intended as a science policy platform. More than 40 European research organizations are represented in this forum. |[117] In 2005, it launched the Money Follows Researcher scheme to promote the mobility of researchers in Europe, emulating a similar, cooperative initiative, existing since 2002, between funding bodies from Germany, Switzerland and Austria (D-A-CH). |[118] The agreement allows researchers moving to another participating country to take with them the remaining budget of their approved and funded project. |[119] This shows in an exemplary manner that bilateral and

ing about 1/5 each to the number of participants (http://www.eurekanetwork.org/ [last downloaded 2010-04-12]).

|[115] A study of the Research Directorate-General from 2001 lists more than 800 bilateral agreements: European Commission, Research General-Directorate (2001).

|[116] On the part of Germany, the German Research Foundation (DFG), the die Helmholtz Association of German Research Centers (HGF), the Max Planck Society (MPG) and the Union of the German Academies of Sciences and Humanities are represented in the ESF.

|[117] German members: DFG, FhG, HGF, WGL and MPG.

|[118] Signatory countries [as of 2009-08-19]: AHRC (UK), AKA (Finland), BBSRC (UK), CNR (It), CNRS (Fr), CSIC (Sp), DCIR (Denmark), DFG (D), EPSRC (UK), ESRC (UK), ETF (Estonia), FCT (Portugal), FNR (Luxembourg), F.R.S.-FNRS (Belgium), FWF (Austria), FWO (Belgium), INFN (It), INSERM (Fr), MRC (UK), NERC (UK), NWO (Netherlands), OTKA (Hungary), RANNIS (Iceland), RCN (Norway), SNSF (Switzerland), STFC (UK), VR (Sweden).

|[119] The German Research Foundation (DFG) and its partner organizations in Austria and Switzerland, the Austrian Science Fund (FWF) and the Swiss National Science Foundation (SNF) have formed a standing collaboration and launched initiatives for improved cooperation. Information about the total volume of

multilateral relations between research funding bodies can serve as instigators for the European Research Area. As an organization of comparable importance, there also is the association of Nordic funding bodies within the NordForsk framework. |[120]

EUROHORCs and the ESF jointly published their vision of a European Research Area in July 2009, where they set out a European Grant Union as the goal of their transnational cooperations. |[121] This shall be brought about essentially by recognizing the principles Money Follows Researcher and Money Follows Cooperation Line. Under the latter, national programs will be opened within certain limits. |[122] According to information from the European Commission, so far about 20 % of the funding programs of national organizations in Europe were opened to applications from abroad. |[123] In cases where separate, national funding will continue, the Lead Agency-process shall be applied, according to which one research organization undertakes the refereeing, whose results are then recognized by the partner organizations.

Apart from the established forms of intergovernmental research funding in Europe (COST, EUREKA) and the transnational networks of various research funding or operating bodies (ESF and EUROHORCs, etc.) with their initiatives, the emergence of topical research consortia of variable geometry has been noticeable more recently. For instance, leading energy research organizations from ten European countries joined up to form the "European Energy Research Alliance", with Germany represented by the Helmholtz Association. The aim of this alliance is to launch joint research initiatives to hasten the development of new energy technologies. The combined annual budget of the research institutions involved amounts to more the 1.3 bn. Euros, available for the field of energy research. |[124] The alliance agreement was reached within the framework of the European Strategic Energy Technology Plan (SET), which is intended to

funds transferred in this way is not available yet, because, usually, the national funding bodies do not systematically record these flows of funds and the EUROHORCs do not systematically poll these data. According to information from the German Research Foundation, the funds transferred annually by the DFG to other European countries under the D-A-CH initiatives *Money follows Researcher* and *Money follows Cooperation Line*, averaged over the past seven years (2002-2008), stands below the € 1 mil. threshold.

|[120] Cf. EUROHORCs (2009).

|[121] EUROHORCs & ESF (2009).

|[122] For instance, projects whose center of gravity is clearly in Germany, with only small parts located in other countries, can be submitted to the *Money Follows Cooperation Line* process. With the submission to the DFG, financial resources for parts of the project carried out in Switzerland or Austria can be applied for, too. Conversely, the same procedure applies to minor German participation in Austrian or Swiss projects, which are financed through the FWF or the SNF.

|[123] European Commission: STC key figures report 2008/2009 (2008), p. 107.

|[124] According to a press release of the Helmholtz Association of 2008-10-29. See also http://www.eera-set.eu [last downloaded 2010-04-12].

bring together the research capacities of the major European research institutions and universities with those of private sector industry. |[125]

III.1.C Research funding and financing in Germany

The differentiated science landscape in Germany is made up, essentially, of the higher education institutions (HEI, i.e. universities and universities of applied sciences) and non-university, state-run research establishments, on the one hand, and private sector corporations with activities in research, on the other. This diversity of the system is also reflected in the financial flows of science funding in Germany, where the share of private industry in R&D expenditure amounts to more than two thirds, compared to one third contributed by investments in research operated by the public sector (both non-university institutions and universities).

Table 3: Investment in research and development in Germany in 2008, by implementing sector*

	Universities	Public sector	Private sector	Total
Mil. Euro	10.700	9.346	46.073	66.119
% of total	16,18	14,14	69,68	100

* Universities figures estimated, private sector provisional data

Source: Federal Statistical Office, Stifterverband Wissenschaftsstatistik GmbH (status: 2010-05-20)

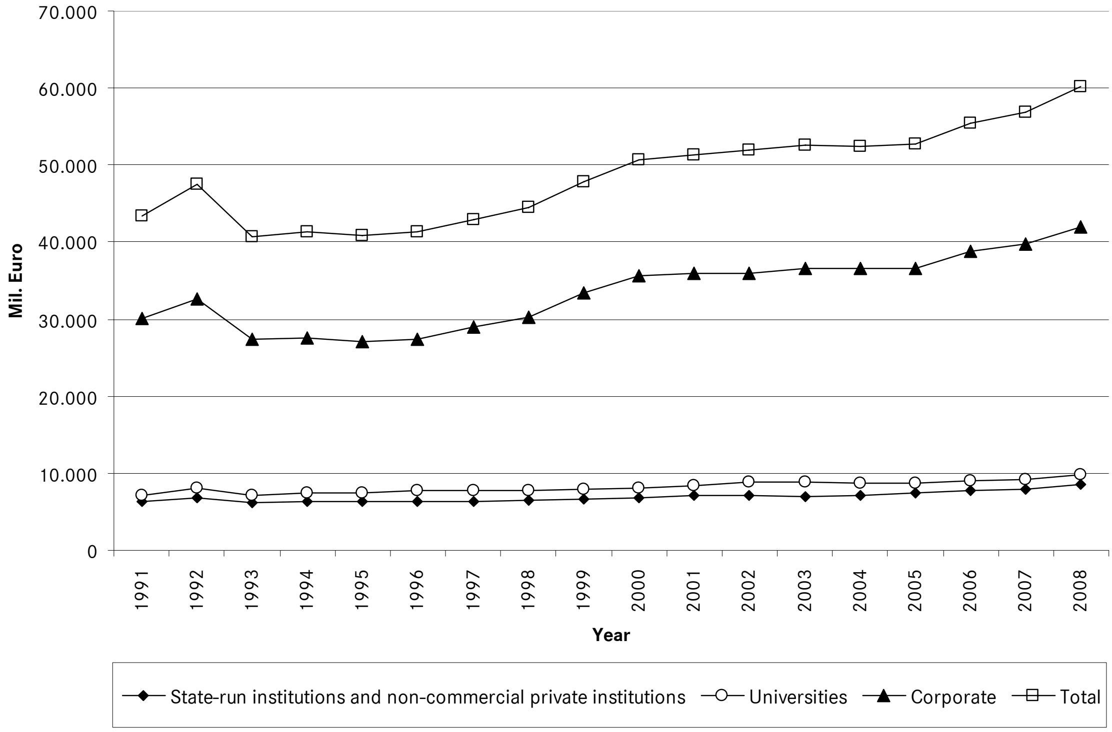
In 2008, R&D investments in Germany amounted to 2.63 % of the gross domestic product, making Germany a stronger R&D investor than the UK (34.1 bn. Euros = 1.88 % of GDP), France (39.4 bn. Euros = 2.02 % of GDP) or the average EU Member State (1.90 %). Still, Germany clearly fails to meet the "Lisbon Target" of 3 %. Set in proportion to the gross domestic product, German R&D spending falls short of the USA figure (2.76 %) and remains far behind Japan (3.44 % in 2007); within the European Union, Germany is clearly beaten by Finland (3.72 %) and Sweden (3.75 %) (cf. Table A.1 in Annex). With a share of about 27 % of Europe-wide R&D investments Germany, nevertheless, remains a central pillar of the European Research Area.

The real-term development of R&D investment in Germany since the beginning of the 1990s presents itself as follows |[126]:

|[125] Cf. European Commission (2006).

|[126] For detailed international comparisons of R&D activities in Germany, cf. Expertenkommission Forschung und Innovation (2009), pp. 71-84.

Figure 3: R&D investment in Germany by implementing sector, 1991-2008 (real-term figures)



Real-term figures, Federal Statistical Office, Fachserie 18, Reihe 1.5, Table 3.3; GDP index 2000=100

Source: Federal Statistical Office, Stifterverband Wissenschaftsstatistik; own analysis

Research funding from the public sector mainly consists of institutional funding and project funding. The federal and state [Länder] administrations invested ca. 17.3 bn. Euros in research and development in 2006, of which the states [Länder] (not including towns) contributed about 8.0 bn. Euros. In 2007, the federal administration invested 10.1 bn. Euros in research and development, compared to the state [Länder] contribution (estimated) of 8.3 bn. Euros. |[127] Approximately one third of these public-sector investments in research and development were allocated to institutional research. |[128] Of the federal monies spent on R&D financing in 2008, amounting to 10.9 bn. Euros, ca. 91 % remained in Germany; the majority of such funds flowing abroad – 902 mil. Euros of the total of 1 bn. Euros – were contributions to international science organizations

|[127] For federal spending, cf. BMBF (2008c), p. 29, and BMBF (2010), p. 436; for Länder spending: GWK (2009d), p. 23.

|[128] For a representation of the funding instruments and focuses of federal and Länder administrations, see BMBF (2008b).

and international research facilities. | [129] The BMBF budget for institutional funding abroad (institutes abroad, MPG) totaled 37.9 mil. Euros in 2007. | [130]

The resources for the basic funding of the universities are usually provided by the states [Länder] (research expenditure of universities in 2008: 10.7 bn. Euros), whereas most of the non-university science establishments are jointly funded by federal and state [Länder] administrations as part of their institutional funding programs, with varying relative contribution from both parties | [131] (research expenditure by HGF, MPG, FhG and Leibniz Association, and by the Academies of Sciences in 2008: 7.1 bn. Euros). | [132]

With the German federal budget for 2009, some of the non-university research organizations (MPG, FhG and HGF) were authorized to forward up to 5 % (maximum 10 mil. Euros for exceptional cases) of their institutional receipts to third parties, for institutional use, provided this contributes to cooperation with other science institutions and the private sector. Still, any such forwarding of funds to recipients abroad, which would greatly facilitate transnational cooperation within the European Research Area, requires case-to-case authorization by the Budget Committee of the German Parliament [Bundestag].

The German Research Foundation (DFG), too, is jointly financed by the federal administration and the states [Länder], using a single financing ratio (58 % federal, 42 % state [Länder] funding). The DFG is the central, self-governing science organization and the principal institution for competitive research funding in Germany. In 2008, it distributed funds amounting to 2.4 bn. Euros through individual grants and coordinated programs. | [133] The funding policy of the DFG aims to broadly support very good and excellent basic research through a consistent bottom-up approach; for some years, it has also put increasing efforts into the funding of knowledge transfer and research within the industrial private sector. | [134]

Project funding from the federal and state [Länder] administrations, which is primarily application-oriented, is benefiting higher education institutions, re-

| [129] BMBF (2010), Table 8, p. 436.

| [130] Cf. Table A.13. in Annex.

| [131] For the institutions of the Max Planck Society and the Leibniz-Gemeinschaft, the distribution is 50:50; for the institutions of the Helmholtz Association and the Fraunhofer-Gesellschaft, the ratio is 90:10 (federal:Länder).

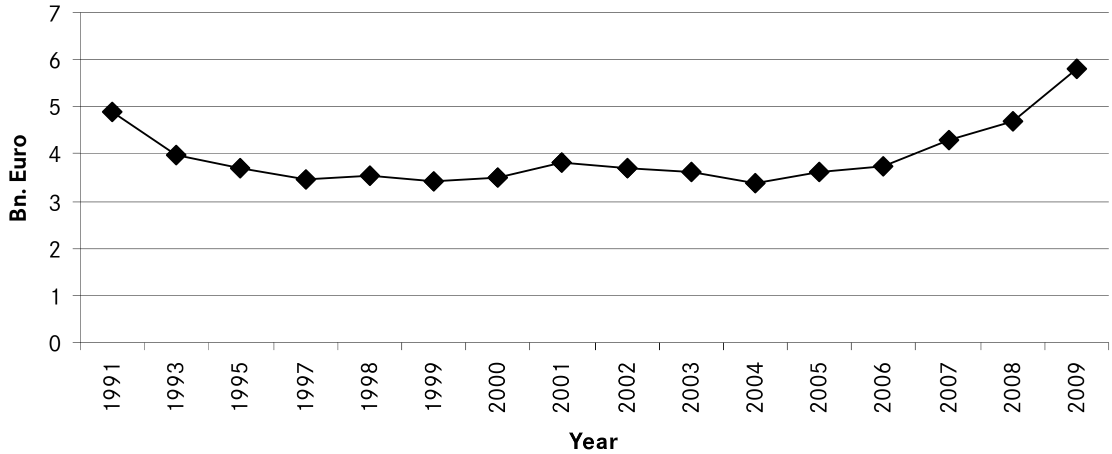
| [132] Source: Federal Statistical Office, Fachserie 14, Reihe 3.6; € 3.0 bn. of this is allocated to the Helmholtz centers, € 1.6 bn. to the Max Planck Society, € 1.4 bn. to the institutes of the Fraunhofer-Gesellschaft, 1.0 bn. to the institutions of the Leibniz-Gemeinschaft and 0.01 bn. to the Academies of Sciences.

| [133] DFG Press Release No. 29 of July 2, 2009.

| [134] On the funding portfolio of the DFG, cf. Deutsche Forschungsgemeinschaft (2008).

search establishments and companies via specific programs. In contrast to institutional funding, its grants offer short to medium-term support. |[135] The development, in real-term figures, of project funding by the federal administration is shown in the following graph:

Figure 4: **Direct R&D project funding |[136] from the federal administration, 1991-2009 (real-term figures)**



1991-2008 actual figures, 2009 nominal figure; real-term index 2000=100; Fachserie 18, Reihe 1.5 Tab. 3.3 Public consumption

Source: BMBF: Bundesbericht Forschung 2000, 2006; Bundesbericht Forschung und Innovation 2010

The universities and other higher education institutions in Germany attracted third-party funding |[137] totaling ca. 4.9 bn. Euros in 2008, of which 4.5 bn. Euros were received by universities as such (including medical schools), while the share of the universities of applied sciences and polytechnics was relatively low at 276 mil. Euros. This means, the ratio of third-party funding to basic funding has reached 1:4. |[138] Measured by the total of third-party funding received by all higher education institutions in 2008, the DFG, which contributed 34 %, is the principal funding provider, followed by the private corporate sector with about

|[135] Source for figures, if not specified otherwise: BMBF (2008b), which also contains a condensed description of the funding activities of the Länder (p. 307ff.).

|[136] Project funding includes project-related funding as well as expenditure for contracts related to departmental and defense research. Departmental research is defined as such research and development activities of the federal administration or the Länder that serve to prepare, support or implement political decisions and are inseparably connected to the exercise of public duties.

|[137] According to official statistics, these are the total of all finance "obtained from public or private parties for the funding of research and development, young scientists and teaching, in addition to the regular university budget (basic funding)".

|[138] In 2007, the higher education institutions received € 31 in third-party funding for every € 100 of current basic funding (2006: € 27). Source: Federal Statistical Office: Fachserie 11, Reihe 4.3.2 Monetäre hochschulstatistische Kennzahlen, Tab. 2.1.2 and 2.1.3; own analysis.

25 % and the federal administration with just under 20 %. Also in 2008, the higher education institutions obtained, on average, 8.9 % of their third-party funding from the EU. | [139]

Table 4: Third-party funds received by higher education institutions (HEIs) in 2008, listed by funding providers

	Receipts total (EUR'000s)	Fed. adm.	Fed. state adms.	DFG	EU	Corporate	Others
HEIs t o t a l	4.852.700	19,9 %	2,5 %	33,7 %	8,9 %	24,8 %	10,3 %
Universities (excl. medical institutes/health sciences)	3.493.439	19,4 %	1,8 %	39,1 %	8,8 %	22,1 %	8,8 %
Medical institutes/health sciences at universities	1.051.168	20,0 %	2,0 %	25,2 %	8,9 %	30,6 %	13,4 %
Universities combined	4.544.607	19,5 %	1,8 %	35,9 %	8,8 %	24,1 %	9,8 %

Source: Federal statistical Office, Fachserie 11, Reihe 4.5; own analysis

The significance of EU funding for research institutions in Germany will be outlined by a description of the funds received through the Sixth Framework Programme, the results of the first calls for proposals of the ERC from 2007 to 2009, and the funding under the Structural Fund framework.

FP6 funds obtained by German institutions

From the Sixth Framework Programme of the EU, about 3 bn. Euros went to German participants, equivalent to a share of ca. 20 % of total payments (ca. 15 bn. Euros) directed to EU Member States. This makes the German partners the principal recipients, by a wide margin, of FP6 funding, followed by the UK with ca. 2.4 bn. Euros and France with about 2.2 bn. Euros. Compared to these countries, Germany also obtained more funding per head of population. | [140] With annual receipts (average of the official term of four years) of 750 mil. Euros, funding from the European Union is equivalent to about 38 % of direct project funding from the BMBF (in 2006), which would be the most reasonable comparison figure, in terms of the functions of the two funding sources. | [141] Germany's approximately 10,400 partners represent the largest country group of FP6 partners, and German partners are most likely in charge of the coordinator function in any joint project. | [142]

| [139] As the relevant data have been recorded by the Federal Statistical Office only since 2006, the funds obtained by universities and other higher education institutions from the EU cannot be represented by longer time series.

| [140] European Commission (2008d); see also ZEW (2009). – On the Marie Curie Actions, see Chap. A.III.3.b.

| [141] In 2006, the last year of the Sixth Framework Programme, about € 2 bn. were spent through direct project funding by the Federal Ministry of Education and Research (BMBF (2008c), p. 29).

| [142] ZEW (2009), Fig. 5, p. 52.

The German record of success in terms of absolute figures is put into perspective when considering the level of public investment in R&D and the strength of human resources employed in R&D: Measured by the number of scientists and academic researchers, Germany remains below average. In this respect, smaller countries such as Belgium, the Netherlands, Ireland, Denmark, Sweden and Austria with comparable R&D expenditures per researcher turn out to be clearly more successful. This finding, however, applies not only to Germany, but also to the UK and France, all three countries ranking at lower mid-table in terms of grants per researcher. |[143]

Of the 3 bn.Euros obtained, ca. 1.1 bn. (= 36.7 %) flowed to non-university research establishments. The higher education institutions received 938 mil. Euros (= 31 %), followed by partners from the private sector (727 mil. Euros = 24 %). |[144]

The third-party funds obtained from the EU by all higher education institutions (HEIs) amount to 8.9 %, on average, of the total third-party finance obtained by them (see Table 4). The majority of the universities, for which such data are available, register EU contributions to third-party funding between 5 % and 10 %; the second-largest group are universities obtaining between 10 and 15 % of their third-party funding from the EU. Among the universities, those in Stuttgart, Aachen, Munich, Karlsruhe and Heidelberg and the two universities in Berlin (HU and TU) showed the strongest participation in the Sixth Framework Programme. |[145]

In terms of scientist numbers employed, non-university research in Germany are the dominant recipients from EU programs, compared to research at HEIs, with the share of EU third-party funding in overall third-party funding ranging between 7 % (Fraunhofer-Gesellschaft) and almost 19 % (Max Planck Society):

|[143] ZEW (2009), p. 4 and p. 62ff.

|[144] ZEW (2009), Tab. 10, p. 37. In the UK, the universities are the main recipients, taking nearly 60 % of the funding, compared to 19 % received by non-university research institutions; in France, again, the largest portion of funding flows to the non-university research institutions: 45 %, compared to about 15 % received by HEIs.

|[145] ZEW (2009), p. 50.

Table 5: Third-party funds received by non-university research institutions in 2008, listed by funding providers

	Third-party funding total in mil. Euro	Received from DFG	Received from EU	Received from private sector	Received from fed. and state adms.	Received from others
Fraunhofer-Gesellschaft	867	0,8 %	7,0 %	52,1 %	29,5 %	10,6 %
Helmholtz Association	909	3,7 %	14,8 %	15,7 %	38,6 %	27,3 % [1]
Leibniz Association	244	19,7 %	13,5 %	22,3 %	41,0 %	3,5 % [2]
Max Planck Society	243	19,1 %	18,8 %	7,1 %	36,0 %	19,0 %

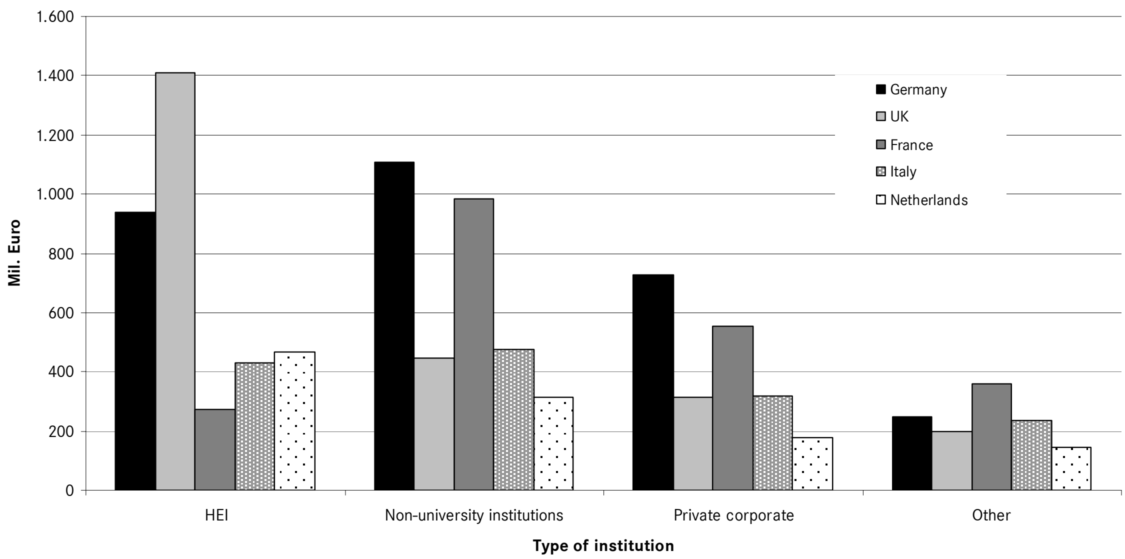
1) 18.8 mil. Euros from ESA and other European agencies; 2) excl. charitable foundations

Source: Individual research organization, upon request

The importance of EU third-party funding for the non-university research establishments has grown significantly in the past ten years: The Fraunhofer-Gesellschaft, for example, obtained three times the amount of EU third-party funding in 2008 compared to the 1998-figure (61 mil. compared to 19 mil. Euros); the institutes of the Leibniz Association more than doubled their receipts, over the same period (from 14.8 mil. to 33.1 mil. Euros), and the Max Planck Society managed to increase their receipts from 24.4 mil. to 45.6 mil. Euros.

In comparison to other countries, the participation of the different institutions presents itself as follows:

Figure 5: FP6 payments to research institutions, by type of institution in selected countries



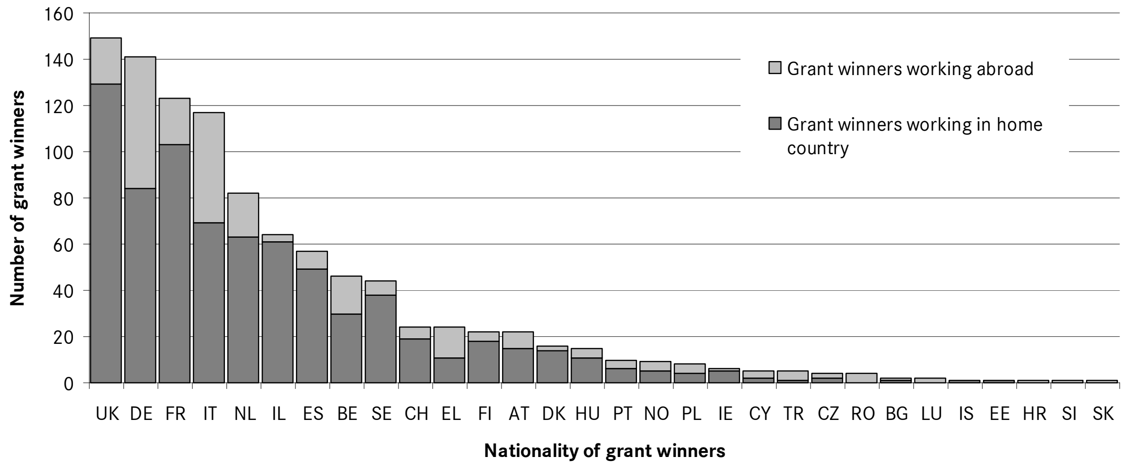
Source: ZEW (2009), own analysis

Funds obtained through ERC Grants under the Seventh Framework Programme

Results of the calls for proposals are available for the Starting Grants 2007 (299 funded) and 2009 (237 funded) as well as for the Advanced Grants 2008 (275 funded) and 2009 (236 funded). The results allow conclusions about both the potential of the respective national research systems (analysis in terms of nationality of the funded parties) and the attractiveness of the receiving research institutions and host countries:

The summary evaluation of both funding lines shows that scientists of German nationality were the second-most successful national group after the UK scientists in obtaining these grants (see also Table A.7 in Annex). Also, German scientists (in common with their Italian colleagues) take their grants and do their research abroad in more cases then the equally successful researchers from the UK and France. This is illustrated by the following figure:

Figure 6: Number of researchers funded through ERC Grants 2007 to 2009, by nationality



Source: ERC; a key to the country codes can be found in the list of abbreviations in the Annex.

In terms of success rates (proportion of grant winners of the total of applications submitted, per nation) for obtaining grants, Switzerland leads in the Starting Grants category for 2007, when she achieved a success rate of 6.5 % – clearly better than Germany's 3.5 % (average of all applying nations: 3.4 %). In regard of Advanced Grants won in 2008, however, Germany is about as successful as Switzerland (18 % and 17.5 %, respectively), taking both countries clearly above the average rate of 13.5 % (cf. Table A.8 in Annex). This is also the case for the Starting Grants 2009, where German researchers registered a success rate of 11.3 %, above the average of 9.5 %, showing clear improvement from 2007.

Looking at another aspect of the results (for the four rounds of applications completed so far), however, German institutions perform not as strongly as German researchers. They attract significantly fewer grant winners than institutions in the UK and France (cf. Table A.9. in Annex). Germany's performance is further put in perspective when considering the number of grants won in the years 2007 to 2009 in relation to the population of researchers: In this ranking, Germany clearly falls behind, with only 0.40 grant winners for every 1,000 researchers, compared to exceptionally successful countries such as Switzerland (3.50) and the Netherlands (1.55), but also against comparable systems like the

UK (0.83) and France (0.64). Germany also falls short of the average ratio for all countries, which is 0.68 (cf. Table A.10 in Annex).

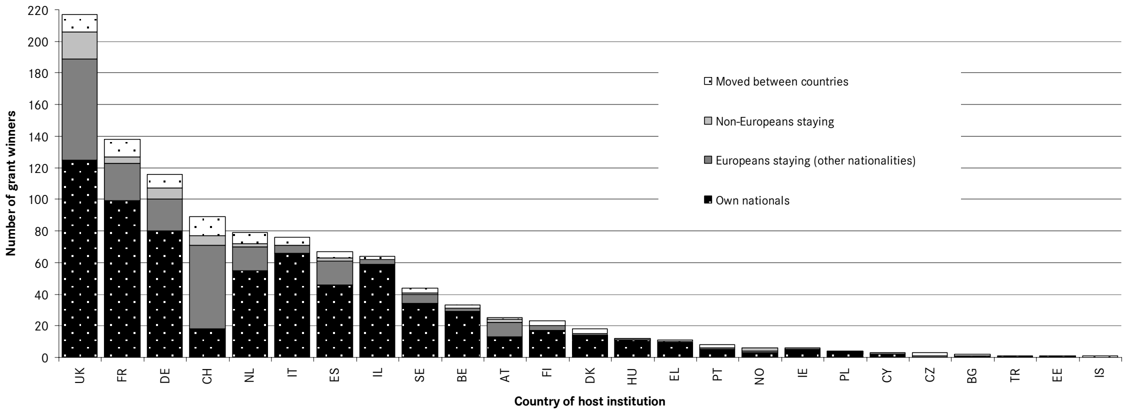
Again comparing Germany and Switzerland, there is a significant gap between their success rates: Swiss institutions won Starting Grants in 2007 with 7.5 % of their applications, and Advanced Grants in 2008 with 29.2 %, while German institutions were only about half as prolific (3 % and 14.5 % respectively). This trend carried on to the Starting Grants 2009, where Switzerland won grants with 27.9 % of her applications, compared to Germany's success rate of only about 11 %. |[146]

Looking at the most successful institutions in terms of winning ERC Grants (ranked by the number of grants obtained, cf. Tables A.11.a-d in Annex), it is notable that, while the May Planck Society is among the most successful institutions in all four rounds of applications, only two German universities make it into the group of TOP institutions in this ranking (Heidelberg University with four Starting Grants 2007 and LMU Munich with three Starting Grants 2009 and four Advanced Grants 2009), whereas universities in the UK, Switzerland or Israel regularly appear among the top performers (e.g. Cambridge, Oxford and London, EPF in Lausanne and ETH Zurich).

Regarding the mobility of grant winners, it turns out that, on the one hand, a majority of foreign grant winners in the UK were already working in the country, before they received an ERC Grant. This also applies to Switzerland. Conversely, France, the UK and Switzerland succeeded, in many cases, in using the grant to attract researchers from abroad, who had not worked in those countries before. Still, overall the ERC Grants' effect in enhancing researcher mobility within Europe and into Europe has been less than hoped for, as becomes clear from the following graph (see especially "Moved between countries"):

| [146] Source: ERC; own analysis.

Figure 7: Origin of ERC Grant winners 2007 to 2009 working in different host countries



Source: ERC

Overall, keeping in mind the low number of funding rounds so far, it can be noted that German researchers performed slightly above average as applicants for ERC grants, especially for the Advanced Grants. Still, measured by absolute numbers, German host institutions are less successful than those in the UK and France |[147] (cf. Table A.9 in Annex). In terms of percentages of general population or researcher population, the grant receipts of German applicants also fall short of those achieved by the Netherlands, Sweden, Austria and Spain (cf. Table A.10 in Annex). Closer inspection of the rather mediocre German success rates, i.e. the ratio of grants approved over grant applications (cf. Table A.8 in Annex), reveals that this cannot be attributed simply to the fact that the institutions in Germany have attractive national funding alternatives at their disposal, such as DFG funding or the funding lines of the Excellence Initiative, and therefore were less active in encouraging their researchers to compete for ERC grants.

Funds obtained from the EU Structural Funds budget

Over the current funding period (2007-2013), Germany will receive EU Structural Fund monies amounting to ca. 26.3 bn. Euros. In Germany, the programming and administration of these resources largely takes place at state [Länder] level. |[148] This is based on the Operational Programmes, in which the states [Länder] describe their respective funding strategies. The Lisbon Targets, with a

|[147] Overviews of the distribution of grant winners over subject groups for different host countries are presented in the Annex (Figures A.2 and A.3).

|[148] Except for the federal programs “Transport” and “European Social Fund”. The Federal Ministry for Economics and Technology is responsible for the coordination of basic issues of EU structural policy in Germany, concerning all relevant funds; it also acts as the coordinating authority for the ERDF administration agencies.

share of 71 % in the Convergence objective and 81 % in "Regional Competitiveness and Employment", will be allocated more funds than required by the EU. | [149]

Infrastructure measures for research and development are mainly funded from the European Regional Development Fund (ERDF). | [150] Accordingly, the biggest portion, by far, of the 16.11 bn. Euros total ERDF funding (7.55 bn. Euros or ca. 46.9 %) is directed to the expenditure block "research and development, innovation and entrepreneurship". Disregarding any funds allocated for "other investments in firms", the area of research and development will receive about 4.7 bn. Euros, which is ca. 670 mil. Euros per year averaged over the funding period (see Table A.12 in Annex). | [151] This is equivalent to about 9.6 % of the annual joint funding of research received from federal and state [Länder] administrations in 2008. | [152]

III.2 European institutions and research infrastructures

In the formation of the European Research Area, the European research institutions play a special role. They were established, primarily to operate large infrastructures, on the basis of intergovernmental treaties since the 1950s. Much more recently, the first Community institution for the promotion of innovation in Europe, the European Institute of Innovation and Technology was founded under European Community Law. Transnational alliances, in which national higher education institutions and non-university research facilities join with partners from other European Member States, also have their role (Chap. A.III.2.a). Finally there is the ESFRI Process, a recent initiative towards coordination between large European research infrastructures, with accompanying processes at national level (cf. Chap. A.III.2.B).

| [149] Cf. footnote 95.

| [150] The European Social Fund contributes € 9.3 bn. of the € 26.3 bn. in Germany. Funds are shared between the federal administration and the Länder; the federal program accounts for ca. € 3.5 bn. R&D projects do not represent a focus for funding through the European Social Fund, which is rather aimed at the funding of specific target groups (e.g. the unemployed, young people, new businesses, etc.).

| [151] For comparison: Funds received by Germany through the Sixth Framework Programme totaled about € 3 bn. (2002-2006), equivalent to an average flow of funds amounting to € 750 mil. per year over the official term of four years.

| [152] The financial volume of joint funding for research from the federal and Länder administrations amounted to about € 7 bn. in 2008 (Gemeinsame Wissenschaftskonferenz (2009e), p. 7). In the same year, the federal administration alone invested € 10.9 bn. in research and development (BMBF (2010a), p. 41).

Intergovernmental institutions

The large, basic research-oriented institutions in Europe are CERN, founded in 1954, near Geneva, with a budget of about 1 bn. Swiss francs (2007) |[153], the European Organization for Astronomical Research in the Southern Hemisphere (ESO, established in 1962) with a budget of 117 mil. Euros (2007) |[154], the European Molecular Biology Laboratory (EMBL) in Heidelberg (est. 1974) with a budget of 117 mil. Euros (2005) |[155], the European Space Agency (ESA) with a budget of 2.7 bn. Euros (2007) |[156], the Institut Laue-Langevin (ILL), established in Grenoble in 1967 (76 mil. Euros in 2007) |[157] and the European Synchrotron Radiation Facility (ESRF) with a budget of 80 mil. Euros (2007). |[158] These institutions primarily serve to operate large research infrastructures (cf. also Chap. A.III.2.B) and are financed and run by EU Member States and other countries on the basis of multinational treaties. |[159]

Seven of these institutions joined up in the EIROForum to share resources and expertise. |[160] The overall annual budget of these seven institutions alone

|153 CERN is funded by 20 member states; it is the biggest research institution for high energy physics in the world.

|154 ESO is funded by 13 member states. Its headquarters are located in Garching. It operates three observatories in Chile.

|155 EMBL, established by 17 West European countries and Israel, now counts 20 member states. It operates a main laboratory in Heidelberg, branches in Hamburg, Grenoble and Hinxton (UK), and an external research program in Monterotondo (It).

|156 The European Space Agency, currently with 17 member states, was established to coordinate the development of European astronautics and allow, by joining financial and other resources, the implementation of programs that could not be realized by any member state on its own. ESA, as an independent, multinational organization, maintains close ties with the EU, based on the ESA/EC Framework Agreement. ESA operates headquarters in Paris and other centers all over Europe, each tasked with different areas of competence.

|157 ILL, the most powerful stationary neutron source in the world, is operated by Germany, France and the UK. Its purpose is to facilitate physical, biological, chemical, medical and material-science research into the structure and dynamics of solid and liquid matter.

|158 ESRF in Grenoble (France) is financed by twelve member states. It is the most powerful synchrotron radiation source in Europe. It hosts condensed-matter experiments for physics, chemistry, biology, medicine, meteorology, material sciences, geophysics and archeology. ESFR has significantly widened its research capabilities in the life sciences by cooperating with ILL and EMBL in the Partnership for Structural Biology (PSB).

|159 Federal expenditure for these and other international science organizations and payments to transnational research institutions at home and abroad totaled approx. € 853 mil in 2006. The comparison figures for 2007 and 2008 are € 854 mil. and € 872 mil, respectively (BMBF (2008b), p. 511).

|160 Cf. http://www.eiroforum.org/ [last downloaded 2010-04-12]. The institutions concerned are: CERN, EMBL, ESA, ESO, ESRF, ILL, and the European Fusion Development Agreement (EFDA); the latter was established by the European fusion energy research facilities and the European Commission in 1999, with the

amounts to approximately 4.4 bn. Euros |[161], almost 6 % of total public expenditure on research and development in the European Union in 2006 (75 bn. Euros).

The European University Institute (EUI) in Florence was established by the six Founding Members of the EC in 1972. Presently, it is financed and run by 20 of the 27 EU Member States (Budget 2005: 33.7 mil. Euros). The EUI is a postgraduate education and research institution. Its research projects include topics from economics, jurisprudence, history and cultural history, politics and social sciences, all from a European perspective. The original idea was to establish a full European University under Community Law. This was resisted and blocked by France, because of her concerns about the national prerogative in the awarding of degrees, but also by national higher education institutions, which feared the effects of any redistribution of national resources. Therefore, in the end, a more modest intergovernmental variant was left as the only realistic option.

European Institute of Innovation and Technology (EIT)

Especially considering the efforts to establish a European institution under Community Law, which could not prevail in the 1950s and 1960s and ultimately resulted in the creation of the European University Institute on an intergovernmental basis, combined with the fact that the European Union had never before created any research institution, the foundation of the European Institute of Innovation and Technology (EIT) in 2008 constituted an absolute novelty for the European Research Area. |[162]

The foundation of this institute can be traced back to an initiative of the EU Commission President, José Manuel Barroso, in 2005. The science policy objective was, originally, to establish a European top-level research institution as a research university – comparable with the MIT – under immediate Community control. However, this intention met with insurmountable political resistance (again). The Member States subsequently agreed on a compromise solution, according to which the EIT was to be neither a university, nor an independent research institution, but some kind of "formative service agency" (in its own legal capacity) to advance the institutionalized cooperation of universities, research

aim to strengthen their coordination and cooperation and to conduct joint activities. EFDA locations are Garching in Germany and Culham in the UK.

|161 European Commission: STC key figures report 2008/2009 (2008), p. 110.

|162 The EIT was established by Regulation (EC) No. 294/2008 of the European Parliament and the Council of 11 March 2008 "establishing the European Institute of Innovation and Technology" (ABl. L 97/01 of 9 April 2008). According to Art. 11 of the Regulation, the EIT is a "Community body and shall have legal personality".

institutions and Excellence Clusters. |[163] The EIT, financed outside the Framework Programme for Research, but still from within the EU Budget, is intended to become the poster child of European innovation. For this purpose the European Union is providing 309 mil. Euros over the period 2007 to 2013, expecting other partners (e.g. the private sector) to contribute significant finance, too. |[164]

The EIT initiates and funds public-private networks between higher education institutions, research institutes and private sector enterprises from at least two EU Member States (so-called "Knowledge and Innovation Communities", KICs) for periods of seven to 15 years. The selection of the institutions and topical networks is strictly guided by the excellence principle implemented through open competition. The first three KICs selected and funded to 2013 are dedicated to the themes "climate change – mitigation and adaptation", "sustainable energies", and "information and communication technologies". |[165]

Transnational clusters and alliances

Apart from the above-mentioned intergovernmental European organizations and the new European institute of Innovation and Technology under Community Law, the European Research Area is largely shaped by transnational alliances of national institutions across several sites (e.g. of universities with each other, but also as clusters between science institutions and private sector corporations). |[166] Such groupings have a long tradition, especially in border regions |[167], because they present a good opportunity for the institutions to form a critical mass and raise their profile. Obviously, apart from such alliances, which, because of the teaching cooperations involved, must be designed for the longer term, there are also project-related transnational research collaborations,

|163 Lindner (2009), p. 65. Therein also a detailed representation of the legal implications.

|164 On decision of the Governing Board, the KICs to be funded may draw only 25 % of their total expenditures from the EIT budget. The remainder must be obtained from national or regional funding, other EU funds (e. g. Framework Programme or Structural Funds), private funding or other sources.

|165 Cf http://eit.europa.eu/ [last downloaded 2010-04-12].

|166 National clusters, established to form a science location by creating networks between university and non-university institutions (example: Karlsruhe, Göttingen), can also present a basis for an enhanced, European profile of the institutions. – In Germany, competence clusters between science and the private sector are funded within the framework of "Leading Edge Cluster Competition", which, however, as a funding instrument is entirely at national level.

|167 The universities in the greater region "Saar-Lor-Lux", for instance, have been cooperating in research and education, on the basis of a proper charter, since 1990. This collaboration is to be institutionally consolidated as a "University of the Greater Region", which is in the process of foundation. A similar configuration is found in the ALMA association of the universities of Aachen, Liège, Maastricht and Hasselt-Diepenbeek, which supports cooperation in research, teaching and services of the four universities. The Community supports these and similar initiatives within the INTERREG program.

which are funded e.g. through the ERA-Nets instrument of the EU. |[168] Provided the appropriate institutional, regulatory and financial frameworks are in place, it is to be expected that bilateral and multilateral, transborder research networks or even organizations will grow in importance.

Apart from such groupings, which also form geographical clusters, there exist transnational associations between universities with the aim to bundle their interests and join up their research and teaching activities, as well as between non-university research institutions. Apart from the EUA |[169] (European University Association), with more than 800 members, the largest group to represent university interests at European level, other associations with more limited memberships have come to existence, such as LERU (League of European Research Universities), founded in 2002 as a group of 20 research universities |[170], and the Coimbra Group, established in 1985 and now counting 38 universities as members. |[171] In 1990, CLUSTER (Consortium Linking Universities of Science and Technology for Education and Research) was founded as a network of technical universities in Europe. |[172] Other application-oriented research institutions became organized in EARTO (European Association of Research and Technology Organizations), with the Fraunhofer-Gesellschaft as a German member.

III.2.B Research infrastructures

In the following, the term "research infrastructure" applies to outstanding institutions and resources or services, respectively, of all fields of science, insofar as they are required by the majority of scientists in the respective field for their specific research. Research infrastructures include large-scale research facilities or instruments, knowledge-based resources such as collections, archives, databases, virtual libraries, digitalized research information and information and communication technology (ICT) infrastructures such as GRID, computers, software or any other high-grade facility for scientific research. They can be located in a single site, or be distributed or even virtual. Extensive research infrastructures – and only these are considered in the present Recommendations – are usually characterized by high investment costs (measured by the standards of

| 168 A survey of the transnational alliances of institutions, as they are formed under EU research funding, is presented in: European Commission: STC key figures report 2008/2009 (2008), p. 98ff. It turns out that in FP5 and FP6 the non-university research institutions showed most networking activity.

| 169 The EUA is open for membership of individual universities as well as national rectors' conferences and other groupings. Its membership roll of more than 800 includes entities from 46 European countries.

| 170 German members are the universities of Freiburg and Heidelberg and LMU Munich.

| 171 The Coimbra Group defines itself as an "association of long-established European multidisciplinary universities of high international standard"; German members are the universities of Göttingen, Heidelberg, Jena and Würzburg.

| 172 The twelve member universities include TU Darmstadt and the Karlsruhe Institute of Technology (KIT).

the respective field) and, without exception, their special, structure-forming or transforming effect, and relatively long terms or life spans. |[173]

Since the establishment of the first intergovernmental facilities of this kind in the 1950s, there has been a consensus that the construction and operation of very large research infrastructures demand cooperation between several nations, with regard both to the expertise and the considerable financial resources required for such purposes. |[174] This transnational, cooperative approach has become ever more necessary as, firstly, the existing large-scale research facilities tended to increase in complexity and size in the course of the essential renovations of recent years; and, secondly, more and more fields of science require large research infrastructures.

In the following, a description of the initiatives of the European Union in relation to research infrastructures is followed by an outline of the Member States' strategy process for the planning of large-scale research infrastructures (ESFRI), as well as the corresponding national and international road map processes.

EU funding of research infrastructures

Over the past 20 years, the European Union steadily expanded its infrastructure initiatives. EU support in this area started in the Second Framework Programme (1987-1991) with a budget of ca. 30 mil. Euros. The Seventh Framework Programme, through its specific "Capacities" program, provides funds amounting to 1.7 bn. Euros for research infrastructures. These include finance for the optimization of existing research infrastructures as well as funding for the development of e-research infrastructures and support measures for the creation of new infrastructures (planning and design studies). In all this, funding by the EU is conditional on accessibility for researchers from other Member States. The European Investment Bank can also contribute to financing by providing

|173 This extended definition of research infrastructure is also used in the ESFRI Roadmap and the latest publications of the EU Commission. Cf. ESFRI (2008), p. 11; European Commission and ESF (2007), p. 3f. The Council of Science and Humanities adopted this definition as early as 2006 (Wissenschaftsrat (2006a), herein p. 93 and pp. 124-126). In the reference just cited, the Council recommended an assessment threshold of € 50 mil, in terms of investment costs, for large-scale facilities for basic research in the physical and natural sciences. A survey of the existing research infrastructures by the European Commission and the ESF (2007) showed that the average construction costs for the 598 facilities covered by the survey were in the region of € 60 mil, however with wide variations between different fields of research (pp. 18-20); average investment costs remain below the € 50 mil. threshold in three out of nine subject groups (social sciences, the field of biomedical and life sciences, and "Computer and data treatment"). Especially for the humanities and most of the social sciences, structure forming and transforming effects are expected even with much lower investment and running costs.

|174 On the existing intergovernmental, European institutions running large-scale research infrastructures in partnership and cooperation, see also A.III.2.a.

loans. |[175] Furthermore, at European level, the Structural Funds include resources for infrastructures (see also Chap. A.III.1.a). Of the total of 10.7 bn. Euros from the Structural Funds directed into research, technology, development and innovation through the funding period 2000-2006, 3.1 bn. Euros were explicitly dedicated to research infrastructures. In the period 2007-2013, the Structural Funds are to provide 9.8 bn. Euros, overall, for research infrastructures, of which 4.8 bn. Euros will flow to the twelve new Member States of the EU. |[176]

Beyond its previous activities, the European Commission is planning to make research infrastructures a central field of action of European research policy, and to establish this intention in the Eighth Framework Programme. The Commission is considering the option of co-financing multilaterally planned research infrastructures according to a selection process yet to be defined. However, EU funds will not be sufficient, under any circumstances, to provide the core financing for the construction of the new, pan-European infrastructures identified by the ESFRI process (see below). |[177] Therefore, mobilization of national and private finance sources remains absolutely essential for the realization of these projects.

Legal framework for European research infrastructures (ERIC)

In June 2009, the Council passed a "Regulation on the Community legal framework for a European Research Infrastructure Consortium (ERIC)". |[178] This EU legal framework should serve to facilitate the joint creation and operation of research facilities of European interest by several Member States, associated countries and international organizations. The Regulation was issued in response to previous difficulties for Member States to identify an appropriate legal

|[175] The European Commission and the European Investment Bank (EIB) jointly established the Risk Sharing Finance Facility (RSFF); based on FP7 (2007-2013), the European Community provides funds totaling up to € 1 bn. Euro for the RSFF; the EIB also contributes up to € 1 bn.

|[176] European Commission: STC key figures report 2008/2009 (2008), p. 114. Outside FP7, the Commission initiated a program for funding scientific publications for open access, amounting to € 85 mil. (cf. European Commission (2007c)). Under this program, e.g. the installation of freely accessible, digital archives (repositories) is to be funded. Another € 50 mil. is intended for the support of coordination and networking between infrastructures in 2007-2008 and for Europe-wide storage of scientific data, € 25 mil. for research into the maintenance and preservation of digital media, and € 10 mil. for improving the interoperability and multilingual access to scientific collections.

|[177] According to the EU Commission, the estimated construction costs for the 32 ESFRI Roadmap 2006-infrastructure projects in preparation alone, at approx. € 13.2 bn. are equivalent to 70 % of EU expenditure for R&D in 2005 (€ 19.1 bn.) (STC key figures report 2008/2009 (2008), p. 113).

|[178] Council Regulation (EC) No. 723/2009 of 25 June 2009 on the Community legal framework for a European Research infrastructure Consortium (ERIC). ABl. L 206/1 of 8 August 2009. Cf. also European Commission (2008b).

framework for the foundation of such infrastructures, which resulted in considerable delays in the foundation process in the past.

The new framework provides a legal personality that is recognized in every Member State and which stands out, most notably, by the advantages of international organizations, such as VAT exemption. Any ERIC should include at least three Member States, and may also be joined by associated countries and qualified third countries and international special organizations. Member States wishing to establish an ERIC have to apply with the Commission and enclose with their application a statement by the host Member state that it recognizes the ERIC as an international organization. With the help of independent experts – which may also include the ESFRI –, the commission assesses the proposed research infrastructure for its compliance with the Regulation. |[179]

European Strategy Forum on Research Infrastructures (ESFRI)

Considering the long-term commitments that may arise from investment decisions on research infrastructures, science politics requires strategic planning of investments in this area. For this purpose the European Strategy Forum on Research Infrastructures (ESFRI) was established in 2002. It consists of delegates of the Member States and a representative of the EU Commission and is supported by a Secretariat at the Commission. |[180] The ESFRI was founded in recognition of the increasing complexity of large-scale research infrastructures and based on the conviction that the development of research infrastructures – no least in the context of the emerging European Research Area – should be considered a partnership task rather than a field of competition.

In 2006, the ESFRI presented its first "European Roadmap for Research Infrastructures", prepared on the basis of a wide consultation process and including research infrastructure projects for the next ten to 20 years. Updated in 2008, the Roadmap uses a broad concept of infrastructures, which covers e.g. not only infrastructure projects for the physical and life sciences, but also those for the humanities and social sciences. Currently, the Roadmap counts 44 projects, without priority against each other. |[181] Based on the Roadmap and the princi-

|[179] Art. 5, para. 2 of the Regulation: "The Commission shall assess the application in line with the requirements laid down in this Regulation. During the assessment it shall obtain the views of independent experts in particular in the field of the intended activities of the ERIC."

|[180] The idea to create a coordinated policy approach for the area of research infrastructures was first brought up at the Strasbourg Conference on Research Infrastructures in the year 2000. On request of the Council of Ministers, the EU Commission established a *High-Level Expert Group* of representatives of all Member States. This group recommended the creation of the ESFRI.

|[181] This shows that the road map concept, which is frequently used in the context of research infrastructures, can be understood in very different ways: It can mean strategic planning, which includes the imple-

ple of variable geometry, the countries represented at the ESFRI can make concrete decisions on the realization of projects. |[182] The Roadmap is to be revised at regular intervals; the next update is scheduled for 2010. |[183]

Presently, there are no regulated processes for the transition of projects from the Roadmap to implementation. This particularly applies to the negotiations on multilateral funding plans. There are no fixed rules, either, for the assessment of fully developed project drafts. In this respect, the process developed by the Council of Science and Humanities is regarded as exemplary at European level. The ESFRI as such, however, is not going to set priorities or make any funding decision. The Commission devoted considerable space in the Green Paper to the development of competitive research infrastructures as a dimension of the ERA. The public consultation on the Green Paper resulted in broad consensus (82 %) that a Community policy approach was necessary for the implementation of the ESFRI projects. |[184]

Global road maps and international cooperations

At the global level, too, there has been growing awareness of the need for coordinated strategy development. For instance, the Global Science Forum of the OECD recently stated its views on the issue of “Road mapping of Large Research Infrastructures” |[185]. Large research infrastructures were also discussed at a meeting of the G8 and O5 ministers in 2008. |[186]

mentation of projects in a sequence defined according to clear priorities; but it can also involve an unprioritized collection of desiderates. Alternatively, the terms “strategy”, “vision”, “plan”, “survey” or “guide” also appear in this context. Cf. OECD (2008d), p. 3.

|182 By now, 32 of the 35 projects of the Roadmap 2006 have reached the preparation stage. Overview in: European Commission: STC key figures report 2008/2009 (2008), Table II.3.1, p. 111f..

|183 Apart from the ESFRI activities, further coordination of the generation of research infrastructures is contributed by the Survey of Research Infrastructures, jointly prepared by the EU Commission and the ESF. This document, which lists 598 existing, large European research infrastructures to compare with projects planned for the future, was explicitly designed as a supplement to the Roadmap. Cf. European Commission & ESF (2007). A database of existing infrastructures can be found at the “European Portal on Research Infrastructures” (http://riportal.eu/ [last downloaded 2010-04-12]), which is run by the EU Commission and the ESF.

|184 “Over four fifth of the respondents agree that a common approach is needed to develop pan-European research infrastructures. An overwhelming proportion of those in agreement state that this should be done at the European level.” (European Commission (2008e), p. 39.l). Also see the report of the EU expert group chaired by Gonzalo Leon: European Commission, Research Directorate-General (2010).

|185 OECD (2008d).

|186 The G8 group of leading economies includes Germany, France, UK, Italy, Japan, Canada, USA and Russia. The Outreach or O5 nations Brazil, China, India, Mexico and South Africa are the so-called emerging countries that are non-member participants in the meetings of the G8 group.

International Cooperation for a mega-scale research infrastructure has already become reality in the shape of the agreement on the International Thermonuclear Experimental Reactor (ITER), which is jointly financed by the EU (as the main funding party, contributing ca. 45 %), the US, India, South Korea, Russia, Japan and China, and built in Cadarache in southern France. Other countries, including Brazil and Australia have announced their interest in taking part in this project, whose costs will reach at least 5.5 bn. Euros over ten years. |[187]

Thematic road maps

Apart from the cross-topical processes for identifying research infrastructure requirements, European thematic road maps are developed, increasingly, by various organizations (e. g. for European astronomy by ASTRONET, for particle physics by CERN, for nuclear physics by the Nuclear Physics European Collaboration Committee (NUPECC), for astroparticle physics by the Astroparticle European Research Area (ASPERA)), which define the demands of specialist scientific communities or fields of research. This shows the wide diversification in the area of research infrastructures, which is due not only to the breadth of fields, but also the widely varying degree of organization of the specialist communities. In physics and related fields, in particular, the scientific community is highly organized and can rely on established research infrastructures, such as CERN, ESA, ESO and ESRF, whereas in other areas (especially in the humanities and social sciences), established processes to articulate demand are much less developed. |[188]

National road maps

The development of the ESFRI Roadmap at European level is accompanied by growing activity of the Member States in creating national road maps with clearly stated priorities, as a basis for their negotiations at European level. Such road maps have been drawn up, e.g. in Denmark, the UK, Finland, France, Ireland, Sweden and Spain. |[189]

|[187] Cf. http://www.iter.org/ [last downloaded 2010-04-12].

|[188] In the Seventh Framework Programme, the European Union increasingly funds initiatives to establish such processes in the humanities (cf. e.g. CLARIN: "Common Language Resources and Technology Infrastructure" and DARIAH: "Digital Research Infrastructure for the Arts and Humanities", which are both part of the ESFRI Roadmap). Presently, a working group of the Council for Science and the Humanities is engaged with the issue of "research infrastructures for the humanities and social sciences". The results of its work are going to be presented to the Council before the end of 2010.

|[189] Danish Council for Strategic Research: Future research infrastructures – needs survey and strategy proposal, December 2005; Research Councils UK: Large Facilities Roadmap 2008; Ministry of Education: National-Level Research Infrastructures. Present State and Roadmap, Helsinki 2009; HEA/Forfas: Re-

A national road map setting priorities across disciplines does not exist in Germany yet, but is provided for in the coalition agreement of the Federal Government. Presently, infrastructure proposals are drafted by the specialist scientific communities in Germany, in a variety of ways. In particle physics, for example, there is the "Komitee für Elementarteilchenphysik" [Committee for the physics of elementary particles, KET]; for marine and polar research, there are the German Marine Consortium and the DFG Senate Commission on Oceanography. The requests formulated in this way are followed up by the respective departments of the BMBF. So far, there is no cross-disciplinary weighing or prioritization, but this is planned for the future. Also, there is no systematic integration of the states [Länder], yet, in the relevant planning processes.

Research infrastructures in Germany

Germany has gained a reputation as an outstanding location of large-scale research infrastructures. Major European research infrastructures already reside in Germany or are scheduled for realization in this country. |[190] Leading examples of large-scale facilities for basic research in natural sciences in Germany are HALO (the High Altitude and Long Range Research Aircraft) and the High Magnetic Field Laboratory Dresden (HLD), which have been completed. Among the ESFRI Roadmap projects to be realized in Germany are the European X-Ray Laser Project (XFEL), with estimated construction costs of about 1 bn. Euros (start version), in Hamburg |[191], and FAIR, the Facility for Antiproton and Ion Research. The FAIR project, with a construction budget of just under 1 bn. Euros, which will reside with the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, is realized with the involvement of 15 countries. |[192] Additionally, at the German electron synchrotron (DESY) in Hamburg, the high-brilliance synchrotron radiation source PETRA III is being made operational after the conversion of an existing accelerator ring.

With 32.7 % of their users being researchers from abroad, according to EU data, German research infrastructure facilities a far ahead of the rest of Europe, con-

search Infrastructure in Ireland – Building for Tomorrow 2007; The Swedish Research Council's Guide to Infrastructure: Recommendations on long-term research infrastructures by the research councils and VINOVA, 2nd edition (May 2008); Ministerio de Educación y Ciencia: Singular Scientific and Technologica Infrastructures, March 2007.

|[190] In the absence of any systematic records of the relevant information, no comprehensive overview of existing large-scale research infrastructures and the investments in this connection is available. However, for basic research in the natural sciences, such overview does exist, see BMBF (2009).

|[191] Germany bears more than half of the costs (with contributions from Hamburg and Schleswig-Holstein); 13 other partner countries will also contribute to financing this project.

|[192] The federal administration bears 65 % of the total costs, the (federal state or Land of) Hesse 10 %, other participating countries, including Russia, China, India, France and the UK the remaining 25 %.

cerning their utilization by foreign visitors, followed by Italy (14.6 %), UK (11.2 %), France (10,0 %) and Switzerland (8.9 %). |[193] This makes German an essential provider of access to research infrastructures for the transnational scientific community.

Federal expenditure for research infrastructures

In 2006, R&D investments by the BMBF in infrastructures for basic research in the natural sciences amounted to 782 mil. Euros, equivalent to about 14 % of total R&D expenditure by the BMBF. This budget is used mainly for the funding of research infrastructures at institutions engaged in large-scale research, especially the 16 member institutions of the Helmholtz Association of German Research Centers (HGF). Another portion of the budget goes to European research establishments. 12 % of the funds for major research infrastructures for basic research are available for project funding, which is predominantly used by university teams working at large-scale facilities. Apart from that, investment in research infrastructures that are not part of basic research in the natural sciences has been rather marginal, so far. |[194] Related to the overall budget of the BMBF, the distribution of expenditures for research can be represented as follows:

|[193] European Commission: STC key figures report 2008/2009 (2008), p. 117.

|[194] The following table is based on the actual BMBF figures from 2006. It should be noted that the BMBF does not operate a dedicated budget title “Research Infrastructures” as defined by the ESFRI, and that investments in new facilities are discontinuous. The individual research infrastructures are isolated from the budget by the funds that are put under the relevant subject title, as required, and included in the titles of the respective institutions. All statements refer to section “large-scale facilities for basic research in the natural sciences” at the BMBF; funding of large-scale facilities by the DFG or through the “university construction funding act” [Hochschulbauförderungsgesetzes (HBFG)] is not considered here. The figures are representative insofar as they reflect current funding practice of the BMBF. For instance, expenditure of institutional funding (row 1 of the table) mainly relate to the typical large-scale physics facilities; infrastructures in the area of “Earth and Environment” (row 2) include e.g. research vessels and planes and computers for climate modeling.

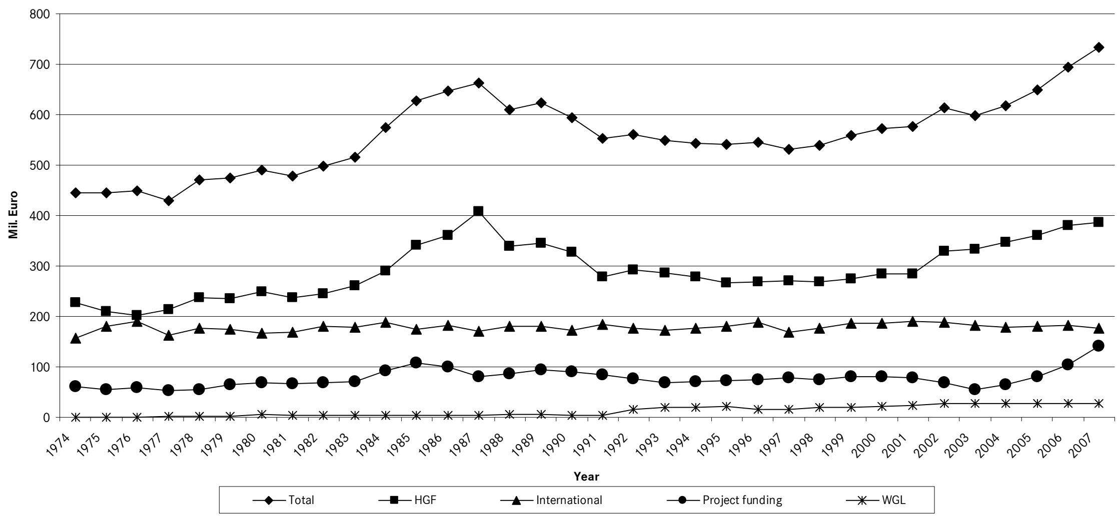
Table 6: BMBF expenditure for large research infrastructures for basic research in 2006 (actual figures)

Funding type	Mil. Euro	Share of research infrastructure funding	Share of total BMBF budget (R&D only)
Institutional funding (mainly large-scale facilities for physics)	419	53 %	7,6 %
Infrastructures in the field of "Earth and Environment"	76	10 %	1,3 %
Contributions to European research facilities (CERN, ESO, ESRF, ILL, ETW)	193	25 %	3,5 %
Project funding	94	12 %	1,7 %
Total funding	782 (R&D only)	100 %	14,1 %

Source: BMBF

BMBF expenditure for large-scale facilities has increased steadily over the past 30 years. The abrupt rises in total funding in that period are attributable mainly to some major, financially effective, individual decisions (e.g. those taken following the recommendations of the Council of Science and Humanities in 2003). The following graph provides an overview of the development of expenditures since 1974, in real terms, in this funding area.

Figure 8: BMBF expenditures for funding of large-scale facilities for basic research, by funding type, 1974 to 2007 (nominal figures)



Source: BMBF; real-term figures (Index 2000=100; Federal Statistical Office, Fachserie 18 Reihe 1.5 Tab. 3.3 Public consumption)

III.3 Mobility of researchers and internationality of personnel

Exceptionally successful European institutions usually show a relatively high degree of internationalization of their personnel. They promote this internationalization by supporting foreign assignments for their personnel and integrating more colleagues from abroad. |[195] It is in the interest of institutions to recruit foreign personnel at all levels of qualification. This applies even more in countries where the proportion of persons of university-level education in the national population is relatively low, as is the case in Germany. |[196]

On the other hand, for a university or research institution to become internationalized at the personnel level, their scientists need to be prepared to be mobile. Due to the advancement of personal expertise and career prospects generally gained by mobility, this preparedness can be assumed in most cases. Therefore, mobility is in the interest not only of the institution, but also of the researcher.

The status description presented in the following paragraphs uses a range of indicators to outline the present status of internationalization at the personnel level, for Europe and, above all, Germany (Chap. A.III.3.a); the advancement of mobility by the European Union as well as by national actors is described in a second step. An analysis of the factors that promote or hold back mobility follows in the recommendations part of this document (cf. Chap. B.II.4).

III.3.A Internationalization of personnel

Doctoral students

Germany is one of the few European countries that record data on completed doctorates, but not on doctoral students. |[197] Such data can only be collected if all doctoral students, independent of their type of employment or funding of their studies are recorded (i.e. if all doctoral students are given identical academic status). As long as this is not the case, data-based conclusions about the mobility of scientists at this career level are hardly possible. Some information about the number of German doctoral students abroad can be gleaned from data collected in other countries.

| 195 Intersectoral mobility as another possible dimension of mobility is disregarded in the following; on this point, cf. Wissenschaftsrat (2007), Chap. A.III.9.

| 196 OECD (2009c), Table A.3.2. The proportion of people with university-level education in Germany has risen – as it has in almost every comparison country – (from 14 % in 1995 to 23 % in 2007). However, in the OECD countries for which data are available for both years the proportion of university graduates increased from 18% to 36 %. This cannot be due simply to the strong role of dual vocational training and education in Germany, as was emphasized in the report of the Commission of Experts on Research and Innovation (cf. Expertenkommission Forschung und Innovation (2009), p. 66).

| 197 As any records of students aiming to complete a doctoral degree are unsystematic and fragmentary, these data can only represent approximate values.

In the European Union as a whole (or the 21 Member States that supplied the required data), in the year 2005, 80 % of the doctoral students studied in their respective country of origin, meaning the average share of foreign doctoral students was 20 %. Of these, 5.8 % originated from another EU Member State and 14.1 % from third countries (5.3 % from the Asia region and only 0.9 % from North America). |[198] The proportion of foreign doctoral students from other EU Member States is particularly high in the UK and in Austria and Belgium (ranging between 12 % and 12.5 %); measured by the absolute number of foreign doctoral students (from EU countries as well as from third countries) the UK, France and Spain are the leading countries. |[199]

Comparing these figures with those from the USA, where about 35 % of all doctoral students are from abroad (mainly from China, South Korea, India, Taiwan and Canada, with Germany at the top of EU countries of origin), it becomes clear that there is a potential for hefty increases in this respect in the European Research Area. Also, more than two thirds of foreign doctoral students remain in the USA for years after their promotion. |[200] In Europe, only Switzerland and the UK achieve similar figures, with 44.4 % and 40.8 % share of foreign doctoral students, respectively, in 2006. |[201]

Doctoral exams

The share of foreigners in doctoral exam passes in Germany has grown continuously over the past decade, from 6.7 % in 1997 to 14.5 % in 2008 (of which just under a third stem from EU Member States). The share of successful doctoral students from abroad thus exceeds that of foreign students, overall, at German universities, which has leveled out at about 12 % over the past years. |[202] Despite this significant increase, the share of foreign students passing doctoral exams remains far below the figures registered by other major science nations: In

|198 European Commission, Joint Research Center (2008), p. 75.

|199 In 2005, 11,500 doctoral students in the UK were from other European countries; the comparison figures for the two next-strongest countries according to this indicator are: 5,400 in France and 3,100 in Spain (ibid, p. 10).

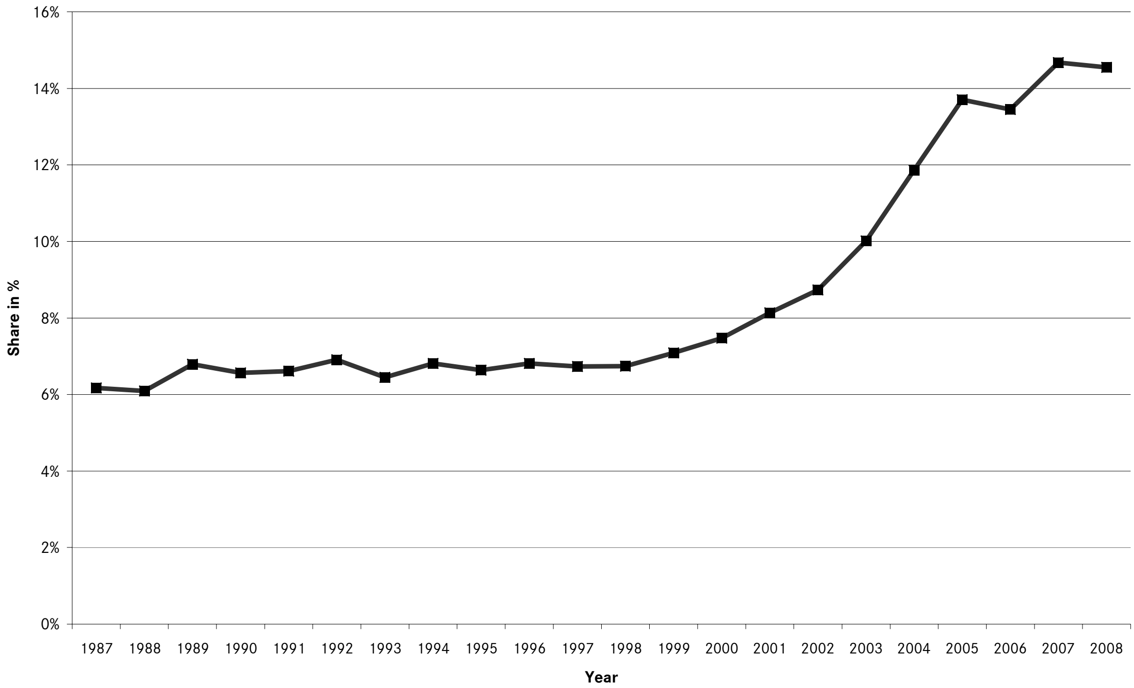
|200 For a detailed comparison between Germany and the US regarding postgraduate education, cf. Bosbach (2009).

|201 OECD (2009e), p. 126f.

|202 The share of educational foreigners in passed doctoral exams stands at 14.2 %. In the Winter semester WS 2008/2009, 11.8 % of all students in Germany were of foreign origin; of the total number of 239,143 foreign students, 74,207 were European Union Citizens. Among the students of foreign nationality, 180,222 (8.9 %) are educational foreigners and 58,921 (2.9 %) educational residents (i.e. holding German university entrance qualifications). At the same time, ca. 90,300 Germans were students at universities abroad in 2007. Cf. Federal Statistical Office (ICE Analysis); Fachserie 11, Reihe 4.1, Tab. 11, 2009.

the US in 2007, about 33 % of new PhDs were foreigners; in the UK, the figure was 40 %. |[203]

Figure 9: Share of foreigners in successful doctoral exams in Germany, 1987-2008*



* Until 1992 “old states [Länder]” only

Source: Federal Statistical Office: Fachserie 11, Reihe 4.2; own analysis

The dominant countries of origin of foreigners that completed their doctoral studies in Germany in 2008 are China (8.1 %) India (6.1 %), Poland (5.1 %), the Russian Federation (4.5 %) and Italy (4.5 %). |[204]

Postdoctoral academics

In many disciplines, especially in the natural sciences, the doctoral promotion is followed by an intermediate career stage, which is usually referred to as “post-doctoral”. |[205] This often involves working abroad and is therefore, without doubt, a key stage in every scientist’s career, regarding their mobility. Because of the diverse discipline cultures, multifarious forms of funding and employment, and variable timing and duration of this career stage, comprehensive and comparable statistical data are available neither for Germany, nor at European level.

|[203] National Science Foundation (2010), p. 25.

|[204] Federal Statistical Office, Fachserie 11, Reihe 4.2, 2008.

|[205] See Wissenschaftsrat (2001), p. 71.

Therefore, if any, only approximate figures can be cited here: According to estimates by the Joint Research Center of the EU, 42 % of the "postdocs" in the EU27 working in life sciences, 28 % in engineering sciences and 22 % in social sciences are of foreign origin. |[206] For comparison, the share of foreign postdoctoral researchers in the US, in 2006, reached 57 %. |[207] US Internal Revenue data were used in a study investigating the present abodes of foreigners that completed their doctoral exams in 'Science and Engineering' in USA in the year 2000. |[208] For some countries of origin, a relatively large number of foreign postdocs remained in the US even five years after their doctoral exams. These are: China (92 %), India (85 %), and Eastern Europe except EU Member States (82 %). The integration rate averaged over all countries covered by the study, five years after promotion is 65 %. This trend is going to continue: According to data from the National Science Foundation, more than three quarters of foreign postdocs newly created in the US from 2004 to 2007 intended to stay in the country; the comparison figure for Germany is a more modest 69.3 %. |[209]

Scientists

Again, any European comparison of the share of foreign scientists on payrolls founders on the rudimentary quality of available data. Few European Member States record the relevant information; the German Federal Statistical Office started systematic recording of scientific personnel according to countries of origin only in 2005. |[210]

Therefore, studies regarding this matter often use the fallback of "human resources in science and technology holding a university degree or equivalent" (HRST core). However, reliable data of this category, too, are available for only 14 of the EU Member States. In these countries, 4.4 % on average of all highly qualified personnel in science and technology were foreigners, 2.4 % from other EU countries and 2 % from third countries (2006 figures). At 4.1 %, Germany registers below the average of the 14 countries, while Luxembourg is leading the field with 51 %, in front of Austria with 10.6 %. The UK scores 6.3 %. Switzerland, with 19.5 %, also comes in with a high share for a European country. |[211]

|[206] European Commission, Joint Research Center (2008), p. 87.

|[207] National Science Foundation (2010), p. 31.

|[208] Cf. Finn (2007).

|[209] National Science Foundation (2010), Annex, Table 2-31.

|[210] Cf. European Commission, Joint Research Center (2008), herein p. 89f.

|[211] European Commission, Joint Research Center (2008), p. 94. See also Eurostat (2007).

In the US, the proportion of foreign personnel at doctoral level employed in science and industry is more than a third (34.6 % in 2003), with China (22 %) leading India (14 %) as country of origin of such employees. |[212]

Regarding the balance of mobility effects, the OECD showed in a recent study that most OECD countries are net winners from mobility, meaning the influx of highly qualified personnel exceeds the outflow of such individuals. |[213] Especially the USA, Canada, Australia and France profit from this situation. Germany too is among the winner countries, even if the absolute share of highly qualified Germans abroad is very high as well, as is the case for the British.

Staff scientists and artists

In Germany, the share of foreign colleagues among staff scientists and artists is slightly higher, at 9.4 %, than among the professors (see below). |[214]

Table 7: Scientists and artists employed at German universities; share of foreigners 2005-2008

Year	Total number of scientists and artists employed	Thereof foreigners*	Share of foreigners
2005	240.186	19.827	8,3 %
2006	248.938	21.911	8,8 %
2007	260.064	22.704	8,7 %
2008	274.769	25.751	9,4 %

* including stateless/unresolved

Source: Federal Statistical Office, Fachserie 11, Reihe 4.4, years as listed

The majority of foreign scientific personnel at German universities (two thirds) are from other European countries (47.5 % from EU countries, 16.9 % from the rest of Europe). At 21.3 %, scientists from Asia are strongly represented, as well, especially those from China (6.4 %) and India (3.6 %). These percentages regis-

|212 National Science Foundation (2010), Chapter 3, p. 52.

|213 OECD (2008b). In its study, the OECD also points out that balancing between “donor countries” and “receiving countries” is inadequate insofar as mobility, in the medium term, also produces positive effects on the donor countries, as family members living abroad convey material and life-style assets to their families, which can lead, e.g. to heightened awareness of the value of education and changed attitudes in their home countries. For other effects, cf. herein p. 42.

|214 The share of female professors in the positions occupied by foreigners at all universities stands at 21 %, with 17 % at classic universities and 25 % at universities of applied science. Among staff scientists and artists at universities, 38 % of the foreigners are women.

tered a rise since 2005. The top 5 countries of origin for 2008 are China, Austria, Italy, the Russian Federation and France. |[215]

The internationalization of personnel has progressed further in the non-university research sector than at universities |[216]: At the non-university institutions, the share of foreign scientists and artists on the payroll reaches 14.9 %, on average, with the highest degree of internationalization registered by the Max Planck Institutes with 22.3 %, followed by the Helmholtz Centers with 16.0 % (2008 figures). |[217] Differences seen between classic universities and universities of applied sciences or polytechnics with regard to their shares of foreigners in the scientific personnel continue into the non-university institutions: At more application-oriented institutions, the share of foreigners is lower than at research institutions oriented more strongly towards basic research. The regions of origin of scientists working at non-university institutions generally reflect the picture found at German universities: Europe dominates by a wide margin.

In the US, on the other hand, European scientists constitute almost one third of all foreign scientific personnel, with Germany leading the field. For some years now, Germany has held position 5 among the countries of origin of foreign scientists in USA (behind China, Korea, India and Japan). |[218] This can be understood as evidence for the excellent education and training received by scientific personnel in Germany, who are in high demand in the US. However, the observation that the share of German researchers at doctoral-student or postdoc level in the US is very high may also point to a lack of attractiveness of German scientific institutions for researchers at certain career stages. The observation that periods of working in the US also improve the career prospects of German researchers in their home country is beside the point, since this will be the case for researchers from other countries of origin as well.

Professors

The share of foreigners in professorial positions amounts to 5.6 % (2008 figures) for all German institutions of higher education and 6.8 % at universities, which is significantly more than the share of foreign professors at universities of applied sciences and polytechnics (2.0 %), whereas the comparison figure for art

|[215] See also the detailed representation in terms of country of origin in the Annex, Table A.17. Shares of foreign personnel listed by subject groups are presented in Table 1.

|[216] As this is based on full-time equivalents, any direct comparison with university personnel (measured by headcount) can only reflect a tendency.

|[217] Fraunhofer institutes: 8.8 %; institutions of the Leibniz-Gemeinschaft: 11.8 %. Source: Federal Statistical Office, Fachserie 14, Reihe 3.6, Tab. 5.5, 2008, and own analysis. Cf. Table A.15. in Annex.

|[218] European Commission, Joint Research Center (2008), p. 104.

colleges is particularly high (19.3 %, see Table A.16 in Annex). Compared to the German universities, the corresponding institutions in Switzerland show a very high level of internationalization of the professorate, with 44.7 % share of foreign professors, on average. In this, German professors, with a share of 45 %, constitute the largest group by far among the foreigners |[219]. As a small country, however, Switzerland may be compared with Germany only with certain qualifications. |[220] In the US, the share of professors (full-time faculty with emphasis on research) with a foreign passport stood at 10.2 % in 2006, apart from another 13.4 % of professors born abroad, but naturalized as US nationals. |[221]

III.3.B Promotion and funding of mobility in the European Research Area

EU initiatives to promote mobility

The Commission defined as one of its objectives to create a unified, open and competitive employment market for researchers. The Commission pursues this objective by generally seeking to improve the working conditions for researchers in the EU |[222]. Such initiatives of the Commission include the European Charter for Researchers (see below), the European jobs portal on the internet, "EURAXESS" |[223] and the Council Directive concerning a researcher's visa (see below).

|[219] A complete overview for all types of higher education institutions and various groups of personnel can be found in the Annex (Table A. 16).

|[220] The success of Swiss universities in the recruitment of foreign personnel is attributed to relatively high salaries, good infrastructure provisions, and more transparent and reliable career paths. Also, the universities operate strategies dedicated to the recruitment of highly qualified staff from abroad.

|[221] National Science Foundation (2010), Annex, Table 5-19.

|[222] http://ec.europa.eu/invest-in-research/policy/human_resource_set_en.htm [last downloaded 2010-04-12]. Cf. European Commission (2007e) and European Commission (2007a), Chapter 3.1. On the exchange between science and the private sector, see European Commission (2007d); see also the accompanying Commission Staff Working Document SEC(2007) 449.

|[223] EURAXESS is an Internet portal for internationally mobile researchers. It comprises more than 200 Service Centers in 35 countries (http://ec.europa.eu/euraxess/index_en.cfm [last downloaded 2010-04-12]). It provides members with information about career and funding opportunities in Europe and offers them opportunities to get in touch with other members and researchers in Europe. The German Service Center resides with the Alexander von Humboldt Foundation (http://www.euraxess.de/portal/home_de.html [last downloaded 2010-04-12]). Also in Germany, the GAIN (German Academic International Network) information portal was created. GAIN is a joint initiative of the Alexander von Humboldt Foundation (AvH), the German Academic Exchange Service (DAAD) and the German Research Foundation (DFG). The Fraunhofer-Gesellschaft, the Helmholtz Association of German Research Centers, the Max Planck Society, the Leibniz-Gemeinschaft and the German Rectors' Conference are associated members. In the past years, GAIN could establish itself as a networking forum for German scientists in North America and as a platform for improving the flow of information across the Atlantic, in both directions. Cf. http://www.gain-network.org/ [last downloaded 2010-04-12].

Furthermore, the European Union directly funds researchers and their mobility through various programs. Within the Seventh Framework Programme, for instance, the specific "People" program with its Marie Curie Actions and a budget of 4.75 bn. Euros aims to advance the training, career development and mobility of researchers. The Marie Curie Actions, which are open to all disciplines, are subdivided into individual program lines, supporting institutions in the education and training of young scientists (e.g. Initial Training Networks to promote structured training for doctoral students), funding young researchers to carry out a project of their choice, or funding the cooperation between the private corporate sector and science through an exchange program for young researchers. Mobility within Europe is funded via appropriate grants (Intra-European Fellowships), as is international mobility (Outgoing International Fellowships/Incoming International Fellowships). |[224]

The two funding lines of the European Research Council within the "Ideas" program also aim at enhancing mobility by allowing young scientists and established researchers to choose an adequate environment at a European research institution. However, the results of the first calls for applications for Starting Grants and Advanced Grants show that relatively few successful applicants used their grant for moving to another country (cf. Chap. A.III.1.c).

Latterly, the European Union has been funding European promotion programs as part of the ERASMUS Mundus Programme, as well, with the aim to improve the quality of university education and foster intercultural understanding through cooperation with third countries. Under the funding action on "joint master and doctoral programmes including scholarships", groups consisting of at least three different European and possibly third-country higher education institutions, which offer a joint master or doctoral program, can apply for the ERASMUS Mundus label. This is accompanied by the award of scholarships to highly qualified individuals from third countries or Europe, who are selected for this program. Also, short-term funding is available for non-European and European scientists to carry out three-months teaching assignments in selected ERASMUS Mundus courses.

The "European Charter for Researchers" and the "Code of Conduct for the Recruitment of Researchers" were published as a Commission Recommendation to the Member States in March 2005. |[225] They are intended to bring the European Research Area closer to reality by standardizing the employment conditions for researchers and establishing a European employment market, and to create bet-

|[224] On the evaluation of the funding measures regarding the attractiveness of science systems in Europe, see Chap. A.III.3.b.

|[225] European Commission (2005b).

ter, more transparent working conditions and career paths for researchers. Both the Charter and the Code of Conduct address the Member State governments, public and private sector employers of researchers, public and private research funding bodies, and the scientists themselves. Universities, research institutions and research and science organizations are invited to sign the Charter and the Code and draw up an implementation protocol, also including the items that the respective institution is unable or unwilling to implement.

The German science organizations, led by the Alexander von Humboldt Foundation, issued a largely positive, joint statement on the objectives of the Charter, which, however, also offered criticism concerning some details. |[226] Many organizations identified as a risk that signing of the Charter and Code could be made a precondition for participation in the Seventh Framework Programme. However, there is no evidence of this in the Guide for Applicants. An EU working group with participation of the Alexander von Humboldt Foundation agreed in April 2007 that science institutions, after a comprehensive, internal evaluation process, may voluntarily declare their consent to the objectives of the Charter and Code, and may announce an action plan for their implementation via their Internet presence. Public and private science organizations have been able to obtain the Charter label since June 2007.

Furthermore, the EU issued a Directive concerning researchers' visa in 2005, in order to allow foreigners adequate access to research projects. |[227] However, by the deadline for implementation of the Directive in national legislation (12 October 2007), only six Member States have done so. Germany introduced a special residence permit for researchers (§ 20 Aufenthaltsgesetz [Residence Act]) in line with the Directive. Researchers from third countries can receive this permit for research purposes for at least one year, provided they entered a contract to carry out a research project with a research institution accredited with the Federal office for Migration and Refugees (BAMF). This can be a university, a non-university institution or accredited businesses engaged in research. The foreigners' registration office in charge only issues the permit, without getting in-

|[226] On the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, statement of the undersigned German science organizations: Alexander von Humboldt Foundation, Arbeitsgemeinschaft industrieller Forschungsvereinigungen [Federation of Industrial Cooperative Research Associations] "Otto von Guericke" e.V., German Academic Exchange Service (DAAD), German Research Foundation, Fraunhofer Gesellschaft, Helmholtz Association of German Research Centers, German Rectors' Conference (HRK), Leibniz-Gemeinschaft, Stifterverband für die Deutsche Wissenschaft, Council of Science and Humanities (2006-10-01) (http://www.humboldt-foundation.de/pls/web/docs/F21999/2006_forschercharta_erklaerung.pdf [last downloaded 2010-06-30]. Of the German organizations and institutions, so far only three have signed the Charter: HRK, the Alexander von Humboldt Foundation, DAAD and the University of Freiburg.

|[227] Council Directive 2005/71/EC.

volved in the selection process. |[228] The residence permit for researchers also includes the possibility of short-term stays (up to three months) in other EU Member States that have implemented the directive, without requiring a separate residence title.

Early June 2009, after lengthy debates, the EU Council of Ministers adopted the EU Directive on a harmonized work permit for highly-qualified employees (Blue Card). It was published in the Official Journal of the European Union on 18 June, 2009. |[229] According to the Directive, the Member States must implement it in national law within a period of two years. The European Union is going to open its borders for highly qualified workers in 2011, the latest – however, due to pressure from some Member States, under stricter conditions than originally planned. Germany, as one of these Member States, intends to give preference to training and continuing education for German workers, in the context of a national "qualification offensive". Nevertheless, the Federal Government, too, acknowledged the demand for highly-qualified immigrant workers. |[230] The conditions for issue of a Blue Card, which is valid for up to four years, are the following: a valid employment contract (or a binding offer of employment for at least one year), a university degree (or five years of professional experience at a comparable level); furthermore, the income from the potential employment must be at least 50 % above the average gross income in the destination country. Blue-Card holders are not entitled to EU-wide change of employment. It is only valid in the issuing country, because a Blue Card that would be valid as a Europe-wide work permit was rejected by the Member States.

Promotion and funding of mobility in Germany

The promotion and funding of mobility at European level is supplemented significantly by corresponding activates of the Member States. In Germany these are, most notably, the activities of the German Academic Exchange Service (DAAD) and the German Research Foundation (DFG) (incl. International Graduate Schools and DFG Research Fellowships) |[231], the Max Planck Society mainly through the International Max Planck Research Schools, the Alexander von Humboldt Foundation |[232] and (for USA) the Fulbright Commission |[233]. The

|228 Bundesamt für Migration und Flüchtlinge: www.bamf.de [last downloaded 2010-04-12].

|229 Council Directive 2009/50/EC of 25 May 2009 on the conditions of entry and residence of third-country nationals for the purpose of highly qualified employment. ABl. L155/17 of 18 June 2009.

|230 Cf. BMBF Press Release No. 165/2007, 2007-08-24: "Impulse für bessere Qualifizierung und Erleichterung für Zuwanderung".

|231 http://www.dfg.de/foerderung/internationale_kooperation/internationale_kooperation_dfg_verfahren/index.html [last downloaded 2010-04-12].

|232 www.avh.de [last downloaded 2010-04-12].

funding facilities in this area have been expanded and amended by further instruments in recent years. |[234] For instance, in November 2007 a new international grant for research in Germany (Research in Germany Award), endowed with up to 5 mil. Euros, was established by the Alexander von Humboldt Foundation. This award is to be granted to foreign, world-leading international researchers of any discipline, who will engage in groundbreaking research in Germany for a period of five years. Individual federal states [Länder] too are taking measures to promote mobility; North Rhine-Westphalia, for example, established a program to bring back German researchers from abroad.

Most recently, the Excellence Initiative contributed considerably to raising the attractiveness of German research institutions and internationalization at the personnel level. At the Graduate Schools, the share of doctoral students from abroad has reached 27.6 %; at the Excellence Clusters the figure is 21.1 %. |[235] The foreign personnel recruited through the Excellence Initiative mainly stems from Europe and Asia. Most of the Asian recruits (primarily from India and China) are engaged in research at doctoral student level, whereas their colleagues at more advanced stages of their careers were recruited mainly from Europe and North America. |[236]

Apart from the personnel numbers revealing the present level of internationalization at different levels (see Chap. A.III.3.a), the use of above-mentioned European and national funding programs provides evidence for the degree of attractiveness of different Member States and third countries.

Balance of European mobility programs

Evaluation of the Marie Curie Actions, which were already part of the Sixth Framework Programme, with regard to nationalities and mobility patterns |[237] shows that the most popular host country, by far, for researchers funded by Intra-European Fellowships was the UK (35.1 % of fellowships), followed by France (15.6 %) and Germany (9.9 %). Equally, the evaluation of the Incoming International Fellowships, which were only open to applicants from third countries, shows the UK as the most popular destination (29.7 %), with Germany coming

|[233] http://www.fulbright.de/home.html [last downloaded 2010-04-12].

|[234] Funds provided by the German Federal Foreign Office to the DAAD alone increased from € 55 mil. in 2005 to € 65 mil. in 2007; over the same period, provisions by the Foreign Office for the Alexander von Humboldt Foundation rose from € 21 mil. to more than € 30 mil. Overall, funds invested for this purpose by the Foreign Office increased by 25 % from the year 2005 to 2007 (Source: Bundestags-Drs. (2007), p. 10f.).

|[235] Sondermann; Simon; Scholz et al (2008), p. 21.

|[236] Ibid, p. 22.

|[237] European Commission, Research Directorate-General (2009).

second in this category (16.1 %), in front of France (15.0 %). Most applicants stem from Russia (15.8 %), China (13 %) or India (11.3 %).

Researchers funded through Outgoing International Fellowships (OIF) mostly used their grants to move to USA (74.8 %), Australia (10.9 %) or Canada (8.6 %), meaning these three countries received nearly 95 % all OIF-funded researchers. For comparison, only 0.6 % of this group went to Russia, China and India. Almost three quarters of all fellows return to their country of origin after completion of their foreign assignments. |[238] This tendency is confirmed by the destination of European Reintegration Grants (ERG): Most recipients use them to return to their home country, whereas only 6.2 % of these researchers moved to another country in Europe.

The above-mentioned evaluations of the first rounds of ERC Starting Grants and Advanced Grants also show that Germany appears to be less attractive as a host country for researchers than the UK or France (cf. Chap. A.III.1.c).

Balance of national funding schemes

In 2007, about 26,000 foreign scientists worked in Germany with German funding (mostly from DAAD, MPG, DFG, HGF and AvH). |[239] The majority of them are scientists from Europe (predominantly Eastern Europe), plus a sizeable share of Asian researchers (nearly 30 %). The most important countries of origin are Russia, USA, China, India, Poland and France, which together account for about a third of all funded assignments, Russia alone contributing 11 %. The length of stay is very variable: Researchers at the postgraduate and postdoctoral stages tend to stay for 7 to 12 months, whereas the majority of scientists and professors come to Germany under funding programs for short-term assignments of up to three months. More than half of all funded foreign researchers belong to the subject group math and natural sciences. Overall, the foreign scientists are about evenly shared between higher education and non-university institutions (mainly MPG and HGF).

Conversely, German researchers also go abroad with the help of funding from national institutions. In 2007, close to 5,500 scientists made use of this option. |[240] About half of the funded scientists went for a foreign assignment in

|[238] Under FP6, recipients of OIF Fellowships were under obligation to return to Europe.

|[239] Best source for these data: DAAD (2009). Since this covers only assignments of foreign researchers financed by German funding organizations, the figure cited here only represents part of the total number of foreign guests. Only central, harmonized registers of the relevant data on scientist exchange at federal and Länder level would allow an assessment of the entire volume of scientist exchange and draw the appropriate conclusions, including political.

|[240] Most of them benefited from a DAAD scholarship or DFG funding.

one of the European countries (predominantly Western Europe), and a third headed for America (USA and Canada). In comparison, Asian countries remain rather unpopular as destination countries. Also, there are clear variations between different groups of funding recipients: While almost half of the postdoctoral researchers take their grants to the US, and 36 % to a country in Western Europe, the majority of the more experienced scientists use them for assignments in Eastern Europe. In the ranking of the most popular destinations, USA remains in the lead by a wide margin, followed by the UK, France and Italy, Switzerland, Russia and Japan. Among the professors and postdocs funded from German sources, the researchers from the fields of math and the natural sciences clearly dominate, whereas at the postgraduate stage, more students of languages and cultural sciences, law, economics and social sciences make use of this funding option for staying in a foreign country. |[241]

Overall, regarding the national programs for promoting the mobility of scientists, Germany achieves a considerable, quantitative "migration gain", with the greatest influx from Russia, China, India and Poland. More equal balances are found between Germany and the Netherlands, France and Canada, while the numbers of scientists attracted by Switzerland, the UK and the USA exceeds the numbers received from these countries.

Analysis of the migration movements of mobile, scientific personnel in Europe as a whole clearly shows that intra-European mobility is the predominant factor (both in the ERA and in Germany), and the movement tends to be westward, the UK, France and Germany being particularly popular destinations. This is evident from the relatively large number of Eastern Europeans coming to Germany, while the flow from Germany, especially of young scientists, goes towards Western Europe. Regarding migration into the EU and out of it, we find the same tendency: inflow from the East (mainly Russia, China and India), outflow towards North America.

The conclusions and consequences for the attractiveness of Germany as a science location are discussed in the recommendations part of this document, as is the importance of career-related (range of options, predictability, transparency), financial (salaries, portability of social security and pension provisions), legal (immigration law and visa, but also legal frameworks for universities) and other, "soft" factors (reputation of the host institution, information and advice, mentality, language, family and equality support) in the choice of destination of mobile researchers.

|[241] DAAD (2009), p. 78ff.

B. Analysis and recommendations

The internationalization of science, as well as the Europeanization of science politics is progressing at increasing speed (cf. Chap. A.I and A.II). The present Recommendations focus on the European Research Area (ERA) as the central arena of Europeanization, because it can be anticipated that it will dominate science policy in the coming decades. The Council of Science and Humanities proceeds from the assumption that Germany will be able to maintain her international competitiveness only in close collaboration with the other European countries. Germany and Europe still have distinctive strength at their disposal in the global competition, even if the US is more successful if measured by a number of indicators (cf. Chap. A.I). However, new actors claiming a role in global knowledge production join the traditional rivalry with the North American science area, making it all the more necessary to further strengthen the European science sector. |[242]

Especially small and medium-sized nation states, like those in Europe, are now unable to react appropriately to this increased pressure. Therefore, the Council of Science and Humanities welcomes the idea of the European Research Area rooted in the context of the Lisbon Strategy, and the related political initiatives. These triggered considerable dynamics in the science policies of the Member States, as well. Cooperation in Europe increases the chances of the Member States to partake in the opportunities of global exchange. In Germany, the national actors at federal level and in the states [Länder], the science organizations, universities and research establishments are aware of the necessary strategic adjustments and have already taken some steps in that direction.

|[242] As shown especially for Japan, China, India and Korea, which have become a serious, competitive Asia-Pacific Region for science. Cf. National Science Foundation (2007).

With the present Recommendations, the Council of Science and Humanities aims to support these actors by exploring the consequences of the European Research Area for the function and significance of the national science system and German science policy, and elucidate how national actors can contribute to the active shaping of the ERA.

In this, the Council proceeds from the following principles:

_ National (in Germany: federal and state [Länder]) and European instances of research politics are jointly responsible, in different roles, for the future shaping of the national institutions in the context of the ERA.

_ A strong national science landscape, which maintains its own identity, remains essential for German institutions to contribute actively and independently to the ERA. |[243] This must be further strengthened in the overarching interest of Europe.

_ The ERA needs to be attractive for individual scientists (as the central actors of science) by providing optimally conducive conditions for scientific research and education. To achieve this, the perspective of the institutional actors must be widened, so that they will also consider the effects on the European Research Area and their positioning in it in all their future, strategic decisions.

_ The objectives of the ERA are not generally supported by a harmonized legal framework, as is necessary to a large extent for the European Single Market. Nonetheless, for specific areas, especially the promotion of mobility in the knowledge system, a degree of convergence in certain fields of the legal system would be helpful.

_ Europeanization and Internationalization are not an end in itself, but must be seen in their specific function for the sciences and in the context of the intrinsic internationality of the sciences.

|[243] The OECD, in their publication "Open Innovation in Global Networks" equally comes to the conclusion that national systems remain the basis, though, to maintain competitiveness, these systems must become open for international cooperation (OECD (2008c)).

Shaping the European Research Area

From the science-policy perspective, “Europe” has two faces: Firstly, European institutions, and thus Europe is an actor in a global science system; secondly, Europe constitutes a geographical and political area, within which students and scientists move and where they enter cooperative and competitive relationships, both as individuals and as representatives of scientific institutions. The latter aspect was emphasized by the Commission when it declared the creation of a European Research Area (ERA) a planned objective in the year 2000.

In the view of the Council of Science and Humanities, the European Research Area presents itself as a space of opportunities, diversity, cooperation and structured competition between research operators and funding bodies, in which individual actors still remain autonomous, to a large extent. Since the primary frame of reference will be national for most actors, the ERA is hardly an area of shared regulations and institutions. However, some Europeanization of national institutions through deeper cooperation and mutual opening of funding programs should be part of the shaping of the ERA, so that the interaction between diverse national and regional actors can be strengthened. The European Union and Commission, in particular, play a crucial role in this area, as catalysts for development, by stimulating competition, and as facilitators for cooperation.

For researchers and scientific institutions, the European Research Area opens a new scope for action with great opportunities. Therefore, the Council of Science and Humanities calls on the federal administration and the states [Länder] and on the German science institutions to participate in the shaping of hat European Research Area even more strongly and actively than before. True balance of interests and sufficient acceptance of the European Research Area can only be generated through coordinated activities of the Member States and institutions and the Commission.

Strong scientific cooperation within Europe is desirable for the following reasons:

_ For certain research projects, joining up of resources and input of complementary expertise are indispensable. With increasing specialization, the latter will be ever more difficult to find in any national scientific environment.

_ Some societal and ecological challenges are not national in nature, but can only dealt with appropriately at transnational, if not global level (e.g. climate change, ageing populations, energy supply).

_ In many cases, large-scale research infrastructures can be built and operated only with participation of the human resources and combined financial capacities of several nations.

These are essentially the same reasons that would also be given for the internationalization of science. As such, they do not offer sufficient justification for a geographically defined European Research Area. The European Research Area as a space of privileged exchange only becomes reasonable by adding the arguments listed in the following, always keeping in mind the backdrop of shared European history and the distinct traditions of European science, which still persist, regardless of science's claim to universality.

_ For the individual scientist, the European Research Area offers a work environment, in which scientific exchange is facilitated by appropriate funding options and low barriers against mobility. This has already contributed to the successful establishment of numerous cooperations within Europe in the past decades, and to the lowering of the threshold for forming new cooperative relations in the future.

_ By joining up resources, facilitating cooperations and, consequently, strengthening locations with outstanding facilities and raising their profile, the European Research Area is an important factor in making Europe more competitive against other regions (especially USA and Asia) in the contest to attract highly qualified researchers.

_ Following a phase of lopsided development of Europe as an economic area, where issues of research were addressed with excessive emphasis on the advancement of industry, the creation of the European Research Area provides a new balance between science and the economy. This will strengthen innovative capacities, in the long term.

_ Science policy is linked with other political fields, which have become, at least to some extent, subject of European politics (employment policy, culture policy, foreign and development policy, social policy). Consequently, science is called upon to contribute to the future understanding of activities in these political fields at European level and, especially, to a shared foreign science policy.

_ Finally, there are pragmatic reasons, as well, for privileged European cooperation, since, in comparison, the governance of global cooperations is even more complex and thus more difficult to organize.

In all this, true Europeanization cannot just mean the combination of national systems. Rather, it requires the development of ideas beyond the question, what advantages Europe brings for the individual nation state. However, one must keep in mind that the European Research Area fulfills a variety of functions from the perspective of Member States with different starting positions. Therefore, it should be essentially characterized by the activities of the Member States and the scientific actors at various levels.

Central importance for the concrete shaping of the Research Area belongs to the scientific institutions, which look for suitable partners on the basis of their specific strengths. In the view of the Council of Science and Humanities, it must be expected that both the trend towards the formation of strong, often transnational locations or regions, where diverse scientific institutions cooperate (as is the case in Germany, e.g. for Karlsruhe/Strasbourg, Aachen/Jülich/Leuven and many other places), and the trend towards the creation of flexible networks and alliances with partners in quite different places in Europe, for instance on the basis of a shared thematic focus or membership of a certain circle (e.g. "exclusive research universities") will continue. |[244] As far as this development progresses, it will transform the national institutions, which are going to define their respective profile less by traditional models of (national) typecast, but rather by referring to the group of institutions they belong, or aspire to belong to. In this way, Europeanization and internationalization will be factors in the differentiation of the higher education and science system. |[245]

For a flexible architecture of task sharing

In the light of the subsidiarity principle |[246], the European Research Area requires readjustment of the relationship between European, multinational, national and regional levels, especially as the Lisbon Treaty gives some responsibility to the European Union too, apart from the Member States, for the shaping of the ERA. On this basis, the Council of Science and Humanities understands that tasks cannot be defined in a precise and level-specific way. In the Council's view, this would not be desirable, either, for a number of reasons:

|[244] Examples are the *League of European Research Universities* (LERU) and the *International Alliance of Research Universities* (IARU): "The IARU is an alliance of ten of the world's leading research universities - ANU, ETH Zurich, National University of Singapore, Peking University, University of California, Berkeley, University of Cambridge, University of Copenhagen, University of Oxford, the University of Tokyo and Yale University. It is a strategic drawing together of universities that share a similar vision and have a commitment to educating future leaders." Cf. http://www.iaruni.org/about [last downloaded 2010-04-12].

|[245] On the process of differentiation, see also the recommendations of the Council of Science and Humanities on the future role of the universities in the science system (= Wissenschaftsrat (2006c). Apart from that, the Council is currently preparing detailed recommendations on differentiation in the higher education system, which are expected to be presented later in 2010.

|[246] Article 5, para. 3 TEU (ex Art. 5 ECT): "Under the principle of subsidiarity, in areas which do not fall within its exclusive competence, the Union shall act only if and insofar as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level."

_ Firstly, EU funding for the Member States can be for very different purposes. For instance, for many Member States it still serves to compensate for national deficits. Since the Member States' expectations on EU funding continue to vary widely, and this will not change in the foreseeable future, an expectation-based assignment of functions to funding from the European Union would be unfeasible.

_ Secondly, in the Council's opinion – and contrary to the Commission's view – any precise division of tasks would be undesirable for reasons of principle, as a degree of overlap of funding programs for research is beneficial in the sense that it provides a wider choice of funding instruments and keeps alive the competition between the funding bodies.

_ Thirdly, a flexible system of funding and political task-sharing better befits the vision of a research area characterized by plurality, cooperation and competition than a tightly organized version with rigorous division of tasks.

Any precise assignment of political competences is also complicated by the fact that the importance of science policy for other fields of policy entails potential conflicts of interest between science, politics and the economy. Therefore, there cannot be a unique policy fit for every case; rather, there must by an intelligent mix of policies, taking into account the different needs, e.g. of society-driven research expected to contribute to the solution of societal challenges, industry-driven research, and science-driven research. |[247] With the emergence of interlaced, multilevel governance, the science-policy actors in Germany and the ERA are entering new territory. New, suitable mechanisms of coordination and ways of self-organization need to be tried out. |[248]

European Union level

In the view of the Council of Science and Humanities, the central tasks of the European Union, especially with regard to its activities in research funding, are the following:

_ The Union should implement the 3 %-target of Barcelona, and to this end make appropriate provisions for research and development in the EU Budget.

|[247] The same conclusion was reached by the Lisbon Expert Group in its report "Lisbon Strategy: Between Revolution and Illusion" (European Commission, Research General-Directorate (2008)), where the Expert Group argues for constructing the "European Knowledge Area … in an multi-level, multi-actor and multi-domain landscape and in a dynamic perspective", p. 8.

|[248] In federal Germany, too, the development of such mechanisms for science policy went through trial phases in the past decades; see also Edler; Kuhlmann (2008).

_ The Union should ensure that the quality measure is established and enforced as the central criterion for research funding in Europe.

_ The Union should expand the science-guided structures for research funding (European Research Council (ERC)).

_ The Union should support transnational cooperations and researcher mobility.

All funding processes should be as simple and effective as possible. The funding instruments should be characterized by continuity and sustainability.

Moreover, the Council of Science and Humanities considers as reasonable that the European Union, within its competence, creates frameworks (including legal) for the advancement of science, as it has done e.g. with the establishment of a European legal framework for research infrastructures (European Research Infrastructure Consortium (ERIC)). Other desiderates include the facilitation of mobility, the formulation of standards on basic issues of science (for instance the treatment of intellectual property in the context of the Intellectual Property (IP) Charter initiative, and open access to scientific primary data), as well as engagement for the scientific community's responsibility concerning scientific integrity and good practice |[249]. The Council of Science and Humanities identifies as another task of the European Union to induce the Member States to agree on comparable, high standards of evaluation and funding practices. Member States and the European Union should work together in the promotion of Europe-wide, standardized indicators of internationalization and Europeanization, which should be accompanied by appropriately harmonized recording of data in the Member States.

Multilateral level

Apart from funding by the EU, joint funding of science by funding bodies from different countries will continue to grow in importance for the formation of the European Research Area. This is a welcome development, as it benefits diversity in Europe and, through the exchange between the agencies via peer-review procedures and quality assurance measures, will have a positive effect on the establishment of Europe-wide standards for research as well as for its funding. These initiatives also contribute considerably to the acceptance of the European Research Area in the science sector. However, they can only work if there is a good level of self-organization of science in the Member States.

|[249] Cf. DFG (1998); OECD (2009f); ESF (2000); ESF (2007b).

Transnational initiatives in variable geometry will still play a crucial role in the ERA in the future. This is particularly evident in the establishment and operation of large research infrastructures (see Chap. B.II.1.e).

Federal administration and state [Länder] level

Germany has a highly developed and differentiated science landscape. Nevertheless, facing the ongoing Europeanization and internationalization of science, national and regional science politics is under pressure to adapt. It needs to reposition with regard to the European Research Area.

In the view of the Council of Science and Humanities, the primary tasks of the German federal and state [Länder] administrations are:

_ forming a diverse funding landscape,

_ creating a reliable political and legal framework for the scientific institutions,

_ allowing maximum freedom and flexibility for the institutions to act, enabling them to develop a strategic profile,

_ advancing the careers and mobility of scientists,

_ ensuring adequate and predictable funding for science, as precondition for its international competitiveness,

_ creating the necessary conditions for the future expansion of international cooperation in research.

Regardless of the status of the EU Framework Programme for Research as the principal international funding program, and despite the European Union's strengthened claim in shaping the science sector, regarding its funding and organization, the national system should remain the primary, formative framework. This does justice to the political responsibility towards the citizens and reflects the necessity of detailed knowledge of the local, regional and national institutions, in order to devise tailor-made policies. Also in favor of maintaining a strong national basis, there are the unmistakable strengths of Germany as a science location, which should not be abandoned; to cite just a few: the system of science-driven research funding based on scientific self-governance, the referee system and high quality standards this entails, the tradition of research funding according to quality criteria, and the broad autonomy of the science institutions. Apart from that, the fundamental responsibility of the federal and state [Länder] administrations for science policy arises from the importance of research-driven innovation policies for growth and employment; in this respect, science policy always also is national and regional development policy.

At the same time, the Council of Science and Humanities regards a degree of flexibilization of institutional organizations, including partial opening towards

Europe, as of elementary importance for national science policy. Only if Germany more actively grasps the opportunity to exert formative influence in the making of the European Research Area, and sets the right course for the national science system, she can maintain her ability to offer very good research conditions for German scientists, continue to be a destination country for foreign researchers while remaining attractive for those considering to return, and meet her responsibility to contribute to the solution of global issues. Considering transnational cooperations in border-crossing major regions, strategies for Europeanization also affect the regional level. The Council of Science and Humanities would therefore welcome solutions by which, with a view to Europe, the funding of trans-border clusters with involvement of neighboring regions is intensified.

The Council of Science and Humanities recommends to the federal administration and the federal states [Länder] to allow the national science organizations and institutions greater, but well-defined scope for appropriate European and international engagement. This should be based on trust in scientific self-governance and in the institutions and in recognition of the fact that, considering the intrinsic internationality of research and the progressive internationalization of science, the perspective of national benefit would be too narrow. Concerning their scope, the relevant activities should be guided by the European nations currently leading in this field (cf. Chap. B.II.1.b and B.II.2.c).

Regarding ethically complex and high-risk research issues (e.g. embryonic stem cell research or research on genetically modified vegetation), the Council proceeds from the assumption that these will still be dealt with at national level, primarily. Beyond that, it is essential for the European Research Area that a transnational discourse about regulations and debates on these issues will take place between the national decision-makers, so that in the future, national decisions can be taken in awareness of the debates and statutory regulations in other Member States of the European Union. Still, other fields of science policy, e.g. the promotion of researcher mobility, would profit from stronger regulatory harmonization (including legal regulations).

Another aspect concerns the need, on the part federal and state [Länder] politics, for competent advice by scientists in the development and administration of funding programs and the quality management of scientific establishments. In many cases, the recruitment of competent scientists for this task is made more difficult by unattractive conditions. While the participation, e.g. in most German institutions is not covered by expense allowances, similar consulting services at foreign and European institutions is often rewarded with, in some cases, considerable compensation payments. Considering the increasing and inevitable internationalization of scientific consulting, such different practices can result in reduced willingness of foreign as well as German scientists to engage in these activities. The Council of Science and Humanities points out that, in the longer term, this situation could put the present practice in Germany under significant pressure to adapt.

Opening of the European Research Area for scientific cooperations worldwide

The benefits of free scientific exchange across national borders have been cited already at several points in this document: It provides access for researchers to knowledge produced worldwide and enhances the diversity of perspectives flowing into the learning process, thus presenting chances to stimulate and push creative research. International communication serves to check new scientific hypotheses and approaches. In this way it strengthens scientific competition and contributes to quality assurance. |[250] Apart from that, it is without alternative, not just politically and economically, but also because of the necessity for joined-up expertise from several countries (e.g. for large-scale research infrastructures). |[251] Global challenges demand transnational, if not global cooperation for the scientific investigation of causes and possible solutions as well as regarding any political conclusions, as is demonstrated impressively in the case of climate change. Accordingly, there is also a tendency towards ever-larger, ever-more complex multilateral networks. Finally, scientific cooperation helps to stabilize the relations between states, and this development does not stop at the borders of the ERA.

For all these reasons, the concept of a European Research Area must include the provision that it is open to the world and to cooperations with science regions worldwide. |[252] This serves the Area's own interests and is in line with Europe's responsibility to address social and economic challenges of global relevance. Moreover, Europe has a duty to support the development of other regions. For this, partnerships with developing and emerging countries are the instrument

|[250] Recent studies reveal a correlation between the degree of internationality and the quality and impact of research. For instance, papers co-authored by foreign researchers usually achieve higher impact factors: In the life sciences, German publications score an average impact of 1.28, compared to 2.24 averaged by papers co-authored with British or US scientists and with French colleagues (impact 2.38) (see Adams et al. (2007) with further literature).

|[251] This development is evident, e.g. in space science, where the European Space Agency (ESA) with other international partners runs the International Space Station (ISS). In the same field, there are plans to hold international forums, which will also invite catch-up states to discuss with the established space nations and organizations about a balanced mixture of worldwide cooperation, coordination and competition.

|[252] This was also stated by the Expert Group chaired by Theodor Rietschel (Rietschel (2009)). In FP6, 5.6 % of all funded partners came from countries outside the EU. These received only 2.6 % of the total funding volume (according to Edler (2008), p. 1).

of choice. |[253] The "Strategy Forum for International S&T Cooperation" (SFIC) as a special formation of the Scientific and Technical Research Committee (CREST) provides an institutional framework for such initiatives. |[254] The Council of Science and Humanities recommends that the Federal Government should continue its engagement to ensure that the emerging EU strategy for internationalization takes this task into account.

The Council of Science and Humanities also points out that the differences between scientific fields with their own, individual interests and needs must be taken into consideration: For instance, the dynamics of institutionalization shown by the novel technological sciences are different from those found in certain areas of the social sciences and the humanities, with different patterns of cooperation and funding requirements. This also means that internationalization cannot be assumed for every institution and scientist to the same degree, and should not be demanded. Apart from highly linked international research, there will always be such that are most effective at local and regional level, even if the region is transnational in some cases.

Differentiated multilingualism

Europeanization and internationalization of science are often equated to the assertion of English as the language of scientific communication and education. In deed, this process is far advanced, especially in math and the natural sciences, with the effect that early acquisition of specialist language competence and general familiarity with English as the *lingua franca* of those disciplines is prerequisite to international mobility and a successful career in science. In this respect, the foundations for mobility at a later stage of the scientific career are laid at school and undergraduate level, where appropriate instruction in the English language should not be neglected.

In this context, however, one must also keep in mind that, despite the dominance of English in many disciplines, German (like some other languages) is still relevant as a language of science. In the humanities and cultural sciences, in particular, but also in neighboring text-oriented, discourse-related disciplines, such as theology and jurisprudence, there exists a plurality of language-specific scientific traditions with productive effects especially due to their complementarity. In this situation, the best way to propagate the results produced by German scientists, internationally, is not a rapid switch to English as the sole lan-

|[253] Any detailed discussion of the considerable importance of science policy in the context of development aid policy would be beyond the scope of the present Recommendations. On the concept of symmetric partnerships, see: Swiss Commission for Research Partnership with Developing Countries (1998).
|[254] Cf. Council of the EU (2008c).

guage of publication, but rather a differentiated strategy, which, apart from publishing crucial results in English, should also include initiatives on the translation of important, German-language publications. [255] This involves funding requirements, which should not be met exclusively by a handful of private foundations.

B.II SHAPING THE EUROPEAN RESEARCH AREA IN CENTRAL FIELDS OF ACTIVITY

In the following chapters, the basic recommendations on science policy in Europe presented in the previous chapter are contextualized and specified for the areas of research organization (from the perspective of institutions), research funding, research infrastructures and researcher mobility and careers.

II.1 Institutional organization of research

In the European Research Area, as in the national context, the concrete institutions of science remain the place where scientists actually do their research. The framework for their work may be national in nature or formed by European organizations. In any case, considering the central principle of freedom for science and research, administrative over-regulation and complex, bureaucratic structures, which would hinder this freedom, must be avoided. [256] Apart from the institutionalized forms of cooperation, which ensure their stability and long-term nature, the universities and non-university institutions must continue to provide the space for researchers to engage in subject-specific, temporary-discontinuous, international scientific exchange with partners of their choice. Such cooperations, initiated by individual researchers or teams of researchers, form the basis for the internationalization of science relations. They must not be marginalized by a one-sided focus on institutional cooperations. Rather, the latter should build on the forms of collaboration established by bottom-up relations.

II.1.A Universities and non-university research institutions

The European Research Area would be inconceivable without the commitment of national universities and non-university research institutions. The less these national institutions regard "Europe" as merely another source of finance, and

| [255] As already suggested by the Council of Science and Humanities, cf. Wissenschaftsrat (2006b), p. 17.
| [256] In Germany, the freedom of science, research and education is constitutionally guaranteed as a basic right, according to Art. 5 Section 3 Clause 1 GG.

the more they understand the European Research Area and its opportunities for cooperation as a means to prevail against ever-stronger international competition, the more diverse and creative they will shape it through their formative engagement.

European, but also international alliances of institutions and certain areas of science, some in temporary, flexible groupings, others in more permanently linked (e.g. topical) networks, which cooperate e.g. in graduate training or pursue shared research interests, have steadily grown in importance. There also emerged transnational science locations and regions. Both forms of cooperation serve to assure and enhance the quality of research and help the respective institutions in raising their profile. So this significant rise of selective cooperations between universities, non-university institutions and, in some cases, corporate partners in flexible networks and – depending on the scientific field – in thematic clusters as well, will continue regardless of any national or regional borders. |[257] Cross-border cooperation and competition are not mutually exclusive anymore. Instead, strategic alliances and networks are more important than ever in the competition for the best students and researchers and for funding from the highest-status sources at European level. Given the increasing importance of flexible forms of organization, the single institution, which is not part of any such network, is bound to fade.

Partnerships of this kind make sense not only for big universities with strong emphasis on research. The existing diversity of higher education institutions in Europe allows a multitude of opportunities for a great variety of local, regional, national and international partners. |[258] For small and medium-sized universities, cooperations adjusted to their own potentials and strategic objectives, with adequate partners in the European Research Area present a way to raise their profile and strengthen their competitiveness.

Stronger European cooperation, which is called for, and global competition require adequate rules of good practice in the science system, as well as a high level of personal integrity on the part of researchers. Universities and non-university institutions should coordinate the guidelines for good scientific practice in a European context, so that conflicts within cooperative projects are avoided and coordinated processes for conflict resolution will be available,

|[257] Cf. Adams et al (2007) on the rapid growth of international scientific cooperation. The role of networks as a new form of interaction between universities was also the topic of the European University Association (EUA) Autumn Conference in Gießen, October 2009.

|[258] Similarly stated – with regard to higher education – in OECD (2009d), p. 14: "When taking into account the diverse objectives of higher education, the model of concentrating resources in a few institutions is not necessarily superior to the model of supporting excellent research departments across the different institutions and regions in a given country."

where necessary. In this, the guidelines on research integrity by the European Science Foundation (ESF) and the Organization for Economic Co-operation and Development (OECD) should be taken into consideration. |[259]

Transnational networks also present opportunities for subjects that, nationally, do not have sufficient critical mass (anymore). By expanding the recruitment base, among other effects, cross-border cooperations can contribute to raising the quality level, and by joining up of resources they can strengthen the subjects concerned and create the conditions for moderate growth. However, the Council of Science and Humanities would emphasize that the so-called “small disciplines” are often characterized by a specific nationality and, consequently, the respective countries should meet their primary responsibility for maintaining and funding them. |[260]

To sustain the desired diversity, which is also important because of systematic considerations, it must be ensured that institutions and regions do not pursue all the same strategies and objectives. To this end, the Council of Science and Humanities advises higher education and non-university institutions to build their individual profiles on the basis of existing focus areas and unique characteristics. This strategy is not only more efficient; it also limits the number of potential competitors and partners. The Council welcomes the fact that more and more universities are developing explicit strategies for Europeanization or internationalization, which should also provide for an assessment of the options of close link-ups with efficient institutions in other European countries. |[261] These should not be limited to the goal to obtain maximum funding from the Framework Programme, but should aim for tailor-made cooperative relations for quality improvement, based on already established relations wherever possible. The German federal states [Länder] should support smart specialization, banking on the specific strength of their institutions and locations by offering appropriate incentives and accompanying advice. |[262] The national research funding bodies, too, should support this development. In individual cases this could be done by continuing the funding of very good teams, which are of central importance for the profile-building of a location, e.g. when an ERC grant

|[259] Cf. footnote 249.

|[260] See also Wissenschaftsrat (2006b), p. 63ff. In Germany, a joint working group of the HRK and Standing Conference of Ministers of Education and Cultural Affairs (KMK), with participation of BMBF and the Council of Science and Humanities was established for this purpose. The HRK is currently working on a map of the “small disciplines”, which provides reasons for the preservation of individual, endangered subjects.

|[261] In individual cases, this may also mean that a higher education institution does not pursue any such strategy at all, because the space of reference for its activities is mainly regional.

|[262] Cf. Foray, D.; Van Ark, B. (2007), based on a report of the EU Expert Group “Knowledge for Growth” from 2006, and Foray, D.; David, P.A.; Hall, B. (2009).

expires, so that the locations are sustained and remain attractive for young scientists.

Cooperations with institutions in neighboring countries increasingly create border regions of high scientific profile and specifically European character. The states [Länder] should widen the options for continuing such transnational profile-building of research locations.

The establishment of branches of German universities abroad can advance their opening to the wider world, as well. Most importantly, competition with foreign institutions can stimulate self-reflection on the part of the university and help building its identity. |[263]

II.1.B National science organizations

German science organizations are developing their own strategies for Europeanization and internationalization to meet the challenges of very intense international competition. |[264] To support the science organizations in their efforts, the funding providers at federal and state [Länder] level should afford them more leeway for foreign spending (e.g. for the establishment of institutes abroad) based on strategies for internationalization with such provisions. This will encourage more institutions to enter cooperative relationships with the best, worldwide, thus intensifying scientific exchange, and facilitating their access to infrastructures, young researchers and research topics. Cooperative relationships can be cultivated either with competitor countries or with emerging and developing countries. Therefore, the Council of Science and Humanities recommends that the science organizations – as far as this does not happen anyway, because the funding providers may be involved in the relevant decision panels – enter a dialog with the funding providers, in order to reach agreement to what extent funds may be spent abroad. Other European Member States, e.g. Denmark, already established (generous) provisions for this purpose (see also B.II.2). Pragmatic and appropriate de-minimus limits should be arranged, up to which the science organizations may decide autonomously about investments abroad, without having to involve the Budget Committee. The relevant organizations should engage more strongly in coordinated position-forming, beyond their individual strategies; in this they should also check whether their strategies are complementary or if there remain gaps in the overall system, which should be filled.

|[263] As already argued in Wissenschaftsrat (2000), p. 23.

|[264] This process is supported by the German federal and Länder administrations in the "Pact for Research and Innovation.

Regarding the external perception of Germany as a science nation ("research marketing"), the Council of Science and Humanities recommends that the individual interests of the organizations should take second priority in favor of a common presence. For this, their joint representation at the "Deutsche Wissenschafts- und Innovationshäuser" (German Houses of Science and Innovation) is a suitable forum. The Häuser can only be successful if the necessary financial resources are ensured and the organizations involved jointly develop a strategy for their topical makeup.

II.1.C Representation in the European Research Area

The representation of interests regarding science policy, in the stricter sense, is in the competence of the federal administration in concert with the states [Länder]. It is regulated by legislation accompanying the Lisbon Treaty and by the Federal Council process. In addition to the mechanisms prescribed by law, the dialog between federal and state [Länder] administrations is institutionalized in the Europe working group of the Joint Science Conference and the European policy circle at the Federal Ministry for Education and Research (BMBF), which also includes science organizations and other actors. The federal side should employ these established forms of dialog in order to integrate the states [Länder], in particular, in the early stages of consultation and be able to represent a strong German position in the interest of science at European level in a proactive and timely manner.

Another factor in the German participation in shaping the European Research Area is the representation of the institutional self-interests of the scientific institutions and, most importantly, their funding organizations, but also of subject-specific interests by the specialist scientific associations. Again this requires effective, scientific self-organization.

In the past decades, this self-organization turned out to be less effective at multinational, non-governmental forums. Therefore, the Council of Science and Humanities generally welcomes the efforts of the German Research Foundation (DFG) to strengthen self-organization at European level, working with the other European Heads of Research Councils (EUROHORCs) and the ESF. If these ambitious plans cannot be implemented, the DFG should pursue this objective perhaps with a slightly different circle of suitable partners. For instance, the DFG could set standards at European level with the self-control established by its "Memoir on Good Scientific Practice".

The national funding and operating organizations and, increasingly, individual universities too established representations in Brussels in order to optimally press their own institutional interests, e.g. in the shaping of the Framework Programmes for Research of the European Union. Even if the Council of Science and Humanities recognizes the strategic considerations behind this approach, it urgently emphasizes the importance of strengthening the capabilities to bundle forces for joined-up, professional action, and thus be involved in agenda-setting at European level. The prevalent fragmentation of lobbying work bears the risk of confusion and lack of effectiveness. This should be counteracted by a joined-up approach.

II.1.D Professional associations

Increasingly, well-organized national and international professional associations and societies, which place the desiderates of their disciplines or scientific fields at European level, prior to the formulation of the relevant funding programs, also become involved in agenda-setting and other tasks at European level. At national level, the professional associations, some of them long-established, are the forum and voice of their respective disciplines. They serve to advance and propagate their science and research and, especially, support the development of the discipline. |[265] Thus the scientific associations and societies are important for the definition of standards for the assessment and appraisal of research in the respective discipline, the identification of new topics and the formation of cooperations among their members. To be able to pursue these aims effectively, they should seek, even more than before, exchange and cooperation beyond the national landscape, with researchers in European and international contexts. Increasingly, professional associations are created at European level with the objective to advance and develop the respective discipline in Europe. Apart from these goals, shared with the national associations, there is an explicit emphasis on the creation of supranational, European networks and on special focus on less developed locations. With their support, including financial, of workshops, conferences and visits and their particular support of young scientists, these associations provide considerable contributions to the formation of European cohorts of young scientists and thus of a European scientific community. As another function, the European associations crucially support the planning of major and large-scale European research cooperations and their successful realization through instruments of European research funding by initiating and forming European groups of researchers. The Council of Science and Humanities welcomes this development and offers the recommendation to the national professional associations to become involved in the establishment of European professional representations at an early stage and to contribute to the development of European standards.

|[265] Instruments are: hosting of congresses, meetings and conferences; organization of summer schools; and funding or publishing of scientific organs, journals and periodicals.

Apart from universities and non-university research institutions constituted and funded at national level, European institutions have grown in importance over the past 50 years.

In the opinion of the Council of Science and Humanities, the demand for new European research institutions must be regarded as rather low, at present. Should such institutions be established, nevertheless, the bottom-up approach, in variable geometry, responding to specific needs of science (cf. Chap. A.II.1), clearly demands preference. Such institutions enjoy much higher acceptance, both in the science sector and politically in the nation states. Consequently, the Council of Science and Humanities confirms the Federal Government in its reluctance towards initiatives from Brussels to install research infrastructures through top-down measures.

The intergovernmental institutions, established on the basis of scientific issues and interests since the mid 1950s, such as the European Organization for Nuclear Research (CERN) or the European Synchroton Radiation Facility (ESRF) (cf. Chap. A.III.2) constitute a crucial step towards the integration of the European Research Area. Since their foundation, these institutions have established themselves as successful models for transnational cooperation and proved to be particularly functional and successful if grouped around a large research infrastructure (see Chap. B.II.3). In the view of the Council of Science and Humanities, to preclude cases based on merely national considerations of structural development, new foundations should be sought only where competitive scientific institutions are already in existence. |[266] However, the difficulties experienced in the past, prior to the establishment of respective institutions, have shown that the considerable challenges involved with treaty negotiations present real obstacles for the creation of more intergovernmental institutions. Therefore, further development of the legal framework is prerequisite to the development of multigovernmental governance structures that would be adequate for science.

The Initiative for the European Institute of Innovation and Technology (EIT) did not result in the establishment of a central, European research institution, as originally planned. Instead, a decentralized concept of the EIT is now being realized. Its mission is the systematic development and funding of regionally based and internationally linked-up clusters, to strengthen the innovative capabilities of the Member States of the EU (cf. Chap. A.III.2). The prospects for the “Knowledge and Innovation Communities” (KICs) currently established are still impos-

|[266] See also Wissenschaftsrat (2000), p. 27.

sible to judge. To ensure that this initiative to support innovation in Europe fits in a coherent, European-level policy for science and innovation, the Council of Science and Humanities recommends implementing further funding of the KICs under the roof of the EU Framework Programme for Research.

II.2 Research funding and financing

The past decades have seen a continuous, more and more rapid rearrangement of research funding in Europe. The share of public funding allocated at European level is increasing, while national structures have become accompanied by European counterparts:

_ The European Union successively gained importance with regard to the financing of research funding and its claim to shape science policy.

_ New European funding bodies were established (most notably the ERC).

_ At the same time, bilateral and multilateral funding schemes (ranging from D-A-CH-programs to European Research Area Networks (ERA-Nets)) have grown in significance, as has the share of funds allocated by several European (and sometimes other) countries for intergovernmental research institutions such as CERN or the European Molecular Biology Laboratory (EMBL).

Apart from that, the substance of the funding programs has changed as well: EU funding programs increasingly reflect the intention of the European Union to put the big societal challenges at the center of its actions. In this, there is a noticeable tendency towards ever-larger projects or funding of programs and institutions, on the one hand, and funding of basic research (ERC), on the other. At the political level, this change of emphasis generates pressure to adapt, which is experienced differently in small Member States than in large ones, not least depending on financial clout, leading to significant divergence between the Member States in their expectations towards the EU. This development calls for a new division of tasks between the European, transnational, multilateral and national levels and the respective actors, which is currently emerging. The present Recommendations represent a first step towards a description of possible tasks, without claiming to deal with these issues in all appropriate depth.

Public research funding in Europe must do justice to various interests. It therefore needs to offer a plethora of funding options, which may also compete with each other. Contrary to the Commission’s thesis that duplicate funding offers should be avoided or reduced, the Council of Science and Humanities regards such competition as a tool for quality assurance. This also means that funding instruments at national and international levels can be directed at similar objectives and contents. Consequently, any unambiguous, clear division of tasks according to levels should not be given precedence over flexible structures, which are more fitting for the European diversity also reflected in the science systems of the Member States (cf. Chap. B.I). However, such duplication of funding options should always be based on conscious, strategic decisions of the funding bodies and in awareness of comparable offers. It should be assessed in each case if the program concept is appropriate to those being addressed and will be effective. Furthermore, the German funding organizations should learn from the European evaluation culture, for instance consider introducing reasoned feedback to all applicants, explaining positive as well as negative funding decisions, as part of their normal procedures. All funding levels should be characterized by slimmed down, efficient administration, and their effectiveness should be assessed at regular intervals. The Council of Science and Humanities sees room for improvement in this respect, especially at European level.

However, coordinated and cooperative procedures at European level, in the sense of Joint Programming, are preferable in cases where, for instance, a competition of projects and ideas is possible only through coordination between the funding bodies and bundling of resources. From the perspective of the Council of Science and Humanities, this is undoubtedly the case for today's societal and economic challenges on a global scale. In this area, complementary approaches of national, bilateral and regional (European) cooperation should be developed, since only in this way the efficient coordination of the European contribution to resolving these issues can be ensured. Joint Programming is a suitable, strategic approach, which allows combined action of Member States in variable geometry within the EU. Nevertheless, for many other funding objectives, a wide range of national schemes will be more conducive to competition and quality.

II.2.A Research funding by the European Union

The funding of transnational cooperation and mobility of scientists through the Framework Programmes of the European Union visibly contributed to the harmonization of quality standards of research in Europe (cf. Chap. A.I). |[267] Globalization and the intensified international competition entailed by it, as well as the global challenges that have attracted increasing awareness in the past decades, present good reasons for an expansion of the funding activities of the European Union. This should be made possible by reassignment of funds within the EU budget and not result in any reduction of national investments in research. The latter also applies with regard to medium-term remedies for the persisting imbalances within the European science landscape, which require instruments for quality-enhancement (Framework Programmes) and the creation of infrastructural foundations enabling the development of Europe-wide scientific capacities (Structural Funds). Finally, the proper expansion of research

|[267] On this, see also the so-called Rietschel Report (2009).

funding by the European Union would be desirable in view of the importance of science and innovation for the European Economic Area.

In the opinion of the Council of Science and Humanities, the European Union should be focused in its funding activities on a small selection of objectives and instruments. This would also serve to increase the rationality and reliability of the funding. To the German Federal Government the Council recommends pressing for the following objectives and instruments of European research funding:

_ Funding of European and international mobility, including transsectoral (Marie Curie Actions, see Chap. B.II.4.a)

_ Funding of pan-European scientific collaborations and consortia ("Cooperation" program, see below)

_ Raising the quality of basic research through European competition (ERC, see below)

_ Strengthening industry through research and development (European Technology Platforms, Joint Technology Initiative, see below).

Furthermore, there is an undoubted necessity for joint European research concerning global challenges. |[268] In this, as in the field of funding for large-scale European research infrastructures (cf. Chap. B.II.3), the European Union should contribute, including financially, to selected research programs. |[269]

In the medium term, the balancing of diverse interests will be a central task for EU science policy. While the economically strong Member States within the European Research Area expect demanding and verifiable quality standards, the structurally weaker regions of Europe hope for European support for the development of science and research. The Union is (co-)responsible for both objectives, which, however in the opinion of the Council of Science and Humanities, should be pursued by different means: Cohesion funding should be provided exclusively through the Structural Funds, whereas the resources for research funding (Framework Programme) should be allocated according to science-guided quality criteria, only. Therefore, the Council of Science and Humanities strongly supports the Commission's present position on this issue. It welcomes

|[268] Also see the High-Level Group paper on EFR rationales: http://ec.europa.eu/research/era/pdf/eg7-era-rationales-final-report_en.pdf [last downloaded 2010-04-12]. Additionally, cf. the so-called Rietschel Report (2009), which recommends focusing EU funding on "Grand Challenges", on the one hand, and "Great Ideas", on the other.

|[269] These recommendations have already been adopted, for the main, by the Federal Government. Cf. BMBF (2010b). Additionally, cf. Bundesrats-Drs. 183/10, which argues in same direction.

the efforts by the European Union to create synergy effects between the two funding programs by using finance from the Structural Funds to establish optimal infrastructures, thus improving the conditions for a successful application for funds from the Framework Programme.

For the research sector, it is of central importance that the multitude of funding options, steeply increased by the iterative development of the research spectrum and the repeated reissue of instruments, does not raise the information and consulting requirements for every application to prohibitive levels. Researchers often perceive the funding instruments offered by the European Union as complicated and confusing. The Council of Science and Humanities recommends addressing this weakness through more focused and long-term programs. Consequently, the Council welcomes the fact that the European Union extended the terms of the Framework Programmes to seven years. Further steps to simplify the application process and reporting duties in the Framework Programme – as already demanded by many parties – should follow.

In the following the Council of Science and Humanities offers more detailed statements on some core elements of EU research funding. |[270]

Funding of science-driven basic research (ERC)

The establishment of the ERC constituted a paradigmatic change in EU funding policy. Up to the Seventh Framework Programme, the Union essentially limited its funding activities to program or project-oriented research and technology funding. With the establishment of the ERC it now entered the frame for personal funding of basic research across the entire spectrum of scientific disciplines. Within the Framework Programme, it is now possible, for the first time, for individual researchers or research teams to obtain EU funding independent of any transnational cooperation. This implies a new definition of "European added value" in the sense of Europe-wide competition in basic research. |[271] As it turned out, the funding lines of the European Research Council serve different purposes for the European Member States: For some it has the function to compensate for (missed) national funding; for others it represents a benchmark. Anyhow, the establishment of the ERC results in a rearrangement of reputation hierarchies in the research funding landscape, which needs to be faced by national funding bodies. |[272]

|[270] On the funding of research infrastructures, see Chap. B. II.3.

|[271] On the concept and its interpretation, see also Krull (2004).

|[272] By way of its decisions, the ERC can also point to certain unfortunate developments in national systems. For instance, the recommendations of the Council of Science and Humanities regarding the neces-

This supplementation of European funding policy by a science-guided, open-topic funding program – which the science sector in Europe had been demanding for a long time – must be welcomed. |[273] The fact that funding proposals are assessed exclusively by the quality of the applicants and their projects shows how quality now dominates EU research funding. The Council of Science and Humanities agrees with the assessment of the expert panel for the midterm evaluation of the ERC, according to which the ERC convincingly succeeded to meet expectations with the first two funding lines (Starting Grants and Advanced Grants).

The independence of the Scientific Council and its decisions about funding lines and selection criteria is indispensable for the ability of the ERC to select excellent proposals exclusively on the basis of quality criteria. This in turn is absolutely essential for the acceptance of the ERC in the science sector. The German Rectors' Conference already pointed out that the rules of the present executive agency of the Commission are restricting the administrative leeway of the ERC, concerning personnel development and financial layout of the funding, because the latter is not awarded as a grant, but has to be negotiated with the executive agency in the form of a contract. |[274] This can be remedied through administration by an independent agency, perhaps modeled in the European Agency for Fundamental Rights. |[275] Therefore, the Council of Science and Humanities recommends examining the options for ERC administration by an appropriate independent institution.

With regard to raising the profile of the existing funding lines, the Council of Science and Humanities considers it a desiderate that the ERC Grants are increasingly used as an incentive for researchers from non-European countries to migrate to Europe, as well as to encourage European scientist working outside Europe to return to the EU. Furthermore, the funding portfolio of the ERC should be developed successively, considering its operational capacities, so that the ERC can fulfill its benchmark function in Europe. For this the ERC needs a framework enabling the Scientific Council to establish new funding programs independent of political prescriptions. A funding scheme for transnational, European bottom-up cooperations free of thematic conditions could be regarded as true added value provided by the ERC. In the interest of simplicity of the funding process, the rules for participation should not force transnational cooperation, if such funding is going to be offered in the medium term. However,

sary improvement in the quality of medical doctoral degrees was confirmed by the decision of the ERC to deny the German „Dr. med." equal status with the international Ph.D.

|[273] See also Wissenschaftsrat (1993).

|[274] HRK (2009a), p. 8.

|[275] Cf. www.fra.europa.eu [last downloaded 2010-03-12].

with the ERC entering the frame for cooperative funding, national funding bodies such as the German Research Foundation would have to face a new competitor in one of their core fields of activity.

For an institution like the ERC, which is changing the European funding landscape, it would be desirable to have a long-term political guarantee of continuance, since its objectives can only be achieved by sustained development. Therefore, the Council of Science and Humanities recommends that the Federal Government should engage for a long-term perspective for the ERC.

Funding of European collaborative research (Cooperation)

According to present assessments, the Commission plans further expansion of large, industry-driven funding schemes, demoting the funding of projects (e.g. through the "Cooperation" program), which so far has been a core activity of European research funding, to lower priority. In the opinion of the Council of Science and Humanities, the "Cooperation" program, which is strongly identified with research funding by the EU and allows thematic focusing, should remain a central part of the Framework Programme, albeit as an improved version and with consistent application of the quality criterion. |[276] It visibly supports European scientific cooperation and strengthens the research sector in Europe by offering opportunities to individual researchers and young scientists at universities and non-university institutions, including smaller institutions, to partake, by their own initiative, in European research. In this way it contributes to the acceptance of the European Research Area in the sciences. |[277] In future, however, the program should allow funding of several [parallel] projects, in the interest of competition between teams. Continuation of the program would also ensure that the very productive, established collaborations will remain financially supported at European level.

Funding of industry-oriented funding (JTI)

The targeted funding of industry-oriented research through Joint Technology Initiatives (JTIs) reflects the continued business orientation of EU research policy and supports the important interaction between science and the economy. By this, due to the scale of the projects, industry is given considerable influence over the research agenda of the European Union.

Increased funding of industry-driven consortia must not come down to cross-subsidizing of industry projects and reduce science to a mere service provider in

|[276] Also stated recently in HRK (2009a).
|[277] Ibid., p. 9.

such projects, which also, by their size, confront the universities with considerable challenges in terms of management. Additionally, financing and partnership rules, which differ from one initiative to the next, and varying rules for dealing with intellectual property rights (IPR) make the participation of universities and non-university institutions more difficult and less attractive. Therefore, the Council of Science and Humanities agrees with the petitum of the Federal Government for maximum harmonization of the financing and partnership rules within the EU funding programs. |[278] Only in this way it can be ensured that participation remains attractive for universities and non-university institutions, even as individual funding programs at European level give preference, decidedly, to industry interests.

Funding of society-driven research towards the resolution of global challenges (Joint Programming)

Joint Programming stands for an attempt to overcome weaknesses in multilateral cooperation. The Council of Science and Humanities welcomes this amendment to the program portfolio at European level. |[279] Due to the importance of the issues and the need for research to be supported by accompanying political initiatives, the primacy of politics applies in the framing of the themes. However, the issues formulated by politics will only be resolved if scientific expertise flows into program definition at an early stage. Therefore the Federal Government ought to press for the long-term establishment of practices, both at European and at national level, that provide for early participation of the relevant scientific actors in a transparent process. |[280]

Various programs and instruments of EU research funding offer formative possibilities for science to act in concert with the economy. The Council of Science and Humanities recommends that businesses, industry, higher education and non-university institutions continue to use the opportunities for strengthening knowledge transfer and the advancement of innovation on offer in this field, and to intensify their networking with the respective other sector.

|[278] Ibid.

|[279] Cf. EUROHORC's "View on Joint Programming" of 14 November 2008: http://www.eurohorcs.org/SiteCollectionDocuments/EUROHORCS_Statement_Joint_Programming_20081411.pdf [last downloaded 2010-04-12].

|[280] More transparency of the consultation processes is also called for by the so-called Rietschel Report (2009).

The Council of Science and Humanities recommends organizing the advice services concerning EU funding in Germany in a clear and cooperative way. For instance, it could be helpful to scientists to create an “advice path” on a shared Internet platform. This would define an ideal sequence of advice steps and assign specific functions to the relevant organizations. The current efforts to improve the division of tasks between the EU office of the BMBF, the national contact points (NCP) of the Federal Government for the EU Framework Programme for Research, and the European Liaison Office of the German Research Organizations (KoWi) are worth mentioning in this respect. The Council of Science and Humanities recommends continuing this process and entering into dialog with other actors (e.g. the EU officers at universities and non-university institutions) about an optimized division of tasks and transparency of advice options. In this area, improved coordination between the organizations would also reduce the need for private consulting services.

Beyond that, the Council of Science and Humanities recommends that the universities and non-university research institutions set up close links between their departments concerned with EU matters and, if applicable, the strategy departments generally concerned with research funding, since only an integrated view of all research options will ensure optimal advice. To ensure efficient support for scientists with their applications and in the administrative management of EU projects, higher education institutions should devote special attention to their administrative departments and, where necessary, introduce systematic personnel development measures in this respect.

II.2.B Transnational research funding in Europe

Forms of transnational and multilateral research funding have become more important in Europe in the past years, most notably those initiated by the European Union, such as ERA-Nets or Article 185 (ex Art. 169) Initiatives, as have certain formats of intergovernmental cooperation (European Cooperation in the Field of Scientific and Technical Research (COST) and European initiative for market-oriented research and development (EUREKA)) and the multilateral research funding initiatives driven by national funding organizations.

From the perspective of the Council of Science and Humanities, these very diverse instruments of enhanced cooperative research funding in Europe are very welcome, insofar as the plethora of approaches and funding schemes correctly reflects the varied needs of science and society. Moreover, both intergovernmental and science-driven cooperation initiatives can be used by the science organizations to actively shape the European Research Area to meet their needs. However, the diversity of funding forms also increases the complexity and risk of confusion in the funding landscape as a whole. Therefore, the funding organizations involved should ensure maximum continuity and transparency and provide appropriate consulting.

The Council of Science and Humanities supports the concept of a European Grant Union, stated as part of the ESF and EUROHORCs Roadmap. This will lead to models of international cooperation, standardization of assessment processes and harmonization of the quality standards within Europe. In this, the assessment procedures of the DFG (peer review) as well as tried and tested processes applied by other funding organizations can serve as benchmark examples for best practice and lead to assessment practices accepted everywhere in Europe. Therefore, the Council of Science and Humanities supports the German Research Foundation in its intention to take a leading role in this process. Considering the much differentiated processes and regulations applied by funding agencies in Europe, the Council of Science and Humanities would regard as reasonable for the European Grant Union to include standardized application forms and harmonized accounting methods. Such science-driven initiatives are indispensable for the formation of the European Research Area. They should be supported by the federal administration and the states [Länder] through the creation of an appropriate legal framework, which should enable the German Research Foundation and other research funding organizations to take part in jointly financed solutions with minimum complication. Because of the anticipated quality gains brought about by stronger European competition, it would be desirable to procure finance for joint funding (cf. also Chap. B.II.2.c).

In the view of the Council of Science and Humanities, there exists a gap in the system of national and European funding with regard to bottom-up cooperation between two or more higher education institutions from different countries. This gap could be closed bilaterally or multilaterally by national organizations or at European level by the European Science Foundation or the European Research Council. The Council of Science and Humanities recommends that the German Research Foundation, with appropriate partner organizations in Europe, sets up a thematically open funding program, and welcomes any planning in that direction. |[281] The federal and state [Länder] administrations are called upon to support the German Research Foundation in this initiative.

II.2.C Public research funding in Germany

The rise of research funding by the European Union must not result in negligence on the part of the Member States when it comes to their own national

|[281] One idea under tentative consideration is to take the initiative of the major research funding organizations of the G8 countries (G8-HORCs) on multilateral research funding, which started with calls for thematic proposals in 2010, and continue it in the medium term without thematic prescriptions.

and regional investments in this area. The idea is, rather, that each individual Member State must raise its competitiveness by appropriate means; at the same time, broad access to infrastructures and knowledge within Europe should be facilitated. It is the duty of the nation states to secure the continued, long-term existence of public research institutions. Apart from institutional funding to this end, there will remain legitimate national objectives that should be funded through time-limited projects. In this, the high level and volume of R&D activities in the private corporate sector constitutes a strength of the German research system. Therefore, federal and state [Länder] administrations should shape their project funding to allow continued support for cooperations between science and businesses.

Precision targeted science funding in Germany

The German Research Foundation (DFG) has an excellent track record in German science funding. As an institution of scientific self-governance and research funding, the DFG is a vital institution for science in Germany, not least and especially because it creates the conditions for the successful participation of researchers and institutions to take part in European and international competition, and ensures that they are in high demand as cooperation partners. Also, the DFG possesses excellent knowledge of the German system and its scientific communities, so that it is able to offer tailor-made funding programs. Its wide spectrum of funding options should be maintained under all circumstances.

In the view of the Council of Science and Humanities, even as national funding activities are essential to sustain the national science base, the trend towards the allocation of funds at European level forces the national actors to examine and, perhaps, redefine their position in relation to multilevel funding. This applies to funding under scientific self-governance (DFG) as well as to program-oriented research and project funding by the federal administration. The different funding sources' unique features should be identified and used to define their interrelation through task-sharing and cooperation. The competition with European funding bodies, which is not a pursuit in its own right, should inspire further improvement of their own programs.

Mutual opening of funding programs

In the view of the Council of Science and Humanities, increased international competition has made it necessary to offer scientists in Germany optimal conditions for cooperation with the best researchers in Europe (cf. Chap. B.I). Therefore, the Council recommends cautious, project and region-related opening of the national funding programs of the German Research Foundation and the BMBF in defined areas (e.g. global challenges), with the aim to co-finance projects across borders, based on mutuality. |[282] This would considerably widen the scope for the German Research Foundation to take part in cooperative programs and exert formative influence in the shaping of the European Grant Union. Other European countries, e.g. Denmark, have already chosen this path. |[283]

This mutual opening of funding programs will contribute to the benchmarking of the programs and further reduce the entry threshold for transnational cooperations. The gain in competence should be in Germany's own interest and thus justify the allocation of funds to foreign partners. However, it should be made a requirement within the programs that the core part of the project is carried out in Germany and the application is submitted in partnership with applicants in Germany.

Internationalization of the assessment process

The Council of Science and Humanities supports the DFG in asserting its own position in competiton with the ERC and in taking every necessary effort to extend its formative role in research funding in Europe. To strengthen its position in Europe, the German Research Foundation should further internationalize its processes by involving foreign experts. The Council of Science and Humanities supports the German Research Foundation in its aspiration to take a pioneering role among the European funding organizations. The reciprocal involvement of referees in bilateral and multilateral research programs will contribute to the Europe-wide, high-level standardization of peer-review processes.

Facilitating entry into European competition

Although this is already practiced by some funding bodies in Europe, the Council of Science and Humanities advises the DFG against funding proposals that were ranked, but are not funded by the ERC, without proper reassessment by the DFG. However, it advises the DFG to examine the possibility of establishing an abridged process for decisions on such proposals. The German Research Council should see its mission, increasingly, in the funding of young scientists at the highest level (in cooperation with the universities), supporting the universities in their efforts to obtain ERC grants, encouraging suitable candidates to submit ERC applications (especially helping younger researchers with grant

|[282] OECD (2008c) also recommends the opening of national R&D programs for foreign cooperation partners, on the basis of mutual agreements.

|[283] The Danish research councils (Council for Independent Research and Council for Strategic Research), for instance, are authorized to allocate up to 20 % of their funding resources to recipients abroad (cf. Consolidated Act No. 1348 of 11 December 2008 on the Research Advisory System [unauthorized translation], Part 6A, section 30a, subsection 2).

applications) and providing an incentive for foreign applicants to perform their research in Germany. In this, the DFG should be actively supported by the universities and non-university research institutions, especially at executive level.

Support for cross-border regional alliances

The Council of Science and Humanities regards regional research alliances as an important instrument for the future development of the European Research Area (see also Chap. B.II.1.a). The aim should be to shape a Europe of the regions across national and regional boundaries, through a bottom-up approach, with alliances formed by higher education institutions, research institutions and small and medium-sized enterprises. This raises the responsibility of the states [Länder] to consider the transnational development of their region in their funding activities, as well, and consider this development in their governance role for universities and non-university establishments. The states [Länder] are asked to create the necessary legal framework for regional funding, including transnational, in cooperation with their neighboring regions, and support the institutions in their initiatives to develop clusters, which can also involve the regional economy (i.e. small and medium-sized enterprises). On this basis, the states [Länder] should take account of their enhanced role in the establishment of regional centers and locations, e.g. by making more use of EU Structural Funds for investments in research institutions.

Overall, the funding programs of the states [Länder] should be designed more in view of their consequences for the European Research Area, and provide more opportunities for cross-border funding. It is still too early to judge how the civil or public-law foundations recently established by some states [Länder] (such as the Einstein Stiftung Berlin or the Science Foundation in Hamburg) |[284] will fit into the system of regional, national and European funding. However, the states [Länder] should ensure that the respective funding bodies consider in their portfolio development the European context as well as regional or national aspects.

II.3 Research infrastructures

Research infrastructures are a core area of European and international cooperation and a pillar of the European Research Area, as well as of the national science systems. The establishment of large infrastructures (such as CERN, the European Space Agency (ESA), the European Organization for Astronomical Research in the Southern Hemisphere (ESO)), which predates even the foundation of the European Union, greatly contributed to Europe's survival as a central ac-

|[284] Cf. http://www.einsteinfoundation.de/,http://www.hamburg.de/forschungsstiftung/ [last downloaded 2010-04-12].

tor in science after World War II (cf. Chap. II.1.e). These success stories of European cooperation, the realization that research infrastructures provide an essential contribution to cognitive progress in ever more scientific fields, and the fact that even the renovation or upgrade of existing research infrastructures involves higher and higher degrees of complexity |[285] and corresponding costs – all these factors, considering the limited financial and human resources of the Member States of the European Union, led to the consensus that research infrastructures present a partnership task rather than a field of competition. |[286]

Their cost volume, long-term nature and effects on the scientific development of specific fields give investment decisions of this kind immense strategic importance, necessitating a robust and transparent assessment and decision process. The following recommendations represent desiderates for the establishment of proper assessment and decision processes at different levels and stages, from the articulation of demand in the proposal drafted by professional societies, through national and then European processes of prioritization and appraisal, to the building and funding decision at intergovernmental and European level.

II.3.A Formulation of research infrastructure proposals in the scientific communities

The impetus for the creation of research infrastructures should always come from specific scientific demand. The formulation of such demand is a task for the respective discipline and requires a certain degree of self-organization. Presently there exists a very heterogeneous field of highly organized and professionalized communities, at one end, and associations hardly constituted as such, at the other. While the former, such as the particle physics community or marine research, formulate and address their desiderates in a concentrated manner, and can build on already established research infrastructures, the latter need to develop better articulation capabilities and the requisite degree of organization, before they can properly formulate infrastructure proposals. |[287] Here it turns out that the publicity for the topic of research infrastructures, generated in connection with the process implementing the European Strategy

|[285] This relates to, among other aspects, the number of disciplines involved, the types of infrastructure (central, decentralized, virtual), potential partners (including private sector) and the spectrum of options.

|[286] However, of the 598 existing research infrastructures examined by the European Commission and the ESF (2007), 65 % had been planned at national level, and their construction costs were financed from national and public sources, even if the operating costs are partly financed by international or multinational bodies (p. 22). Obviously, these individual institutions as well as the potential locations for new establishments are subject to European and international competition.

|[287] In Germany, a successful example for self-organization of a professional association in the context of infrastructure requirements is the German Data Forum (RatSWD), which was founded with the aim to improve the informational infrastructure connecting science and statistics.

Forum on Research Infrastructures (ESFRI), and the broadening of the concept of research infrastructures as such triggered activity even in fields (especially in the humanities and social sciences) where no demand for traditional "large-scale facilities" had ever been formulated. |[288] Therefore the Council of Science and Humanities recommends that those disciplines still lacking in self-organization expedite their relevant organization processes. The BMBF should support this, including with finance allocated to project funding, if necessary.

The Council of Science and Humanities expects from the national scientific communities that they examine, when formulating their infrastructure proposals, whether cooperation with partners in other European countries can achieve potential synergy effects in the use of the infrastructure.

II.3.B National consultation and decision process

Due to the fast arrival and grown importance of pan-European processes in the realization of large research infrastructures, the Member States are pressed to present a clear position in these processes. They have to decide which research infrastructures they deem relevant for themselves, which ones they might wish and be able to finance at national level, and in which European research infrastructures they would like to participate. To this end, according to a study by the Global Science Forum of the OECD from 2008, a significant number of countries developed their own road maps for research infrastructures, which should make it easier for them to argue their position in the ESFRI process, effectively. |[289]

Regarding the construction and operation of infrastructure facilities, Germany has held a key position in Europe for many decades, but still lacks a national road map that would allow weighing investments in various projects across the disciplines. Therefore, the Council of Science and Humanities welcomes the establishment of a national road map process as planned by the Federal Government, since this is urgently required for science policy, so that Germany can maintain the initiative in matters of European and international research infrastructures. A national road map not only serves to prepare for European decision processes; it also serves to promote acceptance of the national policy by combining information about planned investments in various scientific fields, and it provides a basis for political decisions in a transparent process. Apart from that, it allows an overview of already existing infrastructures and their updating needs and, perhaps, new measures to be established, so that the in-

|[288] Cf. e.g. the CLARIN initiative in the Humanities (see also footnote 188).
|[289] OECD (2008d), cf. A.III.2.b.

vestment decisions for future projects will be based on an improved information base.

For preparing the necessary political decision, a transparent, science-led process is of central importance, which requires an interdisciplinary overview of the relevant proposals. As, for this process, the professional associations are asked to articulate their interests (see Chap. B.II.3.a), care must be taken that the diverse expectations, structural and financial, of different disciplines concerning large research infrastructures, as well as the varying capacities of the communities to articulate their demands, do not lead to systematic distortions. The process should allow a reasoned decision about the initiatives Germany should promote, their timing, their scientific and societal motivation, and the institutions that would be suitable for managing and operating the respective infrastructures. The national road map process should also include the states [Länder]. In charge of the higher education institutions and sharing the responsibility for the jointly financed science organizations, the states [Länder] are affected by research infrastructure planning in a multitude of ways. Moreover, as decision-makers in the allocation of Structural Funds resources, they have means of financing at their disposal, which have already been used for such purposes, but could become more important in the future. Considering the extensive planning and negotiation periods, the volume of investment and the operating costs involved, projects fully financed at national level, on the one hand, and those to be realized in international cooperation, on the other, should be viewed together and made comparable at an early stage. For the final decision about the establishment of national research infrastructures, it will be necessary that construction and operation costs be assessed while the projects are still at the design stage. To ensure this, suitable controlling processes need to be established.

The central challenge to be met in a road map process is the relative weighing of competing proposals from different scientific fields and disciplines, which already secured the support of the respective scientific community and are regarded as excellent, measured by the specific criteria of the community. The Council of Science and Humanities points out that, to ensure acceptance of its decisions with the science organizations, communities, states [Länder] and parliaments, optimal transparency of the road map process will be crucial. |[290] Since the science policy decision about the realization of projects is also based on non-scientific aspects, such as societal demand or contribution towards the resolution of global challenges, related criteria should be disclosed early in the process, so that controversies at later stages can be avoided. Equally, compre-

|[290] See also OECD (2008d), p. 13f.

hensive information about the progress of the procedure should be made available.

The final decision about the construction and operation of infrastructures is a political one, in which factors other than those internal to science have their legitimate place. Their will always remain a conflict between scientifically approved proposals and the final decisions of politics, which will never be able to finance every desirable infrastructure to the same degree. Therefore, it will be all the more important that the consultation and selection process allows democratically legitimized prioritization of investment decisions, and that the consequences for the European Research Area are taken into account in each decision. The Council of Science and Humanities has been practicing a process for the assessment and appraisal of research infrastructure projects, whose scope is to produce reasoned recommendations on the quality of the research program, its technical maturity, the importance of the measure and the demand within the user community. |[291] Furthermore, in its statement on BESSY FEL, a free-electron laser, and AURORA BOREALIS, a European Research Icebreaker, of 2006, the Council emphasized the necessity of assessing the creation of new research infrastructures and any extension and continuation of existing ones from an overarching, science-policy perspective. The Council of Science and Humanities is of the opinion that usually, even after the establishment of a road map process, decisions on individual, large-scale research infrastructures will need to be backed up by detailed, individual assessment at a later stage of the project.

Even if research infrastructures are created abroad, research funds must still be made available in Germany, to enable German researchers to participate in these infrastructures. Such cases, too, require regular quality assessments of the related long-term funding commitments.

II.3.C European consultation and decision process

The European Commission intends to make research infrastructures a central field of action of European research politics, and to participate in financing to a larger extent than before. For this, the ESFRI Roadmap is expected to be an important starting point.

However, no regulated way towards prioritization and implementation of individual projects of the ESFRI-Roadmap has emerged yet. This is partly due to the

|[291] Wissenschaftsrat (2006a); Wissenschaftsrat (2009). Also, following a request by the BMBF, a working group of the Council of Science and Humanities is currently preparing recommendations on the development of the German marine research fleet, which will be the first such recommendations on an infrastructure complex.

absence of consensus, at European level, about the appraisal of the scientific quality and the readiness for financing of projects. Presently, the prioritization decision is subject to successful negotiations between the countries interested in the realization of individual projects.

This situation reflects the variable geometries within the EU. However, negotiations that lack transparency and are governed by "free play of forces" can cause systematic distortions in favor of projects that are relatively safe, geographically distributed and sufficiently ostensive, at the expense of the most innovative research infrastructures. For this reason, the creation of transparency and a European discussion about selection criteria for research infrastructures are important elements of European cooperation in the construction and operation of large research infrastructures. Regardless of the particular parties involved, it is crucial that the interleaving of national and European processes, on the one hand, and the integration of international processes and actors (e.g. the Global Science Forum of the OECD), on the other, are successful. Ideally, in the international context, Europe should speak with one voice.

The Council of Science and Humanities recommends establishing a clearing office at European level (e.g. at the ESFRI Secretariat). This would serve as a consulting instance for EU Member states interested in the establishment of large-scale research infrastructures (or other multilateral forms of organization), providing information about possible legal structures for such facilities and their respective implications. It should also compile experiences from the treaty negotiations and the choice of suitable legal constructions of the already established research infrastructures.

Decisions about European research infrastructures should never be determined by cohesion aspects. The selection of locations, too, should be conducted by quality criteria alone, and on the basis of existing centers.

The Council of Science and Humanities welcomes the plans of the EU Commission to strengthen its financial involvement in infrastructure measures. However, the realization of ESFRI infrastructure projects should remain subject to the initiative of the respective Member States. Furthermore, the Council of Science and Humanities welcomes the Commission's commitment to open access for researchers from other Member States as the signum of a European research infrastructure. Especially the user involvement in the financing of the operating costs through competitive, EU-funded programs is an appropriate instrument for the EU Commission in its efforts to promote the openness of new and existing infrastructure facilities within Europe. Opening to third countries should be made a binding obligation for facilities benefiting from EU contributions to their costs. Regarding this, it should be examined whether individual professional associations operate any non-monetary accounting processes. Where this is the case, the Commission should support the respective agreements through commensurate transfer of funds.

Furthermore, initiatives of the European Union to create an adequate legal framework are extremely welcome. The new legal form for research infrastructures (ERIC), which was agreed last year, is a very positive example in this respect.

Although research infrastructures offer great opportunities, create new research contexts and promise added value through cooperation in international alliances, all future consultation and decision processes at national, European or international level should also consider the risks: Research infrastructures give privilege to large-scale projects. They can be biased towards less risky research (normal science) and prefer empirical over theoretical subdisciplines. Most importantly, however, it should be kept in mind that research infrastructures tie up resources for long periods. In this respect, they restrict the ability of the scientific and political actors to react flexibly to new challenges. This need to weigh opportunities and risks in the sense of responsible deployment of financial and human resources presents another reason in favor of a science-led and transparent process that also does justice to societal demand as a decision criterion.

II.4 Mobility, career paths, attractiveness of institutions

International mobility not only benefits the individual development of scientists, but also creates opportunities for intellectually productive encounters, enriching science in its entirety. |[292] Moreover, mobile scientists act as ambassadors for their home country and, after their return, also for their former host country, giving mobility a culture-political dimension as well and making it important for the formation of a European Identity. Hence the exchange of personnel within Europe and the circulation of expertise are desirable also from the perspective of other policy areas, and of society as a whole.

Considering these advantages of free international exchange, the term "circulation of expertise" is more to the point than any talk of "brain drain" or "brain gain". |[293] Simple balancing of migration gains and losses and fear of hemor-

|[292] This is concluded in the study Edler; Fier; Grimpe (2008), p. IV: "The result is that scientists that participate in technology transfer are bringing knowledge to Germany, as well as taking knowledge abroad. Therefore the concern that international mobility must lead to net loss of knowledge in the scientists' home country is unfounded."

|[293] Recent research on the migration of highly qualified individuals shows that there is no simple zero-sum game of *brain drain* and *brain gain* (Guellec; Cervantes (2002), p. 86). Migrants provide complex contributions to the economy not only of the destination country, but also the country of origin. This is why it

rhage do not do justice to the effects of mobility and give privilege to short-term, economic interests. In Germany, for one, said fear of hemorrhage is misplaced also insofar as German scientific institutions are profiting from the opportunities presented by mobility. |[294] Also with regard to the fear of a tendency in Europe to loose personnel, e.g. by migration from East to West, one can point to the medium-term benefits even for countries that appear to be "talent donors" according to simple balancing, with India as the leading example. Nevertheless, the intention should be to support sustainable partnerships of mutual benefit, rather than one-sided migration movements. This particularly applies to the developing countries, which Europe must support as part of its global responsibilities. At the same time, the cohesion resources within Europe should be applied to reduce, as far as possible, the existing disparities concerning the attractiveness of different countries within the European Union. Legitimate national interests, as well as the interests of the institutions competing for good and outstanding scientists should be addressed not by hindering or restricting migration, but by further enhancing the attractiveness of a career in science (cf. Chap. II.4.b). To be able to claim a proper share in global knowledge production, firstly, more people need to be trained for occupations in science and, secondly, more of these need to be recruited for long-term employment in a science profession. This applies both to the European Research Area and to the individual Member States. Among the essential requirements for achieving this objective are good conditions for the advancement of young scientists and attractive career options. For this the responsibility rests with the individual Member States, in principle, although, regarding the desired mobility of scientists within Europe and beyond, there is also a joint responsibility of the Member states and the European Union to ensure favorable conditions.

A European Research Area characterized by the lowest possible barriers against mobility, good mobility funding and attractive working conditions would be a crucial advantage in the contest with the US and the Asia-Pacific region. Therefore, the European Research Area should be shaped with special emphasis on the facilitation of mobility in the international exchange of scientists. In this spirit, the European Union defined the free movement of knowledge in Europe

appears more reasonable to regard the migration of highly qualified persons as a game of *Brain Circulation* (cf. Saxenian (2002)): "…the challenge for policy makers is to facilitate the circulation of highly skilled workers across frontiers while generating benefits for both sending and receiving countries" (Guellec; Cervantes (2002), p. 94). Similarly stated in OECD (2008e), p. 5.

|[294] On the situation in Germany, see also AvH (2009b).

as the “fifth fundamental freedom“. |[295] In this context, the following are cited as central aims:

_ enhancing the cross-border mobility of researchers, students, scientists and university teaching staff;

_ making the employment market for European researchers more open and competitive, providing better career structures, transparency and family-friendliness. |[296]

In the following, starting from these two objectives, it will be examined where improvements have already been implemented, where there is more action required and, in the latter case, at which level. The recommendations are confined to the level of scientific personnel; student mobility is not considered here.

II.4.A Funding for mobility and removal of obstacles to mobility

The EU funding programs in this area (ERASMUS-Mundus and, especially, Marie Curie Actions) are in very high demand and among the model examples of successful European funding. The Council of Science and Humanities takes the view that this funding of talent at European level should be continued with further financial expansion. Special attention should be paid to issues of integrating Marie Curie Fellows at the institutions. Also, all EU mobility programs should allow proper exchange with the non-European science community. ERC grants, in particular, should be used more often to promote mobility into Europe.

At national level, apart from the programs offered by the German Academic Exchange Service, which mainly address students |[297], the mobility funding options of the Alexander von Humboldt Foundation and the German Research

|[295] Council of the European Union (2008a), p. 5: “In order to become a truly modern and competitive economy, and building on the work carried out on the future of science and technology and on the modernization of universities, Member States and the EU must remove barriers to the free movement of knowledge by creating a ‘fifth freedom’ …”

|[296] The following other measures, which are not addressed any further in the context of the present Recommendations, are mentioned in the conclusions of the Council (see footnote 295): further implementing of higher education reforms, facilitating and promoting the optimal use of intellectual property, encouraging open access to knowledge and open innovation, fostering scientific excellence, launching a new generation of world-class research facilities, and promoting the mutual recognition of degrees and diplomas.

|[297] It was shown that mobility as a student increases the likelihood for scientists to choose research assignments abroad at a later stage of their career. Therefore, funding for German students to spend a period abroad and for foreign students to study in Germany through the well-established programs of the German Academic Exchange Service is a valuable contribution to the attractiveness of Germany and the mobility of scientific personnel.

Foundation are of essential importance as proven instruments for the promotion of mobility.

In the opinion of the Council of Science and Humanities, further efforts to increase mobility should focus, primarily, on junior researchers especially at the doctoral and postdoctoral level. As it is at this stage of their career that scientific personnel are most mobile, it is of crucial importance to make attractive funding available to such candidates. Clearly, Germany has been and still is underperforming in this respect, compared with her competitors (with a share of about 12 % of doctoral degrees taken by foreigners, compared to 40 % in the UK and ca. 33 % in USA)). |[298] Therefore, in the development of program portfolios, the German Research Foundation and the Alexander von Humboldt Foundation should pay even more attention to mobility funding for young scientists.

Obviously, programs to promote the mobility of experienced researchers should also remain part of those portfolios. In this area, the recently established Alexander von Humboldt Professorships emerged as a successful instrument to win (back) eminent scientists for research assignments in Germany.

The analysis of migration movements in Chap. A.III.3 showed Germany's position within a westward flow, as German institutions are recruiting the majority of their foreign doctoral students and postdocs from Central and Eastern Europe (Russia, Poland) and Asia (China, India). Still, much attention, not least from the media, is attracted by some very expensive initiatives to win (back) a much smaller number of experienced researchers from the US. Such selective attention poses the risk that strategic decisions are based on untested assumptions about the relative quality or levels of qualification of researchers from different countries of origin. Therefore, the Council of Science and Humanities argues in favor of a review of strategic and political efforts and welcomes the recent attempts by the Alexander von Humboldt Foundation, the German Research Foundation and the Helmholtz Association to make Russia, for instance, a target country for more recruitment initiatives.

Finally, the necessary conditions should be created at European and national level for scholarships and approved research funding to follow the researchers to their chosen place of work. For this, the Money Follows Researcher principle, already established by D-A-CH, can serve as a model. The Council of Science and Humanities recommends that the national bodies awarding the scholarships and the research funding organizations provide the appropriate framework. Any legal obstacles should be removed. While the Council is confident that, in the long term, the outflow of funds will be met by a corresponding return flow,

|[298] For details see Chap. A.III.3.a.

this expectation of reciprocity should not be taken as a requirement. The resulting freedom of movement for mobile researchers is a core feature of the European Research Area, significantly increasing the Area's attractiveness for scientific personnel. The mobility of the personnel in turn brings competition among the European institutions, which is an incentive for continuous quality assurance and enhancement.

Removal of obstacles to mobility

To improve the mobility of scientists within Europe, all professorships as well as posts for junior scientists must be advertised internationally. The establishment of the EURAXESS mobility portal, which allows researchers quick access to an overview of research openings in Europe, represents a very positive development in this respect. The Council of Science and Humanities urges the German universities and non-university institutions to advertise all their available research appointments internationally, via the usual channels for the respective scientific field and including the EURAXESS web portal. Transparent and swift appointment processes and subsequent contract negotiations should become the standard in the EU. This is an area where the Council of Science and Humanities sees considerable room for improvement, not least in Germany. |[299]

Also, persisting obstacles to mobility arising from social security and pension issues |[300] have to be overcome. |[301] Presently, occupational pension provisions organized at national level hamper the mobility between different countries and between public science and the corporate private sector. |[302] The Council of Science and Humanities recommends that the Federal Government and the state [Länder] governments provide remedy for such obstacles, especially in the

|299 See also Wissenschaftsrat (2005) and European Commission (2005b); also HRK (2009b).

|300 Relatively less problematic is the coordination of claims from statutory contributions or state pensions, which is set out in EIU Regulations. In the area of supplementary pensions for public service personnel, however, there is no coordination of rights and only limited portability. This is generally the case for occupational pensions. Moreover, the German "Beamtenstatus" [tenured civil service status] presents a significant obstacle to mobility. If a foreign researcher intends to stay for only a few years, this status is unattractive for them, since they cannot simply take with them the pension title they acquired through it in Germany. Retrospective insurance through the statutory pension fund results in loss of rights, since this only covers the German state pension, but not any supplementary provisions (Versorgungsanstalt des Bundes und der Länder). Generally, there also is the issue of recognition of periods preceding service, which affect the pension rights; this even applies within Germany. If, due to these drawbacks, the researcher prefers a non-civil service employment contract, this usually entails significantly higher payroll costs for the university, because of the social security contributions it has to pay in that case.

|301 Cf. Council of the European Union (2010).

|302 Alternatively, a European supplementary pension fund for researchers could be established, which would facilitate the coordination of the supplementary pension rights of mobile scientific personnel. Possible ways of implementing such fund are currently the object of a feasibility study on behalf of the EU.

public sector, as far as not implemented already. This requires steps at national and European level. For instance, relaxation of the spending framework for all universities in Germany – as far as not already in place – similar to the leeway already afforded to non-university institutions, could enable the universities to compensate their researchers for any losses incurred due to mobility. However, for this to work the universities need to be equipped with the necessary financial resources. The engagement of the German Rectors' Conference, which took up this cause at national level and developed the relevant expertise, ought to be welcomed. |[303] Another aim should be to examine as part of the discussion on career structures, how and from when all junior scientists (including doctoral students) should be given social security rights featuring simple and practical access and transfer rules. At the same time, in the interest of flexibility for young researchers, the award of scholarships should remain possible, at least for doctoral students.

Furthermore, a framework concerning residence rights, making moves to another country in Europe as easy as possible, needs to be in place. The European Union has set very positive markers in this direction – in some cases even against the resistance of member states – and achieved crucial progress for mobile researchers: On EU initiative, the visa regulations for short-term foreign assignments were improved, and immigration was made easier by the introduction of a Blue Card. The Council of Science and Humanities urgently recommends that the Federal Government presses for speedy implementation in national law and provides active support for future EU initiatives to this end. It would befit Germany, and be in the German interest to be at vanguard in setting the legal framework for foreign researchers. Considering the demographic development, such framework is urgently called for, not only for reasons of science policy, but also on economic-political grounds. In Germany, the recognition processes for foreign higher education qualifications, in particular, need further improvement and speeding up. |[304] This is apart from the need for a general reduction of bureaucracy in this area.

The disparities concerning the attractiveness of individual countries coincide with different income levels of researchers both within the EU and compared to

|[303] Cf. HRK (2009b). Additionally, on joint AvH and HRK initiative, the information network "International mobile Wissenschaftler und Alterssicherung" [internationally mobile scientists and their pension rights] was established in October 2009.

|[304] As a first step in this direction, persons with foreign higher education qualification can apply for an assessment of the degree in question by the "Zentralstelle für ausländisches Bildungswesen" (ZAB) [central office for foreign education] at the Secretariat of the Standing Conference of the Ministers for Education and Cultural Affairs (KMK) in Germany.

some third countries. |[305] There is a wide gap in this regard between old and new EU Member States, in particular. Competitive remuneration for researchers at every career level is an essential requisite for the attractiveness of the European Research Area and Germany as a science location.

II.4.B Career perspectives and attractiveness of institutions

In the view of the European Council, the European Research Area should be distinguished by the openness and competitive orientation of the employment market for European and non-European researchers, achieved through improved career structures, more transparency and more family-friendly conditions. There still is much need for action in these areas, indicated by the fact that the share of non-EU foreigners among doctoral students is much higher than that among salaried scientists: Europe is more attractive as an education area than as an employment area.

The deficit in the establishments of attractive career structures is primarily related to the situation at the universities, as a working group of the European Science Foundation could show. Their report identifies the following shortcomings: lack of transparency in recruitment, short-term contracts with little predictability concerning future perspectives, lack of social security provisions (e.g. pension funds), poorly structured and inadequately funded postdoctoral jobs; overall, poor predictability of career paths. |[306] Consequently, the Council of Science and Humanities asks the ESF and the EUROHORCs to establish an alliance for career development of researchers. Among other tasks, the new body should develop a common terminology to describe the different career paths for researchers. |[307] Primarily the universities and states [Länder] are called upon to apply any adjustments regarding the legal framework for higher education. The alliance should also address the issues of social security and look into the requirements for offering more posts or scholarships comprising social security elements. Some of these factors were already addressed by the European Commission in its Charter and Code for researchers.

|305 While researchers' 2006 salaries averaged € 60,000 in the US (≈ € 63,000), € 64,000 (≈ € 62,000) in Australia, € 69,000 (≈ € 61,000) in Japan and as much as € 83,000 in Switzerland (≈ € 60,000), their colleagues in Europe (EU25) averaged only € 38,000 (≈ € 40,000 Euro) (figures in brackets: adjusted for purchase power). In the EU, only the researchers' incomes in Belgium, the Netherlands, Ireland, Denmark, Austria and Luxembourg, amounting to between € 58,500 and about € 64,000 (not adjusted for purchase power) come close to the top countries. In Germany, the average annual gross salary stands at € 56,000 (≈ € 53.000). Cf.: EU Commission, Research General-Directorate (2007), herein p. 56; the table there lists salaries in EUR and the respective purchase power-adjusted figures.

|306 European Science Foundation (2009).

|307 See also LERU; the League of European Research Universities states, for instance "a need for a common European language to describe the diverse pathways of academic progression".

The attractiveness of a science location, determining its ability to recruit foreign scientists and to convince scientists working abroad to return home, are attributable to various aspects. |[308] In their employment decisions, scientists include factors such as the opportunities for independent research, access to research infrastructures (equipment, libraries, etc.), research funding and the reputation of the institution in question, as well as proper remuneration, general quality of life, possibilities to reconcile working and family life, and the language and attractiveness of the cultural environment. The dominant factors are clear and predictable career prospects and direct economic factors, such as salaries and issues of social security and pension provisions. |[309] It must always be kept in mind that mobility can come at a high personal price. Therefore, the host institutions should also ensure that their foreign personnel are offered services to support their social integration in the host country.

National level

The Council of Science and Humanities takes the view that Germany, in her own interest, should become an immigration country for foreign scientific personnel. The trend towards systematic internationalization of academic staff should be welcomed and promoted. In this context, it is worth noting that Germany already belongs to the net winners of researcher mobility (cf. Chap. A.III.3). Apart from increasing the share of foreign doctoral students, further internationalization at personnel level, especially at strongly research-oriented universities should be pursued through active recruitment and international advertising of available posts. |[310] Other efforts in research marketing should be welcomed and reinforced, as well, including the alumni initiatives of the funding organizations, which already initiated activities in this respect. In all this, it must be kept in mind that the internationalization of personnel is intended to enhance the quality of the German system. It is not an end in itself.

Proper analysis of the attractiveness of science institutions in Germany for mobile researchers, which would allow precise and specific recommendations, is

|[308] Cf. e.g. OECD (2008b), p. 24f. with further literature, and CREA (2007): Flat hierarchies, platforms for exchange and an international atmosphere are cited in this report, apart from clear and predictable career paths and early autonomy.

|[309] This is shown by an OECD project on the career of doctoral students, from which first results for the US have become available. Cf. OECD (2007), p. 25. Compared to these factors, family-related reasons are slightly less dominant in most cases, even if the importance of working opportunities for partners must not be underestimated. Cf. European Commission (2008c), p. 37f.

|[310] The survey of universities about their strategies for internationalization, by Brandenburg, Knothe (2008) showed that teaching-related initiatives dominate the internationalization activities in German higher education (45 % of institutions see this as their focus, compared to 31% with stronger focus on internationalization in research) (p. 31).

complicated by the absence of reliable and comprehensive data on foreign scientists in Germany. | [311] The Council of Science and Humanities welcomes current efforts to remedy this situation. | [312] For any analysis regarding the doctoral-student stage, a standardized form of registration of doctoral students at the institutions is required. To increase the transparency of the quantitative and qualitative aspects of the training and funding of young scientists, this should be accompanied by a survey of the form of financing or funding used by doctoral students. | [313]

Considering the inadequacy of the available data, one has to resort to mobility data as a basis for assessing the attractiveness of the institutions and the science location (see Chap. A.III.3). These show: Germany's scientific institutions suffer competitive disadvantages in comparison with those e.g. in the UK, in France, but also in Switzerland. These countries are preferred especially by young, mobile researchers at the doctoral and postdoc stages of their career. | [314] The ERC results (cf. Chap. A.III.1.c), in particular, show that at the individual scientist level, there already exists European competition, whereas institution-related competition remains predominantly national or even regional in its constitution. Even if the results are not taken as scientists' "voting with their feet" and an indicator for weakness of the national system, there can be considerable damage to the external perception and, consequently, competitiveness of German institutions. Furthermore, the competition for grants is also about significant finance, which should not be abandoned by German institutions of international orientation (EPF Lausanne, for example, so far obtained 45 mil. Euros through ERC grants). Higher education and non-university institutions should react to these findings by more proactive recruiting of grant candidates and offering more assistance for preparing their applications, following a rigorous

| [311] The best source available at this moment, the analysis in the DAAD report "Wissenschaft weltoffen" only covers researchers receiving individual funding from a German funding body. The Federal Statistical Office has been recording the nationalities of scientific personnel only since 2005. Those funded through large projects financed from third-party funds, or directly employed as scientific staff at universities, or supported by institutions abroad are not necessarily included in those data.

| [312] Cf. the project "Profildaten zur Internationalität von Hochschulen" [profile data on the internationality of higher education]: The German Academic Exchange Service (DAAD) and the German Rectors' Conference (HRK), in cooperation with the Alexander von Humboldt Foundation (AvH) and the Association for Empirical Studies (GES) are conducting a service project for the development of profile data on the internationality of German higher education institutions; this will also involve recording of basic data from the personnel sector.

| [313] Cf. Wissenschaftsrat (2002), p. 50f.

| [314] However, due to the changes mainly driven by the Excellence Initiative, there are recent signs of improvement concerning the attractiveness of the German science system as an employment market for foreign scientists and German researchers working abroad. Also, the effects of the economic crisis in other EU Member States are likely to affect their competitiveness in this respect.

screening process. They should also consider establishing additional incentives for grant holders (e.g. improved facilities), like those already applied successfully at some universities. |[315] In the medium term, facing an increasingly competitive international market, institutions can secure the loyalty of younger scientists rich in third-party funding only by offering them a reliable career perspective, e.g. in the shape of tenure-track positions (see below). For holders of ERC Advanced Grants, on the other hand, other incentives, such as integration in existing structures (e.g. Excellence Clusters) or possible reduction of their teaching load, are more dominant. Therefore, the states [Länder] should create provisions in higher education law for more flexible arrangements concerning the teaching obligations of researchers, as far as such are not already in place. |[316]

Creating transparent career paths and predictable career perspectives

As the degree of mobility is much higher during qualification than at later stages of the scientific career, the political focus should be more strongly on the conditions for young scientists and the attractiveness of the system for them. From the perspective of that group, the Anglo-Saxon science systems (especially the UK and USA systems) are more attractive, especially as they offer clear and reliable, professional career perspectives at an early stage. This advantage is further enhanced by the widespread use of English as the language of science. |[317]

|[315] Ghent University in Belgium, for example, offers holders of *Starting Grants* permanent professorial positions; in the *Starting Grants* round of 2009, the university won 5 grants (compared to 1 *Starting Grant* in 2007). Universities in Switzerland developed dedicated strategies to assist suitable staff with their applications, as well as for proactive recruiting of researchers still working in other countries. Apart from additional incentives regarding infrastructure facilities, the universities can also create predictable career perspectives by offering *tenure-track* contracts – another important recruitment tool. Some German universities have already adapted to the successful players in the European competition for excellence. For instance, the Goethe University in Frankfurt offers intensive individual consulting services for grant applicants, but also, as an additional incentive for grant holders, the possibility to obtain complementary finance from university funds.

|[316] An overview of applicable regulations was compiled by the Wittenberg Institute for Research on Higher Education (HoF): http://www.hof.uni-halle.de/dokumentation/lehrverpflichtungen.html [last downloaded 2010-04-12].

|[317] See for example "Zukunft Wissenschaft: Initiative deutscher Auslandswissenschaftler für eine attraktivere Hochschullandschaft" [future science: an initiative of German scientists working abroad, for a more attractive university landscape]. Open letter to the federal and Länder ministers for research of May 2005 (http://astro.berkeley.edu/~areiners/izw/OffenerBrief_290905.pdf; last downloaded 2010-04-12), or the "Pro Science" manifest of September 2005, which demands, apart from open, international application processes, security in [career] planning in exchange for performance. – The Council of Science and Humanities already emphasized in several Recommendations the importance of clear and plannable career structures and perspectives for the domestic pool of young researchers. Such demands become even more urgent when applied not only to young German scientists in Germany, which may be tied in by personal and

In the view of the Council of Science and Humanities, the central challenge in the recruitment of foreign scientists lies in the task to create transparent career perspectives for young scientists and to allow them to take the first steps into autonomous scientific occupation at an early stage, for instance while they are working towards a doctorate. |[318] Therefore, the following recommendations focus on this set of issues.

Transparency is lacking not only at the doctoral-student stage, but also thereafter, due to the diversity of employment modes for postdoctoral researchers. |[319] The lack of transparency in connection with the diversity of employment and qualification options for young researchers in Germany hampers the recruitment of foreign (and the retaining of domestic) personnel to a considerable extent. Therefore, the Council of Science and Humanities recommends that scientific and higher education institutions and the states [Länder] agree on a transparent and standardized designation system for employment modes. The Council repeats its recommendation from 1997 to formally mark the beginning of the doctoral/graduate student stage by official enrollment for doctoral or graduate studies |[320]; for this, the states [Länder] must provide proper provisions in their higher education laws. To enhance the attractiveness of the system for foreign scientists, this initiative should be extended to European level, with the aim to create a clear structure with transparent conditions for doctoral students and postdoctoral researchers in Europe (cf. Chap. B.II.4.a).

Often, the career options not only lack transparency, but are also unattractive. The persistent shortage of tenure-track positions, especially compared with the UK, for example, is a particular disadvantage in this respect. Since the European employment market presents alternatives to a career in Germany for German scientists as well, adjustments are vital not only to attract young scientists from abroad, but also to retain existing young personnel in Germany. Irrespective of the fact that doctoral-level employees are highly demanded by the private sector as well, the Council of Science and Humanities reaffirms its urgent plea that the higher education institutions make more use of the option to establish a competitive tenure-track system in the sense of the common, international termi-

family relationships, but to Germany's attraction for foreign researchers considering a choice of possible destination countries.

|[318] Cf. Wissenschaftsrat (2001), herein p. 54: "The stage of autonomy in research and teaching, which constitutes a major incentive to choose a career in higher education, and a predictable career perspective is [...] reached about ten years later than in other countries of comparable scientific capacity." – as shown by the analysis of the mobility programs, Germany is relatively attractive for scientists at more advanced stages of their career, where the recruitment of personnel even from the US or UK is quite successful.

|[319] Cf. Edler (2007). This situation is most pronounced in Medicine, where postdoctoral research has to run in tandem with clinical professional specialization under varying, Länder-specific regulations.

|[320] Most recently in Wissenschaftsrat (2002), p. 50f., and Wissenschaftsrat (1997), p. 73:

nology. Any existing obstacles in higher education law should be removed by the states [Länder]. |[321] This includes improved opportunities for permanent employment of scientists after twelve or 15 years of qualification. |[322] In this it must be ensured that ways of re-entry for researchers returning from abroad are provided, too.

The Council of Science and Humanities regards scholarship funding for post-doctoral researchers as problematic, because of the lack of social security and pension provisions. Nevertheless, such offers should be kept open, as they can be particularly interesting for some foreign postdocs not aiming for permanent stay in the German systems. In these cases, security should be provided by tied financial contributions to build private pension fund.

Since scientific personnel is mobile already at the doctoral stage, the institutions in Germany should also make stronger efforts to attract promising foreign postgraduate students. In this context, structured postgraduate programs are of special importance, as these are emphatically demanded, and often expected as standard by this target group. |[323]

On the one hand, to recruit young researchers from abroad, it is essential to offer a sufficient number of high-level courses in suitable subjects held in English. To make this possible, the institutions must also offer task-specific language training for their German-speaking research, teaching and administrative staff; foreign junior scientists could be involved in conducting the courses. Depending on the region where the institution is located and on the subject culture, it could also be reasonable to pay attention to other languages (e.g. Polish or French). On the other hand, the institutions should offer opportunities for foreign doctoral students and postdocs to acquire German language skills. In any case, foreign junior scientists staying in Germany for several years should be expected to acquire command of the German language to the extent required in the respective professional, institutional and social context. The Council of Science and Humanities would emphasize that the multilingualism achieved in this way represents an important additional competence for German and foreign researchers to advance their future career development.

|[321] On the legal situation, cf. Herkommer (2007).

|[322] Wissenschaftsrat (2004b), herein e.g. p. 33: "The Council of Science and Humanities expects that the prospect of non-tenured but permanent employment below the professorial rank will significantly enhance the attractiveness of a career in science."

|[323] Cf. recommendations for postgraduate education and training (Wissenschaftsrat (2002)), in which the Council of Science and Humanities proposes the large-scale introduction of graduate schools.

The universities and institutions should facilitate integration by running Welcome Centers (emulating the pilot projects funded by the Alexander von Humboldt Foundation). In future, any university and non-university research institution intending to be part of the contest for international top scientists will be measured even more than before by their ability to accommodate the special requirements of dual career couples. |[324] In this, ETH Zurich took a pioneering role with its "Dual Career Advice Office", established in 1999 |[325]. Since then, comparable services were installed at some German universities, as well (e.g. at the University of Duisburg-Essen, LMU and TU Munich, Ruhr-Universität Bochum and Heidelberg University). The institutions should be guided by this example for supporting dual career couples with their selection of employment and during integration.

To enhance their attractiveness for scientists from other regions of the world, universities must ensure that new foreign recruits not only find an inspiring scientific environment in their department, but are also met with intellectual openness for their culture. Creating the appropriate conditions presents a special, important challenge for university executives.

Among the personal factors that can determine any decision for or against a potential host country, those concerning families and partners are of dominant importance. The years before and after doctoral qualification often coincide with the period when couples like to start families. In recognition of this, science locations should offer sufficient, communal services for bilingual childcare, as well as all-day school places. Moreover, local authorities and university administrations need to adapt to the presence of highly mobile scientists by offering services, information and advice in English. |[326]

|[324] Cf. documentation from a meeting of the DFG and the Stifterverband on 24 February 2003 and the resulting brochure: Karriere im Duett. Dual Career Couples. Mehr Chancen für Forscherpaare, (http://www.dfg.de/download/pdf/dfg_im_profil/geschaeftsstelle/publikationen/dual_career_couples_magazin.pdf [last downloaded 2010-04-12]). Further information about the situation in Germany and references to other studies on the issue of dual career couples is available from the "Dual Careers" working group at *Junge Akademie* (cf. http://www.diejungeakademie.de [last downloaded 2010-04-12]). Since November 2007, there also exists a research unit "Dual careers" at the Social Science Research Center Berlin (WZB), studying the "conditions for ... dual careers in academic couples".

|[325] The office at the ETH supports foreign life partners of professors to integrate in the employment market in Switzerland and offers assistance with finding work.

|[326] Internationalization at personnel level presents a challenge for university administrations. International exchange at administration level is advisable not least because the current transformations of the universities through autonomy and changed governance structures are transnational processes. In this, the administrations can turn to the Utrecht Network, for instance, whose mission is to promote international exchange of administrative staff of the 31 member universities; or to the Heads of University Management

The attractiveness of the German science system can only be maintained or enhanced under conditions of gender equality. Looking at the number of female scientists in executive and leadership positions, which remains relatively low, it can hardly be said that this has been achieved already. |[327] For this reason, the Council of Science and Humanities emphatically reaffirms its recommendations on equal opportunities for female scientists of 2007. |[328] Many female scientists from Germany experienced working abroad as an important step towards a career in science, because of better conditions regarding gender equality in some other countries. In this respect, Europeanization and internationalization bring positive effects for the career development of women in science.

and Administration Network in Europe (humane). The EU supports transnational advanced training of university officials through the ERASMUS Programme.

|[327] Although the share of women in the professorate at higher education institutions increased from 7.5 % to 16.2 % between 1992 and 2007, the potentials of women – considering they were awarded about 42 % of all doctoral degrees in 2007 – still remain untapped to an extent amounting to negligence. Cf. GWK (2009b).

|[328] Principal recommendations: involvement of women in management committees, establishing equal opportunities as a strategic objective of university management, transparency and formalization of appointment processes, enhanced consideration of teaching experience and practical experience, coaching and mentoring programs, competition between universities and research institutions to achieve equality targets; cf. Wissenschaftsrat (1998).

C. Summary of recommendations to national actors

In the following the principal recommendations from Chapter B.II are summarized again, with reference to the different parties involved.

C.I RECOMMENDATIONS TO FEDERAL AND STATE [LÄNDER] ADMINISTRATIONS

To assist the federal and state [Länder] administrations in their basic responsibility for science in Germany, the Council of Science and Humanities issues the following recommendations:

_ Federal and state [Länder] administrations should more than before consider all fundamental, strategic decisions from a European perspective and take into account the consequences of their actions for the European Research Area.

_ Federal and state [Länder] administrations should actively promote European Joint Programming in suitable thematic areas and involve the science sector at an early stage.

_ They should create a robust political and legal framework, not least for increased openness of national institutions and funding programs for European and international cooperations.

_ They should allow science organizations and research funding bodies an extended, yet defined scope for the allocation of funds abroad.

_ They should support the German Research Foundation in the establishment of a funding program for bottom-up-cooperations, open to all themes, between two or more institutions in Europe.

_ Through funding of cooperations between science and businesses by instruments of project funding, the federal and state [Länder] administrations should continue to support the high level of R&D activity in the private sector as a special signum of Germany as a research location.

_ They should – as far as not done already – provide the necessary legal provisions for higher education and non-university institutions to pay flexible and competitive salaries to researchers and, where applicable, offer free negotiation of teaching obligations.

_ They should support the universities and the German Rectors' Conference in their joint efforts with the EUROHORCs, the ESF and the national research organizations to develop a common European terminology for different career paths, so that the resulting, improved transparency will increase the mobility of researchers and enhance the attractiveness of science as a field of professional occupation, as a whole.

_ They should promote mobility and remedy the obstacles to mobility in the area of social security and, especially, pension rights by appropriate provisions at national and European level.

_ They should examine if, in the light of variant practices in other EU Member States and in the European Research Area, the present practice in Germany to provide no expense allowances for scientific consulting services leads to reduced willingness on the part of suitable scientists to engage in consulting activities.

In relation to national science policy, the federal administration should

_ involve the states [Länder], organized science and other actors in the preparation of fundamental decisions on the European Research Area and its initiatives at an early stage, so that Germany can proactively argue her science policy position at European level,

_ establish in concert with the states [Länder] a transparent national road map process for large-scale research infrastructures, with early involvement of organized science, as provided for in the coalition agreement of the Federal Government,

_ support professional associations in improving their self-organization where this is necessary (e.g. for the formulation of infrastructure proposals), also by way of project funding, if applicable,

_ in concert with the states [Länder] press for swift implementation of special EU immigration rules (Blue Card) in national law, and actively support future Union initiatives in this respect.

In relation to science policy in the EU, the Federal Government and the states [Länder] should

_ advocate that the EU meet the Barcelona Target – 3 % of GDP invested in research, development and innovation – by reassigning resources in its own budget,

_ support the EU in creating frameworks (including legal), within its competence, for the advancement of science,

_ encourage the EU to initiate an understanding within the ERA about high standards in research as well as in its science-led assessment,

_ press for the EU strategy for internationalization and its funding programs to embrace the objective to be open to the world and to cooperations with science regions worldwide, and promote partnerships with developing and emerging countries,

_ encourage the Commission in its intention to apply different instruments for the purposes of research funding and cohesion funding respectively (Framework Programme versus Structural Funds), but also to use the Structural Funds to support science and scientific institutions, thus achieving synergy effects between the two programs,

_ maintain their cautious stance concerning suggestions from Brussels to establish central European institutions, since institutions based on scientific interests and issues and founded in variable geometry deserve preference,

_ argue that large European infrastructures should be established only at locations where appropriate scientific conditions are already in place,

_ propose the establishment of a clearing office at European level, serving as a consulting instance for institutions interested in the establishment of large-scale research infrastructures and providing information about possible legal, contractual and financial arrangements for such infrastructures,

_ advocate a transnational discourse about the respective national regulations for dealing with ethically complex and high-risk research at national level,

_ ask the Commission to work with the Member States in the promotion of Europe-wide, standardized indicators of internationalization and Europeanization and support equally harmonized recording of data in this respect.

In relation to research funding by the EU, the Federal Government in concert with the states [Länder] should

_ support the Commission in the establishment of high scientific standards in Europe through consistent application of the quality criterion in the EU Framework Programme,

_ argue that European research funding should be targeted towards suitable areas (transnational and intersectoral cooperations, mobility, science-led funding structures, such as the ERC, research concerning global challenges, research infrastructures) and a small number of instruments and programs characterized by continuity,

_ work for a long-term perspective for the ERC,

_ advocate the independence of the ERC, considering every conceivable option for its legal structure as an independent agency,

_ work for the ERC to be given the competence to develop its portfolio successively, considering its operational capacities, so that it can fulfill its benchmark function in Europe (e.g. by expanding the funding for bottom-up cooperations in Europe),

_ argue for financing the Knowledge and Innovation Communities (KICs) of the EIT through a funding line of the Framework Programme for Research,

_ advocate that the Commission should support the establishment and operation of European research infrastructures by contributing appropriately to the funding of the operating costs entailed by the their use by third parties, and make Europe-wide, open access to the infrastructures in question a precondition for the Commission to contribute,

_ argue in favor of streamlining the funding processes of the EU and inspecting the effectiveness and efficiency of administrative procedures at regular intervals,

_ work for optimally harmonized financing and participation rules within the funding programs of the EU.

The federal states [Länder] should

_ meet their grown responsibility in the formation of the European Research Area by increased use of their own funding instruments and resources to shape the structure of the ERA,

_ to this end, increasingly promote regional clusters of universities, non-university institutions and businesses across borders, also involving the neighboring regions,

_ ensure that they, and any foundations endowed with state [Länder] finance take into account not only the regional or national context, but also the European perspective in the development of their funding portfolios,

_ meet their enhanced role in the development of regional centers by increased use of EU Structural Funds resources for investments in research institutions, and also use these resources for contributing part of the financing for large research infrastructures,

_ in some cases continue funding, e.g. of ERC-funded groups that are of central importance for the profile-building of their location, beyond the end of the ERC funding period,

_ support the institutions – especially the universities – and locations in profile-building based on their specific strengths,

_ create the framework in higher education law for the beginning of doctoral/graduate education to be formally marked by enrollment for doctoral or graduate study programs,

_ remove any persisting obstacles in higher education law for the universities to introduce tenure-track positions,

_ support the universities, in particular, in creating a register of foreign researchers at all levels by starting valid and standardized statistical recording,

_ provide the legal framework in higher education law for flexible agreements on teaching obligations, as far as such are not in place already,

_ improve and speed up the practices involved in the recognition of foreign higher education qualifications, regarding professional law,

_ encourage the local authorities at science locations to adapt their services and administration to the presence of mobile researchers and their needs (e.g. advice services in English or provisions for bilingual childcare).

C.II RECOMMENDATIONS TO UNIVERSITIES, NON-UNIVERSITY INSTITUTIONS AND SCIENCE ORGANIZATIONS

_ When framing their strategies, the universities, non-university research institutions and science organizations should examine the options regarding their positioning in the European Research Area. Strategies for Europeanization or internationalization should be tailored to optimally fit the focus areas and unique characteristics of the respective institution or organization.

- More institutional cooperation with individual institutions or strategic alliances may be a method of choice. In border regions, transnational alliances can become instrumental for profile and competence building.
- The institutions should also allow the space for researchers to engage in subject-specific, international scientific exchange with partners of their choice.
- Both for universities and for non-university institutions, the establishment of branches abroad can serve to enable scientific exchange, provide opportunities to recruit highly talented young scientists, and contribute to the advancement of developing and emerging countries.
- Universities and non-university institutions, if necessary in cooperation with the German Research Foundation, should identify or recruit suitable candidates for applying for ERC grants, and assist them with advice in the preparation of such applications. Furthermore, they should ensure by additional finance and support facilities, as well as tenure-track offers where applicable, that successful researchers in the European excellence competition consider German institutions among their locations of choice.
- Universities and non-university institutions should join forces with businesses and industry in making use of the opportunities for enhanced knowledge transfer and the innovation funding presented by the EU funding formats, and engage in systematic networking with the respective other sector, as far as required for this purpose.
- Universities and non-university institutions should cooperate with the German Rectors' Conference, the ESF and the national research organizations in developing a common European terminology for the variety of career paths, so that the resulting gain in transparency will enhance the mobility of researchers and the attractiveness of science as a field of professional occupation, as a whole.
- Institutions should secure their attractiveness by guaranteeing equal opportunities for female and male personnel.
- Universities and science organizations should aim for a cooperative and coordinated approach to institutional representation in Brussels, so that they can engage in effective agenda-setting at European level.
- Universities and non-university institutions should coordinate the guidelines for good scientific practice in a European context, so that conflicts within cooperative projects are avoided and coordinated processes for conflict resolution will be available, where necessary. In this, the guidelines on research integrity by the ESF and OECD should be taken on board.

_ Universities and non-university research institutions should set up close links between their respective EU consulting unit and the relevant strategy department generally concerned with research funding.

Universities, in particular, should

_ actively secure their attractiveness as workplaces for scientists from Germany and abroad, and press ahead with the internationalization of their personnel. To this end, the Council of Science and Humanities regards as necessary that they

  _ provide reliable and transparent career perspectives and, especially, make comprehensive use of any leeway in producing tenure-track offers,

  _ always advertise posts, both at professorial level and for junior scientists, internationally through the usual professional channels and through the EURAXESS portal,

  _ establish transparent and swift appointment procedures,

  _ offer advice and integration services for foreign personnel (e.g. by establishing Welcome Centers), also addressing the particular requirements of dual career couples,

  _ increasingly offer structured doctoral study programs, where such programs are not already in place, in order to attract young scientists from abroad,

  _ offer high-level courses held in English (or another foreign language where appropriate) in suitable subjects, but also offer German language courses for young scientists from abroad,

  _ assist their German academic and non-academic staff with acquiring foreign-language skills,

  _ improve the administrative support for researchers in the application for, and management of EU projects,

  _ provide the conditions for recording the nationality/origin of personnel, including doctoral students, by proper statistics.

Science organizations should

_ – as far as such are not already in place – develop strategies for their positioning in the European Research Area and in international competition, and involve the funding providers at federal and state [Länder] level in their central strategic decisions,

_ should engage more strongly in coordinated position-forming in the context of the Alliance of German Science Organizations, and check whether their strategies are complementary, in relation to the national system as a whole, or if there remain gaps that require remedy,

_ develop a coordinated, joint presence for the promotion of Germany as a science location (e.g. in the context of the "Deutsche Wissenschafts- und Innovationshäuser"), because separate representation of individual interests is less effective. For this, the organizations involved should develop a consistent concept to be followed by all,

_ work for improved self-organization of the science sector at European level, for which the EUROHORCs could provide the adequate framework. Should this turn out to be impractical and unproductive, the objective to strengthen European multilateral engagement can also be pursued within a different circle of suitable partners,

_ exploit the scope for joint representation in the European Research Area, concerning central and overarching issues of science policy, and share information about their positions in areas of European science policy and EU research funding where coordinated action is unfeasible.

C.III RECOMMENDATIONS TO NATIONAL RESEARCH FUNDING BODIES

_ The national research funding bodies should review, on a regular basis, their respective profile and portfolio in relation to multilevel funding in Europe. The relation to European funding should be characterized by task-sharing and cooperation, but still allow competition.

_ They should open up their programs in defined areas of research by project-related and regional initiatives, based on mutuality, so that they will be in a position to co-finance transnational programs implemented abroad.

_ They should further expand the possibilities for researchers to take abroad any approved scholarships and funding.

_ They should support locations in building a European profile, for instance by providing continuity funding for excellent groups at individual locations after expiry of ERC funding.

_ They should help promoting the harmonization of European assessment practices by making reasoned feedback to all grant applicants part of their normal procedures, explaining positive as well as negative funding decision, as far as this is not already done.

_ They should strive for a high level of continuity and transparency of their funding programs and ensure that efficient advice is available on all of them, including the multilateral programs in which they participate.

The German Research Foundation should

_ maintain its claim to funding very good and excellent research, and its broad funding spectrum,

_ further internationalize its processes by involving foreign experts,

_ promote the idea of a European Grant Union set out in the context of the ESF and EUROHORCs Roadmap, and introduce its own procedures as the benchmark model. Harmonized application forms and accounting methods could also be part of a European Grant Union. The Council of Science and Humanities asks the DFG to advocate standardization in this area.

_ continue its consistent initiatives concerning the multilateral shaping of the European Research Area,

_ bring in its established recommendations on good scientific practice in cooperations with European partners and promote their implementation in the ERA,

_ expand the bilateral and multilateral cooperation initiatives already started,

_ set up a bottom-up funding initiative, with suitable partners in Europe, for cooperations between two or more institutions in different countries,

_ support the universities in their efforts to obtain ERC grants and encourage suitable candidates to submit applications,

_ continue the existing provisions for researchers to submit parallel applications to ERC and DFG.

The Alexander von Humboldt Foundation and the German Research Foundation should

_ specially adapt their mobility programs to the requirements of young scientists, because researchers are particularly mobile at the early stages their career,

_ continue to provide for mobility funding for experienced researchers (e.g. Alexander von Humboldt Professorship),

_ strengthen their efforts to provide programs for the funding of researchers from Central and Eastern Europe and from Asia.

_ National scientific communities and researchers should contribute to the development of European standards within their disciplines.

_ The scientific communities should participate in the foundation and development of European representations of their disciplines at an early stage.

_ When formulating a proposal for a large research infrastructure, the scientific communities should examine whether cooperation with partners in other European countries could allow more efficient and productive use of the infrastructure in question.

_ To ensure that the results of their research are received by the international scientific community, researchers – as far as their normal publishing language is German –should consider translation of crucial publications into English.

C.V RECOMMENDATIONS TO ADVICE AND CONSULTING UNITS FOR MATTERS OF EU RESEARCH FUNDING

_ The advice and consulting system should be as clearly organized as possible and avoid duplication of services. To this end, the coordination efforts among the relevant units (national contact offices, EU office of the Federal Ministry of Education and Research (BMBF), European Liaison Office of the German Research Organisations (KoWi), EU officers at universities and institutions) should be continued.

_ A shared Internet platform, where an “advice path” sets out the competences of the individual units, and which offers a central entry point to their respective Internet presences, could contribute to more efficient provision of advice for researchers, in matters of EU funding.

D. List of abbreviations

AA	Federal Foreign Office
AAL	Ambient Assisted Living
ARTEMIS	Advanced Research and Technology for Embedded Intelligence and Systems
ASPERA	Astroparticle European Research Area
AvH	Alexander von Humboldt Foundation
BAMF	Federal Office for Migration and Refugees
BMBF	German Federal Ministry of Education and Research
BMWi	Federal Ministry of Economics and Technology
BONUS	Joint Baltic Sea Research Programme
CERN	European Organization for Nuclear Research
CIP	Competitiveness and Innovation Framework Programme
CLARIN	Common Language Resources and Technology Infrastructure
CLUSTER	Consortium Linking Universities of Science and Technology for Education and Research
COM	European Commission
COST	European Cooperation in the Field of Scientific and Technical Research (Coopération européenne dans le domaine de la recherche scientifique et technique)
CREST	Scientific and Technical Research Committee (Comité de la recherche scientifique et technique)
DAAD	German Academic Exchange Service
DARIAH	Digital Research Infrastructure for the Arts and Humanities
DESY	German electron synchrotron

DFG	German Research Foundation
DG	Directorate-General
DGIA	Foundation of German Humanities Institutes Abroad
DLR	German Aerospace Center
EARTO	European Association of Research and Technology Organisations
EC	European Community
EFDA	European Fusion Development Agreement
EFI	Commission of Experts
EFTA	European Free Trade Association
EIB	European Investment Bank
EIT	European Institute of Innovation and Technology
EMBL	European Molecular Biology Laboratory
EMRP	European Metrology Research Programme
ENIAC	European Nanoelectronics Initiative Advisory Council
ERA	European Research Area
ERA-Nets	European Research Area Networks
ERC	European Research Council
ERDF	European Regional Development Fund
ERG	European Reintegration Grants
ERIC	European Research Infrastructure Consortium
ESA	European Space Agency
ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Organization for Astronomical Research in the Southern Hemisphere
ESRF	European Synchrotron Radiation Facility
ETPs	European Technology Platforms
EU	European Union
EUA	European University Association

EUB	EU office of the BMBF for the Framework Programme for Research
EUI	European University Institute, Florence
EURATOM	European Atomic Energy Community
EURAXESS	Web portal of information and advice units from 35 countries, for internationally mobile researchers
EUREKA	European initiative for market-oriented research and development
EUROHORCs	European Heads of Research Councils
FAIR	Facility for Antipron and Ion Research
FCH	Fuel Cells and Hydrogen
FhG	Fraunhofer-Gesellschaft [Fraunhofer Society]
FP	EU Framework Programme for Research and Technological Development
FWF	Austrian Science Fund
GAIN	German Academic International Network
GDP	Gross Domestic Product
GES	Association for Empirical Studies [Gesellschaft für empirische Studien]
GG	Basic Law for the Federal Republic of Germany
GMES	Global Monitoring for Environment and Security
GWK	Joint Science Conference
HALO	High Altitude and Long Range Research Aircraft
HBFG	University Construction Funding Act [Hochschulbauförderungsgesetz]
HEI	Higher Education Institution
HGF	Helmholtz Association of German Research Centers
HLD	High Magnetic Field Laboratory Dresden
HoF	Wittenberg Institute for Research on Higher Education
HRK	German Rectors' Conference
IARU	International Alliance of Research Universities

IGLO	Informal Group of RTD (Research and Technological Development) Liaison Offices
ICT	Information and Communication Technologies
ILL	Institut Laue-Langevin
IMI	Innovative Medicines Initiative
IPR	Intellectual property rights
ISCED	International Standard Classification of Education
ISS	International Space Station
ITER	International Thermonuclear Experimental Reactor
JTI	Joint Technology Initiatives
KET	Committee for the physics of elementary particles [Komitee für Elementarteilchenphysik]
KIC	Knowledge and Innovation Community
KMK	Standing Conference of Ministers of Education and Cultural Affairs
KoWi	European Liaison Office of the German Research Organisations
LERU	League of European Research Universities
MPG	Max Planck Society
NCP	National contact point
NUPECC	Nuclear Physics European Collaboration Committee
OECD	Organization for Economic Co-operation and Development
OIF	Outgoing International Fellowship
OMC	Open Method of Coordination
PSB	Partnership for Structural Biology
RatSWD	German Data Forum
RSFF	Risk Sharing Finance Facility
SET	European Strategic Energy Technology Plan
SFIC	Strategy Forum for International S&T Cooperation
SME	Small and medium enterprises
SNF	Swiss National Science Foundation

TEC	Treaty establishing the European Community
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
WGL	Leibniz Association (Gottfried Wilhelm Leibniz Scientific Community)
XFEL	X-Ray Free-Electron Laser
ZAB	Central Office for Foreign Education

EU member states		Associated states	
AT	Austria	AL	Albania
BE	Belgium	BA	Bosnia and Herzegovina
BG	Bulgaria	CH	Switzerland
CY	Cyprus	HR	Croatia
CZ	Czech Republic	IL	Israel
DE	Germany	IS	Iceland
DK	Denmark	LI	Liechtenstein
EE	Estonia	ME	Montenegro
EL	Greece	MK	Macedonia
ES	Spain	NO	Norway
FI	Finland	RS	Serbia
FR	France	TR	Turkey
HU	Hungary	**Miscellaneous states**	
IE	Ireland	AR	Argentina
IT	Italy	AU	Australia
LT	Lithuania	CA	Canada
LU	Luxembourg	CN	China
LV	Latvia	JP	Japan
MT	Malta	KR	Korea
NL	Netherlands	MX	Mexico
PL	Poland	RU	Russia
PT	Portugal	SG	Singapore
RO	Romania	UA	Ukraine
SE	Sweden	US	United States of America
SI	Slovenia		
SK	Slovakia		
UK	Great Britain		

E. Annexes

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Table A.1: R&D expenditures 2008 in selected countries and in relation to GDP

		FuE-Ausgaben 2008				
Country	GDP 2008 in bn. Euro	Total in mil. Euro	Thereof private-sector economy in mil. Euro	R&D as share of GDP	R&D as share of GDP private-sector economy	Change in % share of GDP in percentage points 2000-2008 [3]
D	2.496	65.622,0	45.822,0	2,6 %	1,8 %	0,18
UK	1.819	34.144,2	21.930,8	1,9 %	1,2 %	0,07
IT	1.568	18.587,4	9.453,1	1,2 %	0,6 %	0,13
NL	596	9.686,2	5.325,4	1,6 %	0,9 %	-0,19
FR	1.949	39.422,9	24.836,9	2,0 %	1,3 %	-0,13
FI	184	6.871,1	5.102,0	3,7 %	2,8 %	0,37
SE	334	12.314,4	9.119,0	3,8 %	2,8 %	0,14[4]
CH [1]	341	8.485,6	6.257,3	2,9 %	2,1 %	0,37
EU-15	11.516	228.962,1	147.808,1	2,0 %	1,2 %	0,08
EU-27	12.502	237.001,0	151.448,7	1,9 %	1,3 %	0,05
USA	9.819	270.659,5	196.563,1	2,8 %	1,9 %	0,07
Japan [2]	3.313	110.116,0	85.769,9	3,4 %	2,7 %	0,40

1) All figures from 2004, except for GDP; 2) all figures from 2007, except for GDP; 3) own analysis; 4) comparison 1999-2008; most of the GDP figures for 2008 are provisional or estimated [as of 2010-06-08].

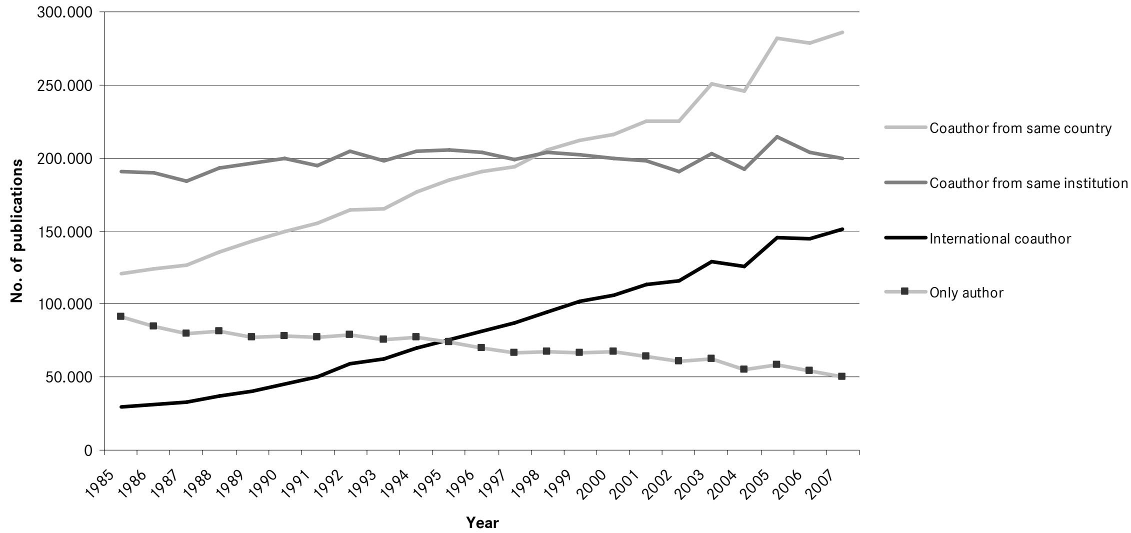
Source: Eurostat; own analysis

Table A.2: Basic data on populations, researchers, publications and patents

Country	Population in mil. 2008*	Researchers 2008**					Publications*** 1999 - Aug 2009			Patents** 2007 acc. to priority year	
		FTE (OECD definition)	per 1.000 employees	thereof civil service and public sector	thereof universities	thereof private-sector economy	Total	per researcher	Citations per publication	Patent families of triad countries	in % OECD total [5]
D	82,2	290.853 [3]	7,3 [3]	43.561 [3]	72.985 [3]	174.307 [3]	766.162	2,63	12,28	6.283	12,56
UK	61,2	261.406	8,3	8.172	154.936	94.279	841.654	3,22	13,68	1.666	3,33
IT	59,6	96.303	3,8	16.319	39.809	36.046	403.588	4,19	10,95	769	1,54
NL	16,4	51.052	10,8 [3]	6.938	17.536	26.578	236.344	4,63	14,47	1.043	2,09
FR	64,0	215.755 [3]	8,4 [3]	26.494 [3]	67.397 [3]	118.568 [3]	548.046	2,54	11,50	2.462	4,92
FI	5,3	40.879	16,1	4.541	11.849	24.132	86.509	2,12	12,87	321	0,64
SE	9,2	48.220	10,6	1.770	12.896	33.378	174.789	3,62	13,77	846	1,69
CH	7,6	25.400 [2]	6,1 [2]	488	12.710 [4]	12.640 [2]	171.248	6,74	15,73	899	1,80
EU-15	321,7	1.166.128 [4]	-	-	-	-	-		-	-	-
EU-27	497,6	1.448.354 [3]	6,4 [3]	183.885 [3]	580.850 [3]	664.373 [3]	-		-	15.062	30,12
USA	303,6 [1]	1.425.550 [4]	9,7 [4]	-	-	1.130.500 [3]	2.974.344	2,09	15,02	15.883	31,76
Japan	127,6 [1]	709.974 [3]	11,0 [3]	32.705 [3]	185.175 [3]	483.728 [3]	788.650	1,11	9,64	14.665	29,32

1) Source: OECD Factbook 2009 Environmental and Social Statistics; 2) 2004 figure; 3) 2007 figure; 4) 2006 figure; 5) own analysis;
Sources: *) Eurostat **) OECD Main Science and Technology Indicators 2009/2 ***) Thomson Reuters: Sciencewatch: Essential Science Indicators 1999-2009, own analysis

Figure A.1: Development of scientific publishing formats* 1985-2007



*) Analysis covering physical sciences and life sciences, medicine and engineering sciences

Source: OECD Science, Technology and Industry Scoreboard 2009

Table A.3: Public funding of research and development in Europe 1995-2006 in bn. Euro (nominal)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Intergovernmental*	3,03	3,49	3,09	3,60	3,57	3,79	3,93	3,99	4,23	4,90	4,80	5,16
EU Framework Programmes	2,98	3,15	3,49	3,50	3,34	3,61	3,87	4,06	4,06	4,82	5,08	5,29
National public gross domestic expenditure for R&D	43,11	43,57	45,07	46,41	48,47	52,09	53,50	56,35	58,51	60,28	62,99	64,88
Total	49,13	50,22	51,65	53,52	55,37	59,49	61,30	64,39	66,80	69,99	72,86	75,33

*) "Intergovernmental" includes funding received from the member states for COST, CERN, EMBL, EMBO, ESA, ESF, ESO, ESRF, ILL and EUREKA I; national R&D expenditure includes government-financed, civil gross domestic expenditure for R&D by EU27+EFTA +CH- 50 % EUREKA (analog for Tables A.4 and A.5)

Source: European Commission, Research General-Directorate (RGD)

Table A.4: **Public funding of research and development in Europe 1995-2006 in bn. Euro (real-term)**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Intergovernmental	3,43	3,85	3,35	3,85	3,71	3,79	3,78	3,69	3,85	4,32	4,08	4,26
EU Framework Programmes	3,38	3,48	3,78	3,73	3,47	3,61	3,72	3,76	3,69	4,25	4,33	4,36
National public gross domestic expenditure for R&D	48,78	48,07	48,83	49,52	50,39	52,09	51,42	52,22	53,20	53,19	53,64	53,54
Total	55,59	56,82	58,45	57,09	57,57	59,49	58,92	59,67	60,74	61,76	62,05	62,16

Real-term figures with OECD final consumption expenditures of general government EU15 Index 2000=100

Source: European Commission, Research Directorate-General (RDG)

Table A.5: **Public financing of research and development in Europe 1995-2006: share of different forms of funding in total expenditure**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Intergovernmental	6,2 %	7,0 %	6,0 %	6,7 %	6,4 %	6,4 %	6,4 %	6,2 %	6,3 %	7,0 %	6,6 %	6,9 %
EU Framework Programmes	6,1 %	6,3 %	6,7 %	6,5 %	6,0 %	6,1 %	6,3 %	6,3 %	6,1 %	6,9 %	7,0 %	7,0 %
National public gross domestic expenditure for R&D	87,8 %	86,8 %	87,3 %	86,7 %	87,5 %	87,6 %	87,3 %	87,5 %	87,6 %	86,1 %	86,4 %	86,1 %

Source: European Commission, Research Directorate-General (RDG); own analysis

Table A.6: **Increase of EU investment under the Framework programmes for Research (real-term)**

Framework Programme	FP1	FP2	FP3	FP4	FP5	FP6	FP7
Duration	1984-1987	1987-1991	1990-1994	1994-1998	1998-2002	2002-2006	2007-2013
Funds provided by EU (in bn. Euro)	5,12	5,97	8,04	14,62	14,94	15,35	42,51
Funding per year (in bn. Euro)	1,28	1,49	2,01	3,66	3,74	3,84	7,08
Increase relative to annual averages of preceding FP		+16,8 %	+34,5 %	+82,0 %	+2,2 %	+2,8 %	+84,6 %

Calculation of real-term figures: OECD final consumption expenditure of general government Deflator download 2009-05-15 EU15 Index 2000=100 with the arithmetic mean value of the deflators for the term of the respective FP; FP7 deflator arithmetic mean value 2007-2008

Source: BMBF: "Das 7. EU-Forschungsrahmenprogramm"; own analysis

Table A.7: Summary of results of the first ERC funding rounds (Starting Grants 2007 and 2009, Advanced Grants 2008 and 2009) by nationality of grant winners

Ranking StG 07+09 + AdG 08+09	Nationality	Grants awarded	Share of grants
1	Great Britain	148	14,1 %
2	Germany	139	13,3 %
3	France	123	11,8 %
4	Italy	115	11,0 %
5	Netherlands	80	7,6 %
6	Israel	64	6,1 %
7	Spain	56	5,4 %
8	Belgium	46	4,4 %
9	Sweden	43	4,1 %
10	United States	24	2,3 %
11	Switzerland	24	2,3 %
12	Greece	23	2,2 %
13	Finland	22	2,1 %
13	Austria	22	2,1 %
14	Denmark	16	1,5 %
15	Hungary	15	1,4 %
16	Portugal	10	1,0 %
17	Poland	8	0,8 %
18	Norway	7	0,7 %
19	Australia	6	0,6 %
19	Ireland	6	0,6 %
20	Turkey	5	0,5 %
20	Cyprus	5	0,5 %
21	Japan	4	0,4 %
21	Canada	4	0,4 %
21	Czech Republic	4	0,4 %
21	Romania	4	0,4 %
22	Argentina	3	0,3 %
22	China	3	0,3 %
23	Bulgaria	2	0,2 %
23	Russia	2	0,2 %
23	Croatia	2	0,2 %
24	Albania	1	0,1 %
24	Estonia	1	0,1 %
24	Iceland	1	0,1 %
24	Korea	1	0,1 %
24	Mexico	1	0,1 %
24	Slovakia	1	0,1 %
24	Slovenia	1	0,1 %
24	Ukraine	1	0,1 %
24	Singapore	1	0,1 %
24	Luxembourg	1	0,1 %
24	Morocco	1	0,1 %
24	South Africa	1	0,1 %
	Total	**1047**	**100,0 %**

Source: ERC; own analysis (successful nationalities only)

Table A.8: Success rates for Starting Grants 2007, Advanced Grants 2008 and Starting Grants 2009 (selected countries)

Success rate for Starting Grants 2007				
Nationality of applicants		**Applications**	**Approved**	**Success rate**
EU - 15	Belgium	293	15	5,1 %
	Great Britain	573	29	5,1 %
	France	637	32	5,0 %
	Netherlands	491	22	4,5 %
	Austria	136	5	3,7 %
	Spain	579	21	3,6 %
	Germany	**1.127**	**40**	**3,5 %**
	Sweden	360	12	3,3 %
	Italy	1.760	34	1,9 %
EU - 12	Hungary	205	8	3,9 %
	Poland	231	3	1,3 %
Associated countries	Israel	206	23	11,2 %
	Switzerland	93	6	6,5 %
Miscellaneous countries	USA	85	5	5,9 %
Applications total		**8.769**	**299**	**3,4 %**

Success rate for Advanced Grants 2008				
Nationality of applicants		**Applications**	**Approved**	**Success rate**
EU - 15	Sweden	66	16	24,2 %
	Austria	36	8	22,2 %
	Netherlands	101	21	20,8 %
	France	170	33	19,4 %
	Great Britain	248	46	18,5 %
	Germany	**200**	**36**	**18,0 %**
	Belgium	71	7	9,9 %
	Spain	112	9	8,0 %
	Italy	327	26	8,0 %
EU - 12	Hungary	26	3	11,5 %
	Poland	73	2	2,7 %
Associated countries	Switzerland	40	7	17,5 %
	Israel	143	16	11,2 %
Miscellaneous countries	USA	46	10	21,7 %
Applications total		**2.031**	**275**	**13,5 %**

Success rate for Starting Grants 2009

Nationality of applicants		Applications	Approved	Success rate
EU - 15	Belgium	98	21	21,4 %
	Netherlands	119	18	15,1 %
	France	200	27	13,5 %
	Finland	45	6	13,3 %
	Denmark	38	5	13,2 %
	Germany	**284**	**32**	**11,3 %**
	Great Britain	161	18	11,2 %
	Ireland	19	2	10,5 %
	Austria	45	3	6,7 %
EU - 12	Hungary	35	3	8,6 %
	Poland	42	2	4,8 %
Associated countries	Israel	80	13	16,3 %
	Switzerland	25	2	8,0 %
Applications total		**2.503**	**237**	**9,5 %**

Source: ERC, own analysis (successful nations only)

Table A.9: **Summary of results from the first round of ERC grants (Starting Grants 2007 and 2009 and Advanced Grants 2008 and 2009), by host country**

Ranking (StG 07, 09 + AdG 08, 09)	Host countries	Grant holders	Share of total number of grant holders
1	Great Britain	217	20,7 %
2	France	138	13,2 %
3	Germany	116	11,1 %
4	Switzerland	89	8,5 %
5	Netherlands	79	7,5 %
6	Italy	76	7,3 %
7	Spain	67	6,4 %
8	Israel	64	6,1 %
9	Sweden	44	4,2 %
10	Belgium	33	3,2 %
11	Austria	25	2,4 %
12	Finland	23	2,2 %
13	Denmark	18	1,7 %
14	Hungary	12	1,1 %
15	Greece	11	1,1 %
16	Portugal	8	0,8 %
17	Ireland	6	0,6 %
17	Norway	6	0,6 %
18	Poland	4	0,4 %
19	Cyprus	3	0,3 %
19	Czech Republic	3	0,3 %
20	Bulgaria	2	0,2 %
21	Iceland	1	0,1 %
21	Estonia	1	0,1 %
21	Turkey	1	0,1 %
	Total	**1.047**	**100,0 %**

Source: ERC; own analysis (successful nationalities only)

Table A.10: Summary of Starting Grants 2007 and 2009 and Advanced Grants 2008 and 2009 per host country, in relation to population of researchers and total population

Host country		StG 2007	StG 2009	AdG 2008	AdG 2009	Grant holders total	Grant holders per mil. Population*	Grant holders per 1,000 researchers**
EU-15	Netherlands	27	17	19	16	79	4,79	1,55
	Sweden	11	5	16	12	44	4,75	0,91
	Belgium	11	15	5	2	33	3,07	0,91
	Great Britain	58	43	58	58	217	3,52	0,83
	Italy	25	16	20	15	76	1,27	0,79
	Austria	4	6	8	7	25	2,99	0,73
	France	38	31	35	34	138	2,14	0,64
	Denmark	4	7	4	3	18	3,27	0,58
	Finland	7	6	9	1	23	4,32	0,56
	Greece	4	3	4	0	11	0,98	0,53
	Spain	25	18	14	10	67	1,46	0,51
	Ireland	2	3	0	1	6	1,35	0,44
	Germany	31	28	26	31	116	1,41	0,40
	Portugal	2	4	1	1	8	0,75	0,20
EU-12	Cyprus	2	0	1	0	3	3,76	3,39
	Hungary	6	1	4	1	12	1,20	0,65
	Estonia	0	1	0	0	1	0,75	0,25
	Bulgaria	1	0	1	0	2	0,26	0,18
	Czech Republic	1	0	2	0	3	0,29	0,10
	Poland	0	2	1	1	4	0,10	0,06
Associated countries	Switzerland	15	17	28	29	89	11,56	3,50
	Iceland	0	0	1	0	1	3,13	0,43
	Norway	1	0	2	3	6	1,25	0,23
	Turkey	0	0	1	0	1	0,01	0,02
	Israel	24	14	15	11	64	9,14	k.A.
	Total	**299**	**237**	**275**	**236**	**1.047**	**1,88**	**0,68**

*) Population 2009; **) Number of researchers, Germany, France, Greece and Turkey 2007, Switzerland 2004

Source: ERC, OECD Main Science and Technology Indicators 2009/2, Eurostat, Israel Central Bureau of Statistics, own analysis

Tables A.11: Institutions most successful in winning ERC grants

Table A.11.a: ERC Starting Grants 2007 – TOP 24 institutions

Ranking	Institution	Grants
1	National Center for Scientific Research (CNRS), France	17
2	Max Planck Society	9
3	University of Cambridge	8
4	Technion - Israel Institute of Technology	7
5	Imperial College London	6
5	Hebrew University of Jerusalem	6
5	National Research Council (CNR), Italy	6
6	Weizmann Institute, Israel	5
6	University of Oxford	5
6	University College London	5
6	VU University Amsterdam	5
7	Spanish National Research Council (CSIC)	4
7	University of Leuven	4
7	Heidelberg University	4
7	Institut national de la santé et de la recherche médicale	4
8	Royal Netherlands Academy of Arts and Sciences	3
8	University of Tel Aviv	3
8	Stockholm University	3
8	University of Amsterdam	3
8	Aarhus University	3
8	Leiden University	3
8	Medical Research Council, UK	3
8	Fundació Privada Centre de Regulació Genómica, Spain	3
8	Spanish National Cancer Research Centre (CNIO)	3

Source: ERC

Table A.11.b: Advanced Grants 2008 – TOP 23 institutions

Ranking	Institution	Grants
1	EPF Lausanne	11
2	National Center for Scientific Research (CNRS), France	10
3	Weizmann Institute, Israel	8
4	University of Oxford	7
4	Imperial College London	7
5	ETH Zurich	6
6	University of Edinburgh	5
6	University of Cambridge	5
6	University of Helsinki	5
7	University of Geneva	4
7	University College London	4
8	Technical University of Helsinki	3
8	University of Tel Aviv	3
8	University of Nijmegen	3
8	Max Planck Society	3
8	Institut national de recherche en informatique et en automatique	3
8	Ecole des hautes études en sciences sociales	3
8	Commissariat à l'énergie atomique	3
8	Hebrew University of Jerusalem	3
8	University of Utrecht	3
8	Politecnico di Milano	3
8	University of Lund	3
8	Karolinska Institutet	3

Source: ERC

Table A.11.c: Starting Grants 2009 – TOP 18 institutions

Ranking	Institution	Grants
1	National Center for Scientific Research (CNRS), France	7
1	EPF Lausanne	7
1	Max Planck Society	7
2	University of Leuven	6
2	University of Oxford	6
3	Hebrew University of Jerusalem	5
3	University of Gent	5
4	University of Cambridge	4
4	University College London	4
4	University of Bristol	4
5	Commissariat à l'énergie atomique	3
5	ETH Zurich	3
5	Imperial College London	3
5	Institut national de la santé et de la recherche médicale	3
5	LMU Munich	3
5	Technical University of Helsinki	3
5	University of Utrecht	3
5	Weizmann Institute, Israel	3

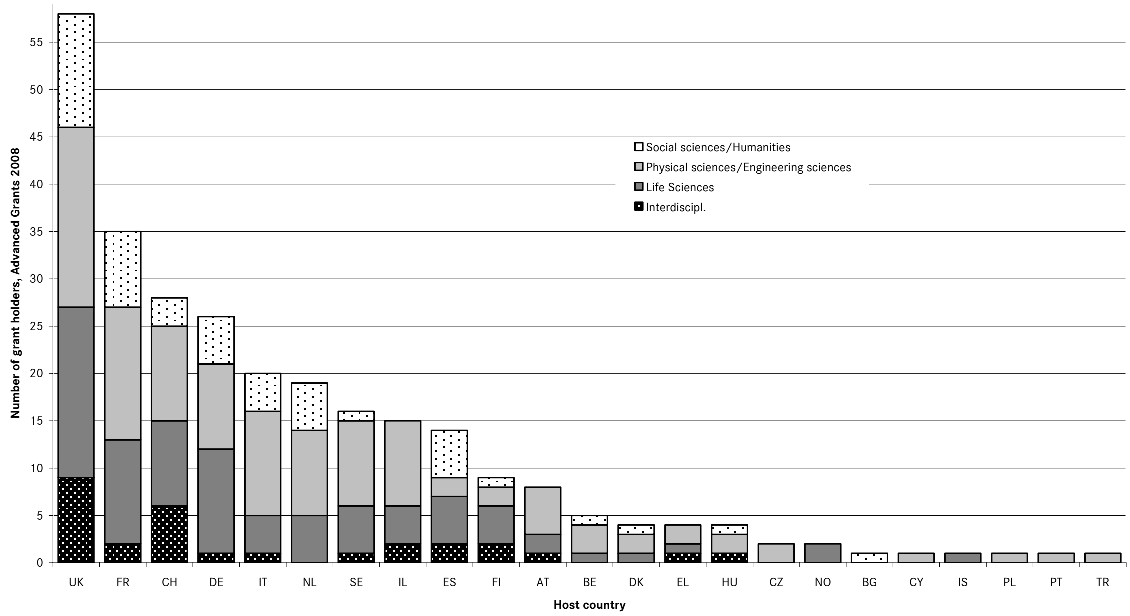
Source: ERC

Table A.11.d: Advanced Grants 2009 – TOP 20 institutions

Ranking	Institution	Grants
1	National Center for Scientific Research (CNRS), France	9
1	ETH Zurich	9
1	University of Cambridge	9
2	University College London	7
2	Max Planck Society	7
3	University of Zurich	6
4	University of Oxford	5
4	Hebrew University of Jerusalem	5
4	University of Bristol	5
5	EPF Lausanne	4
5	Weizmann Institute, Israel	4
5	Imperial College London	4
5	Institut national de la santé et de la recherche médicale	4
5	LMU Munich	4
6	University of Edinburgh	3
6	University of Geneva	3
6	University of Amsterdam	3
6	University of Uppsala	3
6	University of Bergen	3
6	Cancer Research UK	3

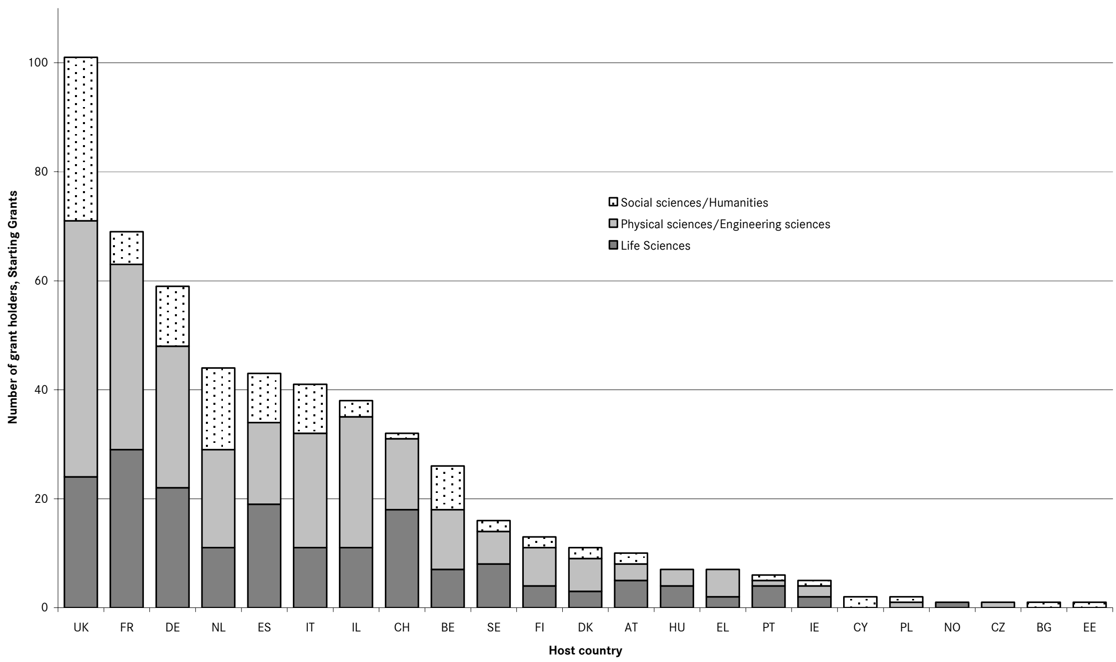
Source: ERC

Figure A.2: Number of Advanced Grant holders 2008 per host country, for different groups of disciplines



Source: ERC

Figure A.3: Number of Starting Grant holders 2007 and Starting Grant holders 2009 per host country, for different groups of disciplines



Source: ERC

Table A.12: ERDF funding for RTD, innovation and the promotion of entrepreneurship in funding period 2007-2013

Code	Research and technological development (RTD), innovation and the promotion of entrepreneurship	Convergence countries (in mil. Euro)	Countries under Regional Competitiveness objective (in mil. Euro)	Total (Mil. Euro)
01	RTD activities at research centers	ca. 187	ca. 238	ca. 425
02	RTD infrastructures (incl. operating facilities, instrumentation and high-speed computer networking between research centers) and technology-specific competence centers	ca. 979	ca. 313	ca. 1.292
03	Technology transfer and improvement of cooperation networks between small and medium-sized enterprises (SME) and between the latter and other businesses and universities, tertiary education institutions of any kind, regional authorities, research centers and science and technology parks, etc.	ca. 323	ca. 383	ca. 706
04	RTD funding, especially in SME (including access to RTD services at research centers)	ca. 759	ca. 168	ca. 927
05	Advanced support services for businesses or business consortia	ca. 132	ca. 198	ca. 329
06	Support for SME to launch environmentally compatible products and production processes	ca. 70	ca. 54	ca. 124
07	Corporate investments directly relating to research and innovation	ca. 157	ca. 187	ca. 344
08	Other corporate investments	ca. 2.309	ca. 582	ca. 2.891
09	Other initiatives to promote research, innovation and entrepreneurship in SME	ca. 335	ca. 185	ca. 520
	Total for RTD, innovation and the promotion of entrepreneurship	**ca. 5.251**	**ca. 2.308**	**ca. 7.558**
	Total excluding funding code 08	**ca. 2.942**	**ca. 1.726**	**ca. 4.667**

Source: BMWi

Table A.13: BMBF institutional funding abroad in 2007

	Institution	Country	EUR'000s
Institutes abroad	Foundation of German Humanities Institutes Abroad (DGIA)	France	5.384
	Foundation of German Humanities Institutes Abroad (DGIA)	Italy	4.846
	Foundation of German Humanities Institutes Abroad (DGIA)	Japan	3.500
	Foundation of German Humanities Institutes Abroad (DGIA)	Lebanon	2.423
	Foundation of German Humanities Institutes Abroad (DGIA)	Poland	2.154
	Foundation of German Humanities Institutes Abroad (DGIA)	United States of America	4.307
	Foundation of German Humanities Institutes Abroad (DGIA)	United Kingdom - Great Britain	3.769
Total for institutes abroad			**26.382**
MPG	Max Planck Society for the Advancement of Science	Italy	8.407
	Max Planck Society for the Advancement of Science	Netherlands	3.081
MPG share, institutes abroad			**11.488**
Total of institutional funding abroad			**37.870**

Source: BMBF

Table A.14: Share of foreigners among scientists and artists employed in German higher education (headcount) in 2008

	Foreigners*		
Type of HEI	**Foreign share in total number of personnel**	**Thereof EU foreigners**	**Thereof non-EU foreigners**
Universities	10,5 %	47,1 %	52,9 %
Universities of applied sciences/ polytechnics (excl. colleges for administration)	4,4 %	52,0 %	48,0 %
Colleges for administration	0,4 %	85,7 %	14,3 %
Colleges of education	3,9 %	62,0 %	38,0 %
Theological HEIs	6,0 %	57,1 %	42,9 %
Art colleges	13,7 %	47,3 %	52,7 %
HEIs total	**9,4 %**	**47,6 %**	**52,4 %**

*) excl. stateless/ unresolved

Source: Federal Statistical Office, ICE Analysis, title 60202

Table A.15: Share of foreigners among scientists employed at non-university institutions 2008 (fulltime equivalent)

Type of institution	Share of foreigners	Thereof from ... (FTE share of personnel of foreign nationality)						
		EU 27	Rest of Europe	North America	Central and South America	Asia	Africa	Austral. & Ocean.
Institutions for science, research and development jointly funded by fed. and state adms.	**14,9 %**	48 %	21 %	4 %	4 %	19 %	2 %	1 %
Helmholtz Centers	**16,0 %**	50 %	21 %	4 %	3 %	19 %	2 %	1 %
Max Planck Institutes	**22,3 %**	50 %	19 %	7 %	5 %	16 %	1 %	1 %
Fraunhofer Institutes	**8,8 %**	41 %	20 %	2 %	6 %	24 %	-	-
Leibniz Institutes	**11,8 %**	42 %	25 %	4 %	4 %	22 %	-	-

Source: Federal Statistical Office, Fachserie 14, Reihe 3.6, Tab. 6.6, 2008, and own analysis

Table A.16: Share of foreign scientific personnel at different types of HEI and in different categories of personnel in 2008

Personnel category	HEIs total Foreigners*				Universities Foreigners*				Universities of applied sciences (incl. colleges for administration) Foreigners*			
			thereof ...				thereof ...				thereof ...	
	Number	Share	EU foreigners	Non-EU foreigners	Number	Share	EU foreigners	Non-EU foreigners	Number	Share	EU foreigners	Non-EU foreigners
Total	25.720	**9,4 %**	47,6 %	52,4 %	22.096	**10,5 %**	47,1 %	52,9 %	2.150	**4,1 %**	52,2 %	47,8 %
Professors	2.164	**5,6 %**	60,3 %	39,7 %	1.442	**6,8 %**	61,4 %	38,6 %	287	**2,0 %**	59,2 %	40,8 %
Lecturers and associates	345	**7,1 %**	57,4 %	42,6 %	302	**7,7 %**	56,3 %	43,7 %	27	**3,3 %**	63,0 %	37,0 %
Staff scientists and artists	14.471	**10,8 %**	44,6 %	55,4 %	14.136	**11,1 %**	44,7 %	55,3 %	248	**5,6 %**	37,5 %	62,5 %
Teaching staff for special tasks	1.189	**15,1 %**	65,3 %	34,7 %	959	**19,7 %**	67,5 %	32,5 %	157	**7,0 %**	62,4 %	37,6 %
Visiting Professors and Emeriti	112	**8,5 %**	55,4 %	44,6 %	95	**8,5 %**	56,8 %	43,2 %	7	**7,0 %**	71,4 %	28,6 %
Visiting Lecturers, Honorary Prof., private lecturers [Privatdoz.], adjunct professors [apl. Prof.]	4.778	**7,1 %**	55,5 %	44,5 %	2.798	**8,0 %**	58,3 %	41,7 %	1.203	**4,7 %**	55,4 %	44,6 %
Graduate assistants, student assistants, tutors	2.661	**12,4 %**	29,5 %	70,5 %	2.364	**14,1 %**	29,0 %	71,0 %	221	**5,3 %**	33,0 %	67,0 %

Personnel category	Colleges of Education Foreigners*				Theological HEIs Foreigners*				Art Colleges Foreigners*			
			thereof ...				thereof ...				thereof ...	
	Number	Share	EU foreigners	Non-EU foreigners	Number	Share	EU foreigners	Non-EU foreigners	Number	Share	EU foreigners	Non-EU foreigners
Total	79	**3,9 %**	62,0 %	38,0 %	28	**6,0 %**	57,1 %	42,9 %	1367	**13,7 %**	47,3 %	52,7 %
Professors	4	**1,1 %**	50,0 %	50,0 %	7	**5,3 %**	42,9 %	57,1 %	424	**19,3 %**	57,5 %	42,5 %
Lecturers and associates	0	**-**	-	-	8	**13,1 %**	75,0 %	25,0 %	8	**10,7 %**	62,5 %	37,5 %
Staff scientists and artists	17	**3,1 %**	64,7 %	35,3 %	2	**3,6 %**	0,0 %	100,0 %	68	**7,7 %**	39,7 %	60,3 %
Teaching staff for special tasks	19	**8,3 %**	73,7 %	26,3 %	3	**16,7 %**	66,7 %	33,3 %	51	**9,8 %**	29,4 %	70,6 %
Visiting Professors and Emeriti	0	**-**	-	-	2	**12,5 %**	50,0 %	50,0 %	8	**9,5 %**	25,0 %	75,0 %
Visiting Lecturers, Honorary Prof., private lecturers [Privatdoz.], adjunct professors [apl. Prof.]	38	**4,6 %**	57,9 %	42,1 %	6	**3,7 %**	66,7 %	33,3 %	733	**12,6 %**	44,6 %	55,4 %
Graduate assistants, student assistants, tutors	1	**1,1 %**	0,0 %	100,0 %	0	**0,0 %**	-	-	75	**18,6 %**	36,0 %	64,0 %

*) excl. stateless/ unresolved
Source: Federal Statistical Office, ICE Analysis, title 60202

Table A. 17: Scientists and artists employed in German higher education, listed by country of origin, 2005-2008*

Nationality		2005		2006		2007		2008	
		Number	Share	Number	Share	Number	Share	Number	Share
European Union		**8.621**	**43,5 %**	**9.764**	**44,6 %**	**11.122**	**49,0 %**	**12.231**	**47,5 %**
thereof	Austria	1.325	6,7 %	1.470	6,7 %	1.510	6,7 %	1.628	6,3 %
	Italy	1.085	5,5 %	1.241	5,7 %	1.287	5,7 %	1.531	5,9 %
	France	1.011	5,1 %	1.165	5,3 %	1.226	5,4 %	1.360	5,3 %
	Spain	837	4,2 %	974	4,4 %	1.033	4,5 %	1.104	4,3 %
	United Kingdom	864	4,4 %	981	4,5 %	1.000	4,4 %	1.041	4,0 %
	Poland	817	4,1 %	885	4,0 %	917	4,0 %	1.003	3,9 %
	Greece	540	2,7 %	584	2,7 %	626	2,8 %	715	2,8 %
	Romania[1)]	-	-	-	-	594	2,6 %	602	2,3 %
	Netherlands	507	2,6 %	585	2,7 %	560	2,5 %	602	2,3 %
	Bulgaria[1)]	-	-	-	-	460	2,0 %	520	2,0 %
	Hungary	259	1,3 %	271	1,2 %	282	1,2 %	334	1,3 %
	Czech Republic	258	1,3 %	265	1,2 %	256	1,1 %	272	1,1 %
Rest of Europe		**4.535**	**22,9 %**	**4.893**	**22,3 %**	**3.914**	**17,2 %**	**4.348**	**16,9 %**
thereof	Russia	1.320	6,7 %	1.394	6,4 %	1.397	6,2 %	1.475	5,7 %
	Switzerland	620	3,1 %	697	3,2 %	724	3,2 %	772	3,0 %
	Turkey	448	2,3 %	494	2,3 %	521	2,3 %	667	2,6 %
	Ukraine	431	2,2 %	477	2,2 %	488	2,1 %	548	2,1 %
	Romania[1)]	574	2,9 %	590	2,7 %	-	-	-	-
	Bulgaria[1)]	432	2,2 %	458	2,1 %	-	-	-	-
Asia		**3.862**	**19,5 %**	**4.231**	**19,3 %**	**4.523**	**19,9 %**	**5.485**	**21,3 %**
thereof	China	1.027	5,2 %	1.174	5,4 %	1.298	5,7 %	1.636	6,4 %
	India	761	3,8 %	806	3,7 %	810	3,6 %	939	3,6 %
	Japan	358	1,8 %	402	1,8 %	399	1,8 %	475	1,8 %
	Iran	267	1,3 %	322	1,5 %	345	1,5 %	424	1,6 %
	Syria	119	0,6 %	139	0,6 %	148	0,7 %	194	0,8 %
	Taiwan	116	0,6 %	121	0,6 %	138	0,6 %	182	0,7 %
	Pakistan	78	0,4 %	108	0,5 %	134	0,6 %	171	0,7 %
	South Korea	106	0,5 %	115	0,5 %	117	0,5 %	161	0,6 %
	Israel	115	0,6 %	122	0,6 %	133	0,6 %	147	0,6 %
	Vietnam	91	0,5 %	93	0,4 %	116	0,5 %	138	0,5 %
	Indonesia	109	0,5 %	123	0,6 %	112	0,5 %	122	0,5 %
America		**1.952**	**9,8 %**	**2.126**	**9,7 %**	**2.256**	**9,9 %**	**2.659**	**10,3 %**
thereof	USA	907	4,6 %	1.046	4,8 %	1.072	4,7 %	1.196	4,6 %
	Brazil	152	0,8 %	198	0,9 %	211	0,9 %	248	1,0 %
	Canada	154	0,8 %	190	0,9 %	196	0,9 %	224	0,9 %
	Colombia	84	0,4 %	114	0,5 %	136	0,6 %	176	0,7 %
	Mexico	92	0,5 %	105	0,5 %	105	0,5 %	157	0,6 %
	Argentina	117	0,6 %	124	0,6 %	129	0,6 %	149	0,6 %
Africa		**668**	**3,4 %**	**690**	**3,1 %**	**693**	**3,1 %**	**800**	**3,1 %**
thereof	Egypt	112	0,6 %	113	0,5 %	135	0,6 %	160	0,6 %
	Cameroon	123	0,6 %	118	0,5 %	119	0,5 %	133	0,5 %
	Morocco	81	0,4 %	94	0,4 %	85	0,4 %	97	0,4 %
	Tunisia	59	0,3 %	58	0,3 %	53	0,2 %	68	0,3 %
Australia and Oceania		**140**	**0,7 %**	**147**	**0,7 %**	**147**	**0,6 %**	**179**	**0,7 %**
Foreigners[2)] total		**19.827**	**100,0 %**	**21.911**	**100,0 %**	**22.704**	**100,0 %**	**25.751**	**100,0 %**

*) The nationality of scientific personnel has been recorded by the Federal Statistical Office since 2005; 1) Bulgaria and Romania are listed under “Rest of Europe” for 2005 and 2006, and under “European Union” from 2007, the year of their accession to the EU; 2)calculation: “Number of scientists” minus. “German” and “not stated”, incl. “stateless/ unresolved”.

Source: Federal Statistical Office: Fachserie 11, Reihe 4.4, Tab. 14, years as stated

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