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Research Report

Research, innovation and technological performance in Germany - EFI Report 2011

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RESEARCH, INNOVATION
AND TECHNOLOGICAL
PERFORMANCE IN GERMANY

EXPERTENKOMMISSION
FORSCHUNG
UND INNOVATION

EFI

REPORT

2008 2009 2010

2011 2012 2013

2014 2015 2016

2017 2018 2019

RESEARCH, INNOVATION
AND TECHNOLOGICAL
PERFORMANCE IN GERMANY

EXPERTENKOMMISSION
FORSCHUNG
UND INNOVATION

EFI

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The Commission of Experts wishes to emphasise that the positions expressed in the report do not necessarily represent the opinions of the aforementioned persons.

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This report is also the result of the highly competent and dedicated work of the staff of the office of the Commission of Experts – and of the staffs of the Commission members.

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FOREWORD

The Commission of Experts for Research and Innovation (EFI) presents its 2011 Report. This report marks the conclusion of the first working period of EFI, which was established in 2007 by the Federal Government.

Over the past four years, the Expert Commission has established a new reporting system and regularly commented on progress and weaknesses in German research and innovation policy. The Commission thanks its dialogue partners in the fields of policy, industry and science, and in other societal areas for their constructive support and openness.

Notwithstanding all of the criticism voiced in the EFI reports, the present administration and its predecessor deserve credit for initiating a growth phase, via trailblazing budgetary allocations and great openness to the areas concerned, for research and innovation in Germany. Now, it is to be hoped that such support will survive the budgetary constraints that lie ahead. Germany cannot afford to rest or desist in its efforts in this area – it has not yet returned to a position of leadership in research and innovation.

The Federal Government has initiated relevant important structural changes, such as the High-Tech Strategy of 2006 and its continuation in 2010. Most importantly, however, Germany's political sector has shown that it understands the importance of research and innovation. And a similar conclusion can be drawn for the area of education – all parties concerned clearly see that education policy is always also innovation policy. At the same time, the prohibition on Federal-*Länder* co-operation in education is blocking progress in this area.

In addition to discussing current trends and requirements for reform in the Federal Government's research and innovation policy, in its 2011 report the Commission focuses on four main points.

In Chapter B 1, firstly, it discusses the tensions between Federal and *Länder* competencies in education, research and innovation policy. It calls for elimination of the prohibition on competition in education policy and for introduction of consistent distribution of responsibilities between the Federal Government and the *Länder* for financing of all non-university research institutions.

In Chapter B 2 the Expert Commission considers the European dimension of research and innovation, which has been gaining importance since 2000. It recommends that the Federal Government take a stronger role in the European co-ordination process – Germany must lead in the area of research and innovation, if it is to play a useful role in shaping the European Research Area.

In Chapter B 3, the Expert Commission comments on the discussion relative to network neutrality. For the sake of innovation, it is vital that the Internet remains open in this regard – and the Expert Commission would like to see the Federal Government play a more active role on behalf of network neutrality.

In Chapter B 4, the Expert Commission considers the still largely ignored role of those innovators who succeed even without undertaking research activities. Innovation processes do not conform to simple logical rules. Consequently, research and innovation policy concepts must be open, able to provide latitude for innovators without research and development (R&D) of their own.

In its report, the Expert Commission again notes that the idea of introducing tax-based R&D support urgently needs to return to the political agenda. Similar priority needs to be given to providing a legal framework for business angels and venture-capital providers; such a framework is still lacking.

Over the past few years, a good basis has been created for the development of Germany's research and innovation sector. But if lasting growth and prosperity are to assured in Germany, research and innovation in Germany will have to be additionally and substantially reinforced.

Berlin, 23 February 2011



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SUMMARY

CURRENT DEVELOPMENTS AND CHALLENGES

A 1 FINANCIAL AND ECONOMIC CRISIS

The financial and economic crisis did not leave research and development activities in Germany unaffected. However, the decrease in R&D expenditures seen in 2009 proved to be considerably smaller, percentage-wise, than the decrease seen in the country's gross domestic product. The overall macro-economic R&D intensity, i.e. R&D expenditures' share of the gross domestic product, even rose slightly in 2009 with respect to the previous year, thereby enabling Germany to surpass the U.S. in this indicator for the first time since 1989. German private sector's R&D activities re-intensified in 2010, in keeping with favourable economic trends. Nonetheless, Germany's international competitiveness as a centre for innovation hinges on further intensification of research and development. The suitable tax incentives for R&D that the Expert Commission has repeatedly called for can provide important incentives in this regard. Policymakers need to show they mean business in this area and at last introduce such incentives.

A 2 VENTURE CAPITAL MARKET

Young companies in Germany face shortages of venture capital. This situation could worsen if German policymakers fail to address it in a suitably measured way. In November 2010, the European Parliament, acting in response to the financial crisis, passed the AIFM Directive, which imposes regulations on managers of alternative investment funds. Even though they present no systemic risks, managers of venture-capital funds can fall within the Directive's scope of application. Transposition of the AIFM Directive could thus further shrink the venture-capital market for early-phase financing. Such transposition should be taken as an opportunity to draft legislation, finally, for an internationally competitive, growth-promoting tax framework for business angels and venture-capital providers.

EDUCATION AND RESEARCH

A 3

The Federal Government has been increasing its investments in education. The Higher Education Pact, the Initiative for Excellence and the Pact for Research and Innovation are all being continued and expanded, and student enrollments at German higher education institutions are growing. Furthermore, PISA results for Germany improved slightly in 2009, over the previous years, even if German school pupils' key competencies are still only about average for OECD countries. Such good news notwithstanding, Germany needs to use its educational resources more effectively. Good innovation policy always depends on good education policy. And good education policy must now include specific improvements in the education sector: The numbers of pupils at risk need to be reduced, model projects at schools need to be properly evaluated and successful projects need to be upscaled to a broad basis. As part of efforts to counter selectivity in the German education system, opportunities need to be improved for applicants with qualifications for higher education, who have non-academic backgrounds, to make the transition to higher education. Furthermore, expanded awarding of Deutschlandstipendium national grants (Germany grants) must not impinge on the work of existing associations for the promotion of the gifted. In the interest of alleviating shortages of skilled specialists and professionals, and of countering disturbing enrollment trends in MINT subjects, efforts need to be intensified to encourage young women to study mathematics, engineering and science. Furthermore, suitable immigration policies, in this regard, are needed at the national and European levels.

COLLECTION OF STATISTICS ON INNOVATION-RELATED ACTIVITIES

A 4

Statistics on research and innovation need to be improved. The currentness of the available data needs to be improved, statistical inconsistencies need to be eliminated, and the quality of statistical surveys of innovation needs to be enhanced. In addition, statistics on start-ups with high growth potential need to be more precise and more reliable. Statistical surveys and analysis of research and innovation would benefit from the creation of an infrastructure project, sited in the social and economic sciences, aimed at "surveying the knowledge economy". Such a project would enhance scientists' access to pertinent data.

HIGH-TECH STRATEGY 2020 FOR GERMANY

A 5

The High-Tech Strategy 2020 for Germany builds on an earlier, related strategy formulated in 2006. In comparison to that earlier version, it provides new direction and greater focus. In addition, it is mission-oriented, concentrating the strategy process on a smaller number of five (now) major priority areas. The Expert Commission welcomes this new strategic direction and its priorities.

The success of the High-Tech Strategy 2020 will depend decisively on its implementation process. For each mission, specific framework programmes need to be formulated, relevant priorities need to be set, and pertinent aims and measures more clearly defined. In addition, the strategic change brought by the High-Tech Strategy 2020 should be highlighted via greater transparency, including sharper differentiation between new innovation support programmes and updated versions of existing programmes.

A 6 DEVELOPMENT OF THE PATENT SYSTEM

The European patent system is still fragmented. Efforts to create a common European patent, and to establish a common patent jurisdiction, have failed for the time being in the face of resistance to the proposed translation policies. Now, efforts to create a European patent are to continue within the intensified co-operation framework agreed as part of the Lisbon Treaty. The Expert Commission welcomes this. In creation of an EU patent, great attention should be given to the quality of the relevant examination process. The Expert Commission also again expresses its support for locating the seat of the European patent court in Germany. Further harmonisation is also needed with regard to taxation of income from licensing of patents. The emerging European competition to provide the lowest tax rates needs to be ended as quickly as possible.

A 7 ELECTROMOBILITY

Last year, Germany made substantial progress in the area of electromobility. Numerous research institutions and companies have intensified their research into electromobility. What is more, the Federal Government has modified its strategy for promoting electromobility: now, the strategy is oriented to positioning Germany as a lead provider of marketable electromobility, rather than as a lead market for electromobility. Ideally, German automakers would cooperate closely toward that end. Experience to date has shown that horizontal cooperation between German automakers is difficult to achieve, however. For this reason, state support programmes should seek to strengthen vertical cooperation between automakers, automotive suppliers and pertinent mechanical engineering companies.

CORE TOPICS

B 1 FEDERALISM

In the area of education, the federalism reform of 2006 brought a transition from cooperative federalism to competitive federalism. The joint *Bund-Länder* Commission for Educational Planning and Research Promotion (BLK) was disbanded. What is more, a prohibition on cooperation between the Federal Government and the *Länder* now applies in the area of relevant investments. In financially weaker *Länder*, this has narrowed options for urgently required quantitative and qualitative enhancement of all-day-school programmes.

On the other hand, the federalism reform has left structures for Federal / *Länder* cooperation largely intact in the area of institutional research funding. The financing ratios on which such joint financing is based are complex and varying, however. The manner in which research organisations and institutions are assigned to different ratio categories for distribution of costs between the Federal Government and the *Länder* is not always logically based. That, in turn, leads to problems in the area of relevant discretionary powers.

- In the view of the Expert Commission, elimination of the joint task of education planning has negative consequences for the development of an effective, efficient education system. As the area of research funding shows, cooperative federalism can indeed go hand-in-hand with effectiveness and efficiency improvements. The Expert

Commission thus recommends that the prohibition on cooperation be rescinded and that the level of cooperative federalism achieved in the education sector, prior to the federalism reform, serve as the basis for further efforts in this area.

- Consistent application of a Federal / *Länder* financing ratio of roughly 70:30 for all non-university research institutions could make current financing practice considerably simpler and more transparent, while also countering any political (and fiscal) instrumentalization of research funding. Furthermore, introduction of a standardised home-state (Land) share of 25 percent in the case of multilaterally funded research organisations could help ensure that all *Länder* remain able to afford to host cutting-edge research in non-university research institutions.
- The Initiative for Excellence and the Pact for Research and Innovation have provided successful incentives for intensified cooperation between higher education institutions and non-university research institutions. Over the past few years, such cooperation has been institutionalised at some locations. The Expert Commission recommends that use of such cooperation approaches be expanded, in the context of preservation of applicable regional or subject-specific characteristics. A standardised financing ratio for all the cooperating non-university institutions would facilitate the establishment of efficient models for cooperation.

EUROPEAN DIMENSION OF R&I POLICY

B 2

Since 2000, in the context of the common European Research Area, the EU has been working to bring its Member States' R&I policies, which are still nationally oriented, into a coherent European R&I policy framework. The effort is designed to prevent duplication and fragmentation – and build Europe into a globally leading research centre. An effective European innovation and research system urgently needs to be created, since no European country could now, on its own, successfully face the growing competition from Asia and North America. Creation of a European Research Area (ERA) is thus the key to successful national research and innovation policy.

Designing the relevant political and administrative structures, and support instruments, has proven to be a complex process in the real world, however. More coordination – and less bureaucracy – are urgently needed in this area. In the interest of furthering “Europeanization” of national R&I policies and making them more effective, the Expert Commission recommends the following:

- In coordinating their R&I activities, individual Member States should be permitted to take the initiative via cooperation arrangements with “variable geometry”. The focussing on specific fields of competence that such flexibility entails can enhance the EU's overall competitiveness.
- Relevant support measures, such as the Structural Funds and the Framework Programme, should be more clearly set off from each other.
- The support activities of the European Research Council (ERC) have been well received, and the ERC has achieved a high measure of credibility within the European research system. Many of the German scientists who have received funding are now pursuing their research abroad, however, and German universities are not attracting enough foreign researchers. The German research system should become more attractive.
- In the interest of efforts toward Europe's research leadership, institutionalised research cooperation should be reinforced with a European Initiative for Excellence in the medium term. Via suitable networks, leading European higher education institutions

could be developed into drivers of cutting-edge basic research. The primary criterion for assessing such efforts should be scientific excellence.

- The cost explosion seen in the construction of the ITER fusion reactor (International Thermonuclear Experimental Reactor) shows that the Federal Government urgently needs to work for efficient management structures in major European projects.

B 3 NETWORK NEUTRALITY AND INNOVATION

The Internet, one of the global economy's most innovation-friendly "locations", is about to undergo profound changes. Originally, the Internet was "blind" to applications, i.e. it was not possible in the Internet to distinguish data packets of different applications, services and content. That limitation has been disappearing. Increasingly, network providers are able to analyse data packets in real time and prioritise, delay or block them in keeping with their own interests. This trend could lead to the loss of two keys to the innovative power of the Internet: in the Internet, innovations do not necessarily require major investments, and new applications can be introduced to markets quickly and cost-effectively. In the interest of innovation in the Internet, the Expert Commission recommends the following:

- Blocking of applications and content should be prohibited.
- All Internet subscribers must be granted a maximum level of transparency, along with the right to switch Internet providers quickly and easily.
- Where capacity bottlenecks occur in the network, price differentiation in accordance with quality levels is justified. At the same time, the network must offer quality-of-service classes on a non-discriminatory basis. In each case, the decision as to which quality-of-service class a given application is to receive must be left solely up to the end user.
- To prevent any strategically motivated hindering of data traffic, the Federal Network Agency should establish minimum requirements for quality of service, and it should be able to monitor relevant violations and penalise offenders.

B 4 INNOVATION WITHOUT RESEARCH AND DEVELOPMENT

Non-insignificant numbers of innovating companies in Germany do not rely on research and development in the conventional sense. It can be useful to provide support for such companies in cases in which the support enhances use of existing knowledge, and in which it enables innovative companies without R&D to carry out research on an ongoing basis. The Expert Commission thus recommends:

- The barriers to inclusion of innovative companies without R&D, within federal support programmes, should be lowered.
- Co-operation between a) innovative companies without R&D and b) scientific institutions should be facilitated.
- Federal and *Länder* programmes relative to innovation vouchers, a support instrument, need to be reviewed.
- Taxation-based R&D incentives should be used to support companies in undertaking R&D activities or continuing such activities throughout the long term.

CURRENT DEVELOPMENTS AND CHALLENGES

A

A CURRENT DEVELOPMENTS AND CHALLENGES

A 1 FINANCIAL AND ECONOMIC CRISIS

The global financial and economic crisis had a highly negative impact on Germany's economy in 2009.¹ As the Expert Commission had expected, German economy was forced to curtail its innovation activities considerably.² In 2009, innovation budgets in industry and in knowledge-intensive services were cut by a total of twelve percent. Business enterprises showed restraint especially in the area of investments in new systems and equipment for product and process innovations. On the other hand, pertinent cutbacks in research and development remained remarkably modest.³ Private sector's R&D expenditures decreased by only 2.4 percent in 2009, with respect to 2008. Germany's overall economic R&D intensity surpassing that of the U.S. for the first time since 1989 has to be considered a success of both private and public efforts. In 2010, the German economy made an unexpectedly marked recovery. German exports benefited from increased international demand,⁴ with the result that Germany's gross domestic product grew by 3.6 percent in 2010.⁵ The economic recovery also has had a positive impact on the employment market. Total unemployment was considerably lower than it had been a year earlier; as of the end of 2010, it amounted to only slightly more than three million.⁶ For Germany, it is now important that this trend continue, so that the economic level achieved in 2007 can be quickly re-achieved and then surpassed. In keeping with the positive economic development in 2010, and in contrast to the situation seen in 2009, German economy's research and innovation (R&I) activities have reintensified. This conclusion is supported by companies' planning data from last spring

and summer. Internal R&D expenditures were expected to grow by 4.6 percent.⁷ Furthermore, industry's and knowledge-intensive services' budget allocations for innovation expenditures were slated to grow by 5.4 percent.⁸

Continue support for the recovery

Business enterprises have indicated they have high expectations for the economy's development over the coming months of this year.⁹ Nonetheless, there are global factors that could again slow down economic growth in Germany. The German Council of Economic Experts sees risks with regard to: economic trends for important trading partners; the strict, in some respects, consolidation policies being pursued in the UK and in some Euro-region countries; the possibility of a further unexpected shock in financial markets; tensions in international currency relationships; and U.S. monetary policy.¹⁰ Furthermore, the cutbacks planned for Germany's public sector will tend to slow the economy. It is true that budgetary consolidation is needed, and that such consolidation is now mandated by the debt brake built into Germany's Basic Law and by provisions under the European Stability and Growth Pact. At the same time, such consolidation could slow down the economic recovery. It thus makes sense to provide state support for the private sector, with a view to stabilising growth.

In 2009, the Federal Government established the German Business Fund (*Wirtschaftsfonds*)¹¹ aimed at supporting companies in Germany in dealing with crisis-related financing problems. The Expert Commission recommends that the term of that fund be extended

until at least the end of 2011.¹² The *Wirtschaftsfonds* industry fund has helped reduce pressures from demand for loans, during the recession – in spite of a considerable decrease in new lending business. It thus has played an important role in assuring financing for business enterprises, which of course is indispensable for continuation of research and innovation. In September 2010, the KfW Bank Group found that the situation in the German credit market had eased considerably.¹³ Nonetheless, small and medium-sized enterprises (SMEs) that lack first-class credit ratings continue to face problems in obtaining loans from commercial banks.¹⁴ Such difficulties affect innovation projects, as the capital goods required for such projects are often financed via loans.

What is more, the availability of equity plays a key role in financing of research and innovation activities in companies.¹⁵ Banks and savings banks are already taking measures designed to assist SMEs in closing gaps in their financing, with a view to ensuring that SMEs are able to exploit the recovery. Initially, companies showed hesitancy in drawing on funding from equity funds that were made available. Relevant demand developed positively through the end of 2010, however.¹⁶

Support R&D in companies via tax-based incentives

As the Expert Commission has repeatedly emphasised in the past, introduction of tax-based R&D support would provide important incentives for expansion of R&D in business enterprises. The tax-based R&D support announced by the governing coalition has not yet actually been implemented, however. This is unfortunate, and it is hindering the development of the German innovation system. Necessary cutbacks must not be permitted to have impacts on research and innovation, which would reduce potential for future growth. German tax policy also runs counter to innovation in a further respect. The current limitation on tax deductibility of losses in connection with share transfers amounting to more than 25 percent (Art. 8c Corporation Tax Act (KStG)) urgently needs to be eliminated. In particular, it tends to hinder initial financing of young, innovative companies by venture-capital providers. Venture-capital providers provide capital for start-ups, often for limited periods of time, oriented to

companies' establishment and initial-growth phases. Losses incurred by companies in such development phases cannot be deducted from later profits if the relevant venture-capital providers later sell their pertinent shares. That, in turn, tends to hinder the establishment and development of new companies, especially in capital-intensive sectors of cutting-edge technologies. Most other European countries do not impose such limitations.

Young biotechnology companies tend to be especially strongly affected by limitations on use of losses carried forward, since such companies tend to incur high initial losses. While research and innovation policy seeks to promote the establishment and growth of such companies, the tax system tends to hinder such development systematically. As this clearly indicates, tax policy is always also innovation policy.

VENTURE-CAPITAL MARKET

A 2

Provide incentives for use of venture capital

Germany's economic recovery in 2010 has also made itself apparent in the venture-capital market. In 2010, after a period in which the investment volume in this area had declined enormously as a result of the financial crisis, investments of capital investment companies began growing again.¹⁷

At the same time, the current figures for this area should not blind us to the fact that the German venture-capital market, notwithstanding its current recovery, has low rates of investment in light of relevant international rates. The German risk-capital market continues to be plagued by a structural problem. In 2009, for example, venture-capital investments in Sweden amounted to 0.07 percent of that country's gross domestic product, while such investments in the UK reached 0.05 percent of GDP. The corresponding figure for Germany was just less than 0.03 percent.¹⁸ Another problem, apart from such low investments by international standards, is that Germany's market for early-phase venture-capital financing is clearly underdeveloped. That conclusion is supported by a recent study. As the study shows, in early phases of business enterprises, private investments are decreasing, in relative terms, in

comparison to funding under public-sector financing programmes.¹⁹ This lasting underdevelopment of the venture-capital market is problematic especially in that young innovative companies are often able to gain a market foothold only if they receive venture capital from private investors in their start-up and development phases. And “big money” rarely is the issue. For years, available funding in the area of small investment amounts has fallen far short of demand.²⁰ That conclusion is supported by information from market participants who have been calling attention to the lack of financing partners for young companies.²¹

Comparative studies have repeatedly confirmed that tax incentives play the most effective role in helping to mobilise venture capital for young companies. A number of countries, including the UK, France and the U.S., have much more extensive systems of tax-based support than Germany does, and their systems are oriented both to increasing relevant investments and to guiding investments’ long-term orientation.²² It is scientifically substantiated that venture capital, especially in the form of early-phase financing, can contribute significantly to economic growth.²³ The Expert Commission has repeatedly called for creation of incentives for provision of venture capital, and such creation is thus overdue.

Weaken the impacts of the AIFM Directive

In November 2010, the European Parliament addressed the financial crisis by issuing a directive focused not directly on regulation of funds, but on control of managers of alternative investment funds (Alternative Investment Fund Manager [AIFM] Directive).²⁴ Examples of the managers aimed at by the legislation include managers of hedge funds, of buy-out funds and of venture-capital funds.²⁵ The AIFM Directive is designed primarily to limit the systemic risks involved in the actions of various financial-market players. It imposes extensive constraints on managers who manage alternative investment funds within the European Union, even in cases in which the funds in question are based in third countries. The directive applies to managers of funds with cumulative assets of more than EUR 500 million.²⁶

It does indeed make sense to tighten regulation of alternative investment funds. At the same time, the

oft-cited reason for such tightening, namely the need to contain systemic risks, cannot apply to buyout and venture-capital funds. Those two categories of funds present no systemic risks. Nonetheless, managers of such funds can fall within the scope of the directive. Enforcement of the directive can thus be expected to have negative impacts on venture capital companies.

If such impacts occurred, companies financed by funds affected by the directive would be at a special disadvantage as a result of special disclosure provisions. In cases in which a fund had a controlling majority (more than 50 percent of voting rights) of such a company, for example, the company would have to disclose sensitive information concerning its business operations. In general, no detailed disclosure obligations should be imposed on the basis of shareholding structures, i.e. such obligations should also not be imposed on companies financed via venture capital.

What is more, the negative impacts of the AIFM Directive’s disclosure provisions are probably not limited to young companies. They could also well apply to family-owned companies, which often have reservations with regard to private equity as it is. As a result, in their choices for growth-oriented financing, family-owned companies may begin relying on private equity financing even less frequently than they now do. A reduction of options for growth-oriented financing is significant, since such financing plays a key role in development of innovative business ideas.

The administrative costs that companies incur in implementing the directive’s provisions are another problematic aspect of the directive. For example, the AIFM Directive requires venture capital funds that fall within its scope to have independent assessments of their assets carried out annually. Such assessments entail extensive organisational overhead. Their usefulness, on the other hand, is not apparent. The provision does enhance security in the area of hedge funds that undergo market valuation. Venture capital funds tend to hold their shares for years, however; they generate capital yields only when they sell their stakes.²⁷ Interim assessments of such funds thus have no key significance and this also applies to such assessments’ relevance for fund managers’ compensation, which is oriented to yields.

As a result of the high fixed costs incurred in implementation of the AIFM Directive, funds could find it necessary to maintain higher investment volumes in future. And the need for such increases, in turn, could force funds to focus their investments more on larger companies. Funds with large numbers of small investments would have even greater administrative overhead. Consequently, companies would find it even more difficult to attract smaller investments. Ultimately, such developments could worsen the shortage of financing in this area.²⁸

Furthermore, restriction of institutional investors to investments in European-regulated venture capital funds, as is currently planned, would increase risks for investors, since such restriction would hamper regional diversification. In all likelihood, investments would tend to concentrate largely on European funds.

The Expert Commission also maintains that venture capital investors based outside of the EU would then become reticent to invest in European companies. To be able to invest in Europe, fund managers from third countries have to apply for an EU passport, and thus they have to fulfill the same provisions that European fund managers have to fulfill. In particular, such a trend would tend to close access to the expertise that capital providers – especially venture-capital providers from the U.S. – often also provide.

The venture capital market for early-phase financing is likely to shrink as a result of implementation of the AIFM Directive. And yet German start-up entrepreneurs need more venture capital, not less. At the same time, the European provisions in this area are an opportunity, as well as a challenge, for German policymakers. In implementation of the directive, by no means should any attempt be made to make use of the option for expanding the directive's scope to include smaller funds that manage less than EUR 500 million in assets.²⁹ Instead, AIFM implementation should be taken as an opportunity, finally, to draft legislation for an internationally competitive, growth-promoting framework for venture-capital providers and business angels.

EDUCATION AND RESEARCH

A3

The Federal Government boosts financing for education and research

The 2011 federal budget earmarks more than EUR 11 billion for the BMBF. That figure is 7.2 percent higher than last year's allocation. And it will benefit the three central Federal-*Länder* programmes. The Higher Education Pact, the Initiative for Excellence and the Pact for Research and Innovation will all be continued and expanded.³⁰

In 2011, the Higher Education Pact will enter a second project phase. The *Länder* are to be enabled to accept additional numbers of new students (pillar 1). Along with the increase originally planned, the measure now, following the discontinuation of conscription for the military and alternative civilian services, includes funding for an additional 35,000 to 59,000 new students through 2015.³¹ The second pillar of the Higher Education Pact comprises federally funded overhead payments, amounting to 20 percent of the relevant project volume, for research projects, at higher education and research institutions, receiving grants from the *Deutsche Forschungsgemeinschaft* (German Research Foundation).³² Through 2015, the Federal Government is providing over EUR 5 billion for those two measures. The Quality Pact on Teaching (*Qualitätspakt Lehre*) is the new, third pillar of the Higher Education Pact. The Federal Government plans to invest some 2 billion euros in it through 2020.

Cutting-edge research is being funded in the framework of the *Initiative for Excellence II*. From 2012 to 2017, it will provide support to universities amounting to a total of 2.7 billion euros.

Financing of the country's five non-university science and research organisations³³ is managed via the Pact for Research and Innovation. From 2011 to 2015, funding in that framework will be increased by 5 percent, for an expected total volume of some 4.9 billion euros.³⁴

The Expert Commission welcomes the clear commitment to education and research seen in these measures. At the same time, it notes that the Federal Government's own goal of having the country's

expenditures on education and research reach 10 percent of its gross domestic product (GDP) has not yet been reached. Efforts toward that goal need to be continued energetically.³⁵

Competence levels of German pupils are growing

Reading skills are core competences (reading to learn) that are of critical importance with regard to innovation. The PISA 2009 results for Germany, when compared to the corresponding results from the PISA 2000, 2003 and 2006 studies, show higher average values in the area of reading competence.³⁶ That is of course a welcome development. On the other hand, Germany ranks only about average, for OECD countries overall, in that key competence. The percentage of school pupils with outstanding reading competences at competence levels V and VI³⁷, 7.6 percent, is precisely the OECD average. The countries with considerably higher percentages of pupils with excellent reading skills include New Zealand (15.7 percent), Finland (14.5 percent), Japan (13.4 percent), Korea (12.9 percent), Australia (12.8 percent), Canada (12.8 percent) and Belgium (11.2 percent). The percentage of pupils with low reading competence, i.e. at a competence level below II, is 18.5 percent in Germany, which is close to the OECD average of 18.8 percent. Korea (5.8 percent) and Finland (8.1 percent) are the two countries with the lowest percentages of pupils with poor reading competence.³⁸

In particular, the percentage of 15-year-old male pupils with reading competence below competence level II, at 24 percent (2000: 26.6 percent), is still very high. The corresponding figure for girls is 12.6 percent (2000: 18.2 percent).³⁹ That figure for male pupils means that nearly one-fourth of male pupils are unable, “within a text passage, [to] follow logical and linguistic links, with the aim of localising or interpreting information; or of relating information distributed throughout a text or text passages, in order to determine the author’s intention.”⁴⁰

It is true that no reliable data are yet available on the ways in which biographies of young people with low reading competence progress. In light of the great deficits in competence involved, however, it must be assumed that such young people are inadequately prepared for education and careers in the knowledge society.⁴¹ Measures for reducing the num-

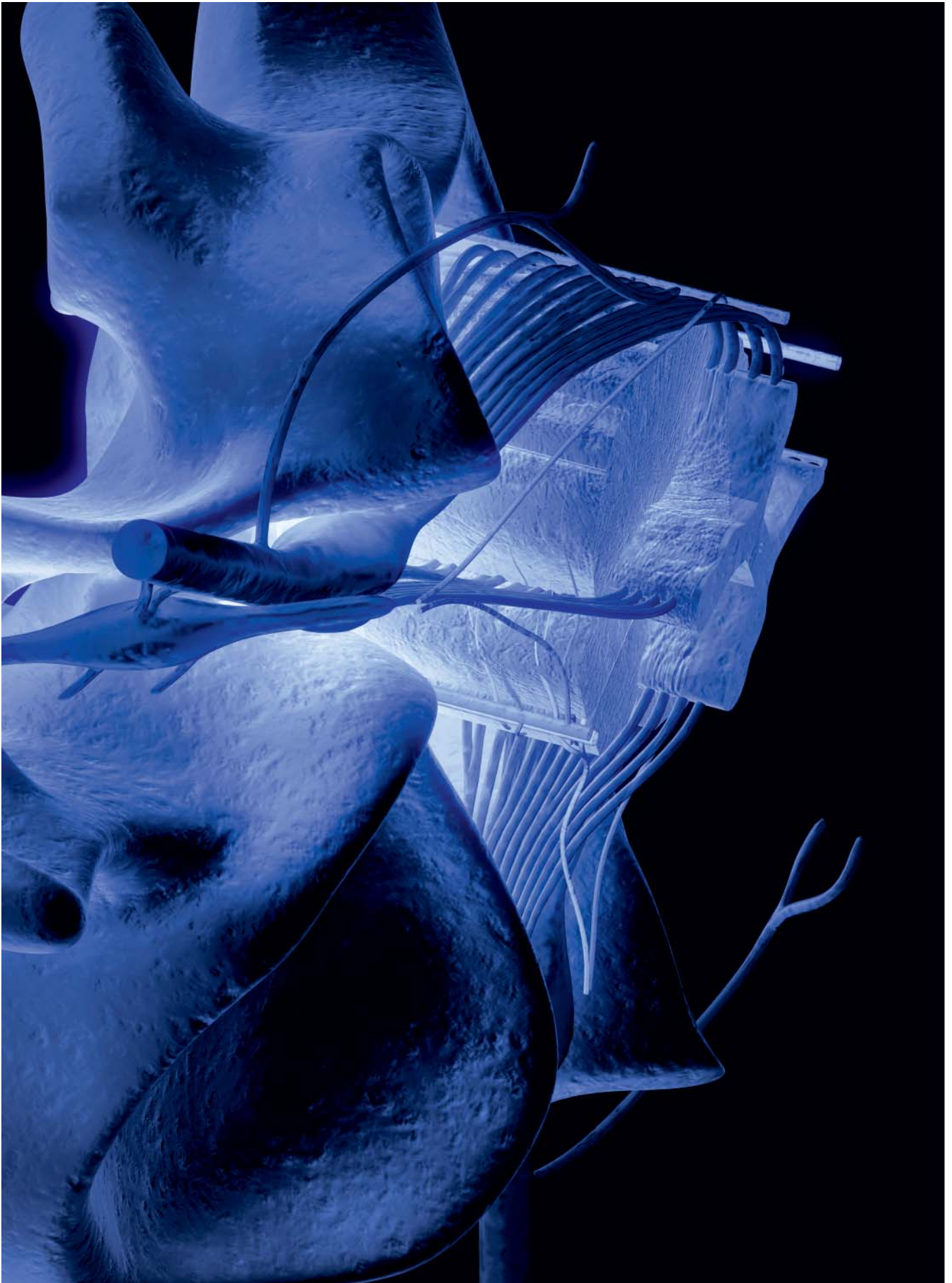
bers of pupils at risk are urgently needed. And such measures must take account of special regional and local circumstances. The Expert Commission thus disapproves of the decision of the Standing Conference of the Ministers of Education and Cultural Affairs of the *Länder* in the Federal Republic of Germany (KMK) to refrain from evaluating the PISA studies by individual *Länder*; that decision makes it impossible to identify the strengths and weaknesses of the different *Länder*. That assessment remains valid in spite of the comparison, carried out by the *Institut zur Qualitätsentwicklung im Bildungswesen* (IQB; Institute for development of quality in education), of the 9th class level throughout all *Länder*, for the subjects German and English.

In this connection, the Expert Commission welcomes the nation-wide support programme *Lesestart – drei Meilensteine für das Lesen* (Starting reading – three milestones for reading) that has been announced for 2011. That programme, which is receiving a total of EUR 26 million in support from the BMBF over an eight-year period, is being carried out in co-operation with the *Stiftung Lesen* foundation (Reading Foundation), in communities with disadvantaged neighbourhoods. The programme begins reaching children when they are in their key early formative years, and it stays with them for long periods of time to encourage their interest in reading.⁴² The Expert Commission calls critical attention to the many comparable model projects also in place that are not being evaluated and are not being expanded. With a view to considerably reducing numbers of pupils at risk, the Expert Commission recommends that such projects be evaluated and that successful programmes be widely introduced. A campaign against poor educational performance can also be expected to help sever the links between young people’s educational performance and their social background.

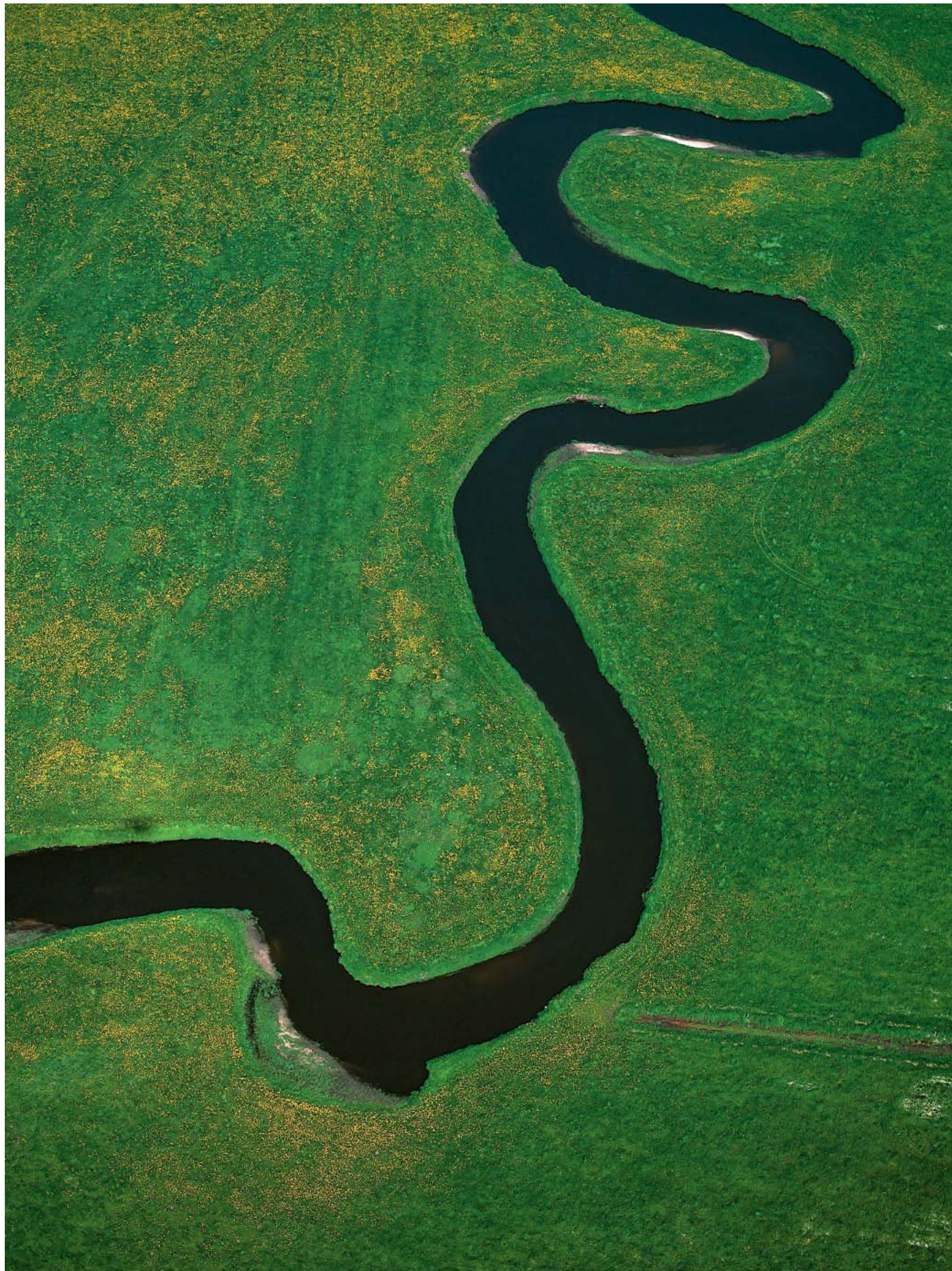
Record numbers of new students and of persons eligible for higher education

In 2009, the percentage of persons with higher education entrance qualifications, with respect to the relevant age cohort, reached 45.9 percent, a new record (449,400 persons eligible for higher education).

In 2009, new students accounted for a total of 43 percent of the relevant age cohort for that year, thereby



Spinal cord segment



River Tollense region in Germany

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surpassing the politically established goal of 40 percent.⁴³ At the same time, the figure includes foreigners who have come to Germany for studies.⁴⁴ When one considers only new students with higher education entrance qualifications earned in Germany, the applicable new-students percentage in 2009 was 36.5 percent.⁴⁵ The percentage calculated in the latter manner has also increased over the past few years, however, although special effects, such as changes in statistical methods and school-system reforms, have to be taken into account.⁴⁶ All in all, higher education institutions, especially universities of applied sciences, have registered considerable growth. For example, new enrollments at universities of applied sciences increased from 119,182 in 2007 to 156,140 in 2009, i.e. by 31 percent.⁴⁷ New enrollments at universities grew by only 10.3 percent between 2007 and 2009. The Expert Commission welcomes the growth in enrollments.

Social selectivity continues to be a problem

Opportunities for higher education continue to correlate closely with social background in Germany. While 71 percent of children from academic families take up studies, only 24 percent of children from non-academic families go on to higher education.⁴⁸ At the same time, the percentage of new students from non-academic families grew by 6 percentage points between 2006 and 2008, while the percentage of new students from academic families grew by only 2 percentage points.⁴⁹ In surveys of persons who have held higher education entrance qualifications for half a year, young people from non-academic families often report that they are not planning to take up higher education studies because they lack the necessary financial resources.⁵⁰

Expand grant programmes

In the 2009 summer semester, a total of 23 percent of all students in Germany received support under the Federal Education and Training Assistance Act (*BAföG*).⁵¹ Throughout all of 2009, a total of 550,369 students in Germany received such support, with 39 percent receiving full-level support. The relevant federal and *Länder* expenditures in that year amounted to nearly EUR 1.9 billion.⁵² As of 1 October 2010, the maximum rates of *BAföG* support dependent on

parents' income levels increased by 2 percent; they now amount to EUR 422 and 597 (which amount applies depends on whether students live at home with their parents or have moved out).⁵³ In addition, changes of subject area have been facilitated⁵⁴, and the applicable age threshold has been changed: persons who have not yet turned 35 when they begin a master's degree programme are now eligible to apply; the previous age limit was 30. The Expert Commission welcomes the new provisions, and it recommends, in the interest of assisting people in juggling work and family responsibilities, that the age limit for students in bachelor's degree programmes also be raised. That age limit is still 30.

Funding for the 12 German foundations that support gifted students (*Begabtenförderwerke*)⁵⁵ has now been reduced, following increases over the past few years. Initially, the draft budget for 2011 called for relevant funding to be cut, with respect to 2010, by EUR 61.1 million, to a level of EUR 136.7 million. Now, funding resources that the BMBF did not use in 2010, amounting to EUR 33 million, are to be allocated to the foundations.⁵⁶ The Expert Commission explicitly regrets that a cut of ultimately EUR 28 million was still made in 2011.

The Germany grant (*Deutschlandstipendium*) is a new form of support for students. As of the 2011 summer semester, gifted and excellent students can receive support of up to EUR 300 per month, depending on available income, under the new programme. Financing for the grants is to be shared equally by private donors and the Federal Government. The relevant federal funding is tailored so that the number of students receiving support in 2011 will, initially, amount to 0.45 percent of all students. In addition, an option has been provided for gradually increasing the funding to a maximum at which 8 percent of all students receive support. Two examples illustrate the scope of the *Deutschlandstipendium* programme. Humboldt University in Berlin has 36,636 students. In the final stage of the programme, it would be able to support 2,930 students. Total support in that case would amount to EUR 10.6 million per year, of which EUR 5.3 million would have to come from private donors. The corresponding figures for Ludwig-Maximilians University in Munich are as follows: up to 3,735 students would receive support, and EUR 6.7 million would have to come from private donors each year.

The Expert Commission welcomes the establishment and development of the *Deutschlandstipendium* programme. At the same time, it proposes that mechanisms be provided to prevent any considerable regional and subject-oriented concentration in the effort. Such concentration clearly emerged during the pilot phase of the grant programme in North Rhine-Westphalia.⁵⁷ Since Germany does not yet have a well-developed culture of fundraising, the Expert Commission warns against cutting funding for the foundations that support gifted students, as a means of boosting funding for the *Deutschlandstipendium* programme.

Unsatisfactory development in MINT subjects

In 2009, some 16.7 percent of all new students chose to study math or science.⁵⁸ The corresponding figure in 2000 was 18.7 percent. The percentage of new students going into engineering subjects increased markedly as of the year 2000, reaching 20.3 percent in 2009 (2000: 16.8 percent).⁵⁹ The numbers of women who graduate in MINT subjects (mathematics, informatics, natural sciences and technology), as a percentage of all graduates in such subjects, continue to be low. In math and sciences, the relevant percentage decreased slightly, from 40.9 to 40.1 percent, while in engineering fields it is stagnating at 22.6 percent (2008: 22.8 percent).⁶⁰ Thus far, only a few German *Länder* are supporting the National Pact for Women in MINT Careers, which the BMBF initiated in 2008.⁶¹ In the second programme phase of the Higher Education Pact 2020, the *Länder* committed themselves to increasing percentages of new students in MINT subjects.⁶² Consequently, the Expert Commission is expecting support to broaden for the National Pact for Women in MINT Careers, and thus is expecting the percentage of women studying MINT subjects to increase noticeably in the coming years.

International mobility for students in bachelor's degree programmes needs to be expanded

The percentages of students in Germany who undertake part of their studies abroad have been increasing for years. In 2008, a total of 102,800 German students enrolled in foreign higher education institutions. That figure translates into 58 German

students at higher education institutions abroad for every 1000 German students at higher education institutions in Germany. The countries most frequently chosen for studies abroad are Austria, the Netherlands, the UK, Switzerland, the U.S. and France.⁶³ German students are thus more mobile than students of comparable industrialised countries. While the Expert Commission considers this trend to be positive, it notes that international mobility continues to be tied strongly to students' social background.⁶⁴

Bachelor's degree programmes continue to offer too few opportunities for international studies. The percentage of German bachelor's degree students (universities) who carried out part of their studies abroad was 15 percent in both 2007 and 2009. Among students in master's degree programmes, the percentage of students who carried out part of their studies abroad decreased slightly, from 30 percent (2007) to 27 percent (2009).⁶⁵ The Expert Commission recommends that enough time and flexibility be allowed, in bachelor's degree and master's degree programmes, to enable students to travel abroad for part of their studies. One way in which German higher education institutions could achieve that aim would be to plan their programmes from the outset in co-operation with foreign higher education institutions and to allow students to earn double degrees.

Shortages of skilled people are becoming a problem

Basic economic and demographic trends are going to change significantly in Germany over the coming decades. The demand for labour will increase markedly, with the largest such increases occurring in the areas of business-oriented services and health and social services. At the same time, the total available workforce in Germany will shrink from about 44.8 million (2008) to 41.1 million (2025).⁶⁶ In the economy as a whole, the number of gainfully employed persons will probably increase by 0.4 million persons through the year 2020. But that number is expected to decrease by 0.5 million persons between 2020 and 2025, for demographic reasons, as job losses in some areas gradually constrain the potential for growth in the employment market.⁶⁷

A comparison of the total available workforce and the numbers of gainfully employed people shows that total underemployment – persons registered as

unemployed, and the hidden labour reserve – could theoretically decrease to below 1.5 million people by 2025. At the same time, it is likely that too many persons of working age will lack the necessary vocational qualifications, and thus it will not be possible to meet growing demand for highly qualified employees. If that situation materialised, i.e. if the demand for labour could not be met with the available workforce, actual underemployment would then be considerably higher than underemployment as theoretically forecast. To counter the threatening shortage of skilled employees effectively, an entire package of measures is needed. A qualification campaign is urgently needed, designed to raise individual educational levels and to establish programmes for retraining and further training.⁶⁸ Schools and companies alike are called on to act in this area. In addition, higher education institutions and Germany's dual system of vocational training must begin allowing people in their middle years to pursue additional (second) education, and they must set up relevant suitable programmes. The Expert Commission again calls for exploiting possibilities for suitably educating additional numbers of people; for increasing the percentages of women in the workplace, and the amounts of work entrusted to women⁶⁹; and for making concerted efforts to attract skilled people from abroad. It would be short-sighted to rely on just one of these measures.

Among German-speaking countries, Germany is a “migration loser”, in both quantitative and qualitative terms.⁷⁰ Although migration into Germany is currently in balance with migration out of Germany, demographically caused shrinkage of the available workforce continues nonetheless. What is more, the trained persons who leave Germany are, on average, better trained and better paid than the persons who immigrate to Germany and than gainfully employed persons overall in Germany. In the view of the Expert Commission, transparent, effective concepts urgently need to be established for guiding and promoting immigration of qualified persons to Germany. At the European level, the possibility of establishing a ministry of migration should be considered; such a ministry could enhance Europe's attractiveness for qualified immigrants from third countries.

COLLECTION OF STATISTICS ON INNOVATION-RELATED ACTIVITIES

A 4

Improve the currentness of statistics

In light of the importance of research and innovation, the quality of procedures for “surveying” the knowledge economy needs to be reviewed and improved regularly. To be able to make suitable, proper decisions, decision-makers in the industrial and political sectors need maximally timely, precise information about new developments. At present, such decision-makers are not always receiving such information.

Although research and experimental development within the meaning of the OECD's Frascati definition⁷¹ is not a *sine qua non* for innovation (cf. the discussion in Chapter B 4), R&D expenditures are still a centrally important indicator for R&I policy. And yet precise data on R&D expenditures in OECD countries become available, for a given report period, only after a considerable time lag. In Europe, a European Commission regulation⁷² requires Member States to provide their final data for all sectors no later than 18 months after the end of year being surveyed. In Germany, provisional data on private sector's R&D expenditures in 2009 became available by the beginning of December 2010. Initial data on state R&D expenditures are published considerably less promptly. Intensive efforts to shorten such time lags need to continue.

In the view of the Expert Commission, R&D-relevant data should be collected in the framework of standard household surveys, in order to ensure that reliable information about development of R&D activities is available as early as possible, and to develop additional possibilities for analysis.⁷³ The Expert Commission especially recommends that the annual Mikrozensus survey also be used as an opportunity to collect data on numbers of people employed in the areas of research, development and innovation. In each case, such data could be provided at a relatively early date, and thus would usefully complement available data on research and innovation.

Identify and eliminate statistical inconsistencies

In the past, relevant political interest has focussed especially on R&D expenditures. Because R&D

expenditures were made primarily by industry and large companies, it was possible to obtain reliable figures for total R&D expenditures without knowing exactly how many companies were involved in R&D. Justifiably, the political sector has now taken a greater interest in R&D in services sectors and in small and young companies. In this context, it is increasingly important to know the numbers of private-sector players involved in R&D. And the various data sources available for that purpose exhibit considerable inconsistencies: the number of R&D-pursuing companies shown by the R&D survey of the Stifterverband is considerably smaller than the relevant figures produced by innovation surveys.⁷⁴ The institutions involved in the pertinent surveys should determine the reasons for the discrepancies and work to eliminate them as quickly as possible.⁷⁵ Furthermore, the organisations involved in collecting data for official statistics should be given access to the Federal Statistical Office's business register, so that they can use the register as a basis for their surveys. In addition, those organisations should use a common sampling procedure in the future.

Enhancement of the quality of statistical surveys of innovation

The data considered for R&I policy should not be limited to data on R&D expenditures, since such expenditure data cover only one – albeit important – aspect of innovation processes. The European innovation surveys, which have been carried out since the early 1990s, provide additional data that can reveal innovation trends in sectors and companies that rely on R&D only to a small extent. At the same time, a number of criticisms have recently been levelled at innovation surveys oriented to the OECD's Oslo Manual.⁷⁶ For example, some researchers have found that the innovation definition being used does not support adequate comparability across national boundaries. What is more, so critics, instances of innovation, when subjectively defined, cannot be compared across different sectors and technology areas.⁷⁷ Such criticisms must be taken seriously. The Expert Commission thus proposes that innovation surveys use a precise definition of innovation, or that new survey techniques⁷⁸ be used to illuminate the understanding of "innovation" being applied by the entities surveyed.

Systematically collect data on start-ups with high growth potential

Yet another difficulty is that statistics are currently not adequately revealing the situation for start-ups with high growth potential. In this area, it would be useful, working on the basis of the Federal Statistical Office's business register and the newly introduced Electronic Commercial Register (*Elektronisches Handelsregister*), to develop a suitable definition of start-ups in general and a suitable, more specific, definition of start-ups with high growth potential. In addition, official reports on the development of such companies should be provided on an annual basis.

Innovation research in Germany: strengthen its quality and its infrastructure

In their efforts to reinforce and systematically develop Germany as a location for R&I, policymakers need suitable empirical data. Innovation research carried out in Germany plays an important role in this connection. High-quality political advising in this area will simply not be possible in the absence of excellent institutes and academic chairs that, in the field of innovation research, can develop and test new forms of data collection and analysis. To date, funding for innovation research has been very modest when compared to funding for other comparable areas (such as research into demographic trends). In this context, the Expert Commission notes that in 2008 the United States' National Science Foundation (NSF) launched an extensive new support programme entitled "Science of Science Policy"⁷⁹, aimed at studying the impacts of science and innovation on growth and prosperity. In addition to considering issues of relevant measurement and indicators, the programme is carrying out in-depth analysis of the impacts of research and innovation. The Federal Government should initiate a similar programme, with a view to providing new impetus to measurement and analysis of innovation in Germany and Europe. Ideally, such an effort should involve the DFG, which could select suitable research projects on the basis of scientific criteria.

In the view of the Expert Commission, data access also urgently needs to be improved for those researchers who, while not themselves involved in carrying out surveys, have pertinent data-selection

skills.⁸⁰ The resulting improved data selection could further enhance the usefulness of R&D and innovation surveys. Presumably, such a measure could also improve interdisciplinarity in innovation research. In addition, the possibility of combining central surveys on R&D and innovation activities into a joint social-sciences infrastructure project should be considered; such combination could well yield synergies in data collection and prevent duplication of efforts. Furthermore, the Federal Government should continue and expand its efforts to promote data centres for research. And the business register should be made available for use in the framework of scientific research projects.

A 5 HIGH-TECH STRATEGY 2020 FOR GERMANY

New orientation of R&I policy

In July 2010, the Federal Government presented the High-Tech Strategy 2020 for Germany, which introduces new emphases for the targeted growth of the German research and innovation system. Under the High-Tech Strategy 2020, innovation policy receives a stronger orientation to “missions”. This means that it is oriented more strongly to major priority areas, rather than to specific technologies and research programmes, the previous main orientation.

In comparison to the High-Tech Strategy 2006, the newly oriented High-Tech Strategy lends itself to greater public awareness and transparency within the political process. And it further enhances inter-departmental co-operation between different ministries. Overall, the Strategy process is systematically oriented to five major priority areas that represent key challenges for Germany. These include:

- Climate / energy,
- Health / nutrition,
- Mobility,
- Security,
- Communications.

The Expert Commission welcomes this focusing process and approves of the priorities that have been defined. In each of these priority areas, Germany’s R&I system offers a favourable basis and existing

strengths that can be efficiently reinforced. German industry has considerable comparative advantages in these areas and sees excellent growth potential in them.⁸¹

The High-Tech Strategy defines a generic process that needs to be effectively implemented. The five priority areas correspond to sectoral innovation systems in which actors from the areas of science, industry and public administration jointly define and implement key measures, programmes and projects. The relevant strategy process conforms to a system, with “priority areas” at the top level, and “framework programmes” as well as “funding programmes” at the next two levels. At the level of framework programme planning, the relevant emphases and funding programmes are specified in keeping with a defined schedule. The framework programmes “Research for Sustainable Development”, “Medical and Health Research”, and “National Research Strategy BioEconomy 2030” were approved by the Federal Government in 2010.⁸² They have been assigned to the area of responsibility of the Federal Ministry of Education and Research (BMBF). In addition, the framework programme “ICT 2020 – Research for Innovation” was approved in December 2010, under the direction of the Federal Ministry of Economics and Technology (BMWi). In 2011, the remaining framework programmes are to be developed, and the strategy for the “Mobility” and “Security” requirements areas is to be specified.⁸³

Sharpen priorities

The Expert Commission supports this focus on mission-oriented innovation policies, and it approves of the greater concentration the programme has brought and of the relevant strategy process that has been initiated. By and large, specific priorities remain to be set for the High-Tech Strategy 2020. That process needs to be carried out quickly, both on an overarching level and in detail. On the other hand, it must be determined whether all requirements areas are to be of equal importance. In addition, clear priorities have to be set for both the framework programme and the relevant funding programmes, and specific pertinent aims and measures have to be defined. Budgetary allocations for the various requirements areas have to be defined. Furthermore, operational criteria and schedules for performance evaluation have

to be defined for all three levels (“priority areas”, “framework programmes” and funding programmes”). The Expert Commission considers it important to show, more clearly than has been demonstrated in the past, that the High-Tech Strategy 2020 will help concentrate and reorient support policy effectively also at the implementation level. The emphasis on mission-oriented framework programmes should not be permitted to fade, particularly if pre-existing funding programmes have a high degree of inertia and are replicated with little focus. A considerable portion of the framework and funding programmes still consists of continuations. With regard to these replicated funding programmes, the Expert Commission recommends systematic evaluation and review to determine whether the continuing efforts are in line with the major priority areas and strategies.⁸⁴

With its High-Tech Strategy, the Federal Government is seeking to implement consistent innovation policy throughout all relevant areas. In the view of the Expert Commission, such innovation policy must be coherently oriented, and logical, throughout several different hierarchical levels. Relevant planning processes must be rigorously organised throughout the levels described (priority area – framework programme – funding programme). This also means that processes must operate consistently and harmoniously even when different departments/ministries are involved in agenda setting and implementation.

In the architecture designed for the High-Tech Strategy, specific action lines are assigned to each priority area. For example, the National Electric Mobility Platform is an action line within the priority area “Mobility”. The number of action lines being pursued within that priority area – 38 – seems too high, however.⁸⁵ Which action lines are of high strategic importance, and which ones have more of an operational character, has not been made adequately clear. It is questionable whether all 38 action lines can be successfully pursued with the limited budgets available.

Define structural terms precisely; promote transparency

The Expert Commission sees a need for further specification of terms being used in this concept, including “future-oriented projects”, “action lines” and “key

technologies”. In addition, the manner in which such terms relate to the requirements areas needs to be clarified. The responsibilities of the various ministries involved need to be made transparent. Strategies for key technologies, cross-disciplinary projects / framework conditions and, in some cases, for future-oriented projects⁸⁶ are being formulated in an overarching manner for all priority areas. That approach dilutes the focus of the High-Tech Strategy 2020 and makes the strategy too complex, in spite of the strategy’s orientation to the five priority areas. And that difficulty, in turn, hampers implementation of the concept – which is useful overall – and impedes the necessary performance evaluation.

The decisive factors in the success of the High-Tech Strategy 2020 also include the process of inviting tenders for funding programmes and the transparency of the relevant budgets and planning systems. The R&D planning system (*Leistungsplansystematik*)⁸⁷ is currently being revised. The conversions involved in this process hamper comparison of past and new funding practices. Relevant reconciliation accounts must be completed as quickly as possible, to permit monitoring of the success of funding programme reorientations resulting from implementation of the High-Tech Strategy 2020.⁸⁸

Bring in new groups of actors

Additional promoters and innovation drivers need to be involved during the process of implementing of the High-Tech Strategy 2020. Already, the Federal Government’s High-Tech Strategy has been reaching important actors within the German R&I system. Such actors especially include the established research organisations⁸⁹, major corporations, and small and medium-sized enterprises (SMEs) that regularly engage in R&D. At the same time, other important target groups are not being reached to an adequate extent. As a result, innovation policy runs risks of focusing too narrowly on established groups of actors and of responding too slowly to new trends.

In particular, groups able to provide additional ideas, and thus of importance with regard to further development of Germany’s R&I system, need to be brought on board. That group includes innovative start-up companies, as well as foreign companies that are carrying out sophisticated R&D projects at

their locations in Germany.⁹⁰ In addition, innovative companies that do not carry out R&D of their own also need to be involved. Chapter B 4 highlights the contributions of such companies to innovation in Germany.

Furthermore, dialog with potential entrepreneurs, business angels and venture capital companies needs to be intensified. Insights obtained in co-operation with such actors, especially insights relative to barriers to innovation and entrepreneurship, should be taken into account in implementation and refinement of the High-Tech Strategy, since they are of decisive importance with regard to achievement of the relevant overall goals.

Be more open and global in innovation

Entrepreneurs, venture-capitalists and innovators who have located at globally significant innovation locations (such as Silicon Valley), need to be attracted as promoters for innovation projects in Germany. Such persons provide expertise and network relations that can be of great value for actors within the German R&I system. At the same time, existing international networks of German companies and science organisations⁹¹ need to be used more effectively with a view to obtaining further impetus for German R&I policy.

Within the High-Tech Strategy 2020, efforts to forge effective links between foreign policy, innovation policy and business development should be intensified. Internationally, Germany still has too little presence with new forms of international innovation and knowledge transfer.⁹² The international component of Germany's innovation policy seems rather weak even in comparison to the corresponding policy components of smaller European countries such as Switzerland, Sweden, Finland, Austria and Denmark.⁹³ The Expert Commission proposes that this discrepancy be promptly eliminated and that bridge-building organisations be established, at leading innovation centres, to carry out and combine tasks in the areas of a) international science policy and b) promotion of innovative German companies with a view to greater international market presence.

The organisation SwissNex⁹⁴, for example, supports the growth of Swiss start-ups at the world's most

important high-technology centres, and it has locations in San Francisco (Silicon Valley), Boston, Singapore, Shanghai and Bangalore. At present, German R&I policy is providing no comparable support for young German companies at those locations, or at other, similar locations. Bridge-building organisations can support the internationalisation process, and the growth of young German companies, in a lasting way. As a rule, concerns that such activities lead to losses of know-how and potential job reductions in Germany have not been confirmed. In sum, the growth impetus and know-how that such activities bring in from abroad, and the activities' positive impacts on Germany's own innovation system, outweigh any negative effects.

DEVELOPMENT OF THE PATENT SYSTEM

A6

New efforts to establish an EU patent

The European patent system is still fragmented and economically inefficient. For this reason, in its 2010 report, the Expert Commission expressed its support for the European Commission's plans to introduce an EU patent that would be valid in all Member States. Developments over the past year have made it relevant to return to this topic.

With the 1973 European Patent Convention (EPC), agreement was reached on the introduction of a unified procedure for reviewing and granting patents in Europe. The organisation commissioned to implement the Convention, the European Patent Office (EPO), began functioning in 1978. That organisation examines patent applications and, for applications that fulfill the relevant requirements, grants patents for a total, now, of 38 countries (all EU countries and 11 additional European countries).

As soon as the EPO has completed its examination, the "European patent" breaks down into a bundle of national patent rights. A patent applicant whose application has been approved by the EPO thus has to apply for validations for those countries in which the patent protection is to be valid. In spite of the elimination of pertinent translation requirements in most of the EPC countries, such validations still normally entail considerable costs.⁹⁵ What is more,

once a period for objection at the EPO has expired, “European patents” can be enforced or challenged only before national courts, since there is no unified European jurisdiction for patents (such as that for trademark rights, for example).

In December 2009, the EU Member States unanimously approved a plan for improvement of the patent system in Europe.⁹⁶ That plan called for the creation of a unified EU patent and of a patent court that would be responsible for both the new EU patents and the national patent rights granted by the EPO. Over the past year, implementation of that plan by the European Commission has faltered. Once again, language policy has proven to be the obstacle. A draft of the new EU patent provisions issued in June 2010 by the European Commission, which called for assuming the EPO’s three-language regulations,⁹⁷ failed under the objections of some Member States, especially Spain and Italy.

The governments of twelve EU Member States⁹⁸ thereupon moved that efforts to create a new European patent system be continued via “intensified co-operation”.⁹⁹ Such an initiative must be supported by at least nine Member States, and the European Commission must give its approval. That provision was agreed in the framework of the Lisbon Treaty, in order to ensure that important projects in the EU could be moved forward even in the absence of relevant unanimous resolutions. With its approval of the initiative, dated 14 December 2010, the European Commission opened the way to introduction of a new patent-law system in the framework of “intensified co-operation”.

The Expert Commission explicitly welcomes this attempt to find a practicable solution for the EU patent. The planned three-language regulations would build on the success of similar regulations in the EPO’s operations. The Expert Commission notes that efforts to establish the new patent system must include ensuring that patent-review processes are of outstanding quality. The requirements for patent grants must be demanding, so that the patent system provides incentives for R&I and does not itself hamper innovation. Resources made available via the simplified language regulations should be applied primarily toward improving examination processes. The structure and organisation of the unified jurisdiction system are also of great significance. The central court

for the new EU patent should be located in Germany, because Germany has the greatest competence, throughout Europe, for resolving patent disputes.¹⁰⁰

Prevent senseless tax competition

Harmonised European-wide solutions must also be sought for the area of taxation of proceeds from licensing of intellectual property rights. It is very easy to transfer intellectual property to other countries. With attractive tax regulations making it the country with the lowest taxation, a country can prompt holders of intellectual property rights to transfer the rights to it. In some circumstances, such measures can even create incentives to transfer R&D activities to the low-tax country involved. At the beginning of 2007, so-called “patent-box” regulations went into force in the Netherlands. Such regulations permit companies, under certain circumstances, to apply a reduced tax rate (up to 10 percent less) on income generated via intangible assets of their own production, such as patents. Belgium, Spain and Luxembourg have introduced similar regulations. Recently, the UK approved a similar measure, and it is also creating especially attractive conditions for holders of intellectual property. As of 2013, the corporate tax rate on income generated via intellectual property in the UK will be only ten percent. That British measure may be seen as another EU country’s reaction to introduction of the “patent-box” regulations in the Netherlands.¹⁰¹

The Expert Commission is concerned that the “race” to introduce the most favourable tax conditions for license income in Europe could intensify. For Germany, such a race could have especially negative impacts, since along with attractive tax rates on license income, countries such as the UK and the Benelux countries also provide tax-based R&D incentives, which have not yet been introduced in Germany.

The Expert Commission recommends that the Federal Government work at the European level for harmonisation of frameworks for taxation of income from intellectual property. If unified regulations cannot be achieved, then Germany, as Europe’s most important location for research, could attempt to use unilateral provisions to counter the negative impacts of the “tax race on innovators in Germany. At the same time, the Expert Commission doubts whether

the current approach to transfers of functions is useful in this regard – it could prompt immediate transfers of R&D activities to countries with low taxation. For this reason, reduction of the relevant tax rates in Germany should be considered, as a last resort.

A7 ELECTROMOBILITY

Germany is slowly catching up

To a large extent, the future of Germany's automobile sector will be decided in the electromobility market.¹⁰² "Auto-nation" Germany thus needs to reorient its automotive sector strategically, and energetically, with a view to achieving leadership in the area of ecologically and economically optimised transport systems.¹⁰³

In its last report, the Expert Commission was sceptical about the outlook for efforts of state and private actors in the area of electromobility. Now, there are signs that Germany has caught up somewhat over the past year. In particular, new energy has emerged in the relevant research sector. At numerous universities and non-university research institutions, future-oriented projects have been launched, and research activities in the area of electromobility have been expanded.¹⁰⁴ In addition, companies have been intensifying their efforts as well.¹⁰⁵

In order to continue supporting this dynamic development, the Federal Government has assured follow-up financing, throughout the medium term, for the EUR 500 million in support provided in the framework of the 2nd economic-stimulus package (*Konjunkturpaket II*) through mid-2011. The funding is especially important with regard to development of high-performance batteries. Via development of battery technologies that move beyond conventional lithium-ion technology, Germany has a chance to regain ground internationally.

A change of strategy: from lead market to lead provider

In contrast to announcements made in 2009, in connection with the adoption of the National Electro-

mobility Development Plan, plans no longer call for developing Germany into a lead market for electromobility. Instead, the Federal Government's support policy is being oriented to making Germany a lead provider of commercially successful electromobility systems.¹⁰⁶ The difference between the two approaches is as follows: as a lead provider, Germany will no longer place top priority on becoming the first country with an especially large percentage of electric vehicles. As a lead provider, Germany must concentrate on supplying the world market with suitable vehicles and vehicle components, and on keeping a major share of the relevant research and added value in Germany.

The Expert Commission welcomes this change of approach, since it fits better with Germany's existing market and research structures than would an attempt to create a lead market. Relevant work-sharing between the Federal Government's various departments has improved, and this must also be positively assessed. The relevant management is now being shared by the Federal Ministry of Economics and Technology (BMWi) and the Federal Ministry of Transport, Building and Urban Affairs (BMVBS). The pertinent technology emphases are being co-ordinated by the BMWi and the BMBF. In the area of battery technology, which is central for electromobility, the two last-mentioned ministries have not yet clearly defined their various responsibilities, however. The Federal Government's joint office for electromobility (*Gemeinsame Geschäftsstelle Elektromobilität*; GGEMO), which was founded in February 2010, has not been able to alleviate that problem to date. The GGEMO has been set up within the BMWi to support the Federal Government in this area and to implement the National Electromobility Development Plan. It is to be hoped that that office will soon acquire a true control function.¹⁰⁷

Promote vertical co-operation, and combine existing capacities

To become a lead provider, Germany needs to ensure that relevant responsibilities at the political level are efficiently combined and concentrated. At the same time, German industry needs to concentrate its own resources so that it can implement projects more quickly. Ideally, German automakers would co-operate closely in this regard. Experience over the past

years has shown, however, that horizontal co-operation between German automakers, oriented strongly to German jobs and industrial activities, cannot really be achieved. Such companies continue to carry out the bulk of their electromobility research by themselves, in order to prevent any loss of technological know-how to competitors.¹⁰⁸

The Expert Commission thus recommends that state support programmes be focussed less on horizontal co-operation between automakers. Instead, vertical co-operation should be efficiently supported, i.e. co-operation between automakers, suppliers, component manufacturers and mechanical engineering companies, and the focus on engineering companies should be related directly to production technologies. Such vertical co-operation, throughout the entire value-creation chain, is not something to be taken for granted, since some automotive suppliers and manufacturers are already competing with each other via their own internal development activities in the electromobility sector. If absolutely necessary, therefore, strategic vertical co-operation should be promoted even without the participation of some of the aforementioned industrial sectors.

Review the value of current model tests

Successful support policies always focus on concentrating existing capacities. Consequently, the Expert Commission continues to doubt whether many of the model tests distributed throughout the country are providing any real benefits, either economically or in terms of funding policy. It is largely unclear what such small-scale tests could teach us about Germany's competitiveness in the international electromobility market, especially since most such tests involve trials of established technologies. Ultimately, such tests can be detrimental to efforts to develop Germany into a lead provider for electromobility, since they tie up resources that are urgently needed for promotion of innovation in areas such as power electronics and battery technology. The useful alternative to the many small projects would consist of a few large, (ideally) trans-boundary model tests in densely populated European regions. In co-operation with one or two other European countries with automaking traditions, infrastructures and incentives systems for introducing electric vehicles

to the market on a realistic scale could be tested in such model regions.¹⁰⁹

The time available until German electric cars appear on the market, a development expected for 2013, should be used for preparation of additional incentives systems. For example, the public sector should generate reliable demand via its own procurement policies. The policy-making and administrative sectors could set a good example by making large-scale transitions, in their fleets of official vehicles, to vehicles with electric drive.

Another promising way of increasing demand for such vehicles would be to provide tax incentives especially for purchases of electric and hybrid vehicles for official use. The current tax framework tends to provide disincentives for new types of drive technologies.¹¹⁰

B CORE TOPICS 2011

B 1 FEDERALISM

One of the Federal Republic of Germany's most important structural characteristics is its federal state system. The German *Länder* are responsible for fulfilling state tasks, except where the country's Basic Law makes other provisions.¹¹¹ Autonomy in matters of education and culture is considered one of the most important aspects of the autonomy of the *Länder*.¹¹² And that area includes both education and research. In Germany, a country poor in natural resources, both of those areas have always been centrally important. What is more, since the 1950s, and with the country's development into a knowledge society in global competition, those areas have been growing even more important, by leaps and bounds.

In the years following World War II, Germany was poorly prepared for the rapid market transformation and globalisation that ensued. Internationally, (West) Germany's research system lagged significantly behind that of the U.S. and those of European neighbours such as the UK, France, Switzerland and Sweden. Germany had also lost ground in the area of education. Too few of its pupils earned their higher education entrance qualifications (*Abitur*) and were able to study at a university. Young girls' talents and abilities often went unrecognised, and children from socially disadvantaged families rarely received an opportunity for higher education even when they did well in school. Overall, too little use was made of the population's real educational potential, and that neglect, in turn, constrained Germany's potential for innovation.

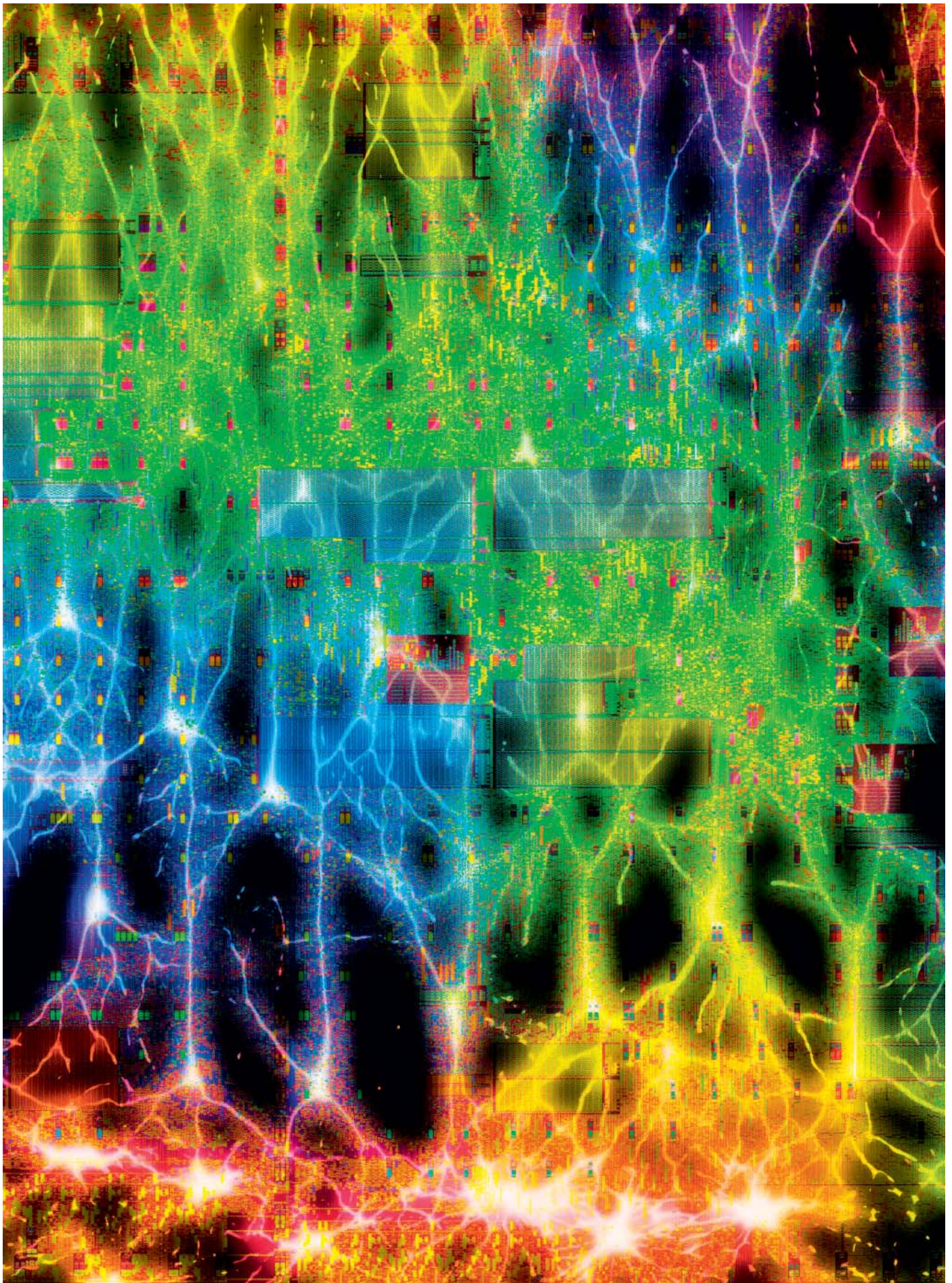
In the 1960s, domestic criticism of Germany's education and research sectors began to grow. With refer-

ence to the international competition, critics warned of a German "education catastrophe"¹¹³ and a "technological gap"¹¹⁴. In addition, they noted that other countries were moving more rapidly than Germany in expanding and improving their education and research systems. Again and again, the main reasons cited for the sad state of Germany's education and research sectors included a lack of suitable federal authority, fragmentation of responsibilities, "egoism" on the part of the *Länder* and inadequate financial support.¹¹⁵

The Federalism reform of 1969

The inauguration of the grand coalition of 1966 brought a paradigm change, in education and science policy, that was supported and even promoted by the *Länder*. For it was the *Länder* themselves – represented by the Conference of Ministers of Education and Cultural Affairs (KMK) – who, in the early 1960s, began pushing for greater co-ordination between the *Länder* and the Federal Government. At their initiative, the German Educational Council (*Deutscher Bildungsrat*) was established in 1964.¹¹⁶

Just a few years later, in 1969, a constitutional reform was adopted. In the main, the reform was designed to obligate the *Länder* to apply standardised economic and budgetary policies. Introduction of joint tasks (*Gemeinschaftsaufgaben*), via Articles 91a and 91b of the Basic Law (GG), and of Federal authority to issue framework laws for higher education institutions, then decisively changed the distribution of responsibilities in the area of education and research, however. Article 91b of the Basic Law made it possible for the Federal Government and the *Länder* to co-operate in the areas of



Neural network
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education planning and research.¹¹⁷ National co-ordination, and joint financing, of education and research became possible.¹¹⁸ As a result, competitive federalism gave way to a form of co-operative, solidarity-oriented federalism with the normative aim of applying “active, society-shaping policy”¹¹⁹ and the ideal of achieving consistent living conditions throughout all *Länder*.¹²⁰

In 1970, as part of the change in the Basic Law, the *Bund-Länder* Commission for Educational Planning was established. In 1975, that commission’s area of responsibility was expanded via the Framework Agreement on Research Promotion (*Rahmenvereinbarung Forschungsförderung*), and in 1976 the body was renamed *Bund-Länder* Commission for Educational Planning and Research Promotion (BLK).¹²¹ In the years that followed, the BLK then provided key impetus for education and research.

The following section considers the area of education. Long before the change in the Basic Law, a *Länder* body for horizontal co-ordination had been in place: the Conference of Ministers of Education and Cultural Affairs (KMK), which had been founded in 1948. With the arrival of the BLK, another federative body came to this arena. The newly founded BLK differed from the KMK in terms of both orientation and tasks. Conceived primarily as a body for developing Germany’s education and research systems, it engaged the assistance of experts in scientific and educational policy, initiated and evaluated relevant programmes and model tests and, in many cases, applied such programmes and tests on a large scale. In addition, the BLK reinforced ongoing dialog between the Federal level and the *Länder*. That, in turn, led to greater transparency on both sides, and it gradually brought the Federal and *Länder* sides closer together in this area. In 2000, in response to publication of the results of the Trends in International Mathematics and Science Study (TIMSS), in 1998, and of the Programme for International Student Assessment (PISA), in 2000, concrete programmes were launched for raising educational levels in Germany and jointly addressing obvious inequalities of educational opportunities, inequalities tied to social background.¹²² A wealth of model programmes were initiated and carried out.¹²³ Outside of the BLK framework, the Investment Programme for the Future, Education and Childcare (IZBB) is an especially noteworthy example. That

programme, which was approved in 2003, comprised two programme areas: quantitative expansion of, and qualitative improvement of, programmes in all-day schools.¹²⁴ The programme provided some EUR 4 billion of funding for establishment of a total of nearly 7,200 all-day schools, including schools in all *Länder*. Furthermore, the programme ran first from 2003 to 2007 and was then extended, on a cost-neutral basis, until 2009.¹²⁵ A second programme, Ideas for more! learning all day (GTL), began in 2003 and was extended until 2014.¹²⁶ Its purpose is to develop content for all-day-school programmes. The GTL programme is supported by the German Children and Youth Foundation (GCYF), reflecting the fact that in 2003 the Federal Government still had no responsibility for the area of school policy, and a mediated form of financing was needed.¹²⁷ It is Germany’s only school-development programme in which all *Länder* and the Federal Government participate and in which regular horizontal exchanges between the *Länder* take place.¹²⁸ As a result of the further constitutional (Basic Law) amendments adopted in 2006, and of the resulting dissolution of the BLK, other relevant programmes, such as programmes for promoting language skills of immigrants, were not able to be implemented on the scale originally planned.

In the area of research funding, Federal-*Länder* co-operation developed prior to the constitutional reform of 1969 – i.e. considerably earlier – and developed more solidly.¹²⁹ In 1955, research into civilian use of atomic energy, which fell within the Federation’s genuine scope of responsibility, led to the founding of a ministry of atomic energy. In 1963, aerospace technology, another major technology area, emerged; later on, it was the focus of key areas of responsibility of the Federal Ministry of Research that was subsequently founded. In 1964, several departments of the Ministry of the Interior that were involved with science funding were moved out of that ministry and incorporated within the Ministry of Research. In that same year, following six years of preparation, a Federal-*Länder* agreement on “funding of science and research” was adopted.¹³⁰ The Troeger Commission, which was appointed in 1966, developed proposals that ultimately led to the constitutional reform of 1969, oriented to financing, and strengthened the Federation’s scope of responsibility. That reform was required because the *Länder* needed Federal assistance in financing an enormous,

rapid programme of new university construction. As a result, a veritable thicket of agreements, forms of co-operation and modes of financing developed, all of which were ultimately covered by the constitutional amendments Articles 91a and 91b GG (Basic Law). In the area of research, the 1969 reform of Germany's federal system was thus "nothing other ... than constitutional institutionalisation, legalisation and intensification of co-operation practices that previously had been unconstitutional".¹³¹

In the following years, Federal-*Länder* co-operation continued to develop apace. Prior to the constitutional reform of 1969, Federal investments had been concentrated on funding of application-oriented and cost-intensive large-scale research. As early as the 1969/70 fiscal year, however, the Federal Government initiated a range of programmes for development of new and innovative technologies, including technologies outside of the bounds of existing large-scale research.¹³² Those programmes included efforts in the areas of environmental protection and environmental management, biotechnology, biomedicine, traffic and transport technologies, new communications technologies and health-care technologies, and a social-sciences research programme on humanising the workplace.¹³³ Among the key changes that now applied, the Federation and the *Länder* jointly financed selected research institutions – the institutions of the so-called Blue List (*Blaue Liste*).¹³⁴ The number of Blue List institutions, which now belong to the Gottfried Wilhelm Leibniz Science Association (WGL), increased continually since 1969, and it nearly doubled when many research institutions in the new German *Länder* were added following German reunification.¹³⁵

The Federalism reform of 2006

The aims of the constitutional reform of 1969 had included addressing the threat of an "educational catastrophe" and the "technological gap". Since then, much had been achieved in the area of research. Major challenges remained in the area of education, however. Nonetheless, Article 91b (2) GG was eliminated, without replacement, as part of the federalism reform of 2006.¹³⁶ For the education sector, that move meant the elimination of the joint task on education planning and of the joint financing of that task.¹³⁷ Now, the Federal Government and the

Länder can co-operate only on the basis of agreements concerning the assessment of the education system's performance in international comparison. In addition, education monitoring is included in the joint task on educational reporting. Even the Federation's financial assistance to the *Länder*, for especially important investments in the education sector, has been eliminated. Pursuant to Article 104b GG, the Federal Government can provide the *Länder* with such financial assistance only insofar as the Basic Law gives the Federal Government relevant legislative authority. In the area of school policy, the Federation no longer has such authority (prohibition of co-operation).¹³⁸ What is more, since the Federalism reform, authority for regulation of provisions pertaining to civil-service careers and to remuneration of *Länder*-level civil servants (and thus also of teachers) lies with the *Länder*.¹³⁹ As a result, in the education sector, the co-operative federalism in place prior to 2006 has been supplanted by a competitive or "shaping" federalism.¹⁴⁰ In the area of research funding, on the other hand, the structures for Federal-*Länder* co-operation have remained largely intact.

In the following section, the Expert Commission considers the current situation of federalism in the area of research funding. The focus of the present report is on joint Federal-*Länder* funding for research institutions in the non-university sector. A study of research funding in the area of universities and universities of applied sciences will follow in the 2012 report; the present report only touches on that topic, with regard to the (constitutional) legal bases for co-operative federalism in research funding.¹⁴¹ Analysis of institutionally oriented research funding leads the Expert Commission to recommend that the already successful co-operation between higher education institutions and non-university research institutions be expanded and that a common financing key be used for all non-university research institutions.

The Expert Commission then comments on the situation of federalism in the area of education. For innovation depends not only on suitable research funding; it also depends on well-trained people who have the opportunity to develop their potential. Good education policy is a necessary basis for good innovation policy. The Expert Commission calls for balanced Federal-*Länder* co-operation that can help solve central problems in the education sector. Specifically, it recommends that the prohibition on Federal-*Länder*

co-operation be eliminated. In addition, it calls for a renewal of the sort of co-operative federalism in place prior to the federalism reform of 2006. At the same time, however, the goals to be pursued should be considerably more ambitious than earlier goals, and reforms in the education sector should be moved forward on a solid scientific basis.

Federalism in basic funding provided to institutions

The fundamental distribution of responsibilities between the Federation and the *Länder*, in the area of basic funding provided to institutions, remained largely unchanged following the Federalism reform of 2006. The amended Article 91b GG also calls for Federal-*Länder* co-operation in funding of institutions and projects for scientific research.¹⁴² To be sure, with the elimination of the Federal framework authority for higher education, and greater autonomy of the *Länder* with regard to the construction of buildings for higher education, the primary responsibility of the *Länder* in the higher education sector was strengthened. In matters of supra-regional importance, however, responsibility for funding research projects at higher education institutions continues to lie with both the Federation and the *Länder*. In addition, the amended version of the article now also allows for co-operation in research and teaching.¹⁴³ On the other hand, in this area, in contrast to the situation prevailing in the non-university sector, any Federal involvement is subject to the explicit consent of all *Länder*.¹⁴⁴

The new aspects that have resulted from the federalism reform include the Joint Science Conference (GWK) of the Federation and the *Länder*, which began its operations in 2008, on the basis of the new Article 91b GG. The entities represented in the GWK include the Federal and *Länder* ministers/senators responsible for science and research and for finances. A successor organisation to the BLK, the GWK considers all issues of research funding, of science and research policy and strategy, and of the science system, that affect both the Federation and the *Länder*. In addition, the GWK develops task and financing structures in the area of basic funding provided to institutions.

Federal-*Länder* co-operation in basic funding provided to institutions

The research funding that the Federation and the *Länder* jointly provide to research institutions is provided via agency organisations. The financing mechanisms for such organisations are set forth in the so-called GWK agreement¹⁴⁵ and in separate “execution agreements” oriented to the specific research institutions concerned.¹⁴⁶ Separate organisations are responsible for managing research funding for a) universities and b) non-university institutions. This separation is a characteristic of the German system that results from the persisting clear separation between research at universities and research at non-university institutions. The German Research Foundation (*Deutsche Forschungsgemeinschaft, DFG*) plays a central role in research funding for the higher education sector. Its funding resources are provided jointly by the Federation and all *Länder*, in keeping with the Königstein key¹⁴⁷. The DFG, the largest self-governing science organisation in the German science sector, is charged primarily with selecting, via competitive processes, and with financing of, research projects at higher education institutions and research institutions.¹⁴⁸ In the area of non-university research funding, which accounts for the majority (about three-fourths) of total joint Federal-*Länder* funding for research institutions, a total amounting to about EUR 6.3 billion,¹⁴⁹ the Federation and the *Länder* co-operate primarily via the country’s major research organisations, most notably the *Fraunhofer-Gesellschaft* (FhG), the Helmholtz Association of German Research Centres (HGF), the Gottfried Wilhelm Leibniz Science Association (WGL) and the Max Planck Society (MPG).

The poor co-operation between the university-research and non-university-research areas has increasingly been criticised as a constraint on the competitiveness of Germany’s science sector, and there have been repeated calls for this deficit to be overcome.¹⁵⁰ The Initiative for Excellence and the Pact for Research and Innovation have provided important impetus in that direction. Via targeted incentives, they have triggered a trend toward greater networking and co-operation between universities and non-university research institutions.¹⁵¹ Undoubtedly, improvement of such co-operation is influencing co-operative federalism’s established (financing) practice in research funding.

TAB 01 Forms of co-operation between universities and non-university research institutions

Model	Form of co-operation	Degree of institutionalisation of the co-operation
GRC	Co-operation in the framework of a joint co-ordination body, with autonomy of the co-operating institutions left intact	Low
JARA	Co-operation in the framework of joint subject-oriented sections, and of partnership-based management structures	Medium
KIT	Institutional merger producing a single legal entity	High
Source: own depiction		

In the following section, three comprehensive models for co-operation are described, as a means of illustrating currently existing forms of co-operation between universities and non-university research institutions. As the illustrative models show, higher education institutions, financed by the *Länder*, and non-university research institutions, jointly financed by the Federation and the *Länder*, are co-operating successfully. On the other hand, differences between the financing keys applied to non-university institutions are hampering the establishment of efficient models for co-operation.

New models for co-operation between universities and non-university research institutions

Good illustrative examples of the development outlined above include the Göttingen Research Council (GRC), the Jülich-Aachen Research Alliance (JARA) and the Karlsruhe Institute of Technology (KIT). While these organisations differ significantly in specific aspects, they all exhibit a new quality of institutionalised co-operation.

In the GRC, which was founded in 2006, the University of Göttingen, along with seven non-university research institutions – the Göttingen Academy of Sciences, five Max Planck institutes and one Leibniz institute – have placed their existing co-operation on an institutional foundation. The GRC is a body for co-ordination and for consensual adoptions of resolutions. In it, the various institutions involved co-operate in central matters of significance affecting all of them. At the same time, each institution retains its own institutional autonomy, and existing internal governance structures are not affected. Among the co-operation

models outlined here, the model applied in Göttingen exhibits the lowest degree of institutionalisation.

In KIT, and in JARA, a university and a major Helmholtz centre co-operate: in KIT, the University of Karlsruhe and the Karlsruhe Research Centre (FZK) work together, while JARA brings together RWTH Aachen University and the Jülich Research Centre. In each of these co-operation models, the university and the non-university research institution involved have established joint governance structures.

In JARA, no attempt was made to completely merge the university and the non-university research institution involved, and thus the foundation for its organisational structure is less complex, both legally and organisationally, than is the foundation for KIT's organisational structure. The "JARA agreement" simply provides a formal framework for establishment of joint topic-oriented sections. Each such "JARA section" is jointly managed by a director from the Aachen side and a director from the Jülich side. The four research areas currently in place in this framework comprise the heart of the co-operation between the two institutions involved. In addition, the management levels of RWTH Aachen and the Jülich Research Centre have been more tightly meshed.

Of the co-operation models outlined here, KIT exhibits the highest degree of institutionalisation, and thus its organisational structure is the most complex of the models' structures. In July 2009, the *Baden-Württemberg* state legislature (*Landtag*) passed the so-called KIT merger act (KIT-Zusammenführungs-gesetz), thereby forging the country's first institutional merger between a university and a non-university research institution. Via a highly involved legal

Financing mechanisms in basic funding provided to institutions¹⁵²

TAB 02

Federal-Länder key	Breakdown of the Länder share
Fraunhofer-Gesellschaft	
90:10	2/3 in keeping with funding requirements for institutes of the Fraunhofer-Gesellschaft that are located within the given <i>Land</i> , and 1/3, for all <i>Länder</i> , pursuant to the Königstein key ¹⁵³
Helmholtz Association of German Research Centres (HGF)	
90:10	As a rule, the <i>Land</i> in which the centre is located (host <i>Land</i>); different provisions apply for some centres
Max Planck Society (MPG)	
50:50	50 percent host <i>Land</i> ; 50 percent, for all <i>Länder</i> , pursuant to the Königstein key
Gottfried Wilhelm Leibniz Science Association (WGL)	
Predominantly 50:50	As a rule: 75 percent host <i>Land</i> ; 25 percent, for all <i>Länder</i> , pursuant to the Königstein key
Different arrangements apply for seven of 86 institutes	Institutes that carry out scientific-infrastructure tasks on a considerable scale: 25 percent host <i>Land</i> ; 75 percent, for all <i>Länder</i> , pursuant to the Königstein key Construction investments: Host <i>Land</i> (state)

Source: GWK (2010: 7).

construction, the two institutions, which were previously independent and – as a result of the large Federal share of financing for the former Karlsruhe Research Centre – were financed in highly different ways, received a joint governance structure. Internally, however, KIT will remain divided into a university area and an area for large-scale research. The two areas are closely interlinked via joint areas of responsibility, centres and priorities.

The KIT, which has a high degree of institutionalisation, illustrates the current constitutional limits to co-operation between universities and non-university research institutions, in a special way: the provisions of Article 91b GG require that the two areas of KIT be financed from separate budgets.¹⁵⁴

In spite of considerable differences in their institutional forms, the co-operation models are similar. The following occurs at all three locations:

- Strategic and research-relevant issues are jointly decided,
- Appointments of holders of academic chairs and heads of institutes are jointly planned or at least jointly co-ordinated,

- (Managerial) scientific staff of the non-university research institution are involved to a considerable degree in teaching at the relevant universities,
- In research priorities of relevance for all institutions, in research centres and in work groups, efforts are made to enhance integration of university and non-university research, and
- Greater co-operation is sought in training of young scientists and researchers.

The Expert Commission welcomes such forms of intensive institutionalised co-operation. It recommends that development of such models for co-operation between universities and non-university research institutions be intensified in future, in each case with retention of relevant regional or subject-specific characteristics. To date, in this area, universities have co-operated only either with non-university research institutions with 50:50 financing or with non-university research institutions with 90:10 financing. In future, however, institutionalised co-operation should be sought between universities and non-university research institutions with different financing keys. For example, in some regional centres, co-operation between Fraunhofer, Helmholtz, Leibniz and Max Planck institutes would be useful. Clearly enough,

an obvious way of facilitating such comprehensive forms of co-operation would be to simplify the financing mechanisms of the relevant non-university research institutions.

Financing mechanisms for non-university research funding

Applicable financing mechanisms differ strongly from research organisation to research organisation. Pertinent differences are found in the shares of total financing that come from the Federation and from the *Länder* (Federal-*Länder* key), and in the manner in which the *Länder* share is broken down by individual *Länder* (cf. Table 02). In the case of multilaterally financed research organisations, the host Land (state) of the jointly financed research organisation assumes only a certain percentage share of the *Länder* share (host Land share). The remainder is distributed, in accordance with the Königstein key, among all *Länder*. Each Land's share is calculated on the basis of population (weighted as one-third) and of tax revenue (weighted as two-thirds).¹⁵⁵

Need for reform of current financing practice

The financing mechanisms for the different research organisations are complex, and they differ widely. Historically, Federal participation in financing of research institutions pursuant to Article 91b GG was called for in cases in which the institutions carried out research of “supra-regional importance”. That differentiation criterion presents considerable problems when applied to current practice in financing research funding, however: in practice, regional and national interests are closely intertwined. Consequently, in relatively few cases will research actually have exclusively regional importance. What is more, the criterion of “supra-regional importance” in fact only determines whether the Federation is eligible to participate in financing of research institutions at all. And such eligibility provides no guidelines to the specific quantitative manner in which financing should be structured. The reasons why the Federation assumes 90 percent of the funding for some research organisations (FhG and HGF), and only 50 percent for others (MPG, WGL), cannot be derived from that criterion. The different keys applied to different research organisations and institutions, for dis-

tribution of costs between the Federal Government and the *Länder*, are historically founded and cannot always be logically justified. The vague justifications used for financing keys thus create considerable discretionary latitude.

The extent that such latitude can assume is illustrated by a current case, involving conversion of the IFM-GEOMAR institute, located at the University of Kiel. Previously, that institute for oceanographic research was part of the Gottfried Wilhelm Leibniz Science Association (WGL), and thus the Federation and the *Länder* assumed equal shares of the relevant costs. Now, as an institute within the Helmholtz Association (HGF), the Federation assumes 90 percent of its financing. The case of IFM-GEOMAR illustrates the risks incurred in instrumentalisation of research funding for purposes of financial policy: neither the institute's management, nor the Leibniz Association, nor the Science Council (*Wissenschaftsrat*) were involved in the decision regarding the change of overarching research organisation. And no convincing justification, founded on science-sector policy, was given for the decision. This indicates that the decision was largely a political one, and it highlights how easily assignment criteria can be misappropriated for political ends. What is more, the entry into force of the debt brake (*Schuldenbremse*), and the expiry of the Solidarity Pact II, in 2019, will considerably complicate budgetary situations, especially in the new German *Länder*. In this light, it must be feared that the above case in Schleswig-Holstein could set a precedent for “Helmholtzification” of research institutions that are financed 50:50 by the Federation and the *Länder*, i.e. for use of such conversion as a budgetary tactic for offsetting financial constraints at least to some degree.¹⁵⁶

“Helmholtzification” of research institutions, as a way of easing pressure on tight *Länder* budgets, is problematic not only because it can lead to undesirable political ends. It is also problematic because the pertinent financial advantages¹⁵⁷ for host *Länder* come at the price of palpable losses of autonomy for the affected research institutions. For unlike the research institutions of the Max Planck Society (MPG) and the Leibniz Association (WGL), which define their research priorities and topics largely by themselves (bottom-up), the research agendas of Helmholtz centres are dictated to a considerable extent by the involved funding providers (top-down).

A common financing key can be applied – and should be applied

For a wide range of reasons, a consistent, unified approach should be sought in research funding.¹⁵⁸ At a number of locations, close co-operation between *Länder*-financed higher education institutions and non-university research institutions has already emerged, with different financing keys being applied. A common financing key would facilitate such co-operation. Germany's non-university research sector is designed as a system of institution based division of work. Internationally, such division of work is seen as a strength of the non-university research system. The manifest trend in which some *Länder*, acting on the basis of budgetary constraints, have been carrying out financially motivated transfers between research organisations thus points in the wrong direction. And that wrong trend could intensify when the “debt brake” comes into force and the Solidarity Pact II expires.

The Expert Commission sees an urgent need for reform in this area, and it recommends that a common financing key be introduced, a key applying to all research organisations and research institutions. This would counter the above-outlined problems, and it would tend to make financing practice of non-university research institutions considerably more transparent and practicable.

But what sort of common financing key should be used? Since the financing keys for non-university research institutions consist of two components – the Federal-*Länder* key and the breakdown of the *Länder* share between the host Land and all other *Länder* – answering that question must involve discussing the following two questions:

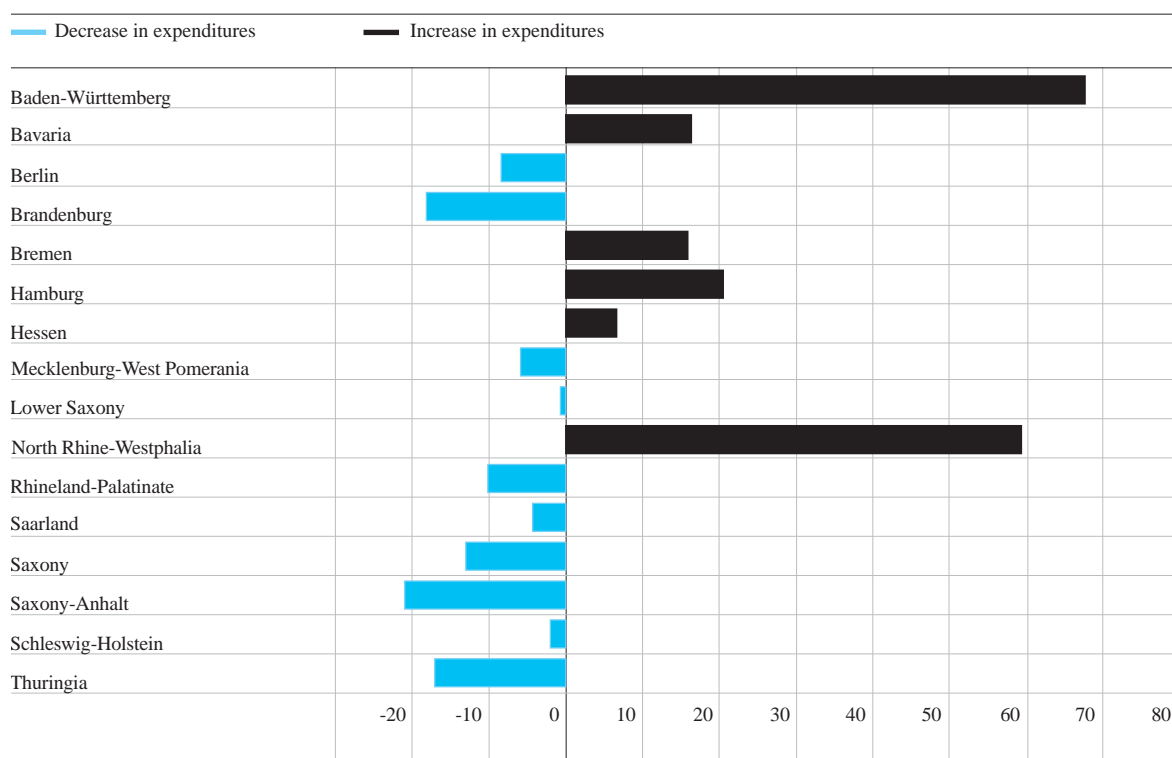
- In the common financing key, what should be the ratio between the Federal and *Länder* shares?
- What share should host *Länder* of non-university research institutions bear of the entire *Länder* share, i.e. how high should the standardised host-Land share be?

The first of these questions can be considered on two levels: on a programmatic level, taking account of principles of scientific freedom, and on a pragmatic level, taking account of the status quo for total Federal-*Länder* expenditures for research funding.

Programmatically, a key has to be found in which pertinent decision-making bodies can feature equal representation from the Federal and *Länder* sides. That aim would tend to negate the idea of a key in which the Federation would bear a very high financing share. In light of the financial restrictions applying to the *Länder* and their financing of higher education, the Federation could well consider a key of about 70:30 to be compatible with the aim of allowing fully equal representation. A pragmatic approach would be oriented to the de facto distribution of costs between the Federation and the *Länder*. The currently applicable distribution ratio is 71.8:28.2.¹⁵⁹ This would suggest that the financing keys for all non-university research institutions could be standardised at about 70:30, since that figure would require only insignificant changes in the ratios between Federal expenditures and *Länder* expenditures.

The second question is best answered programmatically. A host-Land share should be chosen that, on the one hand, allows host *Länder* of non-university research institutions to retain a clear financing responsibility for such institutions. On the other hand, the host-Land share should be tailored to ensure that financially weaker *Länder* remain able to afford cutting-edge research in non-university research institutions. In its calculations below, the Expert Commission has thus worked on the basis of a host-Land share of 25 percent of the *Länder* share.¹⁶⁰ The remaining *Länder* share of 75 percent has been distributed among all *Länder*, in accordance with the Königstein key. Having all *Länder* jointly finance (i.e. via solidarity) three-fourths of the *Länder* share would be in line with the Expert Commission's view that research usually has national priority and importance, and that non-university research institutions should not be concentrated primarily in financially strong *Länder*. Applying the Königstein key to 75 percent of the *Länder* share thus seems useful, since that would give financially strong *Länder* a larger proportional share of total expenditures for research funding than they currently have. Moving to a standardised 70:30 financing key would yield the Federation annual savings of EUR 85 million. Such savings should be applied to research funding, i.e. should remain within the research-funding system. A common 70:30 financing key would enlarge the *Länder* share by the same amount (EUR 85 million).¹⁶¹

FIG 01 Added and reduced expenditures of the *Länder* in connection with use of a common financing key of 70:30 and a standardised host-Land share of 25 percent (in millions of euros)¹⁶²



Reference years: HGF (including the Dresden-Rossendorf Research Centre, FZD), FhG: 2009; MPG: 2010; WGL: 2011)
Source: BMBF (2010e). Own calculations.

The Federal-*Länder* expenditures ratio depends on the number and type of research institutions present in the Land concerned, however. Consequently, the *Länder* would not all be affected in the same way by the added expenditures resulting from a common financing key. The added expenditures would be concentrated especially in those *Länder* in which institutes of the Helmholtz Association and Fraunhofer-Gesellschaft, subject to a 90:10 financing key, are located. *Länder* that primarily host Leibniz and Max Planck institutes with 50:50 financing would experience financial relief. As Figure 01 shows, the proposed change would translate into lower expenditures for ten *Länder* and higher expenditures for six *Länder*. The *Länder* with lower expenditures would include all new German *Länder*, including Berlin, and Lower Saxony, Rhineland-Palatinate, Schleswig-Holstein and the Saarland. The group of *Länder* with higher expenditures would include Bavaria, Baden-Württemberg, Hesse, North Rhine-Westphalia, Hamburg and Bremen. In light of the undisputable advantages of using a common key for funding of research at non-university research institutions, the Federation and the *Länder* should seek

to find ways of buffering any consequences of the new breakdown and should work to find a mutually agreeable solution in the near future. Such efforts could include, for example, considering the idea of making the Federation's EUR 85 million savings available, for a transition period, to the *Länder* with higher expenditures.

In sum, the Expert Commission concludes that the benefits of using a common financing key in funding research at non-university research institutions are clear and that such a key needs to be introduced. The Expert Commission recommends using a common key with a Federal share of about 70 percent and a *Länder* share of about 30 percent. That key would reflect the fact that the *Länder* also have high expenditures to bear in the higher education sector. The Expert Commission also recommends that the financing key be de-coupled from decision-making authority.¹⁶³ To ensure that neither the Federation nor the *Länder* receive disproportionately large decision-making authority, voting rights have to be equally distributed between the Federal and *Länder* sides.

Federalism in education, and the prohibition on co-operation

As part of the Federalism reform of 2006, Article 91b (2) GG was eliminated, without replacement. For the education sector, that move meant the elimination of the joint task on education planning and of the joint financing of that task: a prohibition on co-operation between the Federal Government and the *Länder* now applies in the area of relevant investments. In the view of the Expert Commission, elimination of the joint task education planning has negative consequences for the development of an effective, efficient education system. While the results of the 2009 PISA survey were somewhat better than those of earlier such surveys, significantly better results still can be achieved – and need to be achieved. In the interest of providing the necessary basis for such improvement, the Federation should be permitted to work with the *Länder* in developing and implementing active, structuring education policy. Such an option would greatly benefit Germany's education system as a whole and Germany's overall innovation sector.

In the view of the Expert Commission, the following factors speak in favour of substantive Federal-*Länder* co-operation in education planning and in favour of eliminating the prohibition on Federal-*Länder* co-operation in the area of investments: inequality of life opportunities, and the mobility barriers resulting from the large discrepancies, between the various *Länder*, in structures and performance.

The education systems of the *Länder* differ widely. Some *Länder* provide a great deal of permeability in transitions to grammar school (*Gymnasium*) and to higher education institutions, while other *Länder* impose stronger limits on such transitions.¹⁶⁴ Pupil performance also differs significantly between *Länder*. Comparative studies carried out by the *Institut zur Qualitätsentwicklung im Bildungswesen* (Institute for development of quality in education, IQB) considering the average cognitive skills of pupils of various *Länder*, for example, reveal significant differences, between *Länder*, with regard to performance levels and their distribution.¹⁶⁵ What is more, *Länder* differ in terms of the requirements they impose on their pupils, as is clear from the poor correlation seen between average competence levels achieved and certifications awarded.¹⁶⁶ As a result, a child's educational opportunities depend not only on his or

her own abilities and family background, they also depend on which Land the child grows up in (overall, this latter dependence is systematic). Such differences are likely to hinder the mobility readiness of parents with school-age children, and to hinder the mobility of adolescents seeking places for training or studies. Such barriers are highly detrimental for Germany's function as a centre for innovation.

To date, development of educational standards has done little to change this situation. It is true that educational standards are an area – the only area – in which systematic, *Länder*-overarching activities that affect everyday school life in all *Länder* are seen.¹⁶⁷ The first educational standards were presented in 2003 and 2004. Definitions are in place for Germany, describing what knowledge fourth-year, ninth-year and tenth-year pupils should have, on average, upon successfully completing primary school, secondary modern school (*Hauptschule*) and secondary school (*Realschule*), respectively.¹⁶⁸ And yet implementation of educational standards is left up to the *Länder* and the schools. In one consequence of that status, North Rhine-Westphalia's curricula explicitly take account of the standards, while Bavaria's curricula take virtually no account of them.¹⁶⁹

Barriers to reform, resulting from growing financing problems of the *Länder*

Enforcement of the prohibition on co-operation creates enormous problems especially for financially weak *Länder*. This is even truer now, following the 2009 introduction of the debt brake (*Schuldenbremse*). It is not simply by chance that Schleswig-Holstein abstained from relevant voting in 2006, in the Bundesrat (upper house of parliament), and is now calling for elimination of the prohibition on co-operation.¹⁷⁰ Educational opportunities for children must not be allowed to depend on the financial situation of their home state (*Land*).

Inefficiency in improvement of the education system, as a result of a lack of evaluations and of failures to transfer measures

Germany's 16 *Länder* face highly similar challenges, and they set themselves highly similar goals. All *Länder* make efforts to ensure that the largest possible

numbers of pupils reach high levels of education; all battle educational poverty. All wish to improve early-childhood education and language teaching, to promote pupils with migration backgrounds and from socially disadvantaged families and to enhance permeability between different educational tracks.

And yet many measures are developed, and many reforms carried out, without any knowledge of whether, and how, the efforts will actually work. Relevant systematic comparisons between the *Länder* are lacking. As a result, successful models cannot be transferred (i.e. applied elsewhere). And the *Länder* are not even promoting such transfer. A wide range of different projects and regulations coexist. In one Land, kindergarten is fee-free for one year, while in another it is free for three years. In yet another, kindergarten fees are determined using a sliding scale oriented to parents' social situations. Germany's 16 *Länder* use a total of 24 different language tests in measuring children's language skills before children enter primary school. But which of the language tests involved is the best at predicting how children will actually do? A recent study has shown that the most frequently used language test has little success in identifying potential problems in language learning.¹⁷¹

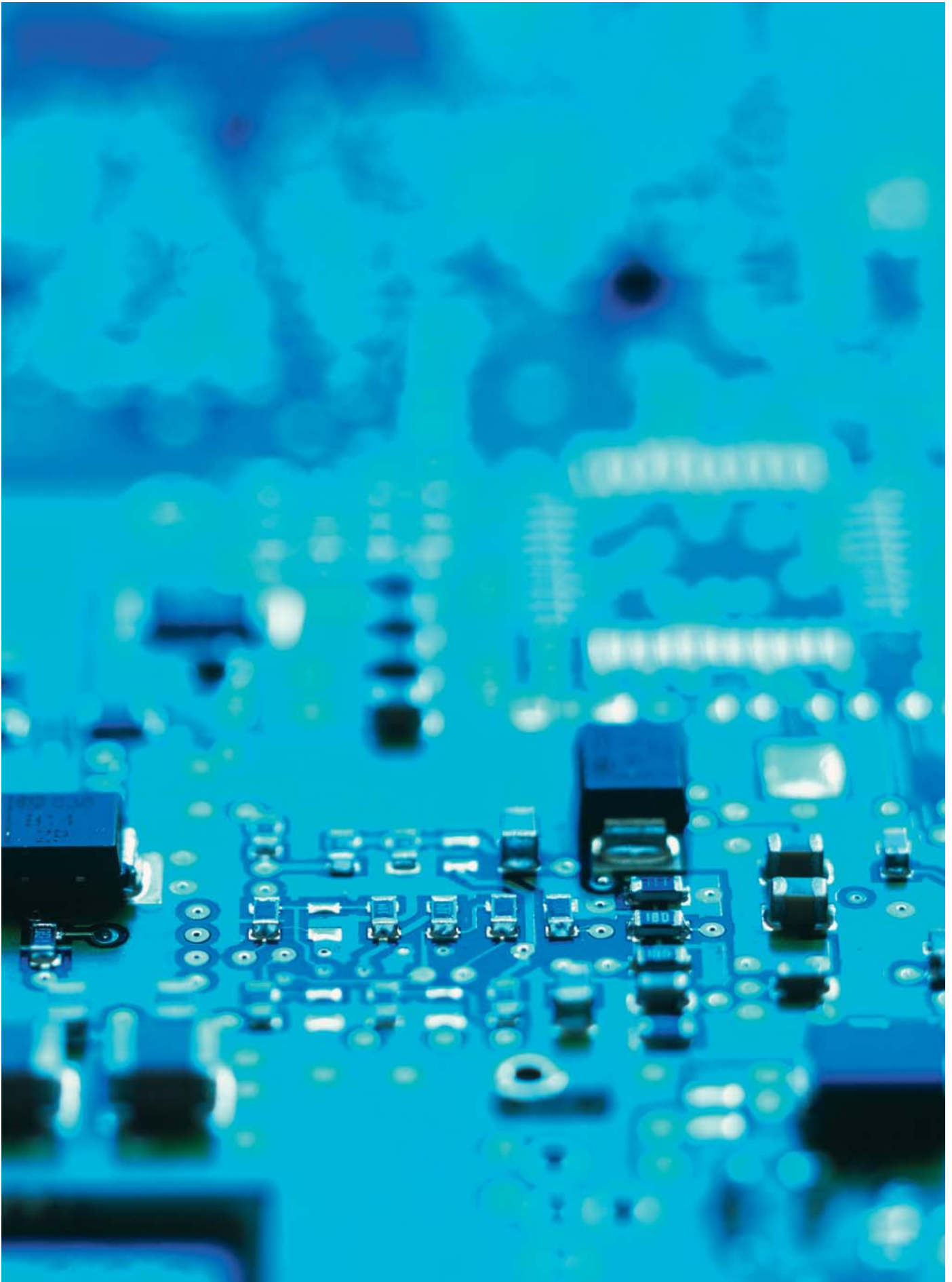
The lack of transparency in this area is constantly worsening. New structures emerge that are similar to existing structures but have been given different names. And different structures often have the same names. For example, secondary school (*Sekundarschule*) in Saxony-Anhalt comprises class levels 5 through 10 and leads to a secondary modern school (*Hauptschule*) or secondary school (*Realschule*) qualification. In Saxony, the corresponding school form is the middle school (*Mittelschule*). The secondary school (*Sekundarschule*) recently introduced in Berlin has its own senior grades (*Oberstufe*); it comprises class levels 7 through 13. In terms of structure and curriculum, Berlin's secondary school is similar to Hamburg's city-district school (*Stadtteilschule*). Such coexistence of measures and reforms has a detrimental effect on Germany's education sector and on innovation in Germany overall. The Expert Commission calls for greater transparency in this area. Measures need to be systematically evaluated, and it needs to be possible to transfer successful programmes from one Land to others. These aims could be achieved via intensified co-operation between the Federation, the *Länder* and the country's science sector.¹⁷²

Barriers to reform, due to halting of existing investment programmes

As a result of the prohibition on co-operation, and of elimination of Article 104a (4) GG, it is no longer possible to introduce new investment programmes in the area of education. Consequently, it is unclear, for example, how it will be possible to expand the all-day-school sector as of 2014 and to build and refine its curricula. Financing for establishment and expansion of all-day-school infrastructures ended in 2009. Since 2006, the Federation has been strongly constrained in its ability to finance school-policy measures. As the current reform of the *Hartz-IV* unemployment-benefit system shows, in providing the "education package for socially disadvantaged children", Federal Employment Agency offices are now organising and financing tasks that (all-day) schools should actually be carrying out for all children: warm lunches, remedial education and homework assistance/supervision, afternoon sports and music instruction. Having the Federal Employment Agencies (*Arbeitsagenturen*) carry out such tasks must be considered a last recourse, since the bureaucracy involved is inefficient and generates significant administrative costs. What is more, Employment Agencies offices are not likely to be able to match local schools and teachers in proper assessment of pupils' real needs. Schools and teachers are more familiar with pupils' everyday lives, and they have a better grasp of pupils' specific problems. In all likelihood, they can tailor remedial programmes much more precisely than Employment Agencies can. And all-day schools, with their afternoon remedial programmes, are especially able to carry out such tasks much more effectively. The Expert Commission thus urgently recommends that all-day schools be enhanced, both quantitatively and qualitatively. For that to be possible, however, the prohibition on co-operation will have to be suspended.

Conference of the Ministers of Education and Cultural Affairs (KMK) decision-making structures hampering reform

The reasons for the inertia in education-policy reform also include the manner in which the Conference of Ministers of Education and Cultural Affairs of the *Länder* (KMK) is organised and in which its tasks are defined. The KMK is a co-ordinating body; it



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Baltic Sea region
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is not an innovative body able to carry out scientifically based planning of innovation in the education system. The principle of unanimity still applies to its decisions, although that principle has been loosened somewhat for key decisions. With its annually changing presidency, and the ongoing shifting of partisan interests that that entails, the KMK was in need of reform even prior to the prohibition on co-operation. That need has become all the more apparent following the Federalism reform. The Expert Commission thus recommends that a body be established that has a longer-term focus and that has governance structures that are less subject to blockage, are scientifically founded and are able to move forward in improving the education system.

Germany's federalism has been a success. The prohibition on co-operation, however, has halted progress in improving Germany's overall educational standards and levels – and, thus, is braking the development of Germany's innovation sector. Efficiency and performance improvements are possible within a system of co-operative federalism, as the area of research funding has proven. For this reason, the Expert Commission urgently recommends that the prohibition on co-operation be suspended. As a central policy area, education policy must be seen as a multi-level task. Federal impetus could help trigger urgently needed reforms in the education sector.¹⁷³ At the same time, suspension of the prohibition on co-operation, and strengthening of co-operative structures, will not alone suffice to solve the problems involved. Such moves have to be followed by suitable education-policy measures. The German education system can be successfully improved only through decisive, concerted efforts, aiming toward specific education-policy goals.

B 2 THE EUROPEAN DIMENSION OF R&I POLICY

Since the year 2000, an attempt has been underway, in the framework of the European Research Area (ERA), to improve Europe's performance as a centre for R&I. To that end, targets and support instruments have been developed, at the level of the Member States and of the EU, aimed at intensifying co-operation and co-ordination and at enhancing information exchange between actors in the R&I sector.¹⁷⁴

As a result of this development, R&I policy in Europe is no longer being managed on the exclusively national basis that guided such policy until about two decades ago. The purpose of such measures is to establish Europe as one of the world's leading research regions. As part of such efforts, its quality standards in research and innovation, already high in some regards, are to be improved, and European economic growth is to be reinforced in a lasting way. R&I activities co-ordinated on an EU-wide basis are to become the heart of European growth policy.

The Expert Commission welcomes the ERA initiative, since it can help reinforce research and innovation in Europe in a lasting way. In this chapter, the Commission comments on the recent development of European R&I policy and provides proposals for its future structure and orientation.

Origin, aims and instruments of the European Research Area (ERA)

Until the year 2000, R&I policy in Europe was nationally fragmented in the extreme. A few trans-boundary initiatives, along with the Framework Programmes (FP) for Research and Technological Development, which were launched in 1984, the EUREKA and COST programmes and a small number of joint research centres¹⁷⁵ were exceptions. Until the year 2000, intensive co-operation developed solely in the areas of nuclear research, aerospace and defence. Basically, R&I policy remained a national concern for each of the Member States, however.¹⁷⁶

In the past ten years, the field of R&I policy has generated great dynamism at the EU level and grown considerably in importance. The initiative for establishment of the ERA, which was launched in 2000, brought a reorientation focused on a coherent European innovation policy. Figure 02 presents the steps taken to date within that initiative.

European R&I policy, in its reoriented form as of 2000, concentrates on three core areas:¹⁷⁷

- Creation of a European Research Area with improved co-operation structures, livelier competition and optimised use of resources,
- Improvement of co-ordination between national research activities and strategies,

- Development of a European research policy that integrates all policy areas of relevance to R&I policy, at the European and national levels.

To achieve these aims, a range of new policy instruments were introduced¹⁷⁹ that complement conventional co-operation-support strategies. Among these are jointly defined national aims, strengthening of excellence support provided by the European Research Council (ERC) and the European Institute of Innovation and Technology (EIT), and co-ordination measures such as the European Technology Platforms (ETP), ERA-Net and ERA-Net Plus (cf. Box 02). These instruments were positively received in Germany in particular. In October 2010, acting under the impression of the financial crisis, the European Commission presented the strategy paper “Innovation Union”, oriented to the further development of European R&I policy through 2020. That paper calls for increases in R&D expenditures, for more effective funding allocations and for modernisation of European education and research institutions, with an emphasis on promoting excellence and enhancing support provided by business enterprises.¹⁸⁰

Funding programmes and resource allocations

Figure 03 shows allocations of resources in important European R&I policy programmes.¹⁸¹ The overview also includes the budgets of major European research institutions, such as the European Organisation for Nuclear Research (CERN) and the European Space Agency (ESA). The various funding programmes are described in Box 01.

The following sections focus in greater detail on the Structural Funds, the 7th Research Framework Programme (FP7) and the European Research Council.

Innovation support in the framework of the Structural Funds

The most important contribution, quantitatively speaking, to promotion of innovation in the European economic sector comes from the Structural Funds.¹⁸² Support in the framework of the Structural Funds is provided via a large number of national and regional programmes, initiatives and measures to which the Structural Funds make financing contributions.

On the one hand, the Structural Funds are oriented to strengthening of cohesion – with an emphasis on supporting catch-up development of selected regions in the Member States. On the other hand, innovation support has been growing in importance. The Expert Commission doubts whether the aims and processes of cohesion policy can be usefully combined with the aims and processes of innovation policy.¹⁸³ The European Commission itself takes a critical view of the current situation – although it does so from a different perspective. In the framework of the Europe 2020 initiative, it proposes that Structural Funds allocations be tailored more precisely, duplicate financing be avoided, and greater attention be given, in funding, to regional circumstances.

Recently, by initiating a working group within the Scientific and Technical Research Committee (CREST), Germany took an active role in optimising co-ordination of the Structural Funds and measures under the 7th Research Framework Programme (FP7).¹⁸⁴ The guidelines formulated by the working group call on national and regional decision-makers to co-ordinate the two funding lines – the Framework Programme and the Structural Funds – as efficiently as possible, in order to achieve greater overall effectiveness.¹⁸⁵ It is urgently necessary for all Structural Funds resources to be used more efficiently. The Federal Ministry of Economics and Technology (BMWi) has already acted on these considerations, by implementing a National Strategic Reference Framework (NSRF). In addition, the German side has called for RTDI-relevant Structural Funds resources to be focussed on application-oriented research areas in the period after 2013.¹⁸⁶

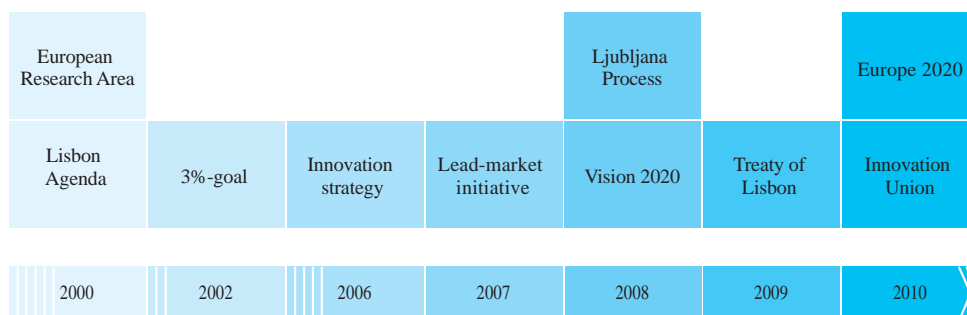
7th Research Framework Programme

Bibliometric studies have shown that parts of the funding provided in the Framework Programme context have been supporting excellent research.¹⁸⁷ The 7th Framework Programme has considerably increased the relevant available funding. For the period 2007 to 2013, it now amounts to EUR 6.15 billion¹⁸⁸ per programme year, or an increase of nearly EUR 3 billion per year over the three preceding framework programmes.¹⁸⁹

Comparisons with previous Framework Programmes show that EU support has been growing in importance

Development of European research and innovation programmes since 2000

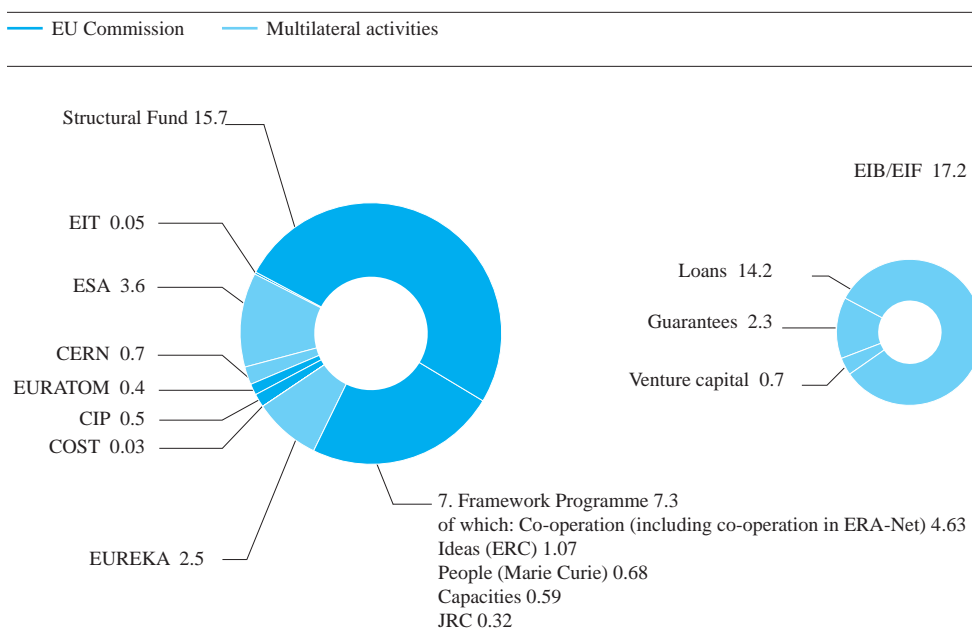
FIG 02



Source: Daimer et al. (2011: 4).

Funding allocations in important programmes of European research and innovation policy¹⁷⁸

FIG 03



In billions of euros per year. Figures relative to funding volumes: for EU Commission programmes and COST, planning period 2007–2013; for EIT, 2008–2013; for EIB, 2008–2009; for EUREKA, 2005–2009; for ESA/CERN, 2009. Source: Rammer et al. (2011: 19).

BOX 01

Important European research and innovation policy programmes¹⁹⁰

Structural Funds are financing instruments of European regional policy, designed to strengthen economic and social cohesion in the EU. Originally oriented to the aim of financially supporting poorer regions in catch-up development, they have been expanded to include (inter alia) support for research, technological development and innovation (RTDI)¹⁹¹. The last of these areas of support is open to all EU Member States. The available Structural Funds resources for the period 2007 to 2013 amount to EUR 347 billion. Of that amount, Germany receives a share of EUR 26.3 billion. Throughout Europe, an average of EUR 15.7 billion are earmarked annually for RTDI measures in the period 2007 to 2013.

The **7th Research Framework Programme (FP7)** comprises the elements Co-operation, Ideas (financing of the European Research Council – ERC), People (the Marie-Curie Programme for support of scientists' mobility), Capacities (research infrastructure) and the Joint Research Center (JRC; for support of the European legislative process in the area of R&I). Pursuant to Art. 163 ff. EC Treaty, the Framework Programmes have the aims of strengthening the Community's competitiveness and supporting its

research measures.¹⁹² For the 7th Framework Programme, the relevant available funding has been increased, in comparison to funding under preceding framework programmes; for the period 2007 to 2013, it now amounts to EUR 7.3 billion annually.¹⁹³

Since 1985, via **EUREKA**, the European Commission has supported application-oriented development of innovative products, processes and services, within the context of trans-boundary projects that are initiated by funding recipients themselves. Projects are not financed from a central budget; instead, relevant funding is managed individually by each Member State.¹⁹⁴ Some EUR 2.5 billion are available annually in the period 2007 to 2013.

Funding in the **COST** framework (European Cooperation in Science and Technology), which has been in place since 1971, supports basic research in the pre-competitive phase. Like EUREKA, COST is not restricted to specific technologies. As a rule, funded projects have small numbers of participants and run for relatively short terms.¹⁹⁵ The COST programme is providing annual funding of some EUR 29 million in the period 2007 to 2013.

The **Competitiveness and Innovation Framework Programme (CIP)** is designed to provide support

relative to national budgets. In FP7, the ratio between Framework Programme funding and the EU Member States' own state R&D financing (i.e. R&D financing by national and regional governments) is about 1:10. From FP4 to FP6, the corresponding ratio was only about 1:15, and in the first two framework programmes it ranged from 1:20 to 1:25.²⁰² Part of the reason for this development is that many Member States have not increased their R&I budgets to the same degree that the European Commission has increased its own budget in this area.²⁰³

The importance of current Framework Programme support can extend beyond the monetary realm: for a number of actors, Framework Programmes can influence the thematic orientation of R&I activities. At present, FP7 does not seem to be giving research a significant thematic bias, however. The relevant overall impacts vary: for smaller, and new, Member States, the support can be of considerable significance, whereas for actors in the large Member

States the available funding tends to be of secondary importance.

The support provided by the Framework Programmes tends to have relatively weak financial effects. With respect to business enterprises, the overall budget is too small. In Germany, EU funding accounts for only a small percentage of R&I financing.²⁰⁴ Under FP6, EU allocations for German higher education institutions amounted to only about three percent of the R&D funding provided, during the same period, by national institutions.²⁰⁵ The corresponding financing share for non-university research institutions under FP6 was somewhat higher, amounting to 4.4 percent. Under FP7, universities and non-university research institutions have indeed profited from improved opportunities for co-operation and the resulting effects of co-operation. Nonetheless, the Framework Programmes have been highly significant for only a few German players.

for small and medium-sized enterprises (SMEs). Its funding emphases are on information and communications technologies (ICT) and on renewable energies. For the period 2007 to 2013, it has a total budget of EUR 3.62 billion (about EUR 518 million annually).¹⁹⁶

The **European Atomic Energy Community (EURATOM)** was established in 1957.¹⁹⁷ Financing of EURATOM's tasks in the area of fusion and nuclear research, and radiation protection, is now carried out within the Research Framework Programme. For the period 2007 to 2011, it amounts to EUR 2.8 billion.

The **European Organisation for Nuclear Research (CERN)** is the largest major European research institution. It was founded in 1954 and is now financed by a total of 20 countries. Its budget of EUR 724 million (2009) is used for basic physical research.¹⁹⁸

The **European Space Agency (ESA)** is tasked with designing and carrying out the European space programme. ESA's budget in 2009 amounted to EUR 3.6 billion.¹⁹⁹

The **European Institute of Innovation and Technology (EIT)** was founded in 2008, with the aim of overcoming shortcomings in knowledge transfer and

co-operation between higher education institutions, non-university research institutions and researching business enterprises. To those ends, Knowledge and Innovation Communities (**KICs**) are formed, within the EIT framework, to drive the EIT's activities. For its work in the period 2008 to 2013, the EIT has an initial budget totalling EUR 309 million.²⁰⁰

The **European Investment Bank (EIB)** and the **European Investment Fund (EIF)** belong to the EIB Group. The EIB is owned by the EU Member States. The shareholders of the EIF include the EIB (66 percent), the European Commission (25 percent) and other European financing institutions (9 percent). The EIB borrows funds on capital markets and makes them available, at favourable terms – and usually in the form of loans and venture capital – for projects. The EIF (working in co-operation with the EIB) primarily supports small and medium-sized enterprises (SMEs). The EIB is financially independent; it finances itself by issuing bonds and other debt products.

The subscribed capital of the EIF amounted to EUR 2.9 billion in 2009; that of the EIB comprised EUR 232 billion.²⁰¹ Each year, in its area “Support for the Knowledge Economy”, the EIB grants loans totalling some eleven to twelve billion euros.

Promotion of excellence by the European Research Council (ERC)

Since 2007, the ERC has supported ²⁰⁶ outstanding scientists (along with their research groups) conducting especially ambitious and demanding basic research. Much of the research involved is interdisciplinary.²⁰⁷ The ERC is integrated within the “Ideas” focus of FP7, and it already has an excellent reputation within the European research community.²⁰⁸ Selections are made by independent, discipline-specific panels whose members are chosen by the ERC itself, and not by the Commission.

ERC grants have surely also been well-received in Europe because they offer attractive project funding, at attractive terms.²⁰⁹ German scientists have been highly successful in competition for ERC grants, while Germany's success in serving as a location for supported projects has been less than satisfactory to date.²¹⁰ Many German ERC grantees do not

work in Germany, and only a few foreign grantees conduct their research in Germany.

Figure 04 shows the numbers of projects supported to date, broken down by the scientists' nationalities. A total of 273 German citizens have received support thus far. Of that number, only 166 work in Germany, however. A total of 107 of the German scientists funded by the ERC conduct their research outside of Germany, either in an EU Member State or Associated State (in most cases, Switzerland). Too few foreign researchers have been coming to Germany, while German researchers have proven to be highly mobile or have even avoided the German system altogether. No in-depth studies have been carried out to determine the reasons why scientists leave their countries in order to work in a different national science system. On the other hand, experience gained to date in this area supports a number of conclusions – less than flattering ones – regarding the German system. With their rigid salary

BOX 02

New EU co-ordination instruments

Co-ordination instruments, such as the Joint Programming Initiative established by the European Commission in 2008, are becoming more and more important. Along with the European Technology Platforms (ETPs), which cover selected technological areas, the Joint Programming Initiative is designed to offer overarching solutions for current societal challenges.²¹¹

ERA-Nets and ERA-Nets Plus measures are established in the framework of thematically defined research areas. Designed to enhance co-ordination of Member States' research activities, they are aimed both at government ministries and at research organisations (in the case of Germany, at project management agencies and at the German Research Foundation (DFG)). Currently, some 70 networks are being supported in the ERA-Net framework (Associated States are also eligible to participate). Financing is provided for activities for co-ordinating, networking (i.e. linking) and opening up regional funding programmes.²¹² A first evaluation of the two ERA-Net initiatives has shown that such network-initiation instruments can be successfully implemented. In conjunction with Art. 185 Treaty on the Functioning of the European Union (TFEU) (formerly, Art. 169)²¹³, such instruments, via a bottom-up approach, can facilitate co-operation on a new level of joint action and can enhance coherence.

in knowledge transfer and in co-operation between higher education institutions, non-university research institutions and researching business enterprises. Via its Knowledge and Innovation Communities (KICs), which are set up in the form of public-private partnerships (PPP), the EIT promotes formation of networks linking partners in science and industry. One of the priorities of the German Council Presidency in 2007 was to build KICs and the institute itself, which Germany saw as a way of enhancing mobility of scientists.²¹⁴ Germany is participating vigorously in the EIT and in the various KICs: two of the 18 members of the Institute's Governing Board are Germans, and all three of the KICs established to date have German participation. It is still too early to analyse the KICs' general impacts and success. In position papers, the measure is termed – somewhat prematurely, in the view of the Expert Commission – as a “model of innovation governance”²¹⁵ that should be applied to other areas as well. The Federal Government has expressed especially clear support for the idea of integrating the EIT and the KIC model, in an institutionalised form, within the Framework Programme.²¹⁶ The Expert Commission views the KIC initiative as a suitable model for improvement of knowledge transfer between science and industry. It advises, however, that detailed impacts analysis be carried before the model is applied to other areas. For example, the question arises whether, in light of the EIT's aims, competition between consortia is the best form of competition.

regulations, civil-servant status for professors, burdensome teaching loads and bureaucratic processes, German universities are often unable to compete with higher education institutions of other countries, especially those of Switzerland and the UK. What is more, Germany is at a disadvantage with regard to the UK and certain other, smaller EU countries in that the international research community tends to be English-speaking.

European Institute of Innovation and Technology (EIT)

Another institution for promoting excellent research is the European Institute of Innovation and Technology (EIT). The EIT is the first European-wide institution to be charged with overcoming deficits

Improve co-ordination, clarify areas of responsibility

R&I policy at the EU level is highly fragmented and exhibits much overlapping of responsibilities. A range of different Directorates-General are responsible for the EU's many different and highly complex instruments for supporting R&I. Such distribution of responsibilities hampers the formation of a coherent EU innovation policy as well as the emergence of synergies between the various relevant measures. Still, at the beginning of the year the European Commission expanded the focus of the Directorate-General for Research, renaming that DG the Directorate-General for Research and Innovation, and initiated a range of relevant structural changes. The Expert Commission considers that initiative to be a step in the right direction. The Expert Commission

Allocations for Germany within FP6 and FP7, and national R&D expenditures

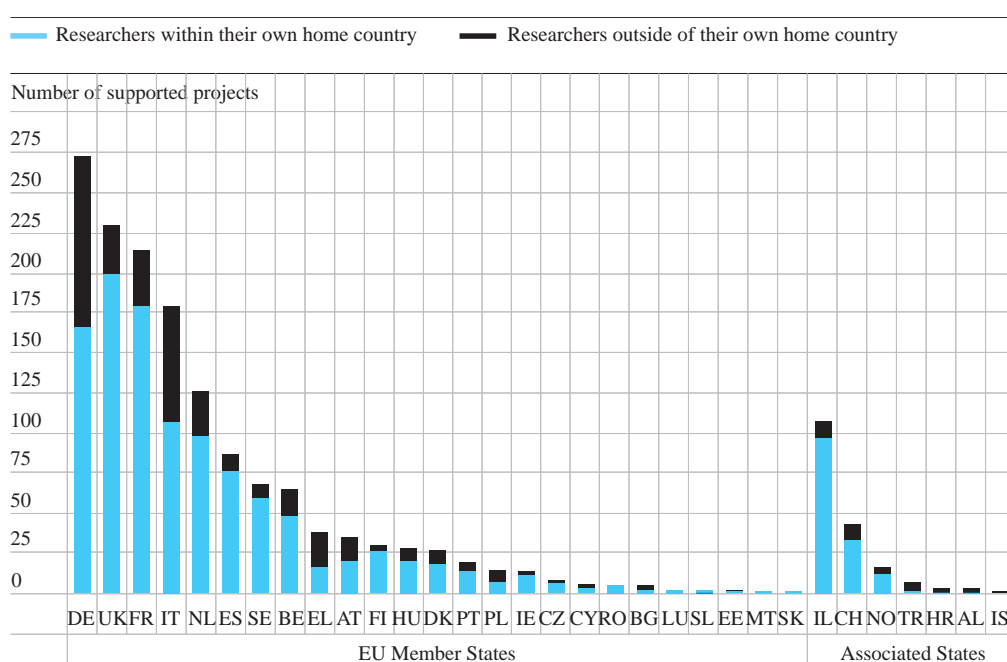
TAB 03

	Universities	Non-university research institu- tions / other	Business enterprises	Total
6th Framework Programme				
Allocations for Germany*, in millions of euros	235	339	182	756
R&D financing by the Federal Government and the <i>Länder</i> *, in millions of euros	7,688	6,739	2,038	16,465
Total R&D financing* in millions of euros	9,247	7,711	39,048	56,006
6th Framework Programme vs. R&D financing by the Federal Government / <i>Länder</i> , in percent	3.05	5.04	8.92	4.59
6th Framework Programme vs. total R&D financing, in percent	2.54	4.40	0.47	1.35
7th Framework				
Allocations for Germany*, in millions of euros	254	253	194	701
R&D financing by the Federal Government and the <i>Länder</i> *, in millions of euros	8,115	6,986	1,936	17,036
Total R&D financing* in millions of euros	10,304	8,820	44,428	63,552
7th Framework Programme vs. R&D financing by the Federal Government / <i>Länder</i> , in percent	3.14	3.62	10.00	4.11
7th Framework Programme vs. total R&D financing, in percent	2.47	2.86	0.44	1.10

*Average value in the period 2003–2006, per year. **Average value in the period 2007–2008, per year. Source: Rammer et al. (2011: 37). Grimpe et al. (2009). EU Bureau of the BMBF. OECD (MSTI 01/2010). Eurostat. Calculations of the ZEW.

ERC support, by researchers' nationality

FIG 04



Source: Calculations of the European Research Council

emphatically calls for better co-ordination between the European Directorates-General, as well as for better co-ordination with national state actors.

Explore possibilities for “variable geometry”

Some observers see a “two-speed Europe” as a prospect to be avoided at all costs. The Expert Commission sees a different prospect to avoid: that the speed of European policy could be determined by the slowest actor. The “variable geometry” principle could make it possible for different groups of Member States to co-operate in the R&I sector. Use of that principle, therefore, should be intensified. Acting flexibly, participating Member States could form theme-focussed groupings, while still remaining open for co-operating partners from less well-“equipped” Member States. The Expert Commission thus recommends that exploration of the possibilities for overlapping co-operation groupings, involving different Member States in different cases, be intensified. Such a model for differentiated integration would enhance Europe’s competitiveness in the global market in a lasting way.

Use the Open Method of Co-ordination more realistically

European R&I policymakers took an unprecedented step when they agreed on consistent, joint national aims without establishing relevant instruments that would be available throughout Europe. That approach is one element of the Open Method of Co-ordination (OMC),²¹⁷ which the EU has implemented in numerous policy areas since the Treaty of Lisbon was signed. The OMC makes possible joint co-ordination of European-wide reform processes in areas that did not originally lie within the EU’s scope of responsibility. In application of the OMC, the principle of subsidiarity is upheld.²¹⁸ Implementation of the aims is left up to the national actors themselves. This approach is based on the hope that integration of national political structures and actors will make it possible to achieve the agreed aims more quickly, and more efficiently, than would be possible via a homogeneous package of measures enacted at the European level.

In principle, the Expert Commission views action in the OMC framework as useful. At the same time, it

must be doubted whether such an approach was suitable in the case of the desired increase in R&D intensity, i.e. the 3 percent goal. The 3 percent goal is well-chosen in the case of Germany – it is not unrealistic, although it necessitates considerable effort. For other Member States, some with R&D quotas of less than 2 percent, the goal has been set much too high, however. On the other hand, some Scandinavian countries had already reached the goal when it was announced. In principle, European-wide goals should be attainable for all Member States, lest they become purely symbolic and undermine the potential of European policy. With regard to increasing R&D intensity, it would have been more useful to agree on aiming to increase national R&D intensities by 0.3 percentage points, in each case, by the year 2010. The Expert Commission calls for a more realistic approach in this area. Grand pronouncements are no substitute for sound policy.

Simplify application-related bureaucracy, and make co-ordination instruments less complex

Throughout all relevant measures, it is clear that stringent administrative requirements create enormous obstacles – for example, for SMEs (small and medium-sized enterprises), and even for SMEs operating within the framework of project consortia. Application-related bureaucracy also hampers first-time applicants, especially applicants from new Member States. Around such obstacles and barriers, an entire consulting economy has thrived. Applicants could avoid some of the costs for required advice if the long-promised reduction of bureaucracy would finally come about. For this reason, reduction of bureaucracy, and creation of transparency within application and approval procedures, should be key concerns of Germany’s current European policy. The issue of simplification also extends to structures and processes of the newly created co-ordination instruments within FP7 (ERA-Net, ERA-Net Plus, Joint Programming Initiative).²¹⁹ While the Expert Commission expressly welcomes the establishment of such instruments, the instruments’ current structures and processes still seem too complex, as the first interim evaluation has indicated.²²⁰

Improve co-operation in industry projects

In its last report, the Expert Commission noted that Germany needs to protect and reinforce its leadership in high-value technologies, such as automotive technology, chemical technology, mechanical engineering and electrical engineering. In addition, Germany's efforts in high technology urgently need to be systematically expanded, especially in segments in which Germany can achieve comparative global advantages.²²¹ In both cases, too little use has been made of technology-focussed co-operation between EU Member States, although such co-operation is highly significant for German companies. By way of example, we mention the urgent need to intensify European co-operation in the area of electromobility. In the framework of co-operation in a selected trans-boundary model region, efficient, focussed product and infrastructure development could be undertaken, and tested on a realistic scale (cf. Chapter A7). Synergies could also be achieved in the area of high-speed trains. National sensitivities play a large role in such efforts. Such sensitivities have repeatedly proven to be a barrier to development of new markets. For this reason, the Expert Commission urges that co-operation throughout Europe be improved in industry projects in the framework of R&I policy. Promotion of trans-boundary markets is a suitable means of encouraging co-operation between European industrial partners. Furthermore, national considerations should not be permitted to stand in the way of possible market consolidation.

Continue to move single-market harmonisation forward

Harmonisation of the European single market needs to be further intensified. Harmonisation of public procurement, of the legal forms that companies can take and of general legal norms (for example, in liability law) would benefit innovators in particular, a group for whom entry into other national markets in Europe continues to entail high costs. And such benefits would accrue especially to growth-oriented start-ups. What is more, patent systems would profit significantly from a simplified judicial system and from the introduction of an EU patent (EFI 2010:88, Chapter A6 of this report). As a result of fragmentation in its single market, Europe is still far from realizing its potential as an economic power.

Give Structural Funds a more precise orientation, and improve co-ordination with the Framework Programme

The Structural Funds have acquired great significance for R&I in Europe. At the same time, the extent to which the various aims of the Structural Funds measures are truly being achieved is unclear. The Expert Commission proposes that the impacts of Structural Funds resources for Research, Technological Development and Innovation (RTDI) be analysed, with a view to reliably quantifying the resources' potential to promote innovation and to creating an empirical basis for discussion regarding the existing parallel structures in the Framework Programme and the Structural Funds. One can gain the impression that Structural Funds resources are serving as tools for systematic, European-wide redistribution of funds – and thus are not achieving their actual convergence objectives. In the main, Structural Funds should be oriented to active support for weaker regions. They should not be generally open – via an expansion of their task spectrum – to all Member States as funding sources.

The Framework Programmes have a strong focus on excellence. To be successful in key European competitive procedures, regional innovation systems and their actors need first to achieve a sufficient degree of maturity.²²² For this reason, lasting support for weaker Member States, with regard to innovation structures, and in the framework of the Structural Funds, is generally to be welcomed, as long as such support is oriented to the aim of convergence.

Focus the Framework Programme more strongly on excellence

The Federal Government has warned against weakening support for excellence, based in the Framework Programme, in favour of cohesion-related aims.²²³ The Expert Commission shares these concerns, and it notes that, in administration of Structural Funds resources, administration of R&I-relevant resources needs to be more effectively separated from administration of other resources. Useful measures in this area include detailed co-ordination of innovation-relevant actors and Directorates-General at the EU level, with respect to the Structural Funds, and interaction between the agencies responsible for the

Structural Funds and for the Framework Programmes. As the German High-Tech Strategy has shown, interdepartmental co-ordination of all participating actors can enhance the effectiveness and efficiency of R&I policy – and such enhancement would certainly also be welcome at the European level.

Strengthen and expand the ERC

The Expert Commission expressly welcomes the establishment of the ERC and the ERC's orientation to research excellence and European-wide competition. The German Rectors' Conference (HRK) and the German Council of Science and Humanities (*Wissenschaftsrat*) have urged that the ERC's organisational stability be protected, and that its independence be assured. The Expert Commission supports that call.²²⁴ One of the special advantages of ERC support is that it promotes individual researchers. In principle, it offers supported scientists the freedom to choose their work location, and thus it enhances mobility. In practice, however, shifting of projects to other institutions often entails major expenses. ERC support highlights key weaknesses of the German university system. It is thus also an important indicator of the success of the German research system. Universities, universities' administrations and the *Länder* will be judged in terms of that success.

Act now to optimize ITER management

In Europe, important scientific projects are managed by supranational organisations such as EURATOM and ESA. The budgets for such projects are regularly approved by the European Commission, the Member States and the European Parliament. Execution of some projects leaves much to be desired in terms of transparency and control, however. In some cases, drastic cost overruns result, requiring national governments, the European Commission and the European Parliament to take "emergency action". Fund shortages in such projects have to be addressed by shifting funds from budgets of EU research programmes and other EU efforts. Such moves, in turn, impose considerable financial limitations on the European Union's Framework Programmes.

An example of serious management failure that produces such effects is seen in the ITER project²²⁵ (International Thermonuclear Experimental Reactor). ITER is a global project for the construction, and later operation, of an experimental fusion reactor in Cadarache, France. The project partners include the European Atomic Energy Community (EURATOM), China, India, Japan, Korea, Russia and the U.S. Operation of the fusion reactor is to begin in 2018.

The project was originally initiated by four partners (Russia, U.S., EURATOM and Japan). In 2003, China and South Korea also became partners in the effort; in 2005, India joined as well. Cost planning for the project, which was based on an estimate dating from 2001, was not questioned when the project was approved by the expanded group of partners. Within only two years after the project commenced, it became obvious that the planned budget framework was too small, by a factor of 2.5 to 3. EURATOM's contribution, for example, which was originally set at EUR 2.3 billion (in 2001 prices), grew to EUR 5.9 billion by the end of 2009. For the years 2012 and 2013 alone, cost overruns for the project are expected to reach 200 percent (EUR 2.1 billion instead of EUR 0.7 billion).

As a result of the large number of parties involved in the project, and of the work-sharing procedure that has been implemented, budget overruns cannot be adequately monitored and controlled. No overall project planning is in place, and each national ITER agency is responsible only for its own work package. Cost overruns for individual work packages, cost overruns that can be useful for national research institutes and for suppliers, can be passed on to other partners within the overall consortium. Since EURATOM has a 45 percent share of the overall ITER project, the EU has to bear a considerable share of the cost overruns.

To date, the European Commission and the participating Member States have been unable to establish efficient, effective management structures for supranational projects. The Expert Commission calls on the Federal Government to work for the establishment of suitable, efficient management structures that conform to standards for major supranational projects. Neither the EU nor Germany can afford the inefficient use of research funding that is currently taking place.

Launch the European Initiative for Excellence

The Expert Commission sees a need for institutionalised, long-term co-operation between excellent European higher education institutions.²²⁶ In some Member States, such as France, the UK, Denmark, Austria and Germany, national initiatives for excellence are already underway, with the aim of providing selective support to researching institutions and alliances between such institutions. The key criterion for such support is scientific excellence.²²⁷ The Expert Commission proposes that a European Initiative for Excellence be initiated, a mechanism whereby small groups of leading European higher education institutions would form networks and receive institutional support via the EU.²²⁸ Support should provide considerable funding, for sufficient duration to permit the establishments of lastingly stable co-operation relationships. As within the French initiative for excellence, funded institutions should receive an endowment that will yield interest that can be used to finance research and co-operation projects. Supported higher education institutions should have full authority over relevant funding allocations, and they should be permitted to co-ordinate their own research and teaching themselves, outside of any central administration for the effort. By properly co-ordinating curricula, such networks would be able to achieve high mobility potential, from the bachelor's degree level up.

An initiative for excellence at the European level would offer a number of advantages at once. It could help strengthen excellent, co-operative organised basic research in a lasting way, by providing the stable structures and long-term investments that are essentially important for open-ended, pioneering research. Furthermore, it would expand institutionalised EU-wide research co-operation. The networking involved could also help fulfil the aims of the Bologna Process and help reinforce what has been achieved thus far in that process. Before such a far-reaching measure can be planned and introduced, it must be discussed intensively throughout Europe, however. The results of the national initiatives for excellence should enter into such discussion. The European Commission should initiate the necessary discussion process by providing an overarching presentation of the experience gained to date with the national initiatives for excellence.

Strengthen Germany's role in European R&I policy

The era in which R&I policy in Europe was solely national in scope has been over for some time now. The aim of European R&I policy must be to establish Europe, via intensified co-ordination and co-operation, as one of the world's leading knowledge economies. In light of prevailing national interests, and because R&D measures at the European level tend to be inefficiently designed and bureaucratically structured²²⁹, that will be no easy task.

Over the past ten years, the Federal Republic of Germany has recognised this challenge and, on various occasions, has taken an active role in European co-ordination processes. The Expert Commission expressly welcomes such participation. Such efforts need to be further intensified. In today's increasing international competition, Germany will have no chance of success with a nationally oriented R&I policy. It lacks the resources that such a national orientation would call for. Strengthening and developing the European dimension of R&I policy is a matter of Germany's own vital interests, and it is in the interest of other European countries for Germany to take a strong, active role in shaping such policy at the European level. With the experience it has gained with the High-Tech Strategy, the Initiative for Excellence and other political processes, the German policy sector can bring much constructive impetus to the European policy process. At the same time, it must not be afraid to continue learning. Germany can profit from other countries' experience with certain political instruments and strategies.²³⁰ Significantly, in all likelihood, a leading role in shaping of European R&I policy will go hand-in-hand with the loss of some national decision-making authority.

NETWORK NEUTRALITY AND INNOVATION

B 3

For years, intensive discussion has been underway in the U.S. regarding the pros and cons of network neutrality, i.e. the issue of whether users or network providers are to decide how the Internet is to be used. This discussion also extends to the issue of whether, or under what circumstances, network providers should be able to block, delay or prioritise certain

content and applications. Yet another aspect has to do with whom network providers should be allowed to impose fees on for access to end customers.²³¹ The European Union,²³² the Federal Government²³³ and the German *Bundestag*²³⁴ have now also begun considering this issue.

BOX 03

Economic importance of the Internet

Internet economy

The spread of the Internet has led to the development of a great number of different services and applications. In 2008, revenue in the German Internet sector amounted to EUR 46 billion, so the Association of the German Internet Industry (eco) and Arthur D. Little GmbH. Of that amount, EUR 23 billion were generated in eCommerce, and EUR 17 billion were generated in the area of network infrastructure and operation.²³⁵

Internet use

In 2009, a total of 89 percent of all German companies with ten or more employees were using broadband access to the Internet.²³⁶ In that same year, a total of 64.6 percent of all German households had broadband Internet access.²³⁷ With those figures, Germany still only held a middle position, in the categories “Internet use by companies” and “Internet use by households”, in a comparison of OECD countries.

In light of the Internet’s economic significance (cf. Box 03), so the Expert Commission, the question arises as to what impacts regulation or non-regulation of network neutrality would have on the emergence and success of innovation in the Internet.²³⁸ In consideration of such impacts, the interests of the various actors involved (cf. Box 04) must be taken into account.

Background to the debate on network neutrality

The net-neutrality debate has developed in light of three main factors.

- In the original architecture of the Internet, network providers were unable to differentiate between the applications, services and content that moved through their network pathways (the net-

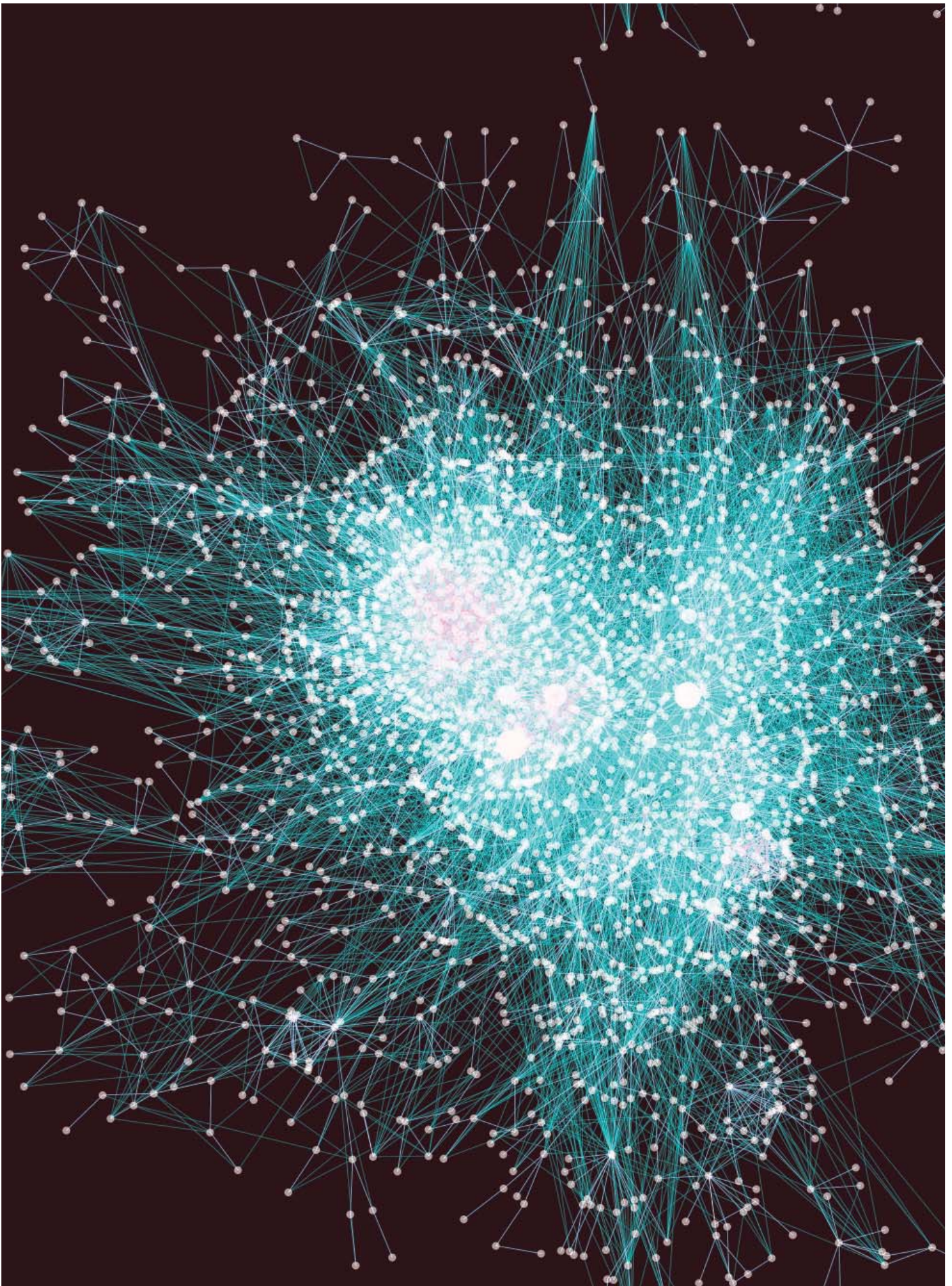
Key actors in the Internet sector²³⁹

BOX 04

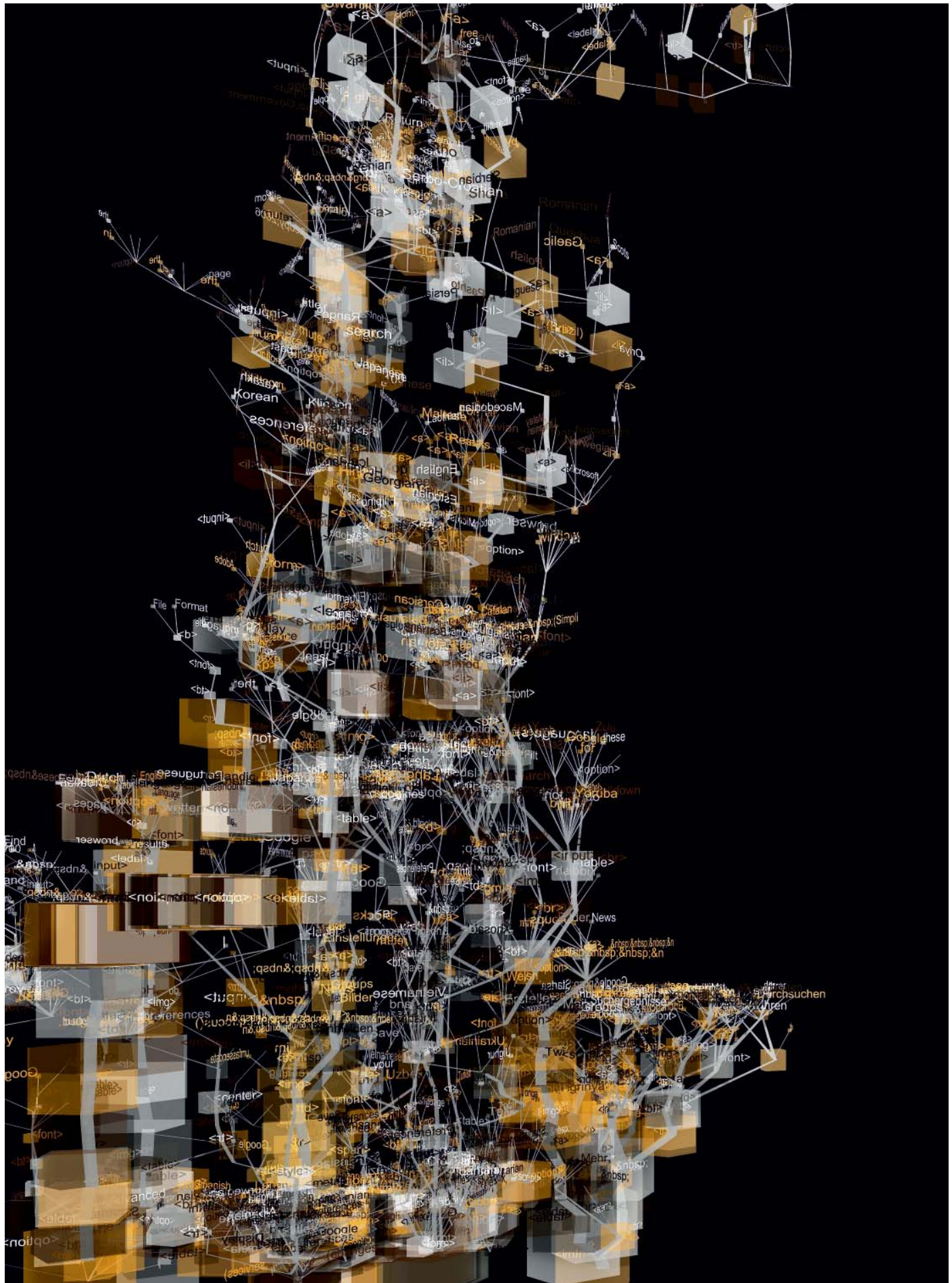
- Commercial providers of information – such as WetterOnline or Reuters – provide both newly created content and edited/processed content in the Internet.
- Private Internet users also contribute significantly to information production and dissemination in the network.
- Virtually all companies, government authorities, non-profit organisations, non-governmental organisations, etc. now have Internet presences via which they offer information, services and transactions.
- Intermediaries combine Internet content and make it available to users. That group includes companies such as Immobilienscout24, studiVZ and XING.
- Internet dealers, Internet-application providers and Internet-services providers, such as Spreadshirt, Pay Pal and ZanoX, offer products and services, in the Internet, for companies and households.
- Hosting and domain providers, such as STRATO, United Internet, Host Europe and Denic, make it possible for companies and private persons to take part in the Internet economy.
- Network providers, such as Deutsche Telekom, NetCologne, 1&1 and DE-CIX, offer stationary and mobile access via transmission pathways and access points that they provide.

work was “application-blind”). That made it impossible for network providers to differentiate between data packets on the basis of services and applications.²⁴⁰ Now, however, technology has emerged that makes it possible to analyse transmitted data packages in real time. In such analysis, it is possible to determine what sort of application a data packet belongs to (Internet telephony, e-mail, Web-search engine, peer-to-peer network, etc.). As a result, it is now possible for network providers to impose rules defining how different types of data packets are to be handled. Transmission of data packets can then be prioritised, delayed or even blocked on the basis of data packets’ origin or application classification.

The amounts of data being transmitted have increased considerably over the past few years.²⁴¹ On the one hand, the number of Internet users has grown.²⁴² On the other, use of motion pictures,



Computer-generated map of relationships between Weblogs
©Matthew Hurst/Science Photo Library



Visualisation of a source text
©Christian Rieckhoff/ Science Photo Library

which are bandwidth-intensive, has also been growing. What is more, data-intensive applications such as cloud computing, software as a service (SaaS) and the “Internet of things” are going to grow in importance (cf. Box 05). Such growth in bandwidth-intensive applications and services can lead to bottlenecks, unless investments in network infrastructure are being carried out at the same time. In data transport, the transit time required for transmission of data packets can increase and vary.

- Increasingly, formerly separate telephone, cable TV and mobile-communications networks are being integrated and replaced with networks using the Internet protocol. Network providers can respond to this trend by adding to their services and emphasising vertical integration. As a result, vertically integrated network providers are increasingly competing with independent content providers.

As capacity shortages – either real or supposed – emerge, network providers can have incentives to block or slow certain applications, or certain classes of applications, as a way of managing network bandwidth.²⁴³ In addition, network providers have made it clear that they wish to impose fees on application providers, for access to end customers, in order to be able to share in the profits of successful application providers (such as Google). Such fees could be imposed on application providers, for normal access to end customers, or could be tied to a special service, of the network provider, that gives preferential treatment to the applications in question. For example, paying application providers could receive better transmission quality, or the data packets making up a relevant application would not count toward end customers’ monthly volume limits for Internet use. Furthermore, network providers will seek to improve their positions in the access market and the application market. Whether the vertical integration that entails will create incentives to block, delay or prioritise applications, for reasons of market strategy, is currently being debated.

Incentives to block and delay

Network providers can exclude, from their own networks, content that – such as viruses and spam – can be damaging for end customers or can overload the network. Because this is not considered problematic from an overall economic perspective, it is

Cloud computing, software as a service and the Internet of things

In cloud computing, IT services (such as database services) are used in real time, via data networks. A study carried out under commission to BITKOM, the Federal Association for Information Technology, Telecommunications and New Media, predicts that revenue from cloud computing will grow from EUR 1.1 billion in 2010 to EUR 8.2 billion in 2015. In addition, half of that revenue will be earned via cloud services, especially via provision of programmes (software as a service).²⁴⁴

Software as a service (SaaS) is an alternative to conventional forms of software licensing.²⁴⁵ In SaaS, customers download software from the Internet and then pay rent or a leasing fee to use it. Operation of the relevant IT systems (installation, maintenance, updating and data back-up) is the responsibility of the provider.

The Internet of things can integrate virtually any type of physical objects within its infrastructure (i.e. not only computers and mobile terminal devices), thereby allowing them to be providers or consumers of various digital services. To be so integrated, objects must be equipped with suitable sensors (such as radio-frequency identification tags).²⁴⁶ Uses of the Internet of things include control of logistics processes and creation of assistance systems for senior citizens.²⁴⁷

not discussed in detail here.²⁴⁸ Most proposals relative to network neutrality call for allowing exceptions to net-neutrality rules in such cases.²⁴⁹ Blocking becomes problematic when vertically integrated network providers use it to exclude applications for reasons of market strategy.²⁵⁰

A vertically integrated network provider who blocks applications that compete with his own applications can be doing so simply as a way of increasing demand for his own applications. In the case of pay services, such blocking can thus directly increase profits.²⁵¹ In many cases, significant portions of the income earned in the applications market are earned via presentation of third-party advertising. In such arrangements, the provider’s incentive to exclude competing applications is the possibility of thereby increasing his own advertising income. Blocking can

also have the purpose of excluding applications of independent providers that compete with one's own applications in third-party markets.²⁵²

The benefits that vertically integrated network providers can gain by excluding competing applications can be offset by losses of market share in the Internet-access market. The key factor in this regard is the number of customers who switch to a different access provider as a result of the blocking.²⁵³ And that, in turn, depends on customers' willingness to pay for the blocked content, as well as on the degree to which the costs of switching providers influence customers' behaviour. In each case, the factors influencing the costs of switching providers include the period for which the customer is bound by agreement to his access provider; whether the service in question includes a package of different telecommunications services; and whether the customer is able to retain his or her e-mail address when he or she switches providers. Customers often greatly overestimate the costs of switching providers and thus are even less willing to make such switches.²⁵⁴ The perceived costs of switching providers must be assumed to play an important role – especially in the short term.

“Delaying” involves intentional slowing of the transport of certain types of data packets. Delaying can be used as a way of restricting use of data-intensive applications (such as peer-to-peer applications), in order to prevent overloading of the network infrastructure.²⁵⁵ In addition, delaying can be used for the same reasons of market strategy that are used to justify blocking. While delaying, when in force, is less apparent to customers than is exclusion of applications, it can greatly impair applications' functionality – and, thus, their attractiveness. Since speed is an important competitive factor, affected applications can be subject to considerable losses of customer demand by comparison to the situation without delaying. Services such as Internet telephony and online games are highly time-critical. For customers, therefore, delays can render services less attractive or even completely useless. When customers are not aware that services are being delayed intentionally, they may fail to see a need to switch providers. They may think that their independent application providers – the providers whose data packets are being delayed in transport – are responsible for the poor services quality they are seeing. As a result, one would expect that net-

work providers' revenue would suffer less from use of delaying tactics than it would from use of blocking.

Prioritisation and quality of service

“Prioritisation” means giving selected data packets preferential treatment over other data. For example, prioritisation might be applied to data packets from certain users, from certain application providers or of certain application types (such as Internet telephony or Internet TV). A closely related term is the so-called quality of service (QoS), which refers to a defined measure of performance. Network providers can offer different QoS levels for different types of data.

When data-transmission volumes near the available capacity limits, certain types of QoS frameworks can enhance efficiency. The many different types of applications offered/used in the Internet differ in their sensitivity to delays, jitter and data-packet losses. For example, Web-search and e-mail services are less sensitive to delays than are Internet telephony, online games and Internet TV. Different QoS levels can also make sense in that not all users of a given application attach the same importance to (optimal) data transport for the application.

Quality of Service (QoS)

BOX 06

The term Quality of Service refers to a defined performance level, provided via various procedures for influencing data streams in the network. A service / application with a given QoS has to reach its recipient with the corresponding quality intact.

For example, quality can be defined in terms of the delays that data packets experience before they reach their intended recipients, in terms of jitter and in terms of maximum levels of packet losses. Quality of Service can be achieved via a range of different techniques. Quality of Service architectures, for example, differ in terms of whether users or network providers assign QoS to applications or data packets, and of whether the pertinent quality criteria are defined relatively or absolutely (relatively: for example, in terms of less delay than would be experienced if all data packets were treated the same way; absolutely: for example, in terms of maximum delay allowed).

In overload situations, treatment of all data packets in exactly the same way can generate inefficiencies, as a result of differences in applications' quality sensitivity and in users' own preferences. During temporary capacity shortages, e-mails, whose technical quality does not suffer at all from short delays, may be transported prior to data packets for an Internet-telephony application, for example. Such preference would make the telephony application less attractive for users. It is possible that services that react sensitively to delays, jitter or packet losses could be forced out of the market.²⁵⁷

Although provision of different QoS levels is basically a way of enhancing data-transport efficiency in the network, it can have undesired economic effects.²⁵⁸ A vertically integrated network provider could have an incentive to slow an existing service, or to cause an overload intentionally, in order to convince more customers to opt for an expensive QoS level. A vertically integrated network provider might also treat different application providers in different ways. For example, for certain types of applications he might give preferential treatment only to his own content. In addition, a provider could auction off QoS services to the highest bidders, with a view to weakening the market position of competing providers. The results of such tactics would be similar to those of blocking and delaying. QoS architectures in which the network provider determines what applications receive what services quality normally fit users' preferences less well than architectures in which that determination is left up to users themselves.²⁵⁹ For innovators, the first of the two types of architectures presents additional hindrances: before a new application can receive the QoS it requires, the application provider might have to convince a range of network providers that the application indeed does require the pertinent QoS level. In comparison to architectures in which users decide on QoS, such QoS architectures make it less likely for new applications to receive the QoS they actually require.²⁶⁰

Use of QoS levels can have both positive and negative impacts. It is thus not possible to generalise about Quality of Service architectures. From an economic perspective, QoS architectures have to be assessed in a differentiated way, taking account of their specific characteristics.²⁶¹

Innovation-related aspects of the net-neutrality debate

The Internet is considered to be one of the most dynamic and innovative "places" in the globalised economy. Protecting its dynamic and innovative aspects should be a central goal of all regulatory efforts in the area of information and communications technology.

Four central characteristics that the Internet has retained to the present day are cited as the reasons for the great diversity of innovation seen in the network:²⁶²

- Innovators' freedom of choice: potential innovators themselves decide what applications they want to develop. They require no support or permission from network providers in order to implement their ideas for new applications.
- Users' freedom of choice: Internet users themselves decide, without the involvement of network providers, what applications they want to use.
- Application-"blindness" (the network infrastructure treats all applications in the same way): The network's application-blindness prevents network providers from influencing users' and innovators' decisions, from distorting competition between applications, services and content and from imposing access fees that skim off shares of, and thus reduce, relevant providers' profits.
- Low costs for innovation and access: the low costs entailed in development of innovative applications, and the low costs of access to users, make it possible to offer an enormous range of different applications. What is more, the low costs involved tend to increase the number and diversity of potential innovators.

It is precisely these characteristics that are acutely at risk, when network providers are permitted, without restriction, to block applications, services and content, to treat different applications, services and content in different ways and to impose access fees for applications. If content providers, for example, before providing their applications to users, first had to consult with their network providers and negotiate pertinent prices with them, two central strengths of the Internet would be lost: a) the possibility of creating innovations without having to make major investments, and b) the freedom to

**TAB 04 Open Internet and non-open Internet:
a comparison of their characteristics and of the resulting risks for innovation in the network**

Open Internet	Non-open Internet
(Application-blind, no blocking, no access restrictions)	(Decisions regarding discrimination, blocking and accesses are made by access providers and network operators)
Innovations in network infrastructure	
The commercial importance of the infrastructure is smaller than the commercial importance of applications. Developments to date indicate that such a framework still provides incentives for innovation in network infrastructure.	The commercial importance of the network infrastructure grows. Investments and innovation activities can intensify. (Prerequisite: network providers have to be competing)
Innovations in the area of applications	
High potential for innovation, since the barriers to market entry by small, independent providers are low. Many Internet participants are able to implement and apply creative ideas.	Low potential for innovation, since the barriers to market entry by small, independent providers are high. Many Internet participants refrain from implementing their ideas. Network providers' own innovation is unable to compensate for the small number of innovators involved. Innovation-hindering impacts can be mitigated somewhat by having end users, rather than providers, bear the costs of data transport.
Costs for applications	
Strong competition between application providers causes prices to fall. The fees for data transport are low, for both application providers and users.	Low competition between application providers causes prices to rise. Data-transport fees increase prices further still.
Chances of success for small, independent providers	
Low barriers to market entry: the chances of success for small, independent providers increase.	High costs, along with dependence on network providers, reduce the chances of success for small, independent providers. Higher risks make it difficult to raise capital.
Source: Dauchert and Meurer (2011).	

bring new applications to the market without first having to obtain permission. The neutral infrastructure has proven to be an excellent field for experimentation with new ideas.²⁶³

Widespread introduction of discriminatory price differentiation, and of access fees, along with establishment of market alliances between network providers and market-dominant application providers, would place the network's openness at risk. Such actions would also mean the end of the age of simple market entry. All in all, the overall climate for digital innovations would worsen, since the following negative effects could be expected to occur:

- In the long term, incentives for network providers to invest in new networks, or to expand existing ones, could diminish.²⁶⁴ After all, when bandwidth, a limited "resource", grows scarce, then higher prices can be commanded for it.²⁶⁵
- Introduction of access fees for providers of Internet applications would lead to higher costs, since providers would then have to pay more to place their services in the network. What is more, such access fees would presumably be high, because network providers would have sole, unsupervised control of access to end customers.²⁶⁶
- The entrepreneurial risks for start-ups in the application sector would increase, and thus the costs

for start-ups would increase as well. Finally, along with the usual entrepreneurial risks, application providers would incur the risk of network providers' delaying their new applications in transit (i.e. delaying them in comparison to transport of other products), thereby rendering the applications unattractive for potential users. Independent application providers would find it increasingly difficult to obtain affordable loans.²⁶⁷

In the past, successful applications, such as e-mail, the World Wide Web, search engines and social networks, have mainly been developed by independent companies and by individual persons. Established telecommunications companies, on the other hand, have not played a key role as innovators.²⁶⁸ In the interest of the Internet's innovative power, it is important to ensure that small, independent companies have non-discriminatory access to the Internet.

While there are many well-documented examples of the innovative power of the open, accessible and non-discriminatory Internet, some analysts have seen those same characteristics as hindrances for innovation and, especially, as a threat to long-term investments in the network's infrastructure.

Such critics begin from the assumption that access fees, along with blocking and discriminatory treatment of applications, increase profits of network providers.²⁶⁹ With such additional profits, so the critics, network providers not only would move forward innovation in the area of network infrastructure, they would also intensify their own innovation activities in the area of applications.²⁷⁰ Finally, so the critics, if network providers were allowed a free hand in prioritisation of, and differential pricing for, data streams, they would have considerably higher incentives to develop services of their own than they now have.²⁷¹ All in all, so this perspective, the end of the open Internet would terminate persisting neglect of the network infrastructure. In addition, it would spur innovation in the areas of applications and infrastructure, thereby enhancing the Internet's economic benefits.²⁷² Whether the innovation expected from the small group of network providers could surpass the innovation achieved by millions of Internet users, must be doubted.²⁷³ And there are good reasons to assume that network providers' incentives to privatise their additional profits would generally be greater than their incentives to reinvest such prof-

its in upgrading the network's infrastructure.²⁷⁴ What is more, there is virtually no empirical evidence that an open Internet promotes innovations only in the area of applications, while allowing the network infrastructure to be neglected. The extensive technological progress made in the infrastructure sector over the past few years clearly tells a different story.²⁷⁵

In light of the aforementioned risks of access fees and network-provider intervention in data traffic, strategies need to be formulated for balancing the efficiency-enhancing effects of QoS with the need to protect the network's innovative power. QoS architectures need to be developed in which users decide, in keeping with their own preferences, what applications are to receive what quality of service.²⁷⁶ Such user-defined architectures would free innovators from having to negotiate QoS agreements with network providers, before bringing applications to market. The principle of "innovation without permission" would remain intact. In general, three rules can be formulated regarding what is needed to make QoS innovation-friendly:²⁷⁷

- Network providers must offer various qualities of service, on a non-discriminatory basis.
- Users, and not network providers, must be able to decide what applications receive what qualities of service.
- Network providers must not be able to charge individual application providers for prioritised transport of their services; instead, they should only be able to charge users, in accordance with a sliding scale, for receipt of particular qualities of service.

If enforced, such rules would protect application providers against discrimination and would preserve the low financial threshold for entry into the Internet market. A segmented Internet, on the other hand, in which companies have to pay entry fees – in the form of fees for QoS – would greatly reduce the network's innovative power, since small, innovative companies – unlike well-established major companies – often lack the financial resources needed for implementing prioritised data transport for their products.²⁷⁸ If the Internet were not open, a sector newcomer such as Amazon would probably have been unable to survive in competition with the established bookseller Barnes&Noble, Microsoft Search could well have forced Google to shut down and Skype would not have achieved its current popularity.²⁷⁹

The EU's new legal framework for electronic communications: impacts on Germany

In Europe, responsibility for regulating electronic communications lies primarily with the European Commission. And the Commission has been relatively late in considering the issue of threats to network neutrality, while in the U.S. policymakers, industry and the public have been discussing it for nearly ten years. What is more, it soon became apparent that the European Commission considers interventions in network neutrality, and prioritisation of services, to be “generally advantageous” for the market,²⁸⁰ at least as long as users have the possibility of choosing among different providers. With its amended directives on electronic communications – known as the Telcoms Package (*Telekompaket*) – the EU confirmed that view.²⁸¹ For example, in its new legal framework the EU has refrained from formally enshrining network neutrality as a basic principle, and has failed to define binding minimum standards for Internet services.²⁸² Instead, the European Commission has been emphasising transparency. In future, so the Commission, the Member States must ensure that users are regularly informed, both before and after signing relevant agreements, when providers restrict their (users’) access to legal content. Those information obligations apply even in cases in which users promulgate content themselves or use legal applications. What is more, network providers can be required to publish current and suitable information, in a form supporting relevant comparisons, regarding the quality of their services.²⁸³ In addition, national regulatory authorities – such as Germany’s Federal Network Agency (*Bundesnetzagentur*, BNetzA) – have been authorised to establish, in consultation with the Commission, minimum requirements for the quality of provided services.²⁸⁴

German lawmakers have until May 2011 to transpose the Telcoms Package into national law. With its draft, presented at the beginning of October 2010, of an act for amendment of telecommunications-law regulations (draft of an amended version of the Telecommunications Act (*Telekommunikationsgesetz*, TKG)), the Federal Government has taken a first major step in transposing the Telcoms Package. In its justifications for the draft, the Federal Government specified network neutrality as a political aim of the act.²⁸⁵ Since a definition of network neutrality is still lacking, and since the term is not used in

the rest of the relevant text, that specification is not particularly meaningful. In addition, the TKG draft does not state how network neutrality is to be protected. The TKG draft simply adopts the information obligations for network providers, as defined in the relevant EU directives, and complements them with regulations designed to make it easier for users to switch between Internet providers.²⁸⁶ Furthermore, the TKG draft gives the Federal Network Agency the option of defining minimum standards for quality of service, with a view to preventing the worsening of services and applications quality that could occur via blocking or slowing of data traffic. The TKG draft does not precisely describe such standards, nor does it provide a legal definition of the term quality of service.²⁸⁷ What is more, network providers are still allowed to block their customers’ access to certain applications. When such blocking is carried out, users simply have to be informed about the relevant restrictions (see above).²⁸⁸

All in all, analysis of the TKG draft shows that German lawmakers have simply adopted the provisions of the EU’s Telcom Package.²⁸⁹ And it does not seem likely at present that German lawmakers will move beyond the EU’s requirements. Consequently, the Expert Commission maintains that network neutrality, and the Internet’s innovative power, are acutely at risk.

Threats to an open Internet, in spite of competition and transparency

The Expert Commission doubts that applicable legal regulations, which are based solely on the ideal of transparency, will suffice to resolve the problems relating to network management. And that doubt weighs all the more heavily in that no special rights of termination are in place with which users could respond to direct intervention by network providers’ in their data traffic. The situation is made all the more threatening in that it is virtually impossible, in practice, to prove that quality has been reduced. While the Federal Network Agency (BNetzA) can require network providers to provide information about their own network management, it remains to be seen how those information obligations will be applied.²⁹⁰

To be effective, transparency requirements have to be supported by a controlling body that monitors and en-

forces compliance, and they have to be applied in the presence of functioning competition. Unless independent network providers are able to offer alternatives, transparency requirements are ineffective. In particular, there is a danger that the TKG draft's transparency provisions would prove useless in the rapidly growing mobile-Internet market. While there are still several independent network providers in the stationary-services market, Germany's mobile-Internet market is now dominated by only three companies.²⁹¹ In addition, the following problems can hinder competition even when there are a number of different providers:

- When all providers block a given application, switching providers provides no escape from blocking.²⁹²
- Users have little chance of determining why their applications are functioning poorly. If they are unaware that their network provider is behind the problem, then they have no incentive to switch providers.²⁹³
- The costs of switching reduce the disciplining effects of competition (cf. “Incentives to block or

delay”). The trend toward package plans – such as plans combining TV, telephone and Internet services from a single source – can make the idea of switching providers even less attractive.²⁹⁴

- A provider's incentives to resolve capacity problems via discriminatory network management grow as the competitive pressures that the provider faces increase. In the UK and Canada, for example, discriminatory network management has already become standard practice.²⁹⁵
- The problems arising via imposition of access fees on application providers are also not eliminated via competition.²⁹⁶

To create innovation-friendly, economically useful regulations, one must implement measures that move beyond simple transparency requirements.²⁹⁷ Effective relevant measures would include a prohibition on discrimination, such as that sought by the Federal Communications Commission (FCC), the U.S. regulatory authority (cf. Box 07), and would establish minimum standards for Internet services.

BOX 07

The situation in the U.S.

The national regulatory authority for the U.S., the Federal Communications Commission (FCC), has been working for years to protect network neutrality. In 2005, it formulated four principles that, inter alia, entitle Internet users to use all legal applications and services and to download all legal content.²⁹⁸ In August 2008, after Comcast, the largest cable-network provider and Internet-access provider in the U.S., had blocked and slowed peer-to-peer applications such as BitTorrent, the FCC, referring to those principles, ordered Comcast to terminate those bandwidth-management practices.²⁹⁹ During his presidential campaign, Barack Obama declared that, if he were elected, his administration would issue formal net-neutrality regulations. In early 2009, after the new administration had taken office, that aim was achieved, initially, in the framework of state promotion of broadband systems. Network providers who receive state funding from the economic-stimulus package must comply with net-neutrality regulations.³⁰⁰ In fall 2009, the FCC launched an Open Internet process, aimed at issuing formal net-neutrality regulations. The FCC's emphatic support for network neutrality has mobilised influential opponents who claim the FCC is

overstepping the bounds of its legal authority.³⁰¹ In December 2010, then, the FCC issued formal net-neutrality regulations.³⁰² Pursuant to those regulations, the following provisions apply to providers of fixed-line and stationary wireless broadband Internet-access services:

- Prohibition against blocking: Blocking of legal Internet applications, services and content is prohibited.
- Prohibition against discrimination: Providers may not discriminate in unreasonable ways. The meaning of unreasonable is decided on a case-by-case basis.³⁰³
- Reasonable network management: The rules against blocking and discriminating do not apply to reasonable network management. To fall within this exception, a relevant affected measure must have a legitimate network-management aim, such as protection of network security or supporting of broadband management.³⁰⁴
- Transparency: Providers must provide accurate information about their network-management practices, about the performance characteristics of their broadband Internet-access services and about the agreement terms for their broadband Internet-access services.³⁰⁵

BOX 08

The situation in Canada

The situation in Canada is interesting for Germany because Canada's market structure is very similar to that of Germany: it has an unbundled telephone network, many independent Internet providers and strong cable-network providers.³⁰⁶

In one case, Canada's regulatory authority, the Canadian Radio-Television and Telecommunications Commission (CRTC), studied Canadian providers' network-management practices in detail. In October 2009, in its final decision in that action, it issued detailed rules for network management.³⁰⁷ From the perspective of the CRTC, network providers should seek to solve the problem of network overload primarily by investing in additional network capacities. Economic measures, such as changes in price structures, would be the next option, so the CRTC. On the other hand, so the CRTC, certain network-management measures could become necessary in responding to temporary network problems, or to changing conditions in the network, or as a way of making provision of innovative services possible.³⁰⁸ Economic and technical network-management practices of access providers and vertically integrated network providers must conform to the following conditions:³⁰⁹

- Network-management practices in support of broadband management must affect all applications, services and content equally. Where a problem cannot be solved without discrimination or preferential treatment, not only must the measure fulfill the declared goal, the discrimination or preferential treatment caused by the selected measure, and the resulting damages for users and access providers, must be kept to a minimum.³¹⁰

The European Commission and (subsequently), the Federal Government have decided against applying such far-reaching provisions. The responsible Commissioner, Viviane Reding, and German legal experts have justified those decisions by claiming that the new transparency regulations, along with the existing legal framework, can be effective in preventing abusive interventions in data traffic.³¹⁴ The following section briefly describes that framework for Germany.

The body responsible for overseeing telecommunications providers – and, thus, network providers –

- Use of network-management practices that result in blocking of applications, services or content, and use of measures that noticeably delay real-time applications, are subject to the prior consent of the regulatory authority, the CRTC.³¹¹
- Providers must inform their customers in detail about the network-management techniques they use. They must explain what measures they use, and when; what types of Internet traffic are affected by the network management; and how relevant measures will affect user experience, especially with regard to data-transport speed.³¹²

Analysts maintain that these transparency regulations are not being followed by all Canadian network providers and access providers. For example, analysts have accused some of the six major network providers of violating transparency requirements by failing to inform their customers, or failing to inform them adequately, about interventions in data traffic (such as bandwidth reductions).³¹³

is the Federal Network Agency (Bundesnetzagentur – BNetzA). The amendment of the Telecommunications Act (TKG) will not change that responsibility. The Federal Network Agency is responsible for monitoring compliance with the TKG's provisions on network management. Those provisions cover the areas of network access, charges, abuses of market power and the secrecy of telecommunications.³¹⁵ Pursuant to access regulations, network providers are not obligated to grant application providers access to their networks. That right is limited to transport services, however, which normally are not considered to include Internet applications. In addition, provisions on regulation of charges, and on oversight with regard to abuses, do not stand in the way of unequal treatment of applications, as long as there are objective, well-founded reasons for such treatment.³¹⁶ The possibilities described here for intervening in data traffic apply for all network providers, i.e. including those who, as a result of their size, have significant market power.³¹⁷ The TKG's data-privacy provisions also do not provide for restrictions on network management. For example, network providers are permitted to have access to traffic data for the data packets they transport.³¹⁸ Such traffic data support provision of, and payment for, services; provide information about the nature of the applications being used (for example, whether a music

or film file is concerned, whether Internet telephony is being used or whether a file is a peer-to-peer file) and identify Internet accesses of recipients. A network provider may thus legally obtain and process the information that he needs to carry out discriminatory network management.³¹⁹

Legal restrictions of network management only apply to arbitrary blocking of content. If a network provider blocks undesired content – especially political content – an affected user can protest on the basis of the principle of telecommunications secrecy and of the right of freedom of opinion pursuant to Article 5 of Germany's Basic Law. The last of the aforementioned provisions also has to be applied to general business terms and conditions. Serious violations of the right of freedom of opinion can thus render certain contractually agreed clauses null and void.³²⁰

It may thus be concluded that blocking of, discrimination in management of, or imposing of fees for, third-party access to end customers all remain permissible, within an imprecisely defined framework, and will remain permissible even after the amended Telecommunications Act (TKG) enters into force. While the new transparency regulations are certainly to be welcomed,³²¹ they won't be sufficient to ward off the threats to the Internet's innovative power that the aforementioned practices entail. In the view of the Expert Commission, therefore, the existing legal framework needs to be more precisely defined, and expanded.

Final considerations, and recommendations

Vertically integrated network providers have growing incentives to treat different applications in the Internet in different ways. It is true that blocking and delaying – if they are noticed – can prompt customers to switch providers. The Expert Commission doubts, however, that such potential losses of customers could keep vertically integrated network providers from applying discriminatory techniques – especially delays. In that light, therefore, it must be assumed that restrictions on network neutrality are going to grow, especially since the EU's current legal framework, and the emerging relevant legal framework in Germany, offer little that could counter such restrictions. For this reason, it seems increasingly likely that innovation incentives for independent application pro-

viders will diminish. Such developments would have a negative impact on start-up emergence in this area.

In the net-neutrality debate, vertically integrated network providers often argue that extensive legal guarantees of network neutrality would constrain market forces. In fact, the opposite is true. Vertically integrated network providers must not be permitted to reduce the diversity of Internet services and applications by using such techniques as blocking, delaying, prioritisation and strategic pricing. Most importantly, they must not be permitted to hinder young companies from entering the market. Only if the costs of market entry are kept as low as possible for independent providers, all relevant actors, with their different innovation ideas and business models, will be able to compete fairly. Where such costs are not kept low, welfare losses will result in the long term.

The Expert Commission recommends a range of measures for strengthening the Internet's potential for innovation.

- Network providers' customers must be offered the greatest possible degree of transparency. The transparency provisions in the planned TKG amendment are only a first step in that direction. In the interest of transparency in a competitive framework, customers should have special rights of termination in cases in which network providers apply discrimination that exceeds the bounds of the illustrative cases described in connection with the signing of the relevant agreement.
- In general, the amended version of the Telecommunications Act (TKG) should prohibit blocking.
- In the case of capacity shortages, price differentiation in accordance with quality levels is justified: network providers must offer quality-of-service classes on a non-discriminatory basis. In each case, the decision as to which quality-of-service class a given application is to receive must be left solely up to the end user.
- To ensure that market entry of new providers is not hampered, QoS differentiation should solely take the form of differentiation of prices for end users.
- The Federal Network Agency should monitor compliance with the aforementioned rules, and should penalise violators. Furthermore, the Federal Network Agency should define minimum standards for quality of service, in order to prevent strategically

motivated worsening of services, and hindering of data traffic. Such minimum standards should be updated continually in keeping with technological progress.

B 4 INNOVATION WITHOUT RESEARCH AND DEVELOPMENT

A review of developments in R&I policy

In many countries, R&I-policy priorities have changed over the past decades. In the 1960s, “innovation” simply meant technological innovation in industry. Research and experimental development³²² within the meaning of the Frascati Manual, i.e. activities aimed at creation of new knowledge, were considered to be the main drivers of such innovation. In subsequent years, that definition proved to be too narrow. The “Oslo Manual” then brought a broader definition of innovation. In addition, it departed from the view whereby innovation was the same as R&D. The innovation surveys based on that manual – known in Europe as “Community Innovation Surveys” – brought a wealth of relevant new findings. Increasingly, policymakers in Germany and other industrialised countries began to view innovation as a key factor in growth. Policymakers’ strong focus on funding research and development gave way to more broadly based innovation policies.

The broader definition of innovation, and the growing interest in more broadly based R&I policy, are to be welcomed, since many other forms of innovation, in addition to technological innovations, can provide benefits for society and private individuals alike. For this reason, in its first annual report (2008), the Expert Commission already applied a broadly based definition of innovation (cf. Box 09). The definition it uses includes not only technical innovation, but also innovation in services, and innovative organisational structures in private and public institutions.³²³

Innovation as defined in these ways has to do with combining something new with application, or at least attempted application, of that something new. It can be empirically proven that innovation often builds on R&D. At the same time, a not inconsiderable share of companies that are involved in in-

Innovation

The Expert Commission uses a broad definition of innovation. In that definition, innovation includes technical, organisational, social and other innovations that are already being implemented or for which implementation is at least being attempted. A “good idea” is not sufficient by itself. In a market system, innovation refers to development and marketing of new products and services, as well as internal deployment of such innovations (process innovation). In public institutions, innovation means the introduction of new procedures, workflows and approaches.

For innovative companies, innovation can provide lasting competitive advantages.

BOX 09

novation rely on R&D either rarely or not at all. It would thus be wrong to equate R&D and innovation. Innovation processes are too complex and too diverse to be reduced to such a simple formula. What is more, the group of innovators without R&D, like the group of non-innovators, both have potential for economically significant productivity improvements, potential that policymakers need to focus on. That is why in this chapter the Expert Commission describes the phenomenon of “innovation without R&D” and discusses the relevant implications for R&D policy.

Innovation and R&D – measurement and differentiation problems

To determine what share of innovators carry out no R&D of their own, one must carry out empirical analyses. The necessary analyses have been carried out in the context of a report commissioned by the Expert Commission.³²⁴ Box 10 summarises important definitions upon which those analyses were based.

Figure 05 gives a first impression of the importance of innovators without R&D. To begin with, R&D frequency increases with company size. Occasional R&D activities, however, can be particularly observed within smaller companies. In the services sector, R&D is carried out considerably less frequently than it is in the manufacturing industry.³²⁵ R&D frequency correlates with company size and sector. Between 18 per cent (companies with 5–9 employees) and 88 per-

BOX 10

Innovators without R&D

The Expert Commission applies the following definitions as a way of differentiating types of companies:

Pursuant to the definition used in the OECD's Frascati Manual, **research and development (R&D)** refers to systematic creative work aimed at enlarging knowledge, including knowledge about human beings, culture and society, as well as at using such knowledge with the aim of finding new applications. Pursuant to the Frascati Manual, the term "R&D" comprises three activities, namely basic research, applied research and experimental development.³²⁶

Innovators refers to the following: All companies that, within a three-year period, have introduced at least one new or significantly improved product or one new or significantly improved service ("product innovation"), or have introduced one new or significantly improved process in the area of production, services creation or distribution ("process innovation").³²⁷

Companies with R&D activities includes all companies that, within a three-year period, have carried out internal research and development. In an orientation to the continuity with which R&D is pursued internally, continuous or regular³²⁸ and occasional R&D activities³²⁹ are distinguished.

Innovators without R&D are thus companies that function as innovators but that in the last three years have not continually or occasionally carried out R&D.

cent (companies with 1,000 or more employees) of all manufacturing companies carry out R&D. In the area of business-oriented services, the share of companies that continually engage in R&D ranges from 15 percent (10–19 employees) to 49 percent (1,000 and more employees). Other analyses indicate that the relevant shares for the two sectoral groups fluctuate considerably. Overall, the share of innovators who do not carry out continuous R&D activities is 57 percent. In absolute figures, that percentage translates into about 72,000 companies with five or more employees. Of those companies, some 25,000 are sited within the industry sector, and nearly 47,000 are sited within the area of business-oriented services.

At the same time, such empirical results must be interpreted with caution. Chapter A4 touched on some of the problems involved in surveys of innovation and R&D. Even when those aspects are ignored, difficulties appear, on closer consideration, in the areas of differentiation of innovation-relevant activities and chronological classification of R&D activities. In the first place, surveys do not, in a statistically correct way, tally all companies that carry out R&D – small companies in particular often carry out R&D informally, i.e. not in R&D departments or in R&D projects explicitly termed as such.³³⁰ In cases in which small and medium-sized enterprises (SMEs) do not carry out continuous R&D activities, and profit, over considerable periods of time, from the results of completed R&D projects, additional survey problems can result.

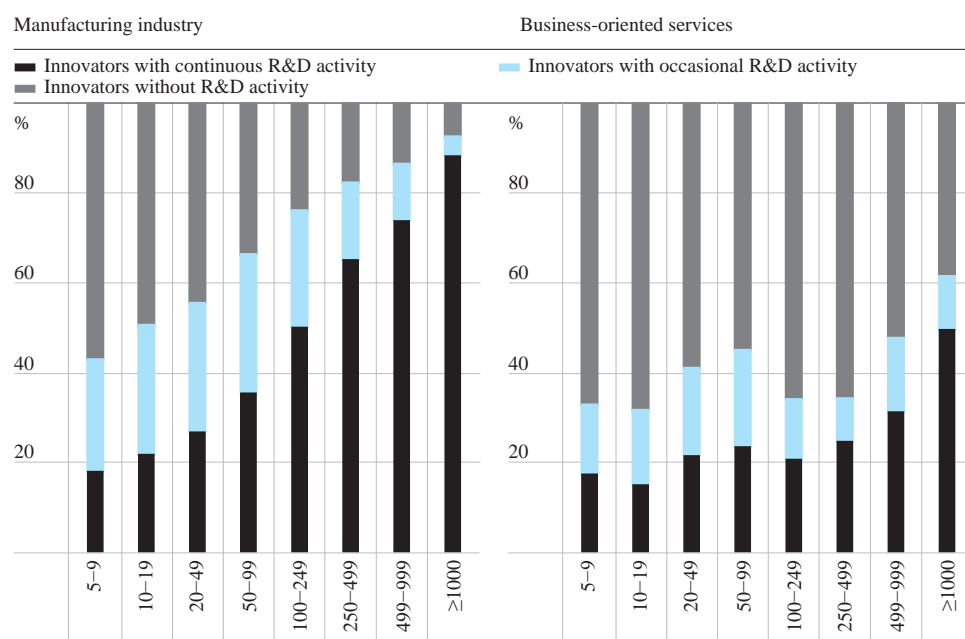
As to the share of companies that, for lengthy periods of time, carry out no R&D in connection with their innovation efforts, a new study of the Centre for European Economic Research (ZEW), and of the Fraunhofer Institute for Systems and Innovation Research ISI, finds those shares to be considerably smaller than those shown in Figure 05. Assuming that companies can gain relevant knowledge, for current innovation projects, from R&D activities up to three years old, then about half of all companies that cross-sectional consideration shows to be innovators without R&D can actually be assumed to have R&D-based innovation activities.³³¹ What is more, a small share of innovators without R&D have R&D carried out externally, with a view to providing relevant knowledge (external R&D). When such effects are taken into account, then the share of innovators without R&D is not 57 percent – it is less than 30 percent.³³²

Characteristics of innovators without R&D

Innovators without R&D play a significant role in Germany's innovation. In 2008, a full 14 percent of all revenue with new products in Germany was achieved by innovators without R&D activities of their own. And such innovators' contributions to process innovations is considerably higher. For example, at least one-fourth of the cost reductions achieved via new processes are due to innovators without R&D of their own.

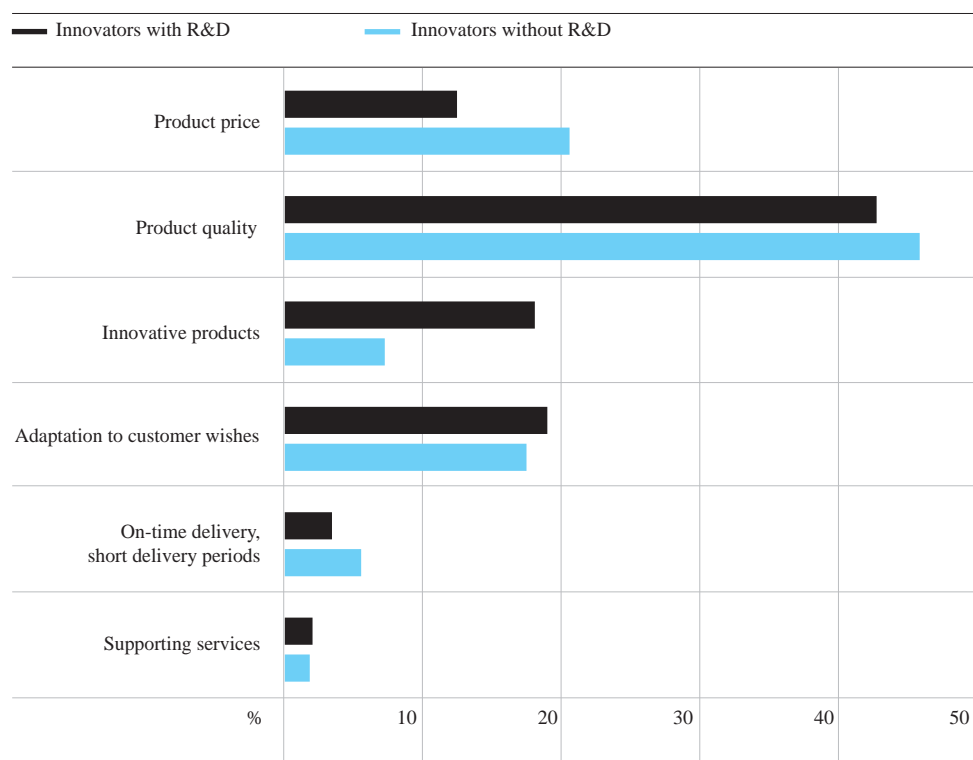
Clearly enough, the services sector has considerably more innovators without R&D than the manufacturing

FIG 05 Innovators, broken down by type of R&D activity in Germany, and by size classes, 2006–2008



Source: Rammer, Köhler et al. (2011)

FIG 06 Key factors for differentiation with regard to competitors – innovators without their own R&D, and researching innovators



In percent of all companies. All figures weighted proportionally in light of the entire group being considered.
Source: *Modernisierung der Produktion 2009*. Calculations of Fraunhofer ISI.

sector does. What is more, the services sector has considerably more large companies in the class “innovators without R&D” than the manufacturing sector does. One important reason for this is that the Frascati Manual’s³³³ definition of “research and development” is oriented strongly to technological products and takes lesser account of comparable activities in the services sector.³³⁴ In the banking sector, for example, while the introduction of a new fund is considered to be innovation, the work involved in conceiving and structuring the fund is not considered to be R&D. Similarly, while user-friendliness-oriented adaptations of existing software can be seen as improvements, they are not generally considered to be R&D.

Innovators without R&D tend to work in sectors that are not particularly research-intensive or knowledge-intensive. The products produced in those sectors thus tend to be less complex. Furthermore, innovators without R&D tend to operate in markets that feature a relatively slow pace of technological change and of product obsolescence. On average, innovators without R&D tend to be less oriented to exports than are companies that engage in research. Nearly half of all innovators without R&D sell their products primarily in local and regional markets, while companies that regularly conduct research generate only about one-third of their revenue in such markets. While some 40 percent of innovators without R&D export at least a certain share of their products, the corresponding figure for researching companies is 66 percent. To achieve competitiveness, innovators without R&D rely primarily on high product quality, on attractive prices and on their own ability to adapt products to customer wishes. The degree of innovation found in products is more important for innovators with R&D than it is for innovators without R&D. At the same time, price is a less-important factor for companies carrying out R&D than it is for innovators without R&D (Figure 06).³³⁵

No statistically significant differences emerge with regard to the production technologies used by innovators with / without R&D. Companies in both groups use state-of-the-art production technologies to about the same extent. The expectation that innovators without R&D would rely more frequently on external R&D providers than would companies carrying out R&D has not been confirmed. Relatively often, innovators without R&D do not rely

on universities and research institutions as sources of ideas.

In fact, innovators without R&D of their own rely less frequently on external R&D than do researching companies. On the other hand, in development and introduction of product / process innovations, external partners play a considerably larger role for innovators without R&D than they do for researching companies. For example, product innovators develop 28 percent of their innovations in co-operation with other companies. Nearly 15 percent of innovations produced by innovators without R&D are adopted by other companies. The innovations involved consist of products that are already on the market and that innovators without R&D have improved.

Germany’s number of innovators without R&D, as a share of all innovators, is relatively small when compared internationally. The corresponding shares are even lower in the Scandinavian countries, France, the Netherlands and Belgium, while they are higher in central and eastern European countries. The percentage of innovators with R&D, i.e. as a percentage of all innovators, is thus larger in high-wage countries than it is in low-wage countries.

With respect to highly qualified specialised employees, innovators without R&D face the same challenges that small and medium-sized enterprises (SMEs) as a whole face.³³⁶ They will be hit particularly hard by shortages of highly qualified persons with higher education degrees, since university graduates seeking employment tend to opt for large corporations, which supposedly pay higher salaries and offer better job security.³³⁷ In addition, innovators without R&D, when compared to researching companies, are seen to spend considerably less on continuing / further education and training for their employees.

Some of the aforementioned characteristics apply to the two company examples presented (Box 11, Box 12). In the main, however, those examples illustrate how innovation without R&D can be a useful and profitable business tactic for German companies.

Central results and recommendations

Overall, it is clear that, all difficulties of statistical differentiation notwithstanding, innovators without

R&D have an economic importance, as a group, that makes them a noteworthy component of the innovation system. Innovators without R&D cannot simply be considered “weak” companies. The results of the aforementioned study of the ZEW and of Fraunhofer ISI make it clear that many innovators without R&D are pursuing intentionally selected innovation strategies. Presumably, their innovation-strategy decisions are economically based: It makes no business sense to invest in R&D when the resulting earnings increases do not suffice to cover the R&D investments. That is particularly true for companies in locally or regionally differentiated markets and in sectors with relatively slow technological change. In such environments, innovators without R&D concentrate on producing high-quality products for niche markets. By drawing on innovations of other companies, and using them for their own product and process innovations, they promote the rapid spread of new product ideas and production concepts. They thus play an important role in dissemination of innovations. By applying and implementing known technologies and processes, they enhance the overall efficiency of production of goods and services.

In this light, the questions arise of whether R&I policy needs to promote innovators without R&D, and of what specific aims such support should pursue. Support measures can certainly be justified if they can make it possible for existing knowledge to be used more effectively – for example, by enhancing companies’ ability to absorb new developments and by strengthening companies’ role in spreading knowledge and technologies.

Reduce obstacles for participation in innovation-support programmes

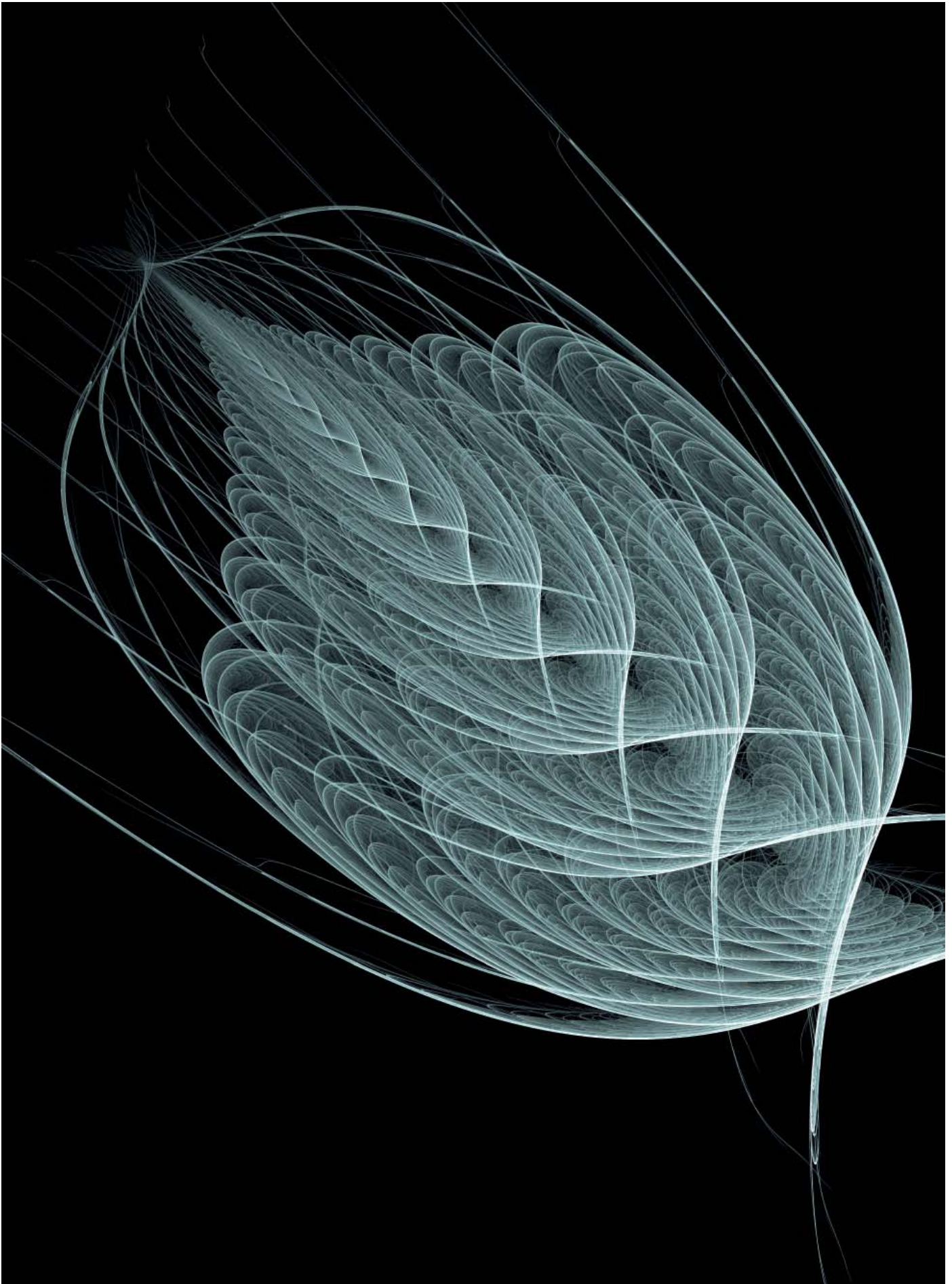
The Expert Commission recommends that more innovators without R&D be included in funding programmes. Most Federal as well as Länder funding programmes provide funding to considerably more companies that carry out continuous research and development than companies with only occasional R&D or without R&D. One of the reasons for the low rate of support provided to innovators without R&D is that such companies tend to view the funding aims of such programmes as not relevant to them and thus do not submit the necessary applications. In addition, evaluators for such funding programmes fo-

cus especially on past research findings, even though the quality of future innovation projects is supposed to be the main criterion. Such a focus tends to keep innovators without R&D from being awarded support in innovation-promotion programmes, even in cases in which the innovators have promise as innovators. Such obstacles need to be modified in useful ways.

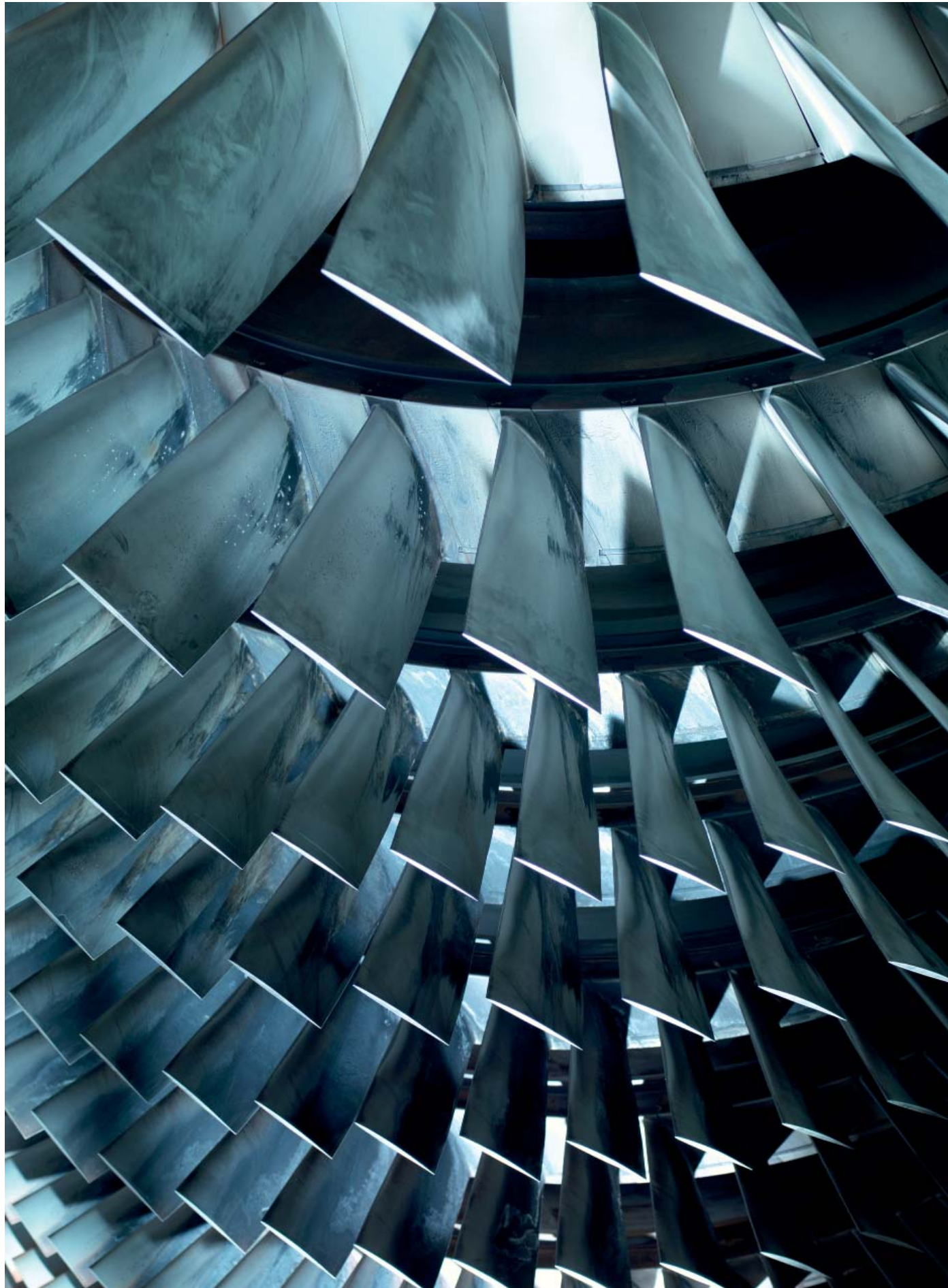
Strengthen co-operation with scientific research institutions, and improve technology monitoring

It could be useful to change the pattern whereby innovators without R&D tend not to participate in collaborative research groups, especially such groups involving scientific institutions. Analyses have shown that innovation-oriented co-operation tends to provide greater innovative success, since it tends to yield greater degrees of “newness” and thus leads to higher income from innovations.³³⁸ Funding has positive impacts on such research especially by supporting development of co-operation and of knowledge and technology transfers with the science sector. The relatively small interest shown by innovators without R&D in co-operating with research institutions can also have to do with the high transaction costs of such co-operation. Higher education institutions and non-university research institutions should seek to keep barriers to contact initiation as low as possible.

Opening of existing programmes to innovators without R&D, and incorporation of such innovators in project-oriented co-operation, can lower transaction costs and help build relevant co-operation resources in such companies. Yet another measure, one oriented both to innovators without R&D and to small and medium-sized enterprises (SMEs) overall, is to promote co-operation with higher education institutions, and with application-oriented research institutes, for purposes of technology monitoring. With their strong orientation to regional markets, and their dearth of co-operation with universities (including universities of applied sciences), innovators without R&D are at risk of being surprised by, and being unable to respond to, new technology developments. This is an area in which action is needed from chambers of commerce, associations of enterprises, and universities of applied sciences – institutions which often have good contacts to regional companies and which can provide useful information about new technological developments.



Fractals
©Ted Kinsman/Science Photo Library



Detail of a turbine
©Monty Rakusen/ Cultura Science Photo Library

BOX 11

Friedrich Freek GmbH

This company, founded in 1950, is part of the electrical and metal products sector. Currently, it has a workforce of 55. Its core business is development, production and sale of electrical heating elements and systems for industrial applications (including medical applications) and for household appliances. The company sells its products primarily to customers in the plastics, machine-construction and household-appliances industries.

Friedrich Freek GmbH has no R&D of its own. To be able to survive in Germany's high-technology economy, the company co-operates in a network of numerous partners based in Germany and abroad. Along with customers and suppliers, that network also includes scientific institutions and competitors. Via such co-operation, Friedrich Freek GmbH profits in the areas of size, flexibility and – especially – innovation, in ways that are reflected in the high quality, reliability and customisability of its products.

Optimise work-sharing in connection with innovation vouchers

In numerous Länder, including North Rhine-Westphalia, Baden-Württemberg and Bavaria, innovation-voucher programmes have been launched.³³⁹ Normally aimed at SMEs that conduct no R&D of their own, the programmes subsidise part of companies' costs for consulting or external R&D services. The Federal Ministry of Economics and Technology (BMWi) launched a similar programme in 2010. Currently, it is unclear whether the work-sharing structures in place in this framework are truly efficient; the Federation and the Länder may be duplicating each other's efforts, as they have been known to do in the past. In the view of the Expert Commission, it makes sense to have the Länder be responsible for promoting SMEs via innovation vouchers. At the same time, the commission urges that exchanges of experience between the Länder be intensified, both in this programme and in other funding programmes. At present, no regular exchanges of experience are taking place.

Pumpenfabrik Ernst Scherzinger GmbH & Co. KG

Located in Furtwangen, Scherzinger produces systems with positive-displacement rotary pumps such as gear pumps. With a workforce of about 100 persons, the company produces some 150,000 pumps per year. Scherzinger supplies customers worldwide, throughout a broad range of sectors, including the automotive, chemical and petrochemical, process engineering, pharmaceuticals, machinery and plant engineering, energy generation and medical technology sectors. It does not conduct research of its own.

By continually applying the well-known principles behind positive-displacement rotary pumps to new application areas – for example, via product miniaturisation or use of new materials – Scherzinger has been able to develop niche markets in Germany and abroad. Along with the ability to recombine technologies in innovative ways, in product development, the company's core competencies include the ability to customise its products without compromising its top quality standards.

BOX 12

Increase the frequency of R&D activities, via tax-based incentives

It seems likely that general state funding for all innovators without R&D, aimed at enabling them to launch R&D activities of their own, would provide little success. After all, most innovators without R&D would be financially capable of carrying out R&D continuously. On the other hand, financial incentives could usefully be provided to those companies that carry out research at irregular intervals. For that group, which accounts for nearly one-fourth of all innovators in Germany and ten percent of all industrial companies and providers of business-oriented services with more than five employees, an easily accessible, continuously available instrument, such as tax-based support for R&D expenditures, could provide incentives to engage in continuous R&D activities. An innovator who has carried out no R&D to date would then be able, at any time, to obtain funding for ongoing R&D activities, without having to first undergo a selection process in an R&D-funding programme. For that reason as well, the Expert Commission recommends that tax-based R&D support be introduced.

STRUCTURE AND TRENDS



C STRUCTURE AND TRENDS

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C 1 EDUCATION AND QUALIFICATIONS

Overview

The society's structural development into a knowledge and services economy has far-reaching consequences for requirements pertaining to qualifications of gainfully employed persons. The reason for this is that the importance of knowledge-intensive sectors with regard to the economy's overall production is continually growing, thereby driving demand for high-quality training. What is more, innovation in knowledge-intensive sectors is a key competitive parameter. These factors continually boost demand for highly qualified employees (in most cases, persons with higher education degrees), who play a key role in the innovation competition.

Human resources are thus the most important resources, and the most valuable asset, with regard to Germany's scientific and technological competitiveness. Human resources comprise all human knowledge and all the various skills and competence that people can possess. And the education system is of central importance with regard to the development of human resources. In particular, the higher-education and vocational-training systems have the task of optimally promoting the talents and skills of people, both young and old, in order to offer them career perspectives in the growing market of the knowledge and services economy. Since human resources cannot be quickly "produced", i.e. they have to be formed and promoted over periods of years, it is especially important to recognize changing qualification requirements promptly and orient the education system accordingly. As a result of the shortages of qualified labour that are emerging via demographic change, this important task will become all the more important in future.

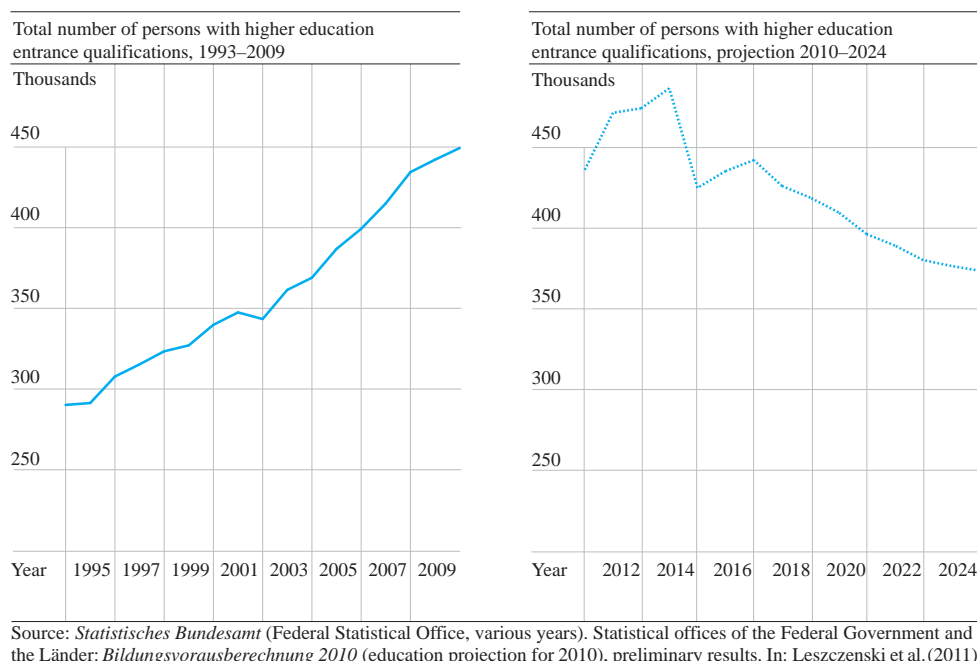
The data for the following short overviews were obtained primarily from a study³⁴⁰ commissioned by the Expert Commission on Research and Innovation (EFI). Based on surveys of relevant research institutes, the study also takes account of surveys of the Federal Statistical Office, such as the Mikrozensus survey and key statistics on higher education (*hochschulstatistische Kennzahlen*), as well as of the OECD publication "Education at a Glance"³⁴¹.

Indicators studied

- School-leavers qualified for higher education in Germany
- New tertiary students in selected OECD-countries
- Foreign students at German universities and colleges
- Graduation rates and relevant subject-group breakdowns
- Further training according to employment status and level of qualification
- Numbers of highly qualified persons, as percentages of employed persons in Europe

SCHOOL-LEAVERS QUALIFIED FOR HIGHER EDUCATION IN GERMANY

C 1–1



Numbers and proportion of school-leavers qualified for higher education: The persons eligible for higher education include those school-leavers who have earned a general or subject-specific entrance qualification for studies at a university or at a university of applied sciences (*Fachhochschule*).

The numbers of school-leavers qualified for higher education continue to grow

In the period between 1992 and 2009, the total number of school-leavers, from general-education and vocational schools, with higher education entrance qualifications grew nearly continually, from 290,600 to 449,400. That jump represents an increase of 55 percent. At least the available numbers of persons eligible for higher education are thus not likely to be an obstacle for desired increases in numbers of persons with engineering and science qualifications. The absolute numbers of school-leavers with higher education entrance qualifications are not expected to decline, as a result of demographic trends, until after 2014.

The significant growth in the numbers of persons with higher education entrance qualifications is due to the growing participation of relevant age groups in school education and vocational training leading to such qualifications. Those numbers are described via the cohort percentage of persons eligible for higher education, which grew from 30.8 percent to 45.9 percent between 1992 and 2009. Two developments have contributed especially strongly to that growth: disproportionately growing participation of women in higher levels of school education, and introduction of the entrance qualification for universities of applied sciences (*Fachhochschulreife*), which has gone hand-in-hand with the establishment of universities of applied sciences (*Fachhochschulen*), and which can be earned via school-based vocational training or further vocational training.

C 1–2 NEW TERTIARY STUDENTS IN SELECTED OECD COUNTRIES*

Countries	1998	2001	2002	2003	2004	2005	2006	2007	2008
Australia	53	65	77	68	70	82	84	86	87
Finland	58	72	71	73	73	73	76	71	70
France	–	37	37	39	–	–	–	–	–
Germany	28	32	35	36	37	36	35	34	36
Italy	42	44	50	54	55	56	55	53	51
Japan	36	37	39	40	40	41	45	46	48
Netherlands	52	54	54	52	56	59	58	60	62
Spain	41	47	49	46	44	43	43	41	41
Sweden	59	69	75	80	79	76	76	73	65
Great Britain	48	46	48	48	52	51	57	55	57
USA	44	42	64	63	63	64	64	65	64
Average	40	48	52	53	53	54	56	56	56

Figures in percent. *Total of net percentages of entry into tertiary education, for each individual age cohort.
Sources: OECD (2010). OECD Indicators, various age cohorts. In: Leszczenski et al. (2011).

Tertiary education entry rate: Proportion of the appropriate age cohort starting tertiary education. It is a measure for the degree to which demographic resources are being used to create human resources with higher education qualifications.

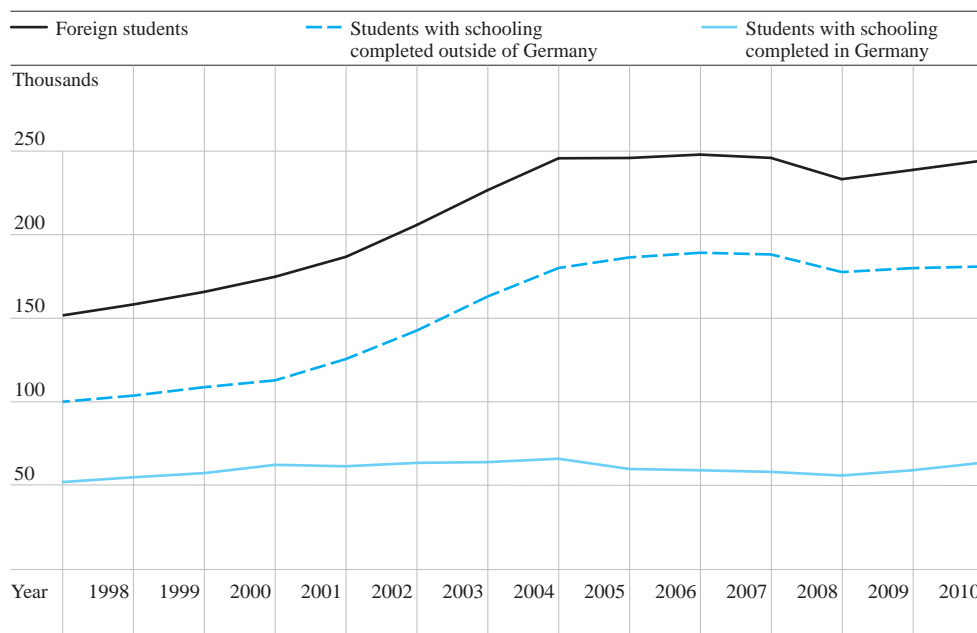
Although its rates of entry into tertiary education have been increasing, Germany still lags behind comparable OECD countries in this regard

Among selected OECD countries, Germany has the lowest entry rate into tertiary education. While that rate has increased by 8 percentage points since 1998, at 36 percent it still is considerably below the corresponding figures in the top group in this category, consisting of Australia (87 percent), Finland (70 percent), Sweden (65 percent) and the USA (64 percent). What is more, the gap between Germany and the relevant OECD average, which increased by 16 percentage points between 1998 and 2008, to 56 percent, has grown considerably. Clearly enough, Germany is not succeeding, to the degree seen in other countries, in interesting its young people to continue on to higher education. One reason for this may be that many types of training that are offered in Germany as dual training, or training with full-time schooling, are provided at universities in other countries. What is more, in Germany children from socially disadvantaged backgrounds are still considerably less likely to undertake university studies than are children from families with academic backgrounds.

Another special aspect of Germany's entry rate into tertiary education is that it shows a balance by gender: 37 percent (women) and 36 percent (men). In all other OECD countries – with the exception of Japan – women account for the majority of new students throughout the entire period covered. On an OECD average, 63 percent of all women of relevant age, and 50 percent of all men of relevant age, entered higher education.

FOREIGN STUDENTS AT GERMAN UNIVERSITIES AND COLLEGES

C 1–3



Source: *Wissenschaft weltoffen* (2010). Statistisches Bundesamt (Federal Office for Statistics).
 In: Leszczenski et al. (2011).

Foreign students are students who are not German nationals. That group is broken down by persons who earned their higher education entrance qualifications in Germany and persons who earned their higher education entrance qualifications outside of Germany.

Numbers of foreign students at German universities growing again

In the 2009 academic year, a total of 239,000 foreign students were enrolled at German higher education institutions. In the 2009/2010 winter semester, their number grew further, to 244,800. The unprecedented decrease in the numbers of foreign students seen in 2008 – consisting especially of a decrease in the numbers of persons who earned their higher education entrance qualifications outside of Germany – thus has not continued. On the other hand, the maximum level achieved in 2006 has not yet been re-achieved. The reasons for the decrease are unknown. A number of factors could be responsible, such as students' doubts concerning the value of a German higher education degree in their home employment markets. For persons who earned their higher education entrance qualifications outside of Germany, it remains extremely difficult to obtain a work permit in Germany following graduation. Possibly, the general tuition fees that some Länder have introduced have contributed to the decrease in the numbers of foreign students. On the other hand, the number of persons with German schooling who enroll at German higher education institutions has increased again, following years of slow decline; it grew from 56,000 in 2008 to 63,500 in the 2009/2010 winter semester.

The strong increase in the numbers of foreign students seen since the end of the 1990s may be considered indicative of growing interest abroad in German academic degrees. That development is significant for the German innovation system, since foreign students, once they graduate and are highly qualified potential employees, have the option of working either in Germany or for German companies in their home countries.

C 1–4 GRADUATES AND SUBJECTS STUDIED

	1995	2000	2002	2005	2007	2008	2009
Total number of graduates	197,015	176,654	172,606	207,936	239,877	260,498	287,997
Percentage who are women	41.2	45.6	48.1	50.8	51.8	52.2	51.7
Percentage who studied at a university	63.6	64.3	63.2	60.8	62.4	62.4	-
Linguistics and cultural sciences	27,125	29,911	30,175	35,732	43,827	50,680	53,003
Percentage for that subject group	13.8	16.9	17.5	17.2	18.3	19.4	18.4
Law, economics and social sciences	66,538	62,732	62,284	76,566	85,838	87,196	101,391
Percentage for that subject group	33.8	35.5	36.1	36.8	35.8	33.5	35.2
Mathematics, natural sciences	27,800	21,844	21,594	30,737	38,417	43,333	47,782
Percentage for that subject group	14.1	12.4	12.5	14.8	16.0	16.6	16.6
Medicine / health sciences	12,075	10,620	10,223	11,817	13,358	14,345	15,142
Percentage for that subject group	6.1	6.0	5.9	5.7	5.6	5.5	5.3
Engineering sciences	47,295	35,725	32,414	34,339	38,065	42,558	47,004
Percentage for that subject group	24	20.2	18.8	16.5	15.9	16.3	16.3
Art, art history	7,280	7,630	7,857	9,678	10,399	11,185	11,541
Percentage for that subject group	3.7	4.3	4.6	4.7	4.3	4.3	4.0

Source: Federal Statistical Office. *Fachserie 11. Reihe 4.2. Research in HIS/ICE*. In: Leszczenski et al. (2011).

Subjects structure and rate of graduation: The subject structure shows the proportion of first degree graduates in each subject or subject group. The rate of graduation measures the proportion of tertiary graduates in the relevant age cohort of the population.

The graduate percentage has increased again sharply; the total number of graduates will remain at the 2008 level until 2023

The trend whereby the number of first-time graduates has been increasing continued in 2009, and that number reached a new record in that year: 288,000. At the same time, not all new graduates are available to the employment market. A considerable percentage of the some 71,000 persons with bachelor's degrees continue their studies, and about one-fifth of graduates who earn a traditional degree (*Diplom* or *Magister*) first pursue doctoral studies before seeking employment. At the same time that the numbers of first-time graduates were increasing, the graduate percentage also increased. That latter trend shows that larger and larger percentages of young people earn a higher education degree. At 23 percent, the graduate percentage is still far from the 35-percent level that the Science Council (*Wissenschaftsrat*) considers desirable, in light of the continuing development of knowledge-society structures.

In 2009, the relevant subject structure shifted in some cases significantly with respect to the previous year. While the number of graduates in linguistics and cultural sciences increased by only 4.6 percent, the number of graduates in law, economics and social sciences increased by an average of 16.3 percent. The pertinent increases in engineering and the natural sciences were of an average order, and those fields' share of all graduates remained unchanged. The small percentages of women in both subject areas remained largely unchanged (engineering: 22.6 percent; natural sciences: 40.1 percent).

FURTHER TRAINING ACCORDING TO EMPLOYMENT STATUS AND LEVEL OF QUALIFICATION

C 1–5

	1996	1997–1999	2000–2002	2003–2005	2006	2007	2008
Gainfully employed persons	4.1	3.8	3.4	5.2	5.3	5.5	5.6
low (ISCED 0–2)	1.1	1.0	0.9	1.3	1.3	1.1	1.3
medium (ISCED 3–4)	3.8	3.4	3.1	3.8	3.9	4.0	4.1
high (ISCED 5–6)	6.7	6.2	5.4	10.0	10.6	10.8	10.8
Unemployed persons	5.5	4.5	4.4	2.7	2.4	2.8	3.3
low (ISCED 0–2)	2.0	2.0	2.1	1.5	1.4	1.7	2.0
medium (ISCED 3–4)	5.9	4.8	4.7	2.7	2.4	2.9	3.6
high (ISCED 5–6)	10.7	8.5	7.9	5.2	5.0	5.5	5.2
Persons outside the labour force	4.1	3.5	3.3	1.1	0.9	0.8	0.9
low (ISCED 0–2)	0.5	0.5	0.6	0.4	0.4	0.4	0.5
medium (ISCED 3–4)	5.8	4.7	4.2	1.3	0.9	0.8	0.9
high (ISCED 5–6)	8.9	7.4	6.3	2.1	2.0	1.7	2.0

Figures in percent. Basic total considered: All persons from the ages of 15 to 64. With regard to ISCED. cf. page 92. Source: *Mikrozensus 1996 bis 2008*. Calculations of HIS/NIW/BIBB. In: Leszczenski et al. (2011).

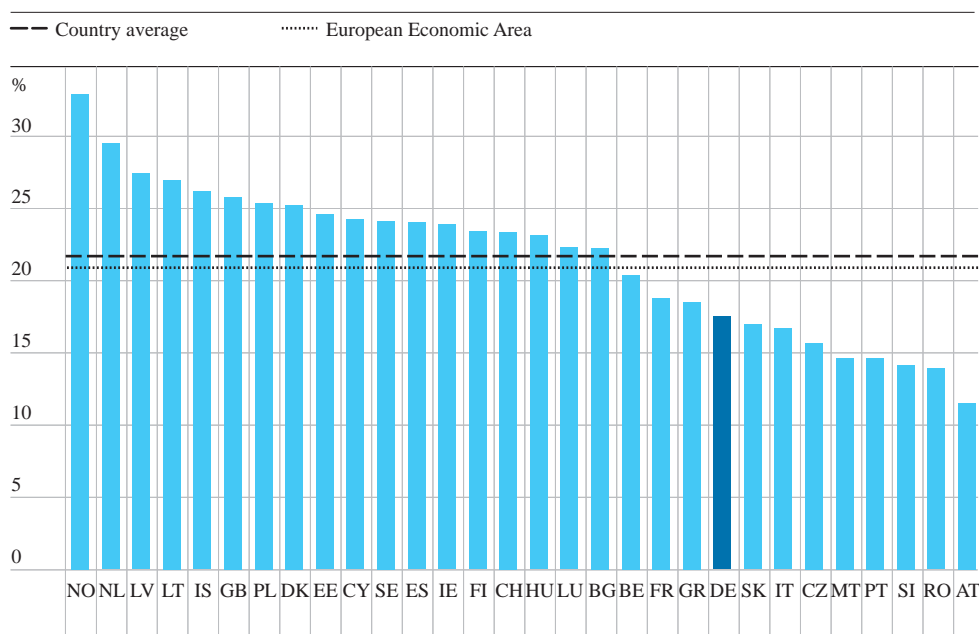
Further education rates: percentages of persons who participated in a continuing vocational training measure within the four weeks preceding the time of the survey.

Trend continues whereby working persons engage in continuing vocational education and training

In the area of further vocational training, gainfully employed persons continue to be more active than unemployed persons and persons outside the labour force. From 1996 to 2008, the percentage of persons who had participated in further vocational training within the four weeks preceding the pertinent survey increased from 4.1 percent to 5.6 percent. The increase in further vocational training on the part of highly qualified gainfully employed persons is particularly noticeable (10.8 percent in 2008 and only 6.7 percent in 1996).

While this trend is welcome, it is accompanied by another that gives grounds for concern: since 1996, participation rates of unemployed persons, and of persons outside the labour force, in further vocational training have been decreasing continually. While in 1996 5.5 percent of all unemployed persons, and 4.1 percent of all persons outside the labour force, had participated in further vocational training within the aforementioned four-week period, in 2008 the corresponding figures were (respectively) only 3.3 percent and 0.9 percent. In a noticeable contrast to the increasing rates of participation in further vocational training seen among highly qualified employed persons, the corresponding rate on the part of highly qualified unemployed persons and persons outside the labour force has been decreasing sharply since 1996. Only 5.2 percent of highly qualified unemployed persons, and 2 percent of highly qualified persons outside the labour force, took part in further vocational training in 2008. The corresponding figures for 1996, respectively, were 10.7 and 8.9 percent.

C 1–6 PROPORTION OF EUROPE'S WORKFORCE WHO ARE HIGHLY QUALIFIED* IN 2009



*ISCED 5a + 6.

Source: Eurostat. *Europäische Arbeitskräfteerhebung*. Calculation of the NIW. In: Leszczenski et al. (2011).

Highly qualified persons: persons who, pursuant to the International Standard Classification of Education (ISCED), have a tertiary educational qualification. That level comprises Diploma, Bachelor's and Master's degrees (level 5a), as well as doctoral degrees and habilitation qualifications (level 6) at universities (including universities of applied sciences).

In spite of increases, the numbers of highly qualified persons in Germany (as a percentage of all persons) are still below the European average

Although the percentage for employed persons with higher education qualifications has been increasing for years, in 2009 that percentage in Germany, at 17.6 percent, was more than three percentage points below the corresponding average value for the European Economic Area (EEA).

Germany's lag in employment of persons with higher education qualifications is not due to any deficits in individual sectors. Employment of persons with higher education qualifications is below the EEA average in both knowledge-intensive and non-knowledge-intensive branches of the manufacturing and services sectors. The discrepancies are particularly large in the area of knowledge-intensive services. While in the UK and in northern European countries 43.2 and 45.7 percent, respectively, of all employees in that sector have a higher education qualification, the corresponding figure for Germany is only 30.4 percent. And most European countries also have higher rates of employment of highly qualified persons in non-knowledge-intensive economic areas than Germany does. This indicates that Germany's relatively low percentage of highly qualified persons, in knowledge-intensive economic areas, is not due to any misallocations between knowledge-intensive and non-knowledge-intensive sectors. Instead, it seems as if Germany simply has too few highly qualified persons.

RESEARCH AND DEVELOPMENT

C 2

Overview

Research and development (R&D) is a key basis for new products and services. The benefits of research and development are not limited to the companies and state research institutions that pursue R&D; society as a whole profits significantly from R&D. Such indirect societal effects, in particular, will significantly affect competitiveness, prosperity and the numbers and quality of jobs in a given country or region. For example, over the past decade economic growth has tended to be particularly strong in those areas in which R&D capacities have been expanded the fastest. As a result, optimising the basis for execution of R&D will continue to be a central task for companies and policymakers alike.

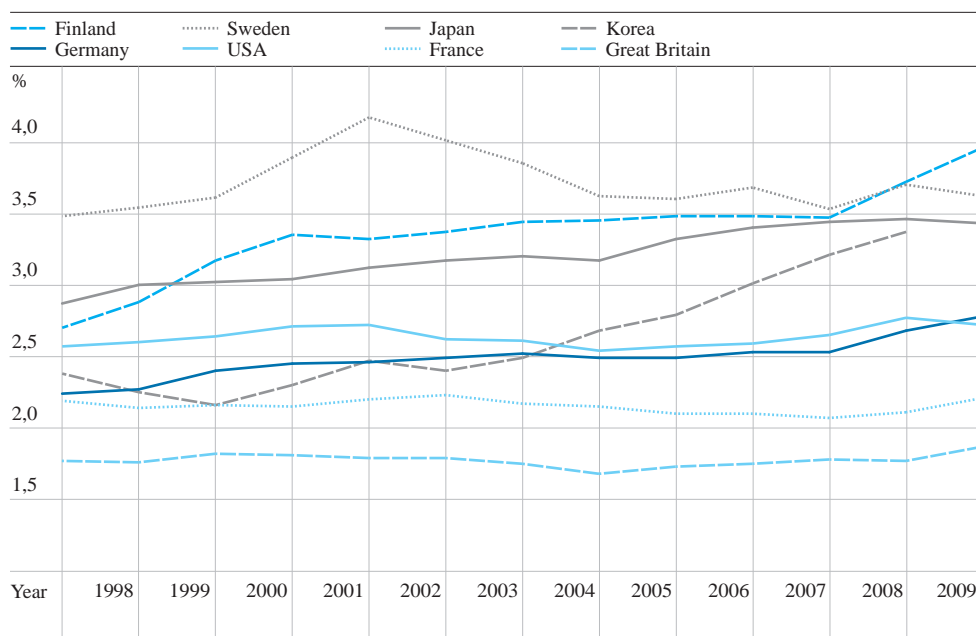
In major Western industrialised countries, expenditures for R&D tend to change procyclically. When growth stagnates, R&D expenditures stagnate as well. During the worldwide economic and financial crisis, therefore, it was thus feared that German companies would considerably curtail their research and development activities. As it happened, such effects materialised only in part. While the crisis did not leave the research and development sector untouched, it only slightly reduced industry's research investments. What is more, the R&D expenditures decrease seen in 2009, 2.4 percent, was considerably smaller, with respect to the corresponding figure for 2008, than the corresponding decrease in gross domestic product (nominal decrease of 3.4 percent). The crisis' impacts on research and development were relatively small thanks to state intervention, aimed at bolstering the economy, and thanks to many German companies' long-term orientation. What is more, state-financed R&D activities – such as R&D at universities and department research institutions – were not affected by cutbacks.

Most of the data evaluated in the framework of this indicator segment were taken from OECD sources (Main Science and Technology Indicators) and from the R&D survey of the Donors' Association for the Promotion of Sciences and Humanities in Germany (*Stifterverband für die Deutsche Wissenschaft*). The data published by the OECD include data on the organisation's 30 member countries, and on nine non-members, and they cover central resources available for R&D, patent data and figures on foreign trade in technology-intensive industries. The Stifterverband regularly surveys some 30,000 companies in Germany with regard to their R&D expenditures, their R&D workforces, their sources of financing for R&D, their R&D locations and their products.³⁴²

Indicators studied:

- Development of R&D intensity (R&D expenditures as a percentage of GDP), by countries
- Total private sector R&D-expenditure relative to turnover, compared internationally
- The state's civilian R&D investments
- Internal R&D expenditures of higher education institutions and non-university research institutions

C 2-1 R&D INTENSITY IN SELECTED OECD COUNTRIES



Some figures are estimates. Source: OECD. Eurostat database. *SV-Wissenschaftsstatistik*. Calculations and estimates of the NIW. In: Schasse et al. (2011).

R&D intensity: Expenditures for research and development, as a percentage share of an economy's gross domestic product.

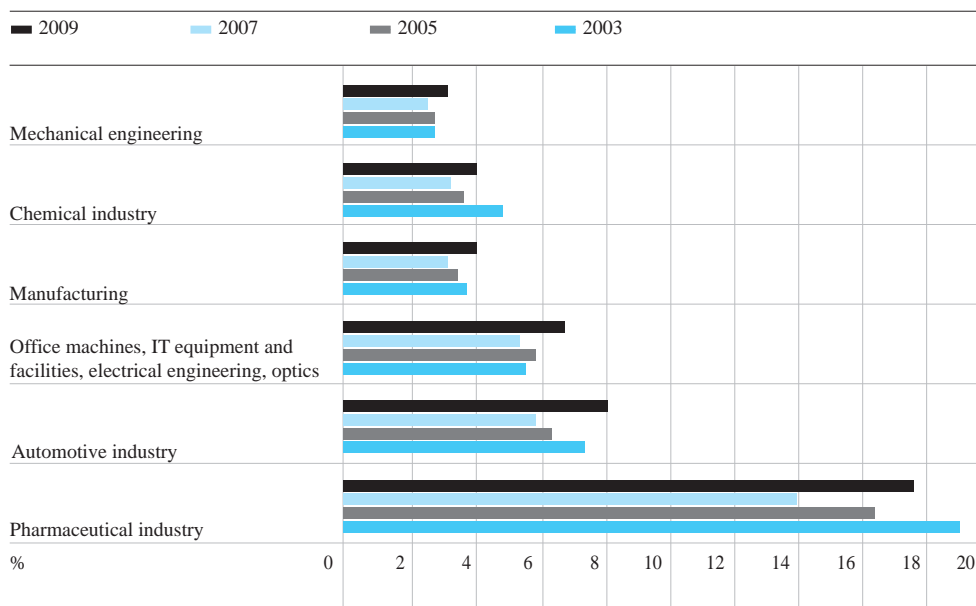
German R&D intensity stable in spite of the crisis

In Germany, both industry and the state have been intensifying their investments in research and development, following a lengthy phase of cutbacks in the late 1990s. While such efforts have failed to match R&D growth in the global economy, Germany has still been able to set itself apart somewhat from other major European economies. Nonetheless, Germany's relatively good performance in comparison with other European countries does not change the fact that Germany's R&D expenditures have lagged behind R&D investments of Asian economies such as Japan and Korea, and behind those of smaller European countries, such as Finland and Switzerland. Those European countries, largely free of the procyclical R&D trends in major Western industrialised countries, have been sharply increasing their real R&D expenditures since the beginning of the 1990s. The growth in German R&D expenditures that took place during the economic and financial crisis, to a level of 2.78 percent (2009), cannot be necessarily taken as indicative of a change of trend, however. It is primarily a statistical effect: it results in that gross domestic product, which serves as a reference for R&D expenditures, shrank significantly as a result of the global crisis (minus 3.4 percent).

On the positive side, however, both industry and the public sector in Germany have continued to invest vigorously in research and development, in spite of the crisis and of tight budgets – and in contrast to actions by industry and the public sector in many other industrialised countries. For example, Germany's R&D intensity in 2009 was higher, for the first time since reunification, than that of the U.S. (2.72 percent).

TOTAL PRIVATE SECTOR R&D EXPENDITURE RELATIVE TO TURNOVER

C 2–2



Through 2007, economic sectors differentiated pursuant to WZ 2003 classification of economic activities.

Sectors for 2009 differentiated pursuant to WZ 2008.

Source: SV-Wissenschaftsstatistik. Federal Statistical Office, *Fachserie 4, Reihe 4.1.1*, and unpublished data.

Calculations and estimates of the NIW. In: Schasse et al. (2011).

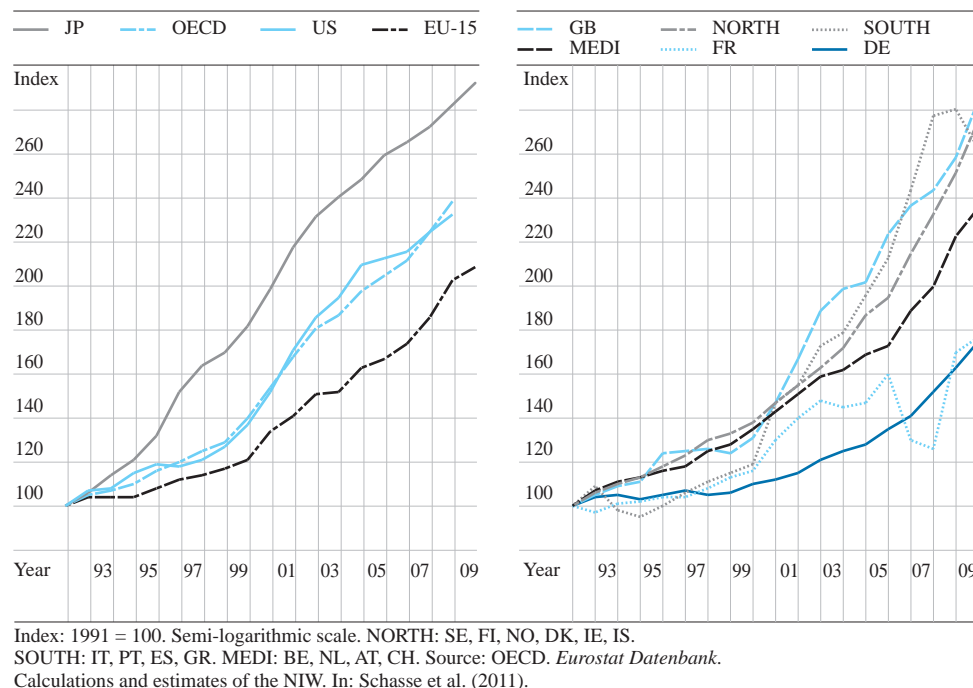
R&D intensity: Expenditure on research and development as a proportion of turnover of a company or a branch.

Strong R&D growth in the pharmaceutical industry – Automakers' predominance in R&D expenditures continues, however

Industry's R&D intensity increased again in 2009, in the first such increase following continual decreases that had begun in 2003. The increase, which at first glance would seem considerable, has to be put into perspective – it is due in large measure to temporary revenue decreases. One exception is provided by the pharmaceutical industry, which registered strong growth in R&D expenditures and only slight revenue decreases.

In spite of the pharmaceutical industry's strong R&D activity, the automotive, mechanical engineering and chemical sectors were the ones mainly responsible for the growth in R&D that occurred since the mid-1990s. In particular, growth in R&D capacities was especially high in the automotive sector. That sector accounted for over half of all growth in R&D capacities since 1995. A full 22 percent of automotive R&D capacities throughout the entire OECD are located in Germany. Consequently, the German innovation system has become more and more dependent on R&D in that industrial sector. Over the past decade, the country's mechanical engineering sector has been able to keep its share of worldwide R&D capacities at about the same level, and that sector remains a key hub of German R&D structures. In the chemical sector, Germany long enjoyed major advantages deriving from specialisation. Those advantages have clearly diminished, however.

C 2–3 STATE BUDGETS FOR CIVILIAN R&D IN SELECTED WORLD REGIONS

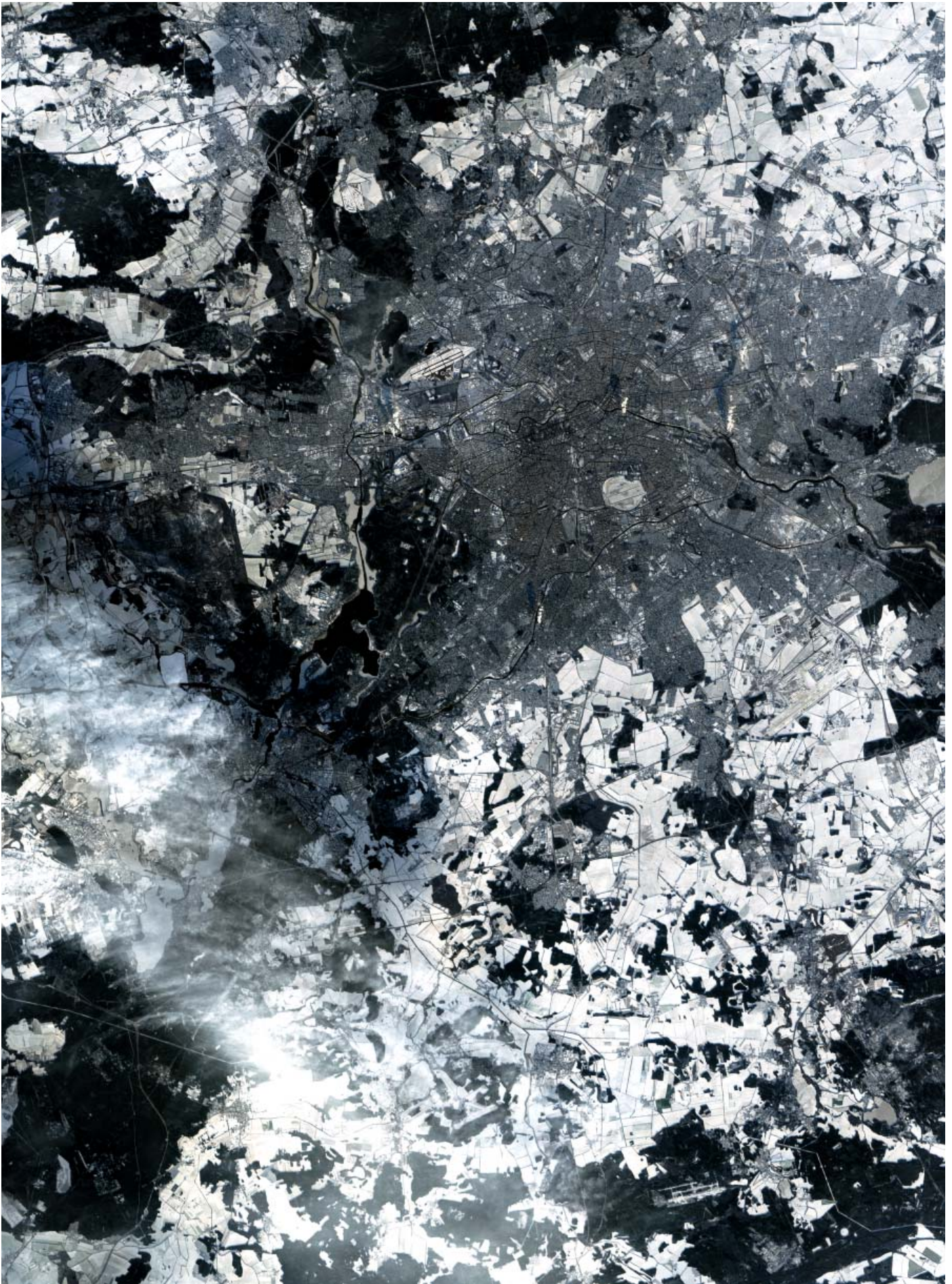


R&D budget: Includes budgetary plan allocations available for financing R&D.

The state's investments in research and development keep growing, in spite of the crisis

Germany's public-sector budgets have sharply increased their allocations for R&D, in spite of the economic and financial crisis. In 2009, budgetary allocations for R&D registered nominal growth of 5.9 percent, more than had been seen in years. With that expenditures increase, not only has the state made up for the crisis-related decline in industry's R&D investments, it has also brought about slight growth in German R&D expenditures overall. Those expenditures increased to EUR 66.7 billion, from the previous year's level of EUR 66.5 billion. With that growth, the public sector's share of Germany's total R&D expenditures also increased in 2009, to 32.3 percent, up from the previous year's level of 30.7 percent.

The development of state R&D investments in Germany, development that an OECD comparison casts in a positive light, is quite a recent phenomenon, however. For nearly all of the 1990s, R&D expenditures registered meager annual growth of only 0.5 percent, i.e. practically stood still. As of 1998, the R&D budget began to increase by a full 2.5 percent annually. By the middle of the last decade, they increased even more strongly. From 2004 to 2008, German R&D budgetary allocations increased by an average of 5 percent per year, while the corresponding increases throughout the OECD were less pronounced, amounting to only 3.6 percent per year. R&D growth for the OECD as a whole was modest, having been constrained primarily by the U.S., the largest R&D investor throughout the OECD. As of 2004, following sharp increases in its budgetary allocations for R&D at the end of the 1990s, the U.S. cut back its expenditures considerably, thereby driving down the R&D-expenditures rate for OECD countries overall.



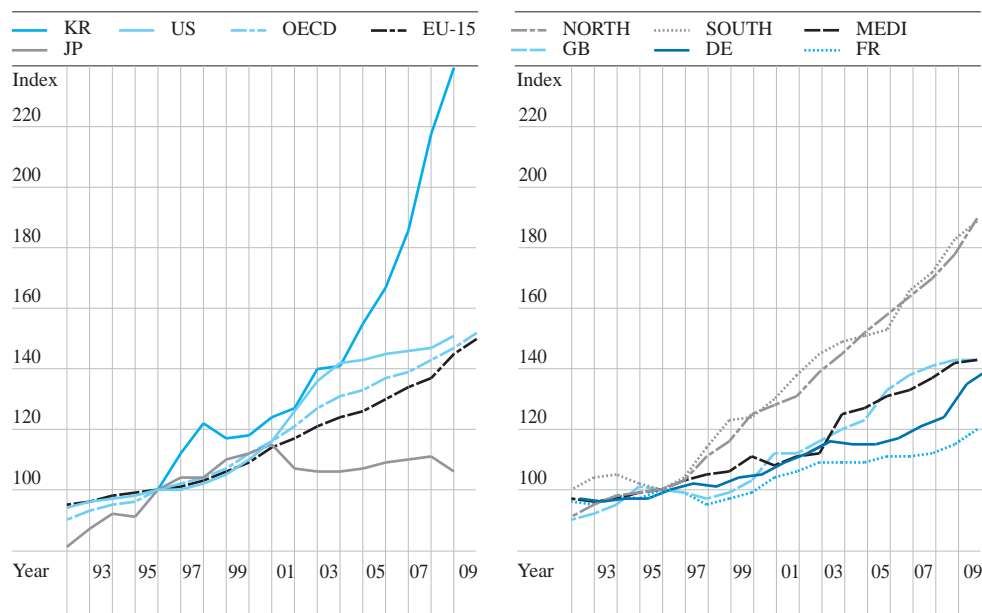
Berlin under a snow cover
©JAXA, ESA



Great Britain and Ireland
©ESA

INTERNAL R&D EXPENDITURES OF UNIVERSITIES AND NON-UNIVERSITY RESEARCH INSTITUTIONS*, IN CONSTANT PRICES, ACCORDING TO WORLD REGIONS

C 2-4



*Including non-profit private organisations. Index: 1995 = 100. Semi-logarithmic scale.

Some figures are estimates. NORTH: SE, FI, NO, DK, IE, IS. SOUTH: IT, PT, ES, GR. MEDI: BE, NL, AT, CH.

Source: OECD. *Eurostat Datenbank*. Calculations and estimates of the NIW. In: Schasse et al. (2011).

Internal R&D expenditures: financial outlays for R&D staff, for R&D equipment and for investments in R&D within a company's own organisation.

Internal R&D expenditures: financial outlays for R&D staff, for R&D equipment and for investments in R&D within a company's own organisation.

State investments in the education sector cause universities' R&D expenditures to rise

Since the early 1990s, public-sector R&D expenditures have grown by 35 percent in Germany, or considerably less than in the Nordic countries (93 percent) and in southern Europe (83 percent). Growth in public-sector R&D expenditures was also considerably higher in the UK and the U.S., at 58 percent and 61 percent, respectively, than it was in Germany. The comparatively low growth seen in Germany is a result of expenditure decreases since the beginning of the last decade. Not until 2005 did public-sector R&D expenditures return to the level they had had in 2002. At the end of the decade, then, expenditures increased considerably. The factors in that growth included the creation of 90,000 additional study places in the framework of the "Higher Education Pact" (*Hochschulpakt*).

In addition, public commitments grew in training providing scientific and engineering qualifications, as did state assistance for financing of R&D and innovation projects in the private sector. The impacts of the R&D-expenditures growth have included accelerated expansion of teaching and research capacities at higher education institutions. Engineering sciences have profited especially from that effect; their teaching and research workforces began increasing again as of 2004, following a decline that had begun in the mid-1990s.

C 3 INNOVATION BEHAVIOUR IN THE GERMAN PRIVATE SECTOR

Overview

The data shown in C 3–1 through C 3–5, relative to the innovation behaviour of German industry, are based on an annual innovation survey, the Mannheim Innovation Panel (MIP)³⁴³, that has been carried out since 1993 by the Centre for European Economic Research (ZEW). The MIP surveys legally independent companies with five or more employees, in industry and selected services sectors, relative to their innovation activities. It represents Germany's contribution to the Community Innovation Surveys (CIS) of the European Commission. A number of changes were made in the MIP 2009 survey as part of conversion to the new classification of economic sectors (WZ 2008)³⁴⁴. In addition, it became possible for the first time to use the statistical offices' company register as a basis for extrapolations. Those two factors necessitated a review of the relevant data back to the 2006 report year. The values presented in the following are based on that review, and thus they can contain discrepancies relevant to the EFI's 2010 report.

The most important source of financing for companies' innovation, far and away, consists of companies' own funds.³⁴⁵ The BACH European database³⁴⁶ managed by the *Banque de France* makes it possible to determine companies' equity ratios (not including those of finance-sector companies) for various European countries. On that basis, C 3–6 presents the equity ratios of small and medium-sized industrial companies in four countries. Innovation projects can also be financed with the help of venture capital. Such capital is provided by venture-capital investors, in the form of liable equity capital or equity-capital-like financing instruments. The data presented in C 3–7 relative to venture capital investments were taken from the current yearbook of the European Private Equity & Venture Capital Association (EVCA).³⁴⁷

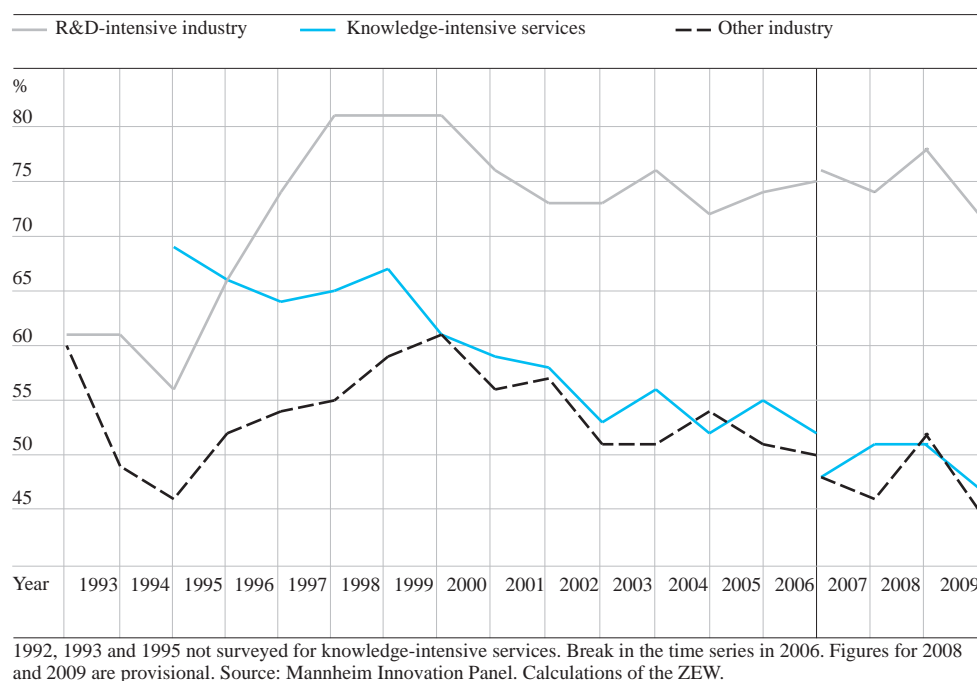
Norms and standards can promote the development and spread of innovation.³⁴⁸ C 3–8 shows the extent to which various countries are involved in the work of the International Organization of Standardization (ISO). The relevant data have been taken from the Annual Reports of the ISO.³⁴⁹

Indicators studied:

- Innovator rate in Germany's industry and knowledge-intensive services
- Companies with continuous or occasional R&D activities in Germany's industry and knowledge-intensive-services
- Innovation intensity in Germany's industry and knowledge-intensive services
- Proportion of revenue achieved with new products in Germany's industry and knowledge-intensive-services
- Planned innovation expenditure in Germany's industry and knowledge-intensive services
- Equity ratios of small and medium-sized industrial companies
- Venture capital investments as a percentage share of gross domestic product
- Number of assigned secretariats for ISO technical committees and subcommittees

INNOVATOR RATE IN GERMANY'S INDUSTRY AND KNOWLEDGE-INTENSIVE SERVICES SECTORS

C 3–1

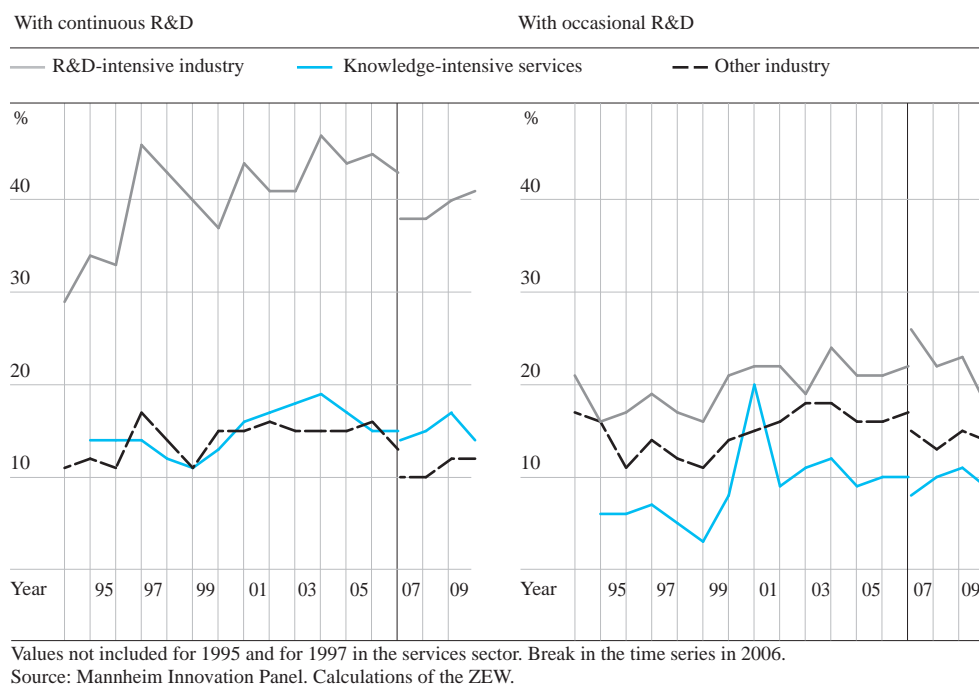


Innovator rate: Percentage share of companies that, within a three-year period, have brought at least one new product to the market or introduced at least one new process.

Innovator rate decreased during the economic and financial crisis

In 2009, the economic and financial crisis had a clear impact on companies' involvement in innovation. In both R&D-intensive industry and other industry, and in the knowledge-intensive services sector, the innovator rate was below the previous year's level. Innovation participation fell particularly strongly in R&D-intensive industry (from 78 to 72 percent) and in other industry (from 52 to 45 percent). In those areas, the innovator rate decreased, following a sharp increase in 2008, to below the level seen in 2007. The percentage of innovating companies also decreased considerably in the area of knowledge-intensive services (from 51 to 47 percent); in 2009, it was about at the level seen in 2006. In 2009, 33 percent of all companies in R&D-intensive industry introduced innovations that were completely new to the market. That percentage was slightly higher than the corresponding figure for 2008. In other industry, the share of companies with new products on the market decreased by 2 percentage points (from 14 to 12 percent), while in knowledge-intensive services the corresponding figure decreased by five percentage points (from 15 to 10 percent). In comparison to the situation in other European countries, German companies' participation in innovation must be considered very high. Significant differences emerge between the 16 German Länder, apart from structural influences³⁵⁰. Companies in Baden-Württemberg and Hesse had the highest innovator rates, 61 and 60 percent, respectively, in 2009. The corresponding figures were below 50 percent in Saxony-Anhalt (42 percent), Mecklenburg-West Pomerania (43 percent) and Brandenburg (46 percent).

C 3–2 COMPANIES WITH CONTINUOUS OR OCCASIONAL R&D ACTIVITIES, IN INDUSTRY AND IN KNOWLEDGE-INTENSIVE SERVICES



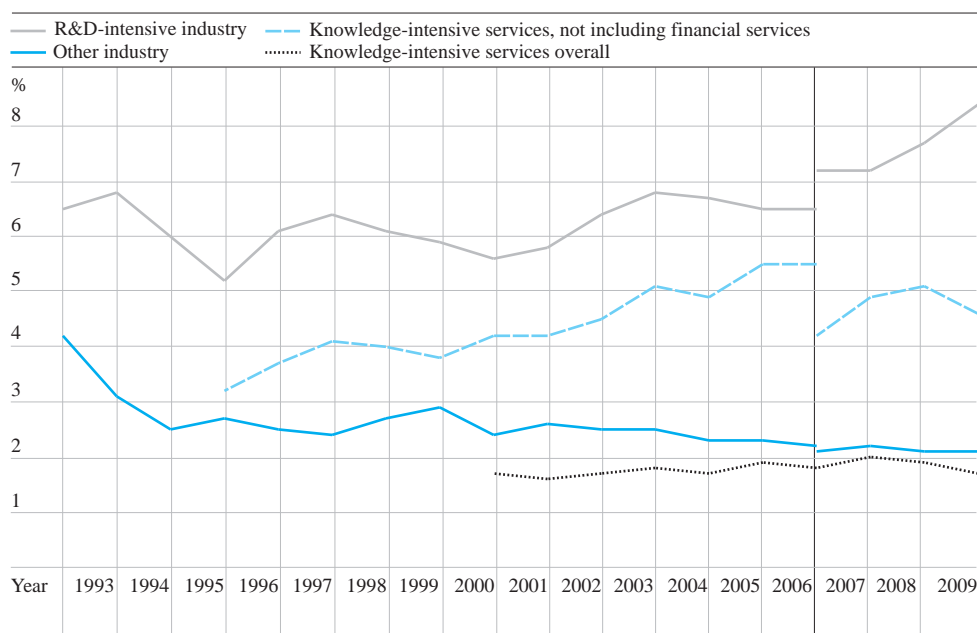
Share of companies with continuous or occasional R&D activities: Innovation-active companies that, over the previous three-year period, pursued R&D either continuously or occasionally.

R&D participation highest in R&D services and the chemical and pharmaceutical industries

Companies that wish to introduce new products that differ from existing products must normally carry out their own research and development. Consequently, R&D participation of companies is an indicator of the degree to which companies orient their innovation strategies to bringing original innovations to the market, rather than simply adopting innovative ideas of other companies. In 2009, some 59 percent of all companies in R&D-intensive industry carried out research and development. The relevant shares were particularly high in the chemical and pharmaceutical industries. In that sectoral group, the overall share decreased by 4 percentage points with regard to 2008, however. While the share of companies with continuous R&D slightly increased (from 40 to 41 percent), the share of companies with only occasional research activities decreased by 5 percentage points (from 23 to 18 percent). In other industry, the percentage share for companies with continuous R&D (12 percent) was lower than that for companies with occasional R&D (14 percent). Those figures were hardly changed from the corresponding figures for the previous year. In knowledge-intensive services, on the other hand, R&D participation decreased markedly during the same period. The percentage share for companies with continuous R&D decreased by 3 percentage points (from 17 to 14 percent), and the share for companies with occasional R&D decreased by 2 percentage points (from 11 to 9 percent). Overall, some 22 percent of all companies in this sectoral group carry out continuous or occasional R&D.

INNOVATION INTENSITY IN GERMANY'S INDUSTRY AND KNOWLEDGE-INTENSIVE SERVICES

C 3-3



Break in the time series in 2006.

Source: Mannheim Innovation Panel. Calculations of the ZEW.

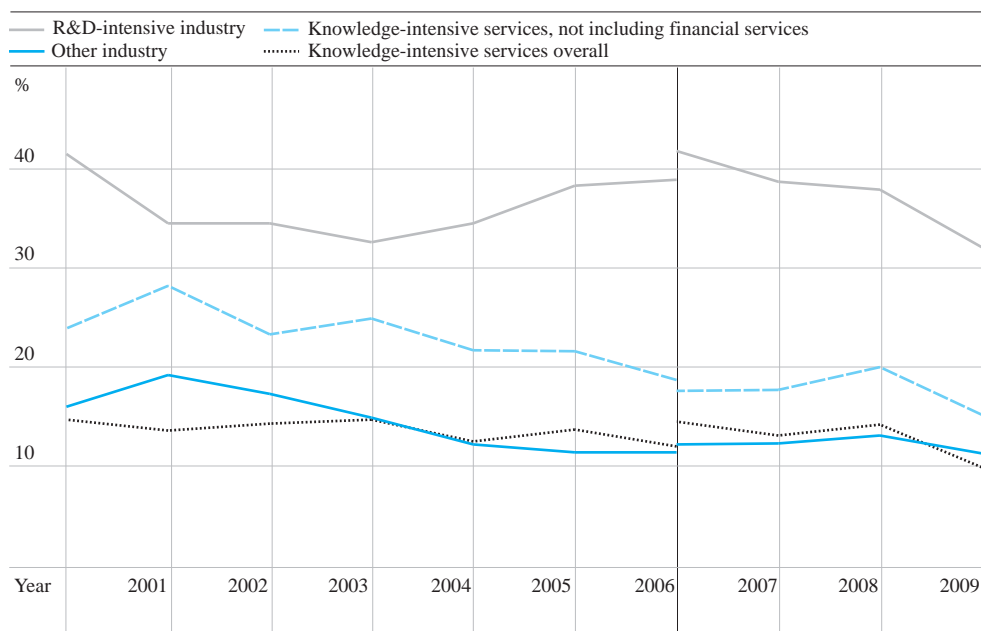
Innovation intensity: Companies' innovation expenditures in relation to total revenue.

During the crisis, innovation expenditures did not fall as sharply as revenue did

In 2009, companies in R&D-intensive industry, other industry and knowledge-intensive services spent a total of EUR 101 billion on internal and external R&D, patents and licenses, innovation-related machinery and equipment, product design, market introduction of new products and other innovation-related goods and services. The corresponding figure for the previous year was EUR 114 billion. The main reason for the sharp decrease of 12 percent is that investment-related innovation expenditures fell strongly.

In 2009, revenue in the three sectoral groups under consideration fell even more strongly than did innovation expenditures. As a result, innovation intensity increased from 3.8 to 3.9 percent during the crisis year. That intensity increased particularly sharply in R&D-intensive industry, where it reached the highest level, 8.4 percent, seen during the period under study (1992–2009). Within that sectoral group, the pharmaceutical industry, and the areas of electronics, measurement technology and optics had the highest innovation intensities (14.4 and 12.0 percent, respectively). In the other industry, innovation intensity remained where it had been in the previous year, at 2.1 percent. In knowledge-intensive services, it decreased, during the same period, from 1.9 to 1.7 percent. Within that sectoral group, innovation intensity in R&D services was especially high, at 36.7 percent.

C 3–4 PROPORTION OF REVENUE ACHIEVED WITH NEW PRODUCTS IN GERMANY'S INDUSTRY AND KNOWLEDGE-INTENSIVE SERVICES



Break in the time series in 2006.

Source: Mannheim Innovation Panel. Calculations of the ZEW.

Proportion of revenue achieved with new products: Revenue with new or significantly improved products introduced by innovating companies in the past three years, for the first time, in relation to total revenue.

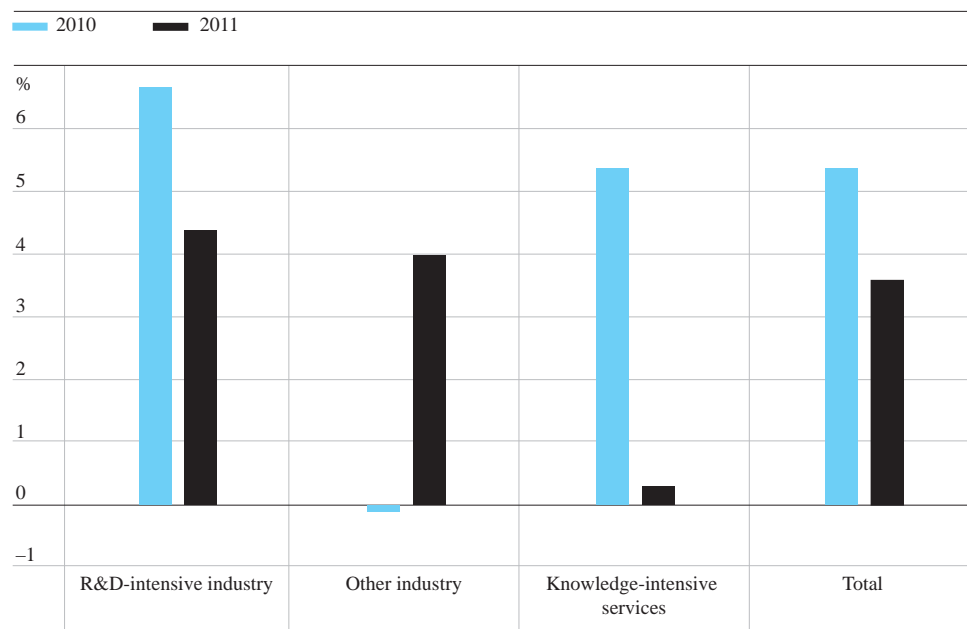
Marked decrease in revenue with derivative innovations

Revenue shares with new products, including both new products on the market and derivative innovations, decreased in 2009 in all three sectoral groups considered. In R&D-intensive industry, it decreased by 6 percentage points with respect to the previous year (from 38 to 32 percent). The highest relevant shares in this sectoral group were seen in the automotive industry (48 percent) and in the areas of electronics, measurement technology and optics (39 percent). In other industry, only 11 percent of revenue was earned with new products in 2009; the corresponding figure for the previous year was 13 percent. In knowledge-intensive services, the share decreased, during the same period, from 14 to 10 percent. When financial services are excluded from that category, the decrease was from 20 to 15 percent. The sectors in this sectoral group that generate the largest revenue shares with new products are R&D services and IT / telecommunications.

The smaller new-product revenue shares overall are the result of markedly decreased revenue with derivative innovations. During the crisis, many companies may well have opted not to introduce new products of that type. What is more, customer demand for standard products, oriented to keeping costs down, may have grown. On the other hand, the revenue share earned with new products on the market increased slightly in 2009. While relevant absolute revenue decreased in that category as well, the general drop in revenue was larger.

PLANNED INNOVATION EXPENDITURE IN GERMANY'S INDUSTRY AND KNOWLEDGE-INTENSIVE SERVICES

C 3–5



Values based on companies' planning data from spring and summer of 2010.
Source: Mannheim Innovation Panel. Calculations of the ZEW.

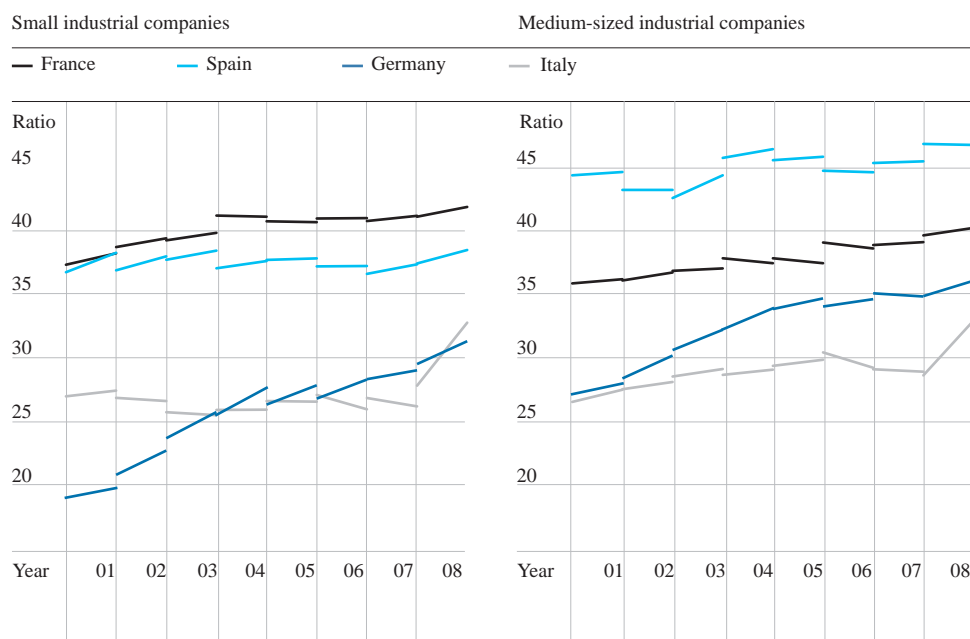
Planned innovation expenditures: Data, obtained from companies' planning figures, regarding changes in innovation-related expenditures, with regard to the previous year.

Innovation expenditures in 2010 not yet back up to their 2008 level

No data has become available to date showing how innovation expenditures have developed following the end of the economic and financial crisis. The latest innovation indicators cover only the period up to 2009. For 2010 and 2011, relevant company planning data are available from spring and summer of 2010.³⁵¹ In all likelihood, innovation expenditures increased again in 2010. The planning figures show that companies in R&D-intensive industry, other industry and knowledge-intensive services increased their innovation budgets by a total of 5.4 percent, to EUR 106.5 billion. The increase does not yet compensate for the strong decrease seen in 2009, and thus expenditures can be expected to still be considerably below innovation expenditures of 2008 (EUR 114 billion). For 2011, the pertinent companies are planning to increase their innovation budgets by an additional 3.6 percent. Even if that increase occurs, innovation expenditures would still be nearly 4 percent below the value for 2008.

For R&D-intensive industry, the planning figures for 2010 and 2011 indicate that above-average growth in innovation budgets can be expected, with the result that that sectoral group's innovation expenditures in 2011 will be back up to their 2008 level. Companies in other industry areas are not planning to increase their innovation budgets until 2011. In the area of knowledge-intensive services, planning called for innovation budgets to rise in 2010. No further increase is planned for 2011, however.

C 3–6 EQUITY RATIOS OF SMALL AND MEDIUM-SIZED ENTERPRISES³⁵²



Source: BACH-ESD, Banque de France. Own depiction.

Equity ratio: A company's equity in relation to its balance-sheet total.

Increasing equity ratios in German companies

Equity ratios of small and medium-sized industrial companies in Germany have been growing since the beginning of the millennium. Companies have been increasing their equity ratios in preparation for, and in response to, the equity-ratio regulations (*Basel II*) that banks have had to apply throughout the EU since 2007.³⁵³

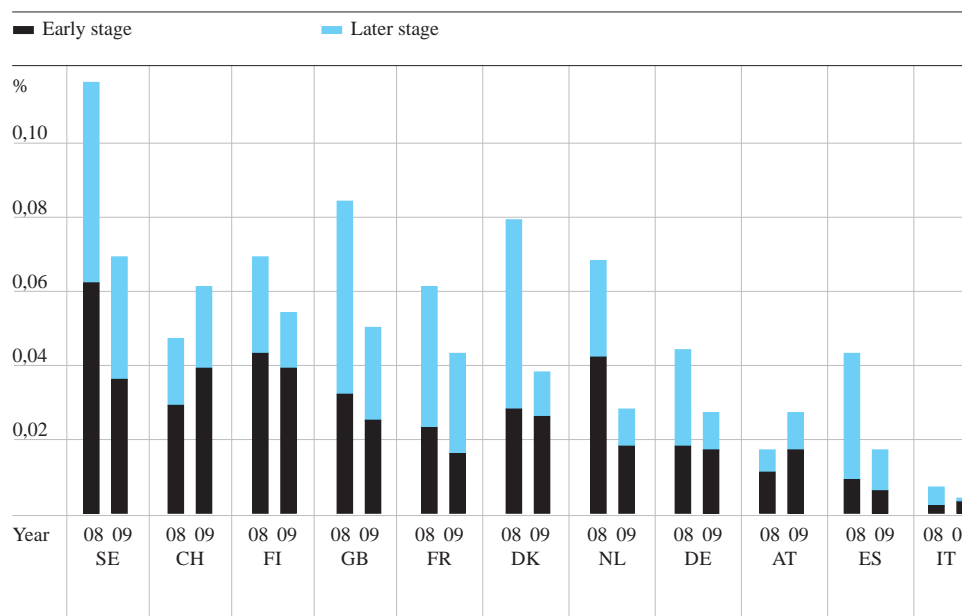
In Germany, small industrial companies tend to have considerably lower equity ratios than medium-sized companies. Small companies thus find it more difficult to finance innovation processes.

An international comparison shows that German and Italian companies – especially small companies – have lower equity ratios than French and Spanish companies. This can be explained as follows:³⁵⁴

- In Germany and in Italy, creditors enjoy better protection than they do in France and Spain and are thus less averse to taking risks. That, in turn, makes it easier for companies in Germany and Italy to find creditors. And that leads to lower equity ratios for such companies.
- In Germany, companies tend to have close and long-lasting relationships with their principal banks. As a result, principal banks tend to be well-informed about their customer companies, and that enables them to offer lower interest and easier access to loans.
- Differences in tax models can also explain some of the differences in equity ratios.

VENTURE-CAPITAL INVESTMENTS AS A PERCENTAGE OF GDP (INVESTMENTS DETERMINED ON THE BASIS OF COMPANIES' LOCATIONS)

C 3–7



The early stage comprises the phases “seed” and “start-up”.
Source: EVCA (2010). Eurostat. Own calculations.

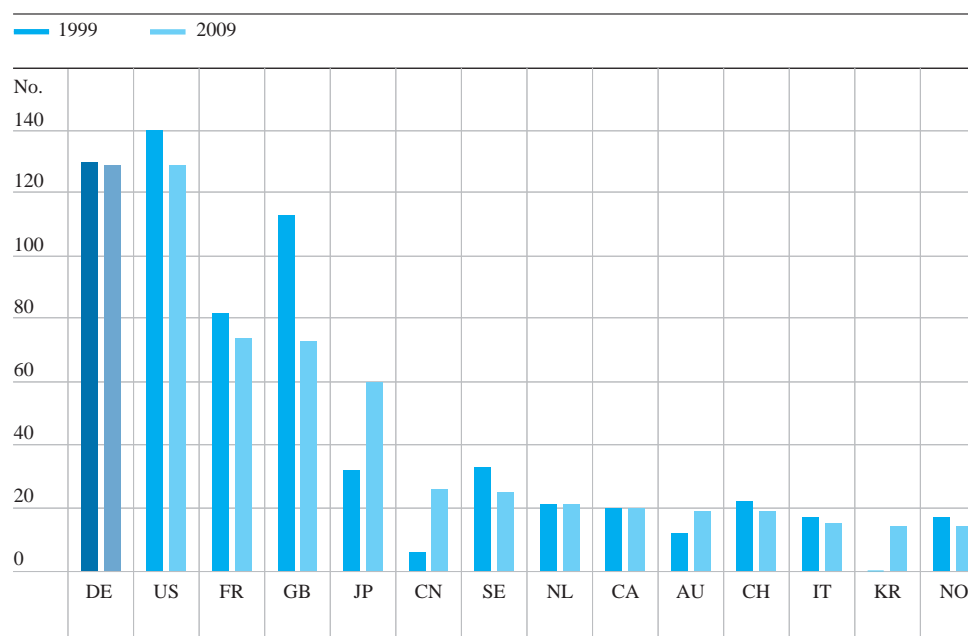
Venture capital: Time-limited equity participation in young, innovative, unlisted companies.³⁵⁵

Sharp drop in venture capital investments during the crisis

Venture capital plays a decisive role in providing young, innovative companies with the capital base they need. Tax-based incentives are particularly suited as instruments for mobilising venture capital. Such incentives are too weak in Germany, however. For that reason, the venture-capital market is underdeveloped. During the crisis, investment volumes, already rather low, dropped sharply. In the crisis year 2009, venture-capital investments in German companies reached a volume of EUR 647 million. That figure represented a drop of nearly 42 percent with respect to 2008. The venture-capital market fell especially sharply in the “later-stage” area, in which the investment volume amounted to hardly more than one-third the previous year’s level.

In 2009, venture-capital investments were equivalent to 0.027 percent of Germany’s gross domestic product. Among the five largest European economies, Germany thus occupies a middle position at best in this category. The countries that had the highest shares of venture-capital investments in 2009, expressed as percentages of GDP, were Sweden (0.069 percent) and Switzerland (0.061 percent). The rates for the UK and France, 0.050 and 0.043 percent, respectively, were also considerably higher than the rate for Germany. In comparison to Germany, both of those countries offer much more extensive tax incentives for such investments. The levels for Spain and Italy, 0.016 and 0.004 percent, respectively, were lower than the level for Germany.

C 3–8 NUMBER OF ASSIGNED SECRETARIATS FOR ISO TECHNICAL COMMITTEES AND SUBCOMMITTEES



Source: ISO (2000 and 2010). Own compilation.

Standardisation: Standardisation of important characteristics of products, processes and services.

Germany strongly committed to, and involved in, international standardisation

Standardisation play an important role in commercialisation of innovative technologies in cases in which different implementation options are available or the actions of different actors have to be co-ordinated. At the international level, standards are developed by the committees of the International Organization for Standardization (ISO). By participating in such committees, a country can significantly influence global technical infrastructures. Such participation significantly reduces adaptation costs for the country's companies, and thereby generates competitive advantages.³⁵⁶ What is more, co-operation in international standardisation processes makes it possible to support national preferences in standards of quality, safety and environmental aspects. In 2009, the ISO had a total of 740 technical committees and subcommittees. In that same year, the German Institute for Standardization (DIN), which represents Germany in the ISO, had been assigned the secretariats of 129 technical committees and subcommittees. Among other countries, only the U.S. shows similar commitment. The number of secretariats managed by DIN has remained nearly constant since 1999. The U.S., France and the UK have all cut back their own involvement. On the other hand, Japan, China, Australia and Korea have significantly increased the number of secretariats assigned to them. The Asian region (including Oceania) has been gaining increasing influence in development of international standards.

NEW ENTERPRISES

C 4

Overview

Start-ups support technological structural change by providing new business ideas that expand and modernise the existing range of products and services – and, thus, challenge existing companies to respond. Start-ups in research-intensive and knowledge-intensive sectors are especially important in this regard. In new technology fields, in connection with new trends in demand and in early phases of translation of scientific findings into new products and processes, young companies open up market niches and enable good innovative ideas, often ideas ignored by large corporations, to succeed.

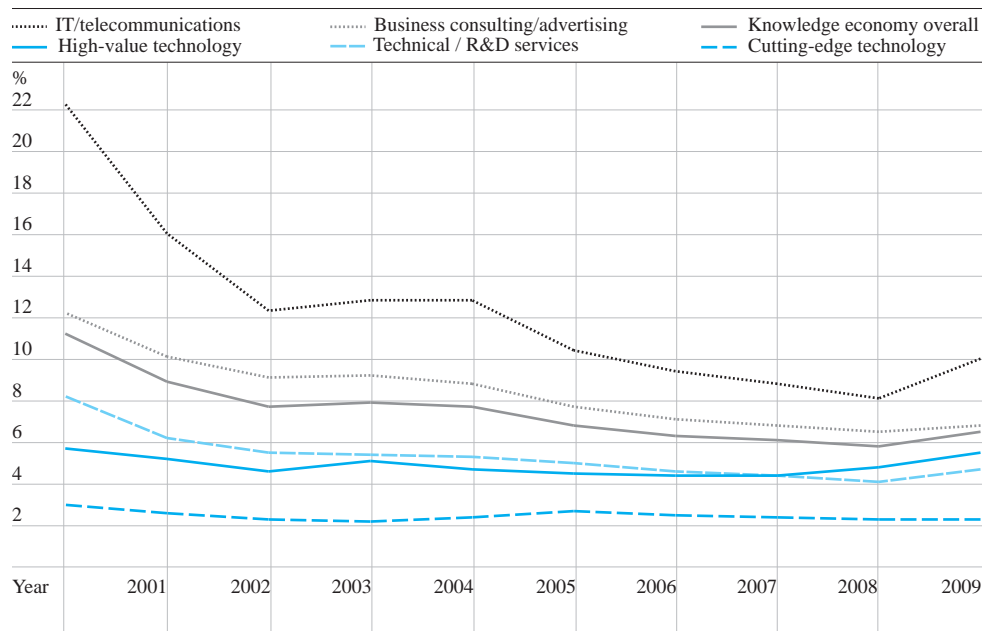
The results presented in C 4–1 through C 4–3, on company trends in the knowledge economy, are based on analysis, carried out by the Centre for European Economic Research (ZEW), of the Mannheim Enterprise Panel (MUP).³⁵⁷ The MUP, which now includes the former ZEW Start-up Panel, is a panel data set of the ZEW relative to companies in Germany. It is prepared in co-operation with Creditreform, the largest German credit reporting agency. The “enterprise” definition used in the MUP covers only economically active companies. Only truly new start-ups are included as start-ups. To qualify as such a start-up, its founder(s) must be engaging in entrepreneurial activity that they previously were not involved in, and at least one person must be using the start-up as his or her main source of income. A company closure is said to have occurred when the relevant company no longer carries out economic activity and no longer offers any goods on the market. For the current report year, the sectoral evaluations relative to company trends were prepared, for the first time, on the basis of the new WZ 2008 statistical classification of economic sectors³⁵⁸. In addition, the method used for identifying company shut-downs, and the method used for extrapolation, were changed considerably, to enable better surveys and statistical description of shut-down events. What is more, for purposes of differentiation of R&D-intensive industry, the revised list of research-intensive industrial sectors was used.³⁵⁹

In C 4–4 and C 4–5, findings of the Global Entrepreneurship Monitor (GEM) are presented³⁶⁰. In 2009, the GEM, a project in progress since the end of the 1990s, compared start-up activity in 54 countries, with regard to scope, trends, framework conditions and motives. The data for the GEM is obtained via interviews with a cross-section of citizens and with experts.

Indicators studied

- Start-up rates in Germany’s knowledge economy
- Closure rates in Germany’s knowledge economy
- Company dynamics in Germany according to sector groups
- Nacent entrepreneurs
- Opportunity entrepreneurs

C 4-1 START-UP RATES IN GERMANY'S KNOWLEDGE ECONOMY



Values for 2009 are provisional.

Source: Mannheim Enterprise Panel. Calculations of the ZEW.

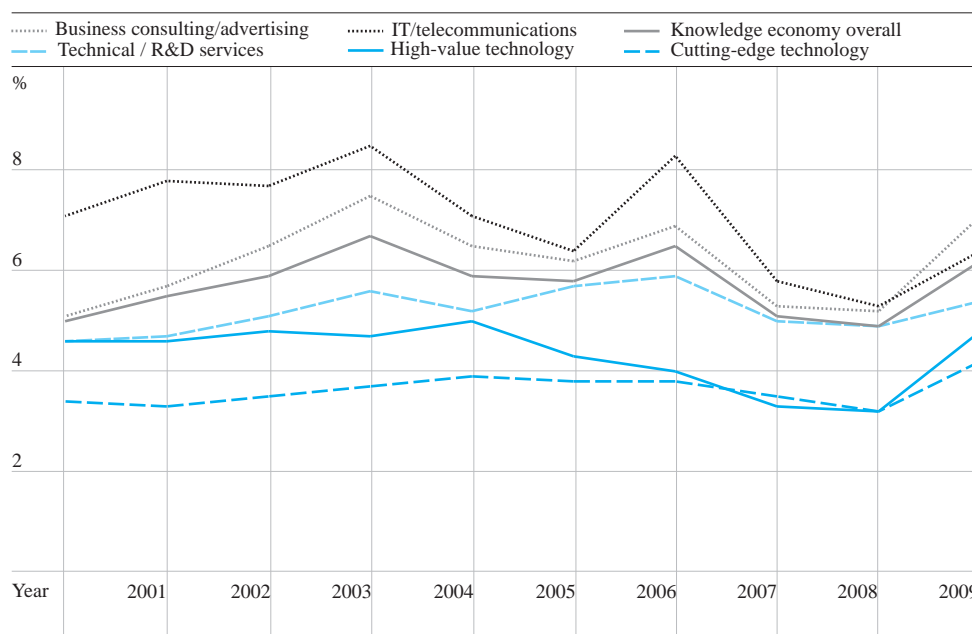
Start-up rate in the IT and telecommunications sector considerably higher again

Closure rates increase during the economic and financial crisis

In 2009, a total of 205,000 economically active companies were founded in Germany. Of those companies, 25,500 were knowledge-economy companies – i.e. companies in the areas of R&D-intensive industry and knowledge-intensive services. In 2009, the start-up rate, which measures the extent to which the total group of existing companies is being rejuvenated via new market entries, was 7.2 percent for the economy as a whole and 6.5 percent for the knowledge economy. Start-up rates increased in all sectors of the knowledge economy in 2009, except for the area of cutting-edge technology. The largest increase, at 2 percent, occurred in the IT and telecommunications sectors. The overall start-up rate in those sectors, at 10.0 percent, was higher than in any of the other sectors considered. The IT and telecommunications sectors enjoy low market-entry barriers and have high expectations regarding sales and growth in demand. The lowest start-up rates in 2009, at 2.3 and 4.7 percent, were seen in cutting-edge technology and in technical and R&D services, respectively. The low rate seen in cutting-edge technology is due primarily to high financing requirements for capital equipment and development of new products, as well as to high requirements with regard to the skills and the specific market knowledge of relevant companies' workforces. For technical and R&D services, regulation of market entry is likely to be responsible for low start-up rates. In addition, the construction sector's weakness over the past ten years is holding the rates down, since many technical-services providers work in the area of structural engineering and architecture.

CLOSURE RATES IN GERMANY'S KNOWLEDGE ECONOMY

C 4-2



All values are provisional.

Source: Mannheim Enterprise Panel. Calculations of the ZEW.

Closure rate: Number of companies shut down during the course of a year, as a percentage of all companies.

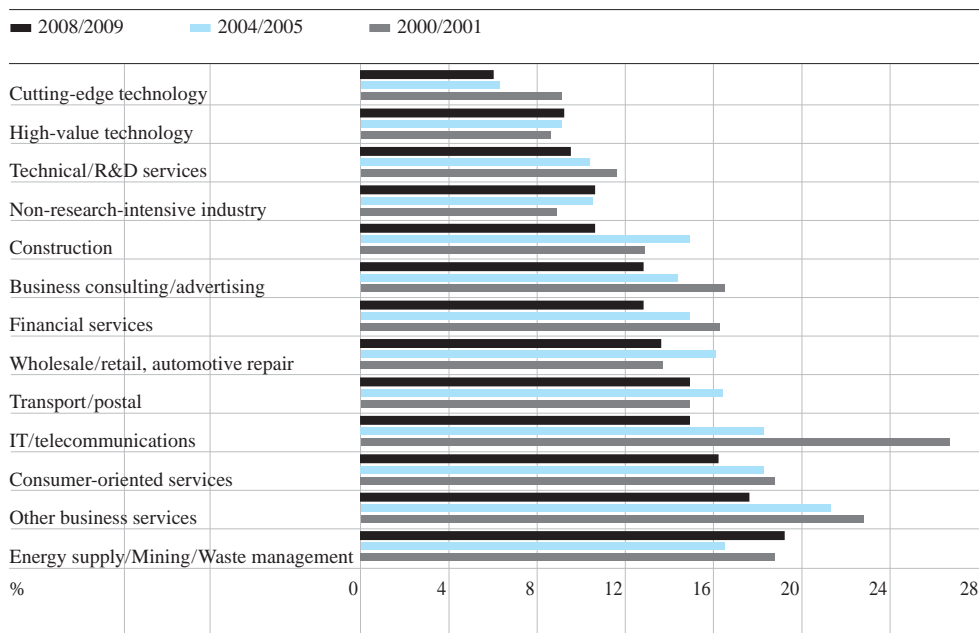
Closure rates increase during the economic and financial crisis

Market entries by start-ups are offset by market departures via shut-downs. Shut-downs include both voluntary closures of companies and forced closures via insolvency.

According to estimates of the ZEW, a total of 217,000 companies left the market in 2009. That figure is 29 percent higher than last year's figure. A total of 24,000 shut-downs took place in knowledge-economy sectors, with the number of market departures increasing by 27 percent with respect to the 2008 level. Knowledge-economy sectors thus account for 11 percent of all shut-downs. That value is slightly below those sectors' share of all start-ups (12.5 percent).

The closure rate in knowledge-economy sectors in 2009 was 6.2 percent, or less than the corresponding figure determined for the economy as a whole (7.6 percent). The shut-down figure was particularly low in cutting-edge technology (4.2 percent), in high-value technology (4.8 percent) and in technical and R&D services (5.4 percent), all areas in which the start-up rate was also relatively low. The closure rate was disproportionately high in the area of business consulting and advertising (7.1 percent) and in the IT and telecommunications sectors (6.4 percent). In comparison to the corresponding figures for 2008, the closure rate increased in all sectors in 2009.

4-3 COMPANY DYNAMICS IN GERMANY ACCORDING TO SECTOR GROUPS



Average for the years 2000 and 2001, 2004 and 2005, and 2008 and 2009. All values are provisional.
Source: Mannheim Enterprise Panel. Calculations of the ZEW.

Company dynamics: Number of start-ups, plus number of company closures, as a percentage of total number of companies at mid-year.

Continuous decrease in company dynamics in cutting-edge technology and in technical and R&D services

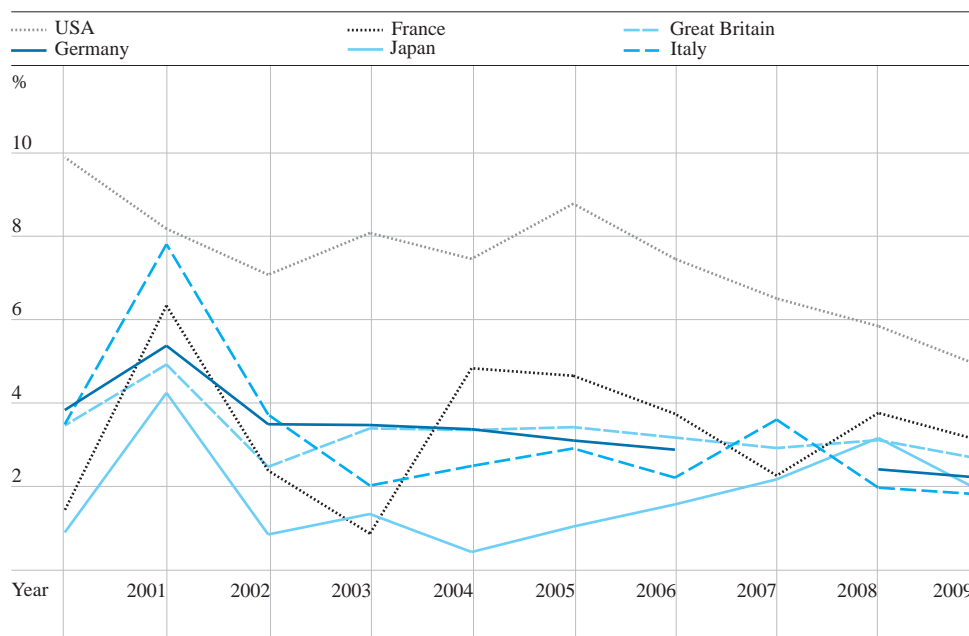
In an intersectoral comparison, the company-dynamics figure gives an indication of the intensity of competition within the various sectors, as well as of how high the barriers to market entry and to market departure are. A comparison over time shows how the company-dynamics figure is shaped by changes in the economic framework and by incentives for start-ups and company closures.

The intersectoral comparison shows that in the 2008/09 period, the area of energy supply, mining and waste management was the sector with the highest level of company dynamics. Among knowledge-economy sectors, the highest figure was seen in IT and telecommunications, while cutting-edge technology had the lowest company dynamics level. In the 2008/09 period, a total of 94 percent of the cutting-edge-technology companies in existence at the end of the year had been active in the market at the beginning of the year. In high-value technology, the company fluctuations level was only slightly higher. In that area, 91 percent of the companies active at the end of the year had been active at the beginning of the year.

In cutting-edge technology, and in technical and R&D services, company dynamics have continuously decreased. In high-value technology, they remained at about the same level. Since the market-entry and market-departure barriers have not changed fundamentally, that result gives pause in that a high level of company dynamics is indicative of strong innovation competition.

PERCENTAGE OF NASCENT ENTREPRENEURS

C 4–4



Germany did not participate in the GEM in 2007.

Source: Global Entrepreneurship Monitor. Adult Population Surveys 2000–2009.

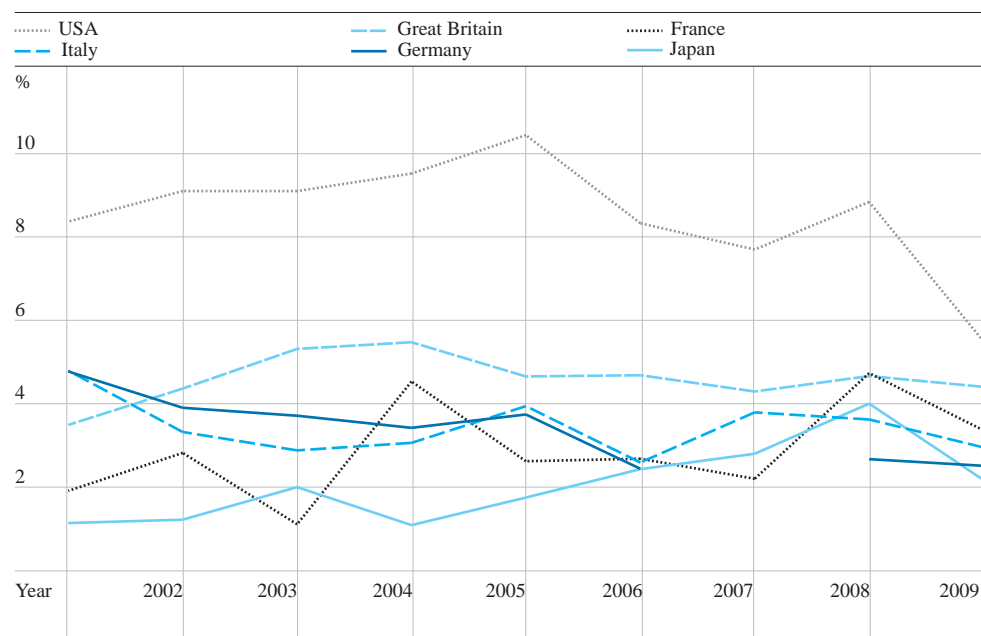
Percentage of nascent entrepreneurs: Number of persons between the ages of 18 and 64 who actively take part in the founding of a new company³⁶¹, who wish to be the company's owner or a shareholder/partner and who, during the past three months prior to the survey, did not pay any wages or salaries, as a percentage of all persons between the ages of 18 and 64, for the country in question.

Numbers of nascent entrepreneurs have been at a consistently low level in Germany for years

Not only do start-ups expand the range of products and services in the market, they also create growth and employment. And yet not many potential entrepreneurs in Germany actually go into business for themselves. In 2009, only 2.2 percent of the German population between the ages of 18 and 64 were in the process of founding a company. And the rate has been dropping continuously since 2002 (3.5 percent). It thus may be concluded that neither the extensive economic upswing of the years 2006 through 2008, nor the economic crisis of 2009, significantly influenced the number of nascent entrepreneurs.

In general, highly developed economies have lower rates of start-up aspiration than do economies that are less highly developed. For example, the numbers of nascent entrepreneurs in the U.S. are relatively low. Nonetheless, the relevant rate there in 2009, at 4.9 percent, was much higher than the rate for Germany (2.2 percent). As this shows, Germany has a low rate of start-ups in comparison to other leading industrialised countries. This is an area in which Germany clearly has a low ranking. Only the reference countries Japan and Italy had lower figures – statistically significant ones – for numbers of nascent entrepreneurs.

C 4–5 OPPORTUNITY ENTREPRENEURS



Germany did not participate in the GEM in 2007.

Source: Global Entrepreneurship Monitor. Adult Population Surveys 2000–2009.

Opportunity entrepreneurship: Number of persons between the ages of 18 and 64 who are nascent entrepreneurs (cf. C 4 – 4) and who wish to go into business for themselves in order to exploit a business idea, as a percentage of all persons between the ages of 18 and 64, in the relevant country.

Persisting reluctance to start-up companies in order to implement business ideas

People start-up companies for many different key reasons.³⁶² In 2009, 2.5 percent of all start-up entrepreneurs in Germany founded companies in order to take advantage of a market opportunity. The numbers of persons in this category, which have remained low, and nearly constant, since 2006, indicate that few of Germany's start-ups of recent years were founded with the aim of implementing a business idea. In a comparison of the above-listed industrialised countries, Germany had the second-lowest rate in this category. Only in Japan did even smaller numbers of persons found companies with the aim of placing a new product on the market. The companies that ranked higher included France, the UK and, especially the U.S., where start-up entrepreneurs are much more likely to study the market for chances of success.

In Germany, would-be entrepreneurs have rarely seen adequate market opportunities for their products. Traditionally, Germany's start-ups tend to be founded for reasons of economic need and a lack of employment alternatives.³⁶³ And yet it is the start-ups that are based on innovative ideas that often create high-quality jobs and thus spur economic growth. In the long term, a lack of innovative start-up entrepreneurs could be an hindrance for development toward an actively entrepreneurial society.

Overview

A patent is a right of exclusion. A holder of a patent has the right to exclude others, for a certain time, from use of the invention on which the patent is based. Patents are national rights – they always apply within a particular jurisdiction.

To patent an invention, an inventor must submit a patent application with a description of the invention. To qualify for a patent, an invention must fulfill three conditions. It must be novel, it must be of a certain quality (must involve an “inventive step”) and it must have a commercial use. Normally, patent applications are reviewed in light of these criteria in a review process carried out by the competent patent office. For Germany, the competent patent offices are the German Patent and Trade Mark Office (DPMA) and the European Patent Office (EPO).

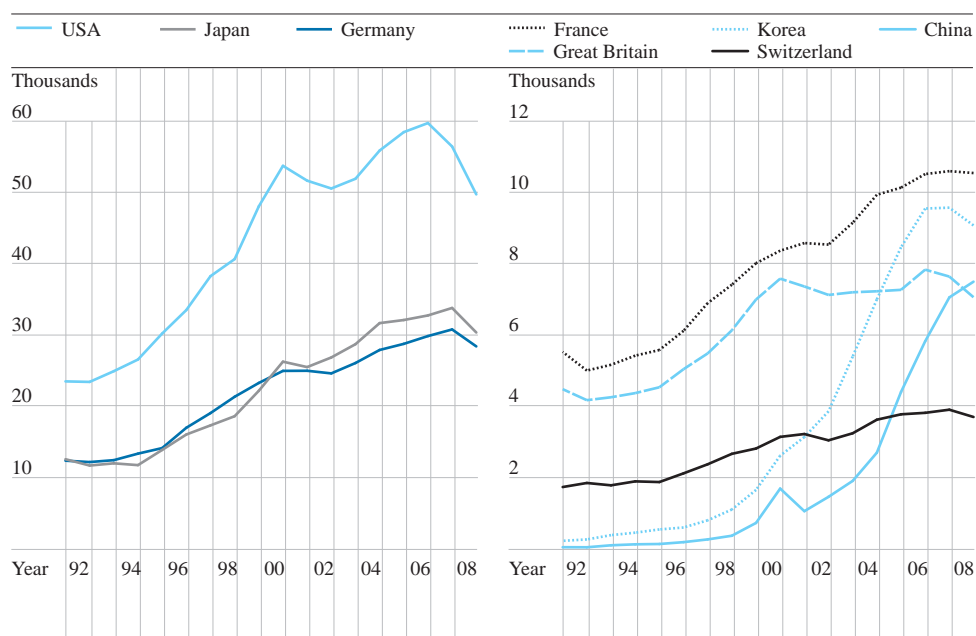
Along with detailed information about the invention involved, patents also contain information about the inventor and the applicant, a classification by time and place and a technical classification of the invention. Because patents contain such data, they are important sources of useful information for assessing the technological performance of a country, a region or a company. And yet there are a number of constraints that reduce the usefulness of patent data for R&I analyses. For example, not all inventions are protected by patents. In addition, the patenting process necessitates disclosure of the pertinent invention. In many cases, therefore, inventors and companies opt to keep inventions secret. Furthermore, patent law excludes certain areas from patenting, such as scientific theories and mathematical methods.

In its patent analyses, the Expert Commission relies primarily on “transnational patent applications”. That group consists of patent applications filed with the European Patent Office, for European countries, or filed as PCT applications³⁶⁴, for non-European countries. Transnational patent applications are filed in cases in which the invention is to be commercialised in a range of different national markets. For purposes of patent statistics, and pertinent indicators, use of data of the relevant international offices (EPO and WIPO³⁶⁵) offers two advantages. Firstly, transnationally filed patents are of greater relevance in this context. Secondly, such patents provide a better basis for comparison of national economies than does any set of national patent data.

Indicators studied:

- Trends in transnational patent applications, in selected countries
- Numbers and intensity of, and growth in, transnational patent applications
- Patent specialisation in high technology
- Patent specialisation in cutting-edge technology

C 5–1 DEVELOPMENT OF NUMBERS OF TRANSNATIONAL PATENT APPLICATIONS



Source: EPO (PATSTAT). Calculations of Fraunhofer ISI, December 2010.

Transnational patent applications are applications in the form of patent families³⁶⁶ that include at least one application filed with the World Intellectual Property Organization (WIPO), via the Patent Cooperation Treaty (PCT) procedure, or one application filed with the European Patent Office.

Financial crisis has marked impacts on patent applications

In terms of absolute numbers, the U.S., Japan and Germany, in that order, are the world's leaders in the area of transnational patent applications. Patent numbers grew in those countries after the economic crisis that took place at the turn of the millennium. The largest growth in recent years has been in Asia, however, especially in Korea and China. Over the past five years, for example, the numbers of patent applications from China have nearly quadrupled. In Korea, the corresponding numbers grew by nearly 70 percent.

The impacts of the global financial crisis are clearly apparent in the patent statistics for 2008, for all countries. While downward trends for international patents in priority year 2007³⁶⁷ can be attributed largely to reduced internationalisation of patent applications, as companies sought to reduce their costs for international applications (international applications can be submitted with time lags of 1 to 2.5 years), the reasons for the effects seen in 2008 are more complex. For example, it is also true for that year that companies applied for international patents less frequently. At the same time, the crisis left visible impacts on R&D processes – and, thus, on indicators such as patent figures. That is clear in the decrease in applications filed with national patent offices such as the USPTO³⁶⁸ and the German Patent and Trade Mark Office (DPMA).

TRANSNATIONAL PATENT APPLICATIONS IN HIGH TECHNOLOGY³⁶⁹ 2008

C 5–2

	Absolute	Intensity	Intensity, high technology	Total growth*, in percent	Growth* in high technology, in percent
Total	190,456	---	---	155	153
Switzerland	3,689	809	407	139	147
Sweden	3,592	736	356	170	163
Germany	28,354	697	373	133	131
Finland	1,783	673	315	119	121
Japan	30,304	475	273	163	160
Netherlands	4,140	459	237	212	215
France	10,537	380	214	142	153
Korea	9,067	346	208	830	771
USA	49,690	330	204	122	122
EU-27	71,156	306	159	146	144
Italy	5,712	242	105	155	148
Great Britain	7,051	225	121	115	107
Canada	3,187	176	98	222	201
China	7,487	8	4	2,102	1,884

*Index: 1998=100.

Source: EPO (PATSTAT). OECD (MSTI). Calculations of Fraunhofer ISI, December 2010.

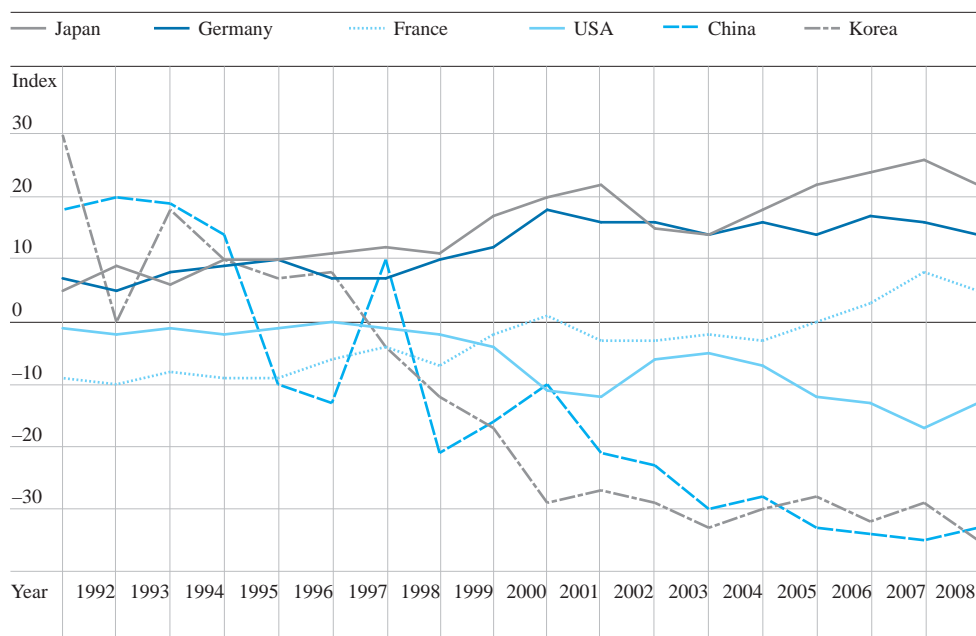
The high-technology industry sector comprises industry areas that invest more than 2.5 per cent of their revenue in research and development. “Intensity” refers to numbers of patents per one million gainfully employed persons.

High-technology patents more strongly affected by the crisis

The figure “number of patent applications per one million gainfully employed persons” (intensity) is an indicator of economies’ relative strength in innovation. Switzerland, with 809 patents, ranks first, followed by Sweden and Germany, which in this category rank ahead of countries such as Japan, the U.S., France and the Netherlands. In the area of high-technology patents, Germany ranks second, behind Switzerland. The rapid development of China and South Korea manifests itself in those countries’ enormous growth rates in high-technology patents during the period 1998–2008, although both still lag considerably behind Germany in terms of absolute figures.

All in all, the relative shares for research-intensive and for less research-intensive applications have remained quite stable over time. For high-technology patents, the share is 55 percent. On the other hand, some countries have experienced profound changes with respect to that breakdown over the same period. For example, in 1991 high-technology patents accounted for nearly 50 percent of Italy’s patents; now, the corresponding figure is only about 42 percent, which is considerably below the global average. Changes in this area have also occurred in China and Korea, which are now moving into the world’s technology markets with patents in less research-intensive areas (i.e. their patents are no longer exclusively high-technology patents). Overall, those countries are broadening their profiles, thereby developing structures more similar to those of established industrialised countries.

C 5–3 HIGH-VALUE TECHNOLOGY SPECIALISATION INDICES FOR SELECTED COUNTRIES³⁷⁰



Source: Questel (EPPATENT, WOPATENT), EPO (PATSTAT). Calculations of Fraunhofer ISI, December 2010.

The specialisation index³⁷¹ is calculated in terms of all transnational patent applications worldwide. A country's score shows how active it is in comparison to the global average (positive score = above-average activity; negative score = below-average activity).

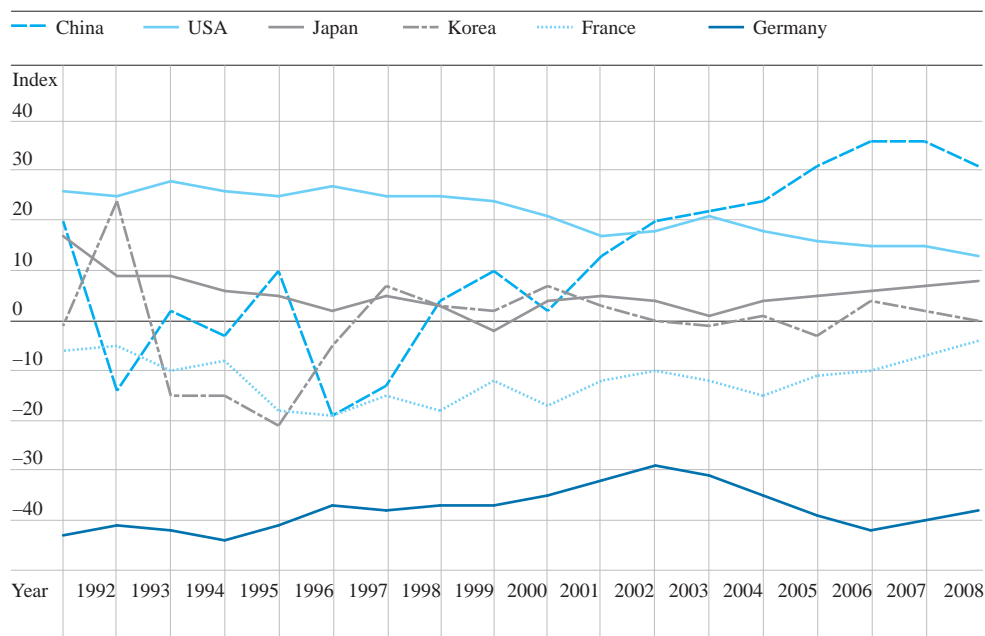
Germany, Japan and Switzerland oriented to high-value technologies

With its traditional strengths in the automotive, mechanical engineering and chemicals sectors, Germany has above-average specialisation in the area of medium-high technology. Japan's profile in this category features electrical engineering and optics, along with auto-making and some chemical sector areas. China and Korea, two rapidly growing countries, are less strongly focussed on those areas. A similar situation prevails in the U.S.

When one differentiates in terms of cutting-edge technology, high-value technology and less research-intensive technology, one obtains polarised profiles for many countries. "Polarised", for a given country, means that the country has a large share of patents in cutting-edge technology, in areas such as biotechnology, pharmaceuticals or information and communications technologies, a large share of patents in less research-intensive areas, and a relatively small share of patents in the area of high-value technology. Germany has a large share of patents in high-value technologies, but a relatively small share in cutting-edge technology. The same is true, in part, for Switzerland – in spite of its many pharmaceutical companies. In that regard, those countries' profiles differ markedly from those of the majority of innovation-oriented industrialised countries – such as the U.S., whose profile is somewhat complementary to that of Germany. This insight makes it possible to protect German technologies efficiently in Germany's U.S. export market.

CUTTING-EDGE TECHNOLOGY SPECIALISATION INDICES FOR SELECTED COUNTRIES³⁷²

C 5-4



Source: Questel (EPPATENT, WOPATENT). EPO (PATSTAT). Calculations of Fraunhofer ISI, December 2010.

The specialisation index³⁷³ is calculated in terms of all transnational patent applications worldwide. A country's score shows how active it is in comparison to the global average (positive score = above-average activity; negative score = below-average activity).

Cutting-edge technologies are among the most dynamic areas

In comparison to the rest of the world, the U.S. has a disproportionate orientation to cutting-edge technology, as is apparent in its patents in life sciences (including medical technology) and in computer technologies. China's orientation to cutting-edge technology is even more pronounced, although in its case the orientation is based exclusively on information and communications technologies.

Among the major industrialised countries, Germany has the lowest orientation to cutting-edge technologies, although its primary technology areas, which are high-value technology areas, are enhanced by cutting-edge technology. German companies continue to be competitive especially in high-value technologies. And yet it is the cutting-edge technology areas that are especially dynamic in terms of growth of patent applications. That also holds for Germany, where information and communications technologies are among the country's fastest-growing technology areas.

C 6 SCIENTIFIC PUBLICATIONS AND PERFORMANCE

Overview

For many years already, “knowledge” has been a key competitive factor in the globalised economy. Many technologies and services are now knowledge-based. While the main aim of science is to produce new knowledge, in an economic context, training of a skilled workforce, and providing a scientific basis for future technological developments, are also key scientific tasks. One indication of the importance of “knowledge” in today’s world is that assessments of countries’ technological performance now also consider the aspect of scientific performance. And such additional assessments focus not mainly on immediate economic benefits but on medium-term and long-term orientation to additional technological developments.

At the same time, scientific performance is difficult to measure, because different scientific disciplines differ widely in terms of their basic structures and contexts. Scientific publications are used as indicators of research performance, for example, and yet publications reflect only the formal side of scientific communication in public research institutions. Differences between disciplines can lead analysts astray in their assessments, and thus assessments have to be carried out carefully, with solid methods. Fortunately, bibliometry – i.e. analysis of scientific publications – is now able to draw on a wealth of experience gained by a range of international research groups.

By themselves, numbers of scientific publications in internationally renowned journals can serve only as rough indicators of performance. Numbers are indicative of quantity, but they tell little about quality. For this reason, citations are also analysed. Citations are indicative of how publications are received by the scientific community, i.e. they give an idea of scientific impacts. In recent years, publications-based measurement of scientific performance has increasingly been used in assessment of institutions and individual researchers, leading both to modify their behaviour in connection with publications. Nonetheless, comparisons of countries remain possible, since that is an internationally widespread and consistently similar phenomenon.

In recent years, publication activity in China has been growing, obviously and continually. That growth reveals that China has been investing massively in training of highly skilled specialists, and that it will thus be able, in the coming years, to intensify its activities in technology-intensive areas.

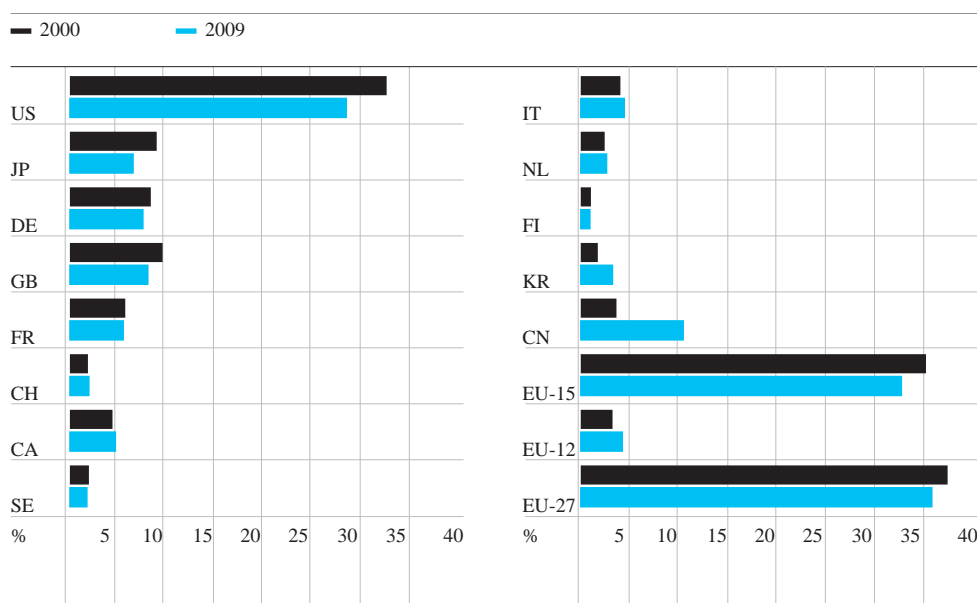
The following section is based on results of a study³⁷⁴ of internationally renowned scientific publications. It includes the following areas: natural sciences, technology, medicine, life sciences and the humanities and social sciences.

Indicators studied:

- Shares of selected countries and regions for all WoS publications
- International alignment (IA) of selected countries and regions for WoS publications
- Scientific regard for WoS Publications from selected countries and regions

SHARES OF SELECTED COUNTRIES AND REGIONS FOR ALL WoS PUBLICATIONS 2000 AND 2009

C 6–1



Source: WoS. Research and calculations of Fraunhofer ISI.

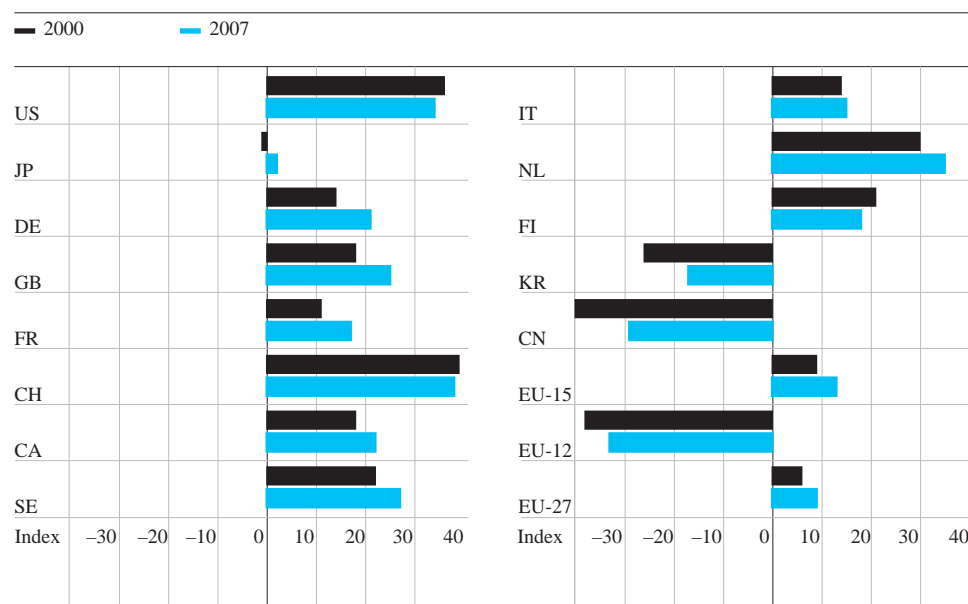
The database used for bibliometric analyses is the Web of Science (WoS) database.³⁷⁵ In the present case, countries' shares of publications, and not absolute numbers of publications, are considered, in order to take account for changes – especially, continuous expansion – in relevant data collection.

Booming Asian countries are displacing major industrialised countries in the WoS

Since 2000, the WoS publication shares for Germany, the U.S., Japan, the UK and France have been continuously decreasing. British and Japanese authors have been affected even more strongly by this trend than German authors have. On the other hand, authors from Canada, Italy and the Netherlands have been able to maintain or even improve their positions. The decreases seen in the shares for many countries are due to the increasing shares of South Korea and, especially, China. And India, Russia and Brazil have been catching up as well. Since the WoS only covers a limited number of journals, growth in the shares of the countries that are catching up has been reducing the shares of the countries that have established themselves as leaders in this category. For example, in 1990, South Korea and China together had a share of 1.4 percent of all WoS publications. By 2009, their combined share had grown to 13.4 percent, i.e. had increased nearly tenfold. A regional consideration shows that the publication shares of the “old” EU Member States (EU-15) have been decreasing gradually. Those of the new EU Member States (EU-12) have been growing, on the other hand, although the pace of that growth has been slow. The new EU countries' growth in this area does not come close to that of South Korea and China.

For a qualitative assessment of publications, cf. the additional indices “international alignment” and “journal-specific scientific regard”.

C 6–2 INTERNATIONAL ALIGNMENT OF SELECTED COUNTRIES AND REGIONS FOR WOS PUBLICATIONS 2000 AND 2007³⁷⁶



Source: WoS. Research and calculations of Fraunhofer ISI.

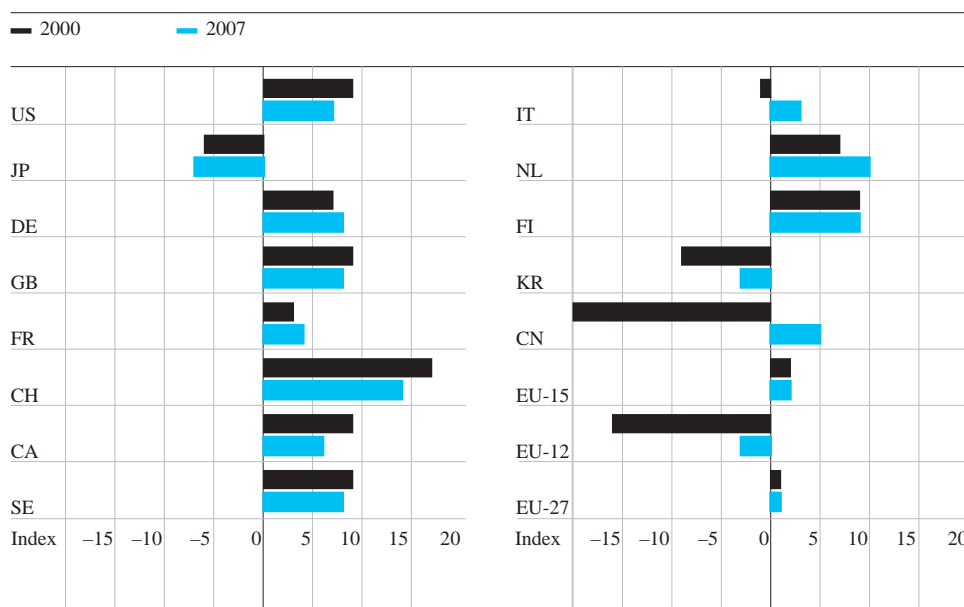
The IA index for a country shows the extent to which the country's authors, in comparison to the world average, are publishing in internationally noted journals and in less-noted journals. Positive values are indicative of above-average IA; negative values are indicative of below-average IA. Index calculations do not take account of self-citations.

Intensifying competition in science

The continuously growing IA values for Germany point to an increasingly international alignment for German authors. On the other hand, the significance of that conclusion is lessened somewhat in that nearly all countries studied have growing IA scores. Authors' own career motivations play a key role in this context, since publications in internationally noted journals lead to higher rates of citations, and citations are increasingly being used as a means of assessing scientific research achievements – for example, in connection with hiring of professors or awarding of third-party funding. While growing publication in internationally visible journals benefits the worldwide scientific dialogue, it means that specialised topics that reach smaller groups of readers, and thus garner fewer citations, are being neglected. Since U.S. journals have a predominant position worldwide, American scientists are at an advantage in calculation of citations in the WoS. That advantage is reflected in their high IA scores. At the same time, Switzerland and the Netherlands achieve comparably high scores. Since authors from those countries have few national options for publication, they have to publish internationally from the outset. On the other hand, authors from Asian countries are in a less favourable position in this regard. Nonetheless, Japanese authors have been able to connect somewhat more effectively with the international scientific discussion. The new EU Member States (EU-12) have especially poor scores; their IA is comparable to that of China.

SCIENTIFIC REGRAD FOR WOS PUBLICATIONS FROM SELECTED COUNTRIES AND REGIONS 2000 AND 2007³⁷⁷

C 6–3



Source: WoS. Research and calculations of Fraunhofer ISI.

The SR indicator for a country shows whether the country's scientific articles are cited more frequently, or less frequently, on average, than the articles in the journals in which the country's own articles appear. Positive values are indicative of above-average SR; negative values are indicative of below-average SR. Index calculations do not take account of self-citations.

Qualitative improvement in publications of China

The SR indicator for Germany indicates that assessment of German publications is stable: its authors have a growing – and suitably noted – presence in internationally respected journals. Countries with SR scores similar to that of Germany include the UK, the U.S., Canada and Sweden. With respect to English-speaking countries, Germany's SR indicator is considerably better than its simple citations rate, since the SR indicator eliminates any advantages of language. In light of their high SR scores, Switzerland and the Netherlands, in addition to maintaining their publication shares, are achieving high levels of recognition for their research achievements. The growing SR scores for South Korea and China point to qualitative improvements in publications of those countries. But since those countries' authors tend to publish in journals that are less well-noted (cf. their IA indicators), it may be concluded that the quality of their publications remains considerably below world standards. While China's SR score is somewhat better than South Korea's, its IA index is lower. That indicates that China's higher level of recognition is being achieved in journals that are not particularly well known. Japanese authors continue to score poorly in this category. Nonetheless, Japanese authors have increasingly been publishing in internationally noted journals, and thus have increasingly been competing with more widely known scientists. The new EU countries currently have a poor position within the scientific community: they have low SR scores, and their publications tend to appear in journals that are not particularly well-known (cf. their IA indicator).

C 7 PRODUCTION, VALUE CREATION AND EMPLOYMENT

Overview

Successful innovations generate added value and create jobs. Highly developed economies can earn well in global markets by specialising in technical innovations and in goods and services with outstanding quality standards. When countries achieve such success, their domestic workforces enjoy high real-income levels, and their companies experience growth in production and employment. As these relationships indicate, countries that achieve technological prowess do so on the basis of R&D-intensive products and knowledge-intensive services. By offering such products and services, highly developed countries make the best use of their advantages, such as high technical standards, extensive investments in R&D and highly qualified workforces.

To develop successfully in the economic sphere, countries today have to undergo sectoral structural change, toward R&D-intensive industries and knowledge-intensive services.

In terms of gross value creation and employment, Germany's knowledge-intensive manufacturing sectors have been developing considerably more dynamically than its non-knowledge-intensive sectors. In the area of services, the differences between knowledge-intensive and non-knowledge-intensive sectors are less pronounced. All in all, a trend towards tertiarisation, i.e. the growing importance of services, is apparent.

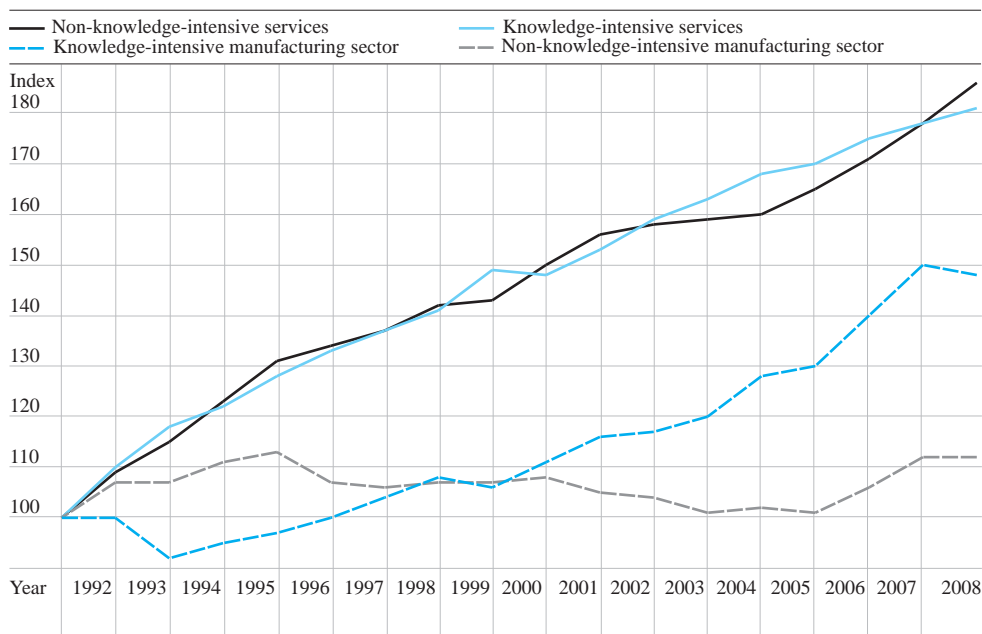
In comparison with the situations in other OECD countries, technology-intensive and knowledge-intensive economic sectors in Germany have especially high shares of overall value creation, employment and exports. In 2007, Germany had the world's largest shares of global trade in the categories of both industrial goods and research-intensive goods. At the same time, the advantages that Germany enjoys as a result of specialisation in trade with industrial goods are shrinking over time. Increasingly, German companies are having to compete with foreign companies in their own domestic markets. Germany has never really specialised in selling cutting-edge-technology goods. Because research-intensive sectors are strongly dependent on foreign trade, the global financial crisis also brought an economic downturn in Germany. However, in comparison to the recoveries in other countries, Germany's recovery has been faster and more pronounced.

Indicators studied:

- Gross value creation in Germany's business economy
- Employment in the business sector in Germany
- Value added in the R&D-intensive industries and non R&D-intensive industries
- Labour input and value added in the knowledge economy
- Germany's foreign-trade specialisation in R&D-intensive goods
- Net contribution of R&D-intensive goods to foreign trade for selected OECD countries

GROSS VALUE CREATION IN GERMANY'S BUSINESS ECONOMY

C 7-1



Index: 1991 = 100.

Source: Federal Statistical Office, Fachserie 18, Reihe 1.4. Calculations of the NIW.

Shares of gross value creation in 2008: knowledge-intensive manufacturing sector, 21 percent; non-knowledge-intensive manufacturing sector, 17 percent; knowledge-intensive services, 36 percent; non-knowledge-intensive services, 27 percent.

Growth in gross value creation in services and knowledge-intensive industry

The German economy has been restructuring as a result of increasing links between industry and services. Since 1991, both knowledge-intensive and non-knowledge-intensive services have been growing consistently. At the same time, many services have become more and more technology-dependent, as a result of their own internal R&D activities, and of their broad application of industrial-sector technologies.

The long-term growth outlook for the manufacturing sector is less rosy, however. The manufacturing sector is more strongly dependent on the economy as a whole than is the services sector. At the same time, knowledge-intensive and non-knowledge-intensive individual sectors can differ in the degree they are affected by such dependence. As a result of the global recession that occurred in the early 1990s, knowledge-intensive sectors suffered sharp downturns, while non-knowledge-intensive sectors (especially consumer goods and durable goods) profited from the special economic benefits occurring via German reunification. As of 1993, a fundamental change began to emerge. Industrial sectors that were less knowledge-intensive began to stagnate or even decline, while knowledge-intensive sectors embarked on a lasting upswing, with growth that almost matched that of the services sector. On the other hand, trends in the most recent years being considered were also positive for industry sectors that are less knowledge-intensive.

C 7–2 EMPLOYMENT TRENDS IN THE BUSINESS SECTOR IN GERMANY³⁷⁸

	WZ03			WZ08					
	2002	2005	2008	2008	2009	2002–05	2005–08	2008–09	2002–08
	In 1.000s					Changes in percent			
Manufacturing sector	9,421	8,554	8,724	8,646	8,493	–3.2	0.7	–1.8	–1.3
Knowledge-intensive sectors	3,510	3,376	3,521	3,083	3,045	–1.3	1.4	–1.2	0.1
Non-knowledge-intensive sectors	5,910	5,178	5,203	5,564	5,447	–4.3	0.2	–2.1	–2.1
Services	13,418	13,037	13,983	14,136	14,056	–1.0	2.4	–0.6	0.7
Knowledge-intensive sectors	5,504	5,379	5,556	5,522	5,569	–0.8	1.1	0.9	0.2
Non-knowledge-intensive sectors	7,914	7,657	8,427	8,614	8,487	–1.1	3.2	–1.5	1.1
Industry	22,839	21,590	22,707	22,782	22,549	–1.9	1.7	–1.0	–0.1
Knowledge-intensive sectors	9,015	8,755	9,077	8,604	8,615	–1.0	1.2	0.1	0.1
Non-knowledge-intensive sectors	13,842	13,350	13,631	14,178	13,934	–2.4	0.7	–1.7	–0.3

Source: Federal Employment Agency. *Sonderauswertung der Beschäftigtenstatistik* (special evaluation of employment statistics). Calculations and estimates of the NIW.

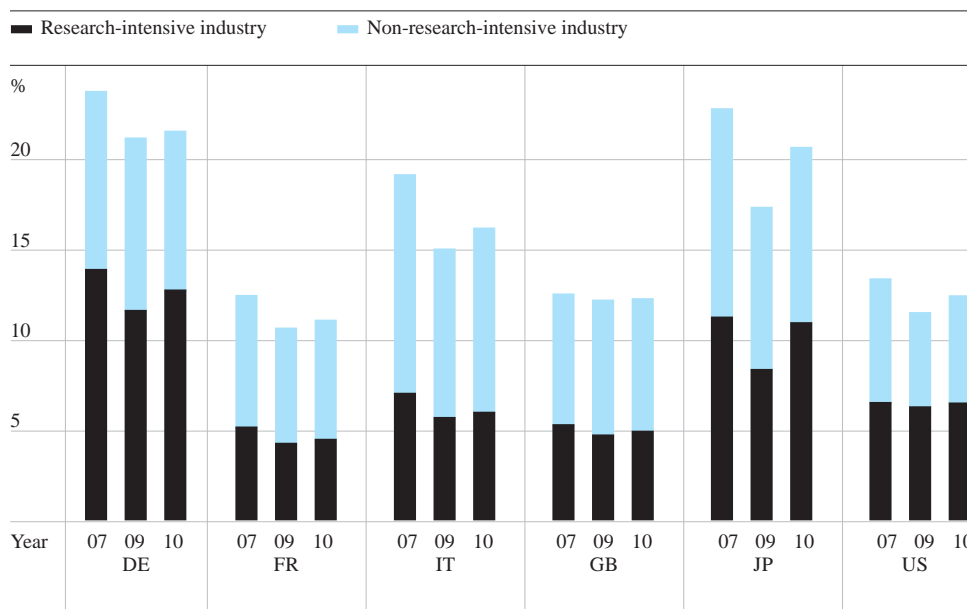
Industry: not including agriculture, public administration and services, education, private households, etc.

Employment in knowledge-intensive services rides out the crisis

Obvious restructuring to the benefit of the services sector continues in Germany's employment market. In the period 2002 through 2008, the number of employees in the services sector increased by an average of 0.7 percent per year (for a total of 570,000 persons), while employment in the manufacturing sector decreased by –1.3 percent per year (–700,000). Differentiation of economic sectors by knowledge-intensity and consideration of economic sub-periods enhance insight into employment trends. In the sub-period 2002 through 2005, jobs subject to social-insurance requirements decreased by nearly 2 percent per year, as a result of weak economic growth. In non-knowledge-intensive sub-sectors, the employment losses were considerably greater (–2.4 percent) than in knowledge-intensive sectors (–1 percent), however. In non-knowledge-intensive sectors of the manufacturing sector, the decrease, at 4.3 percent per year, was particularly pronounced. On the other hand, non-knowledge-intensive economic sectors, especially services sectors, profited from the broad-based job growth that took place in the period 2005 through 2008. During that period, knowledge-intensive economic sectors in particular increasingly encountered shortages of skilled personnel. In spite of the sharp drops in growth that took place in 2008/2009, employment decreased by only 1 percent in Germany. In knowledge-intensive services, it even increased. When the period in question is compared with other periods of economic weakness, it is seen to have taken an extremely favourable course.

VALUE ADDES IN R&D-INTENSIVE INDUSTRIES AND NON-R&D-INTENSIVE INDUSTRIES 2007 AND 2010

C 7-3



Source: EUKLEMS Datenbasis 2010. Calculations and estimates of DIW Berlin (German Institute for Economic Research).

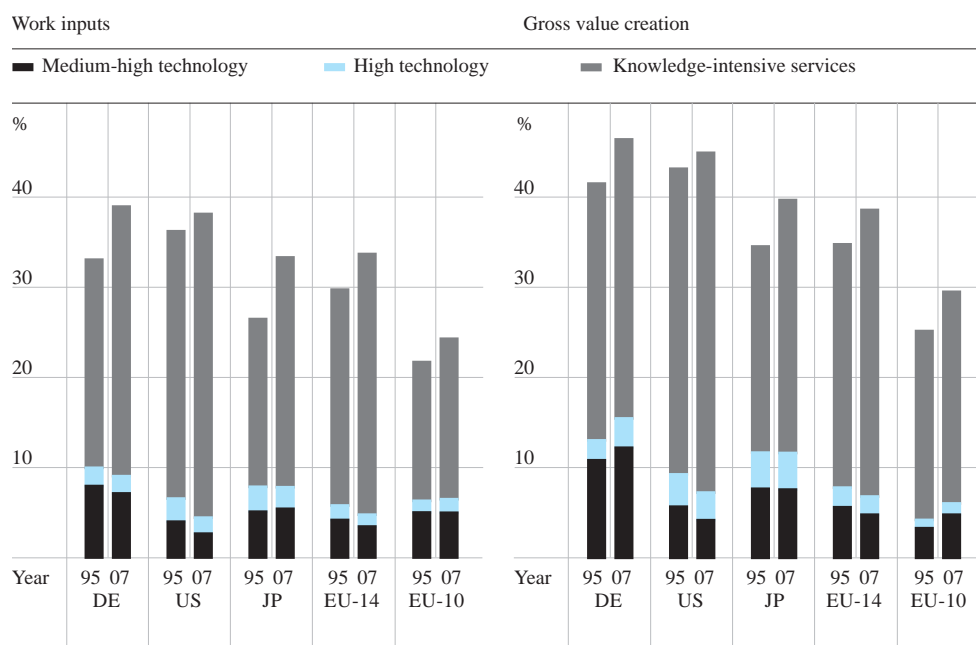
Value creation: Value of production of economic units, less the relevant preliminary outlays.

Research-intensive industry stands firm in the economic and financial crisis

For years, Germany's research-intensive industries have been the main drivers of the country's overall economic development. And they continued to register above-average growth until well into 2008. However, the crisis of confidence triggered by the turbulence in financial markets led to a worldwide slump in demand for investment goods. Production in export-intensive high-technology areas declined dramatically. That proved to be the start of the worst recession in Germany's post-war history. In 2010, then, growth took off again in all sectors of research-intensive industry, causing such sectors' share of total value creation in Germany to increase markedly. At the same time, that share probably did not reattain its pre-crisis level in 2010 (in light of available figures extrapolated for the year as a whole).

Similar crisis-related trends in economic structures have emerged in other major OECD countries as well, although Europe's other major economies have not been keeping pace in the recovery process for their research-intensive industries. In the UK and the U.S., the relevant swings have proven to be more moderate. In those countries, research-intensive industries and the economy as a whole differed little in terms of the shrinkage and growth impetus they experienced. The largest changes in shares of value creation occurred in Japan. Its pertinent losses in 2009, and its relevant share gains in 2010, were larger than the corresponding losses and gains in Germany. By 2010, Japan's research-intensive industries' share of total value creation had almost returned to its pre-crisis level.

C 7-4 LABOUR INPUT AND VALUE ADDED IN THE KNOWLEDGE ECONOMY



Source: EUKLEMS Database (2010). OECD STAN (2010). Calculations and estimates of DIW Berlin (German Institute for Economic Research).

Work inputs, measured in hours of work, are used as part of economic input measurement in a given sector, while nominal value creation measures the corresponding output side. “EU-14” refers to the “old” EU countries, except for Germany, while “EU-10” refers to the new EU countries, except for Romania and Bulgaria.

Germany with a strong international position in knowledge-intensive sectors

Inter-country comparison of work inputs and value creation in research-intensive and knowledge-intensive sectors highlight those sectors’ importance with regard to employment and economic growth. From 1995 to 2007, work inputs in the area of knowledge-intensive services increased in all countries and regions considered. That trend is a reflection of the economy’s growing dependence on knowledge. At the same time, a relative loss of importance has been seen in research-intensive industries. On the output side (value creation) as well, knowledge-intensive services have, in general, tended to have higher growth rates. Other trends have taken place in eastern European countries; they have experienced above-average growth rates especially in research-intensive industries. In an international comparison of overall work inputs and value creation in research-intensive sectors, Germany emerges with the highest ranking. The primary reason for that position is that high-value technologies account for an unusually large share of Germany’s economy, in comparison to the corresponding shares in competing countries.

The relatively small significance of services in Germany was long considered to be a competitive disadvantage. Now, however, the strength of Germany’s industrial sector is proving to be a bastion in the context of global structural change. What is more, Germany’s high-technology industrial sector is providing a solid foundation for the development of complementary services. As shown above, that foundation has been enabling knowledge-intensive services to grow continuously in importance in Germany.

GERMANY'S FOREIGN-TRADE SPECIALISATION IN R&D-INTENSIVE GOODS

C 7–5

Year	DE	US	JP	FR	GB	DK	SE	FI	CH	IT	EU-14
Comparison of export and import structures (Revealed Comparative Advantage – RCA)											
1995	24	13	64	8	11	–22	–16	–50	17	–17	–5
2000	14	17	49	10	13	–6	–7	–29	15	–20	–2
2005	13	24	46	13	17	–3	–3	–19	19	–18	2
2009	12	13	45	13	19	5	–4	–15	26	–15	3
Relative world-trade share of imports (Relative Import Advantage – RMA)											
1995	–9	9	–29	–5	4	–16	8	7	–7	–9	–4
2000	–2	2	–19	–4	2	–23	3	3	–11	–9	–3
2005	3	–2	–16	–4	–3	–18	–3	2	–5	–7	–3
2009	3	3	–18	–3	–7	–24	–3	–3	–7	–6	–4
Relative world-trade share of exports (Relative Export Advantage – RXA)											
1995	16	22	35	3	15	–38	–8	–43	10	–25	–8
2000	14	19	30	6	14	–30	–5	–25	4	–29	–4
2005	15	22	30	8	14	–20	–7	–17	14	–25	–1
2009	16	16	31	10	12	–19	–6	–18	19	–22	–1

Japan's 2009 share of RXA is its value for 2008.
Source: DIW-Außenhandelsdaten (foreign-trade data). Calculations of DIW Berlin (German Institute for Economic Research).

“EU-14” refers to EU-15, without Germany, in trade with third countries. The RCA indicator refers to the ratio between exports and imports, in a specific goods sector, in relation to the corresponding ratio for all of a country's exports and imports. The indicators RMA and RXA denote similar relationships for imports and exports, respectively.

German imports of R&D-intensive goods growing

Scores achieved for the RCA specialisation indicator confirm the leading positions of Japan, the U.S., Switzerland, the UK, Germany and France in the area of international trade in R&D-intensive goods. In those countries, comparative advantages in the area of R&D-intensive goods (RCA values larger than ten) result from above-average specialisation in exports (high RXA values).

At the same time, Germany's comparative advantages in this area have been decreasing continually. The reason for this is that Germany's imports of R&D-intensive goods from countries that are catching up have been growing in the middle and lower price segments; Germany's RMA index changed from a clearly negative value (–9) in 1995 to a slightly positive value (3) in 2009. The countries that are catching up can be expected to become even stronger in this area in the medium term. A similar trend is seen in Japan, where proximity to China is having added impacts. Finland and Denmark, on the other hand, have markedly improved their net positions in the area of R&D-intensive goods – as their growing RCA values indicate. They have achieved those improvements primarily via intensified exports of R&D-intensive goods. In countries with only slight changes of net position, with regard to specialisation in R&D-intensive goods – the U.S., France, the UK, Sweden and Switzerland – the relevant values have been decreasing for both exports and imports.

C 7–6 NET CONTRIBUTION OF R&D-INTENSIVE GOODS TO FOREIGN TRADE FOR SELECTED OECD COUNTRIES

Year	DE	US	JP	FR	GB	DK	SE	FI	CH	IT	EU-14
R&D-intensive goods											
1995	70	28	199	23	30	–50	–43	–135	50	–50	–14
2000	49	43	170	31	36	–18	–23	–91	43	–58	–5
2005	50	58	158	37	47	–7	–12	–57	60	–50	6
2009	47	28	146	38	54	8	–12	–45	81	–44	8
High technology											
1995	–24	21	47	5	26	–12	–14	–51	11	–44	–9
2000	–36	38	4	6	19	2	4	–12	7	–50	–7
2005	–33	34	–21	11	36	7	2	7	46	–43	1
2009	–19	–10	–36	26	31	12	11	–28	94	–43	4
Medium-high technology											
1995	94	8	151	18	4	–39	–30	–84	39	–6	–5
2000	85	5	165	24	17	–19	–27	–79	37	–8	3
2005	83	24	179	26	10	–13	–14	–64	14	–7	4
2009	66	38	182	11	23	–4	–22	–18	–13	–1	4

Source: DIW-Außenhandelsdaten (foreign-trade data). Calculations of DIW Berlin (German Institute for Economic Research).

A positive / negative value in the category of net contribution to foreign trade is indicative of a country's comparative advantages / disadvantages in this area. Net contribution = contribution to exports, minus contributions to imports.

Medium-high technology remains Germany's export forte

R&D-intensive goods continue to play an important role in Germany's foreign trade, and that role is due primarily to strengths in the area of high-value technologies; Germany has marked weaknesses in foreign trade in the area of cutting-edge technologies.

Since the mid-1990s, noticeable shifts have occurred in a number of highly developed countries in the relationship between high technology and medium-high technology. The U.S., long the most important country in high technology, lost considerable ground in this category between 2005 and 2009, while it strengthened its position in the area of medium-high technology. In Switzerland, the trend has gone in the opposite direction, toward high technology. High technology has also grown in importance in France, the UK, Denmark and Sweden.

Overall, Switzerland and – especially – Japan have leading positions in foreign trade with R&D-intensive goods. In the case of Japan, that leadership is clearly due to medium-high technology, while its index score for high technology, which was still clearly positive in 1995, is now negative. In interpretation of foreign trade data, it must be remembered that such data reflect only part of a country's economic strength, and, as shown above, that knowledge-intensive services make key contributions to economic strength. Such services play only a subordinate role in foreign trade, however. Analysis of foreign trade in the area of services shows that Germany's position in this category has been improving continually.³⁷⁹

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LIST OF ABBREVIATIONS

AIFM	Alternative Investment Fund Manager
BaföG	<i>Bundesausbildungsförderungsgesetz</i> (Federal Education and Training Assistance Act)
BAS	<i>Beitrag zum Außenhandelsaldo</i> (contribution to foreign trade balance)
BIBB	<i>Bundesinstitut für Berufsbildung</i> (Federal Institute for Education and Vocational Training)
GDP	Gross Domestic Product
BITKOM	<i>Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V.</i> (Federal Association for Information Technology, Telecommunications and New Media)
BLK	<i>Bund-Länder</i> Commission for Educational Planning and Research Promotion
BMBF	<i>Bundesministerium für Bildung und Forschung</i> (Federal Ministry of Education and Research)
BMVBS	<i>Bundesministerium für Verkehr, Bau und Stadtentwicklung</i> (Federal Ministry of Transport, Building and Urban Development)
BMWi	<i>Bundesministerium für Wirtschaft und Technologie</i> (Federal Ministry of Economics and Technology)
BnetzA	<i>Bundesnetzagentur</i> (Federal Network Agency)
BZM	<i>Beitrag zu den Importen</i> (Contribution to imports)
BZX	<i>Beitrag zu den Exporten</i> (Contribution to exports)
CERN	European Organisation for Nuclear Research
CIP	Competitiveness and Innovation Framework Programme
Cf.	compare
CIS	Community Innovation Surveys
CO ₂	Carbon dioxide
COST	European Cooperation in Science and Technology
CRTC	Canadian Radio-Television and Telecommunications Commission
DFG	<i>Deutsche Forschungsgemeinschaft</i> (German Research Foundation)
DIN	<i>Deutsches Institut für Normung e. V.</i> (German Institute for Standardisation)
DIW	<i>Deutsches Institut für Wirtschaftsforschung e. V.</i> (German Institute for Economic Research)
DKJS	<i>Deutsche Kinder- und Jugendstiftung</i> (German Children and Youth Foundation)
DPMA	<i>Deutsches Patent- und Markenamt</i> (German Patent and Trademark Office)
eco	<i>Verband der deutschen Internetwirtschaft e. V.</i> (Association of the German Internet industry)
EFI	<i>Expertenkommission Forschung und Innovation</i> (Commission of Experts on Research and Innovation)
EFR	<i>Europäischer Forschungsraum</i> (European Research Area)
EIB	European Investment Bank
EIF	European Investment Fund
EIT	European Institute of Innovation and Technology
EPO	European Patent Office
EPC	European Patent Convention
ERA	European Research Area

ERC	European Research Council
ESA	European Space Agency
ETP	European Technology Platforms
etc.	et cetera
EU	European Union
EURATOM	European Atomic Energy Community
Eurostat	Statistical Office of the European Union
EVCA	European Private Equity and Venture Capital Association
EEA	European Economic Area
FCC	Federal Communications Commission
FhG	<i>Fraunhofer-Gesellschaft</i>
R&D	Research and development
R&I	Research and Innovation
FZK	<i>Forschungszentrum Karlsruhe</i> (Karlsruhe research centre)
GEM	Global Entrepreneurship Monitor
GG	<i>Grundgesetz</i> (German Basic Law)
GGEMO	<i>Gemeinsame Geschäftsstelle Elektromobilität</i> (Federal Government's joint office for electromobility)
GmbH	<i>Gesellschaft mit beschränkter Haftung</i> (limited liability company)
GRC	Göttingen Research Council
GTL	<i>Ideen für mehr! Ganztägig lernen</i> ("Ideas for more! Learning all-day" programme)
GWK	<i>Gemeinsame Wissenschaftskonferenz</i> (Joint Science Conference)
HGF	Helmholtz Association of German Research Centres
HIS	<i>Hochschul-Informationen-System</i> (Higher Education Information System)
IA	International Alignment
IAB	<i>Institut für Arbeitsmarkt- und Berufsforschung</i> (Institute for Employment Research)
ICE	<i>Information, Controlling, Entscheidung</i> (Information, Controlling, Decision)
IFM-GEOMAR	Leibniz Institute of Marine Sciences
ICT	Information and Communications Technology
IQB	<i>Institut zur Qualitätsentwicklung im Bildungswesen</i> (Institute for quality development in education)
ISCED	International Standard Classification of Education
ISO	International Organization for Standardization
IT	Information Technology
ITER	International Thermonuclear Experimental Reactor
IZBB	<i>Investitionsprogramm "Zukunft Bildung und Betreuung"</i> (Programme for the Future, for Education and Childcare)
JARA	Jülich-Aachen Research Alliance
JRC	Joint Research Center
KfW	<i>Kreditanstalt für Wiederaufbau</i> (KfW Bank Group)
KIC	Knowledge and Innovation Communities
KIT	Karlsruhe Institute of Technology
KMK	<i>Kultusministerkonferenz</i> (The Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany)

SMEs	Small and medium-sized enterprises
KStG	<i>Körperschaftsteuergesetz</i> (Corporation Tax Act) ()
MINT	Mathematics, Informatics, Natural Sciences, Technology
MIP	Mannheim Innovation Panel
MPG	<i>Max-Planck-Gesellschaft</i> (Max Planck Society)
MUP	<i>Mannheimer Unternehmenspanel</i> (Mannheim Enterprise Panel)
NIW	<i>Niedersächsisches Institut für Wirtschaftsforschung</i> (Lower Saxony Institute for Economic Research)
NRW	North Rhine – Westphalia
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
OMC	Open Method of Co-ordination
PCT	Patent Cooperation Treaty
PISA	Programme for International Student Assessment
PPP	Public-Private Partnership
QoS	Quality of Service
RCA	Revealed Comparative Advantage
RFID	Radio Frequency Identification
RMA	Relative Import Advantage
FP	EU Research Framework Programme
RTDI	Research, Technological Development and Innovation
RWTH	<i>Rheinisch-Westfälische Technische Hochschule Aachen</i> (RWTH Aachen University)
RXA	Relative Export Advantage
SaaS	Software as a Service
SCI	Science Citation Index
SF	Structural Funds
SR	Journal-specific scientific regard
TKG	<i>Telekommunikationsgesetz</i> (Telecommunications Act)
USPTO	United States Patent and Trademark Office
WGL	Gottfried Wilhelm Leibniz Science Association
WIPO	World Intellectual Property Organization
WoS	Web of Science
WZ 2008	Classification of Economic Sectors, Edition 2008
ZEW	<i>Zentrum für Europäische Wirtschaftsforschung</i> (Centre for European Economic Research)

LIST OF ABBREVIATIONS OF NAMES OF COUNTRIES

AT	Austria
AU	Australia
BE	Belgium
BG	Bulgaria
CA	Canada
CH	Switzerland
CN	China
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GB	UK
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KR	Korea
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
US	United States of America

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CLASSIFICATION OF ECONOMIC ACTIVITIES FOR R&D-INTENSIVE INDUSTRY AND KNOWLEDGE-INTENSIVE INDUSTRY SERVICES³⁸⁰

R&D-INTENSIVE INDUSTRIAL SECTORS WITHIN THE CLASSIFICATION OF ECONOMIC ACTIVITIES, EDITION 2008 (WZ 2008) (4-DIGIT CLASSES)

WZ 2008

Cutting-edge technology

20.20	Manufacture of pesticides and other agrochemical products
21.10	Manufacture of basic pharmaceutical products
21.20	Manufacture of pharmaceutical preparations
24.46	Processing of nuclear fuel
25.40	Manufacture of weapons and ammunition
26.11	Manufacture of electronic components
26.20	Manufacture of computers and peripheral equipment
26.30	Manufacture of communication equipment
26.40	Manufacture of consumer electronics
26.51	Manufacture of instruments and appliances for measuring, testing and navigation
26.60	Manufacture of irradiation, electromedical and electrotherapeutic equipment
26.70	Manufacture of optical instruments and photographic equipment
30.30	Manufacture of air and spacecraft and related machinery
30.40	Manufacture of military fighting vehicles

High-value technology

20.13	Manufacture of other inorganic basic chemicals
20.14	Manufacture of other organic basic chemicals
20.16	Manufacture of plastics in primary forms
20.42	Manufacture of perfumes and toilet preparations
20.51	Manufacture of explosives
20.53	Manufacture of essential oils
20.59	Manufacture of other chemical products n.e.c.
22.11	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres
23.19	Manufacture and processing of other glass, including technical glassware
23.44	Manufacture of other technical ceramic products
26.12	Manufacture of loaded electronic boards
27.11	Manufacture of electric motors, generators and transformers
27.12	Manufacture of electricity distribution and control apparatus
27.20	Manufacture of batteries and accumulators
27.31	Manufacture of fibre optic cables
27.33	Manufacture of wiring devices
27.40	Manufacture of electric lighting equipment
27.90	Manufacture of other electrical equipment
28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
28.12	Manufacture of fluid power equipment
28.13	Manufacture of other pumps and compressors
28.15	Manufacture of bearings, gears, gearing and driving elements
28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)
28.24	Manufacture of power-driven hand tools
28.29	Manufacture of other general-purpose machinery n.e.c.

28.30	Manufacture of agricultural and forestry machinery
28.41	Manufacture of metal forming machinery
28.49	Manufacture of other machine tools
28.92	Manufacture of machinery for mining, quarrying and construction
28.93	Manufacture of machinery for food, beverage and tobacco processing
28.94	Manufacture of machinery for textile, apparel and leather production
28.99	Manufacture of other special-purpose machinery n.e.c.
29.10	Manufacture of motor vehicles
29.31	Manufacture of electrical and electronic equipment for motor vehicles
29.32	Manufacture of other parts and accessories for motor vehicles
30.20	Manufacture of railway locomotives and rolling stock
33.20	Installation of industrial machinery and equipment

KNOWLEDGE-INTENSIVE INDUSTRIAL SERVICES WZ 2008 (3-DIGIT CLASSES)

Knowledge-intensive services

Emphasis on finances and assets

411	Development of building projects
641	Monetary intermediation
642	Activities of holding companies
643	Trusts, funds and similar financial entities
649	Other financial service activities, except insurance and pension funding
651	Insurance
652	Reinsurance
653	Pension funding
661	Activities auxiliary to financial services, except insurance and pension funding
663	Fund management activities
681	Buying and selling of own real estate
683	Real estate activities on a fee or contract basis
774	Leasing of intellectual property and similar products, except copyrighted works

Emphasis on communication

611	Wired telecommunications activities
612	Wireless telecommunications activities
613	Satellite telecommunications activities
619	Other telecommunications activities
620	Computer programming, consultancy and related activities
631	Data processing, hosting and related activities, web portals
639	Other information service activities

Emphasis on technical consulting and research

711	Architectural and engineering activities and related technical consultancy
712	Technical testing and analysis
721	Research and experimental development on natural sciences and engineering
749	Other professional, scientific and technical activities n.e.c.

Emphasis on non-technical consulting and research

691	Legal activities
692	Accounting, bookkeeping and auditing activities; tax consultancy
701	Activities of head offices
702	Management consultancy activities
722	Research and experimental development on social sciences and humanities
731	Advertising
732	Market research and public opinion polling
821	Office administrative and support activities

Emphasis on media and culture

581	Publishing of books and periodicals; other publishing activities
582	Software publishing
591	Motion picture, video and television programme activities
592	Sound recording and music publishing activities
601	Radio broadcasting
602	Television programming and broadcasting activities
741	Specialised design activities
743	Translation and interpretation activities
823	Organisation of conventions and trade shows
900	Creative, arts and entertainment activities
910	Libraries, archives, museums and other cultural activities

Emphasis on health

750	Veterinary activities
861	Hospital activities
862	Medical and dental practice activities
869	Other human health activities

GLOSSARY

Bologna reform respectively Bologna process:

These are based on the Sorbonne Declaration of 1998, which entered into the EU's Bologna Declaration 1999. The aim of the reform/process is to harmonise higher education and relevant qualifications by 2010. The central aspects include: achievement of comparable qualifications (two-stage system with bachelor's degree and master's degree), unified standards for evaluation (credits in keeping with the ECTS system), enhanced mobility via elimination of barriers to mobility, and European co-operation in the area of quality assurance.

Business Angels:

Business Angels are well-to-do private persons who provide capital and entrepreneurial know-how to innovative start-up entrepreneurs or to young, innovative companies. They invest part of their private assets directly in a company, without the aid of an intermediary, and receive shares of the company in return.

Buyout funds:

Capital investment companies who use capital, normally provided by institutional investors, to acquire stakes in established companies. The funding so provided to companies strengthens their equity-capital bases, enabling them to expand and to carry out innovative, often highly risky projects. As a rule, such investments are limited to a period of several years, after which the relevant company shares are sold.

Community Innovation Survey:

The Community Innovation Survey (CIS) is the European Union's most important statistical instrument for surveying innovation activities in Europe. The CIS analyses the economic impacts of innovation (on competition, employment, economic growth, models for trade, etc.) on the basis of a survey of a representative sample of companies. Further information is provided in the study by Rammer, C. and Pesau, A. (2011) that was prepared under commission to the EFI.

Curriculum:

Teaching plan or specification of teaching goals. While a teaching plan normally only lists subject matter to be taught, curricula tend to be oriented to teaching goals and define teaching / learning processes and course of studies. In particular, a curriculum defines a framework for learning.

Cutting-edge technology:

Cutting-edge technology goods refers to R&D-intensive goods whose production, on an annual average, entails spending more than seven percent of relevant revenue on research and development.

Education natives and education foreigners:

New students who are foreign nationals who have earned their higher education entrance qualification in Germany are referred to as education natives (*Bildungsinländer*); persons with higher education entrance qualifications earned abroad who come to Germany for studies are known as education foreigners (*Bildungsausländer*).

Entry rate into tertiary education:

Number of new students in their first semester of higher education studies (students in their first programme of studies), as a percentage of the total number of persons of the relevant age. This entry rate figure is useful in highlighting changes in participation in higher education.

Equity capital:

Liable capital of a company. Equity capital is provided by the company's owners, for financing purposes, or consists of earnings left in the company. Equity capital can also be obtained externally, as venture capital.

Equity ratio:

Ratio of a company's equity capital to all of its capital. The ratio is used in assessing the financial stability and independence of companies.

Europe 2020:

The core aim of the Europe 2020 initiative is to enhance co-ordination of national economies and the European economy. As a follow-on programme to the Lisbon Strategy, it applies an even more holistic approach with regard to R&D funding, lifelong learning and promotion of environmentally friendly technologies.

Excellence initiative:

A Federal-*Länder* agreement for promotion of science and research at German higher education institutions, with a view to enhancing international competitiveness. The initiative is being implemented via the German Research Foundation (DFG) and the Science Council (*Wissenschaftsrat*).

Export quota:

The value of an economy's entire exports, in market prices, expressed as a percentage of the relevant country's gross domestic product. The export and import quotas for a given country are important indicators of the degree to which the country is integrated within the global economy and the international competition between economic centres.

Federal Framework Act on Higher Education:

A nation-wide law applying to universities, colleges of education, colleges of art and music, universities of applied sciences and to other educational institutions that, pursuant to *Länder* laws, are state higher education institutions. It functions as a model for *Länder*-specific higher education acts (cf. state university acts). The first version of the act was adopted in January 1999, and the most recent amendment was adopted in April 2007. As part of the Bologna process, a number of provisions of the act have since been suspended, with a view to giving higher education institutions greater autonomy and responsibility.

Federalism Reform II:

The centrepiece of the Federalism Reform II is a reform of the constitutional provisions for limiting public-sector borrowing by the Federation and the *Länder*. The purpose of the reform is to constrain public-sector indebtedness more effectively than has been possible in the past.

Frascati Manual:

The OECD's Frascati Manual specifies methods for collecting and analysing data on research and development. In 1963, OECD experts met for the first time with members of the NESTI group (National Experts on Science and Technology Indicators), in Frascati (Italy), in order to define key concepts such as "research and development". The results of those discussions formed the first Frascati Manual.

Since then, the Frascati Manual has been revised several times. The most recent edition dates from 2002 (OECD 2002).

Global Entrepreneurship Monitor (GEM):

The GEM is an empirical research project that is now being carried out in a total of 54 countries. It is co-ordinated by the Global Entrepreneurship Research Association (GERA). The aim of the GEM is to analyse start-up activity, internationally and intertemporally, on the basis of surveys of the public and of experts. In addition, it serves as a vehicle for deriving proposals for optimising policies for promoting and funding start-ups.

Governance:

Governance refers to the control and regulation achieved via relevant structures (structure and process organisation) of a political and societal unit, such as a state, an administration, a municipality, or a private or public organisation. The term is often used to refer to control or regulation of any sort of organisation (such as a company or a plant).

Graduation rate:

In a given examination year, percentage of persons, with respect to the local relevant population, of a given age group who complete a first programme of studies at a higher education institution. This indicator provides information about higher education institutions' real output of graduates. The relevant data are broken down by gender, nationality and German *Länder*.

Hedge fund:

A special type of investment fund with a great diversity of investment focuses and strategies, especially highly speculative investment strategies. The possible investment focuses for such a fund include stocks, bonds or derivatives. Hedge funds also engage in short-selling, and they use loans in order to leverage their investments. As a rule, when hedge funds acquire shares in companies, they acquire minority shares.

High-Tech Strategy:

A Federal Government policy initiative for integration of innovation funding throughout all federal ministries. It was launched in August 2006, and extended in 2010 (cf. Chapter A 5). The strategy focuses especially on holistic control of complex technology systems, and on market-relevance. A key characteristic of the strategy is that it concentrates on selected fields of innovation. Its key emphases include designing and structuring R&I policy interministerially, orienting research and innovation more strongly to markets and optimising relevant framework conditions. The Federal Government's High-Tech Strategy is being managed by the Federal Ministry of Education and Research (BMBF).

High-value technology:

High-value technology refers to R&D-intensive goods whose production, on an annual average, requires more than 2.5 percent, but not more than 7 percent, of relevant revenue to be spent on R&D.

Hybrid drive:

A hybrid drive is a drive system that combines different drive principles, or different energy sources, within a single application.

Import quota:

The value of an economy's entire imports, in market prices, expressed as a percentage of the relevant country's gross domestic product. As a country's import quota grows, its dependence on goods from abroad also grows.

Innovation expenditures:

Innovation expenditures refer to expenditures for ongoing, completed and discontinued projects within a single year. They consist of ongoing expenditures (personnel and equipment costs, etc.) and expenditures for investments. Innovation expenditures include innovation-related expenditures for machinery, plants, software and external know-how (such as patents, licenses); for engineering, design, product design, services concepts, employee training and further training; for market introduction and other preparations for production and sales of innovations. They also include all internal and external expenditures for research and development (R&D).

Innovation intensity:

Innovation expenditures in relation to revenue.

Innovation system:

A network of institutions, in the public and private sector, whose activities and interactions initiate, modify and disseminate new technologies. The speed of technological change in various countries, and companies' business effectiveness in global competition, depend not only on the scope and intensity of R&D and other technical activities; they also depend on the manner in which available resources are managed and organised, both by companies themselves and at the national level (Freeman 1987).

Innovation Union:

The Innovation Union is a lead initiative of the Europe 2020 strategy. Its measures focus especially on stimulating the private enterprise sector, via strategies such as facilitating access to financing, supporting research initiatives and increasing the pertinent role of public procurement.

Innovator rate:

Number of companies with product or process innovations, as a percentage of all companies in a relevant country. A newer, expanded definition of the term also takes account of companies with innovations in the areas of organisation and marketing.

Lead market:

When different technological designs are developed that are basically oriented to the same function, the design that is the first to be accepted by a market is the one that wins out internationally. That market is a lead market, and it forces alternative designs into lag markets. A number of different factors influence this process: the legal framework, cultural differences, the market power that good alternatives may have, company know-how available in specific regions, sales channels, the availability of qualified personnel, etc.. It is thus difficult to predict which markets will emerge as lead markets in a particular case.

Lead Market Initiative:

The European Lead Market Initiative (LMI), which has been in progress since 2007, under the guidance of the European Commission, the Member States and industry representatives, comprises a number of political measures (regulation, public procurement, standardisation and other measures) aimed at actively supporting the creation of markets. To date, the LMI has been aimed at markets for eHealth, protective clothing, sustainability-oriented construction, recycling, organic products and renewable energies.

Lisbon Agenda:

The Lisbon Agenda, which dates from the year 2000, is the programmatic strategy for the European Research Area (ERA). It is aimed at the goal of making the EU the world's most competitive, most dynamic knowledge-based economic area by 2010.

Lithium-ion battery:

Lithium-ion batteries (Li-Ion) are batteries with especially high energy densities. Considered to be thermally stable, they provide largely constant voltages throughout their discharging periods and show virtually no memory effect. The batteries store energy by positioning lithium ions (Li+) in a layer lattice in the cathode (consisting of graphite, for example). Other important components of such batteries include an anode (for example, made of lithium-metal oxides), electrolytes (water-free) and a separator (made of polymers or ceramics). Intensive efforts are being made to improve all of the components involved.

Ljubljana Process:

Since 2008, efforts to shape the European Research Area (ERA) have been taking place within the Ljubljana Process. The process is connected with the Vision 2020 Initiative, the Lisbon Treaty and Art. 181 Treaty on the Functioning of the European Union. Activities within the process are focussed on enhancing co-ordination between the EU and the Member States and supporting the creation of a European Research Area.

Knowledge-intensive services:

The primary feature of knowledge-intensive services is they are carried out by workforces with above-average percentages of persons with higher education qualifications.

Manufacturing sector:

The largest part of the industrial sector, comprising all industrial branches with the exception of energy and construction. Key areas include the food industry, mechanical engineering, automotive and automotive supply, production of metal products and the chemical industry. At present, some 95 percent of all persons employed in industry are employed in the manufacturing sector.

Oslo Manual:

The OECD's Oslo Manual contains specifications relative to statistical surveys of innovation activities. The Oslo Manual moves beyond the R&D concept used by the Frascati Manual, and it differentiates between different forms of innovation. The Oslo Manual serves as the basis of the Community Innovation Surveys, which have been carried out four times to date in Europe. The most recent revision of the manual dates from 2005 (OECD 2005).

Outside capital:

Outside capital is capital that is provided to companies by external capital providers, for limited periods of time. Providers of such capital expect to be repaid their funds with interest. With a view to ensuring that relevant loans can be repaid, banks condition provision of outside capital on adequate, reliable planning of future business results and/or provision of financial guarantees.

Patent Cooperation Treaty:

In 1970, the Patent Cooperation Treaty (PCT) was concluded under the aegis of the World Intellectual Property Organization (WIPO), which had been founded in 1969. It is designed to simplify procedures for applying for international patents. Inventors from PCT countries submit advance applications to the WIPO. Within a year after submitting such an application, an inventor can submit a patent application in the various signatory countries of relevance. The relevant priority period for such applications is the time of the original submission to the WIPO.

Peer-to-peer networks:

Peer-to-peer networks are networks of computers that co-operate on a basis of equality. Each computer in such a network can both use and provide the relevant services and functions for the network.

Percentage of persons with higher education entrance qualifications:

In a given year, the number of persons with higher education entrance qualifications, as a percentage of all persons at least 18 years old who have not yet turned 21. The size of that age-group population is determined as the average of the most recent three age cohorts.

Power electronics:

Power electronics is concerned with using electronic components to reform electrical energy. Power electronics is used to reform electrical energy with respect to voltage form, voltage / current amplitude and frequency. In hybrid vehicles, part of the drive power is generated by an electric motor (in electric vehicles, an electric motor generates all of the power). Power electronics convert electrical energy to the voltage and frequency that the electric motor requires.

Private equity:

Private equity refers to equity that is provided on an off-market basis to companies. In the customary procedure, companies receive the capital from investors who, in return, receive the prospect of sharing in the company's future business success.

Public-private partnership (PPP):

Form of co-operation, between public administrations and private companies, in which the public sector co-operates with companies in order to carry out tasks with which it is charged. PPP arrangements include arrangements in which the two parties co-operate in actually carrying out the relevant tasks, and arrangements in which the relevant private company carries out the tasks completely by itself. In PPP arrangements, companies profit from the contacts and experience of the involved public administrations, in the pertinent areas, and, of course, they profit from pertinent orders and investments. For public administrations, PPP arrangements make it possible to carry out projects, with the financial support of the participating companies, that might not otherwise be possible for them.

RCA Index:

Ratio of exports to imports, for a given group of goods, in relation to the export-import ratio for the pertinent economy as a whole. For purposes of mathematical presentation, the ratio is formulated logarithmically and then multiplied by a factor of 100.

R&D intensity:

Expenditures for research and development (R&D), as a percentage of a company's or a sector's revenue or of a country's gross domestic product.

Research and development (R&D):

The OECD's Frascati Manual defines research and development as systematic, creative work aimed at expanding knowledge – also with the aim of developing new applications.

Science Citation Index:

Database of scientific publications in internationally renowned journals, offering access to bibliographic information, summaries and cited references from a total of 3,700 leading scientific and technical journals, representing over 100 different disciplines. The Science Citation Index Expanded covers a total of over 5,800 journals. It can be accessed online (Internet) via SciSearch®.

Start-ups:

Newly founded companies.

Start-up rate:

Number of start-ups as a percentage of the total number of companies concerned. The start-up quota is thus a useful indicator of the extent to which an entire group of companies is being rejuvenated.

State university act (Landeshochschulgesetz):

Act enacted by a Land (state) for regulating all matters that pertain to its own higher education institutions. In exercising their sovereign rights in matters of education and cultural affairs, all *Länder* issue state university acts for their own universities. In this area, the *Länder* co-ordinate their efforts via the Conference of Ministers of Education and Cultural Affairs (KMK).

Subsidiarity principle:

A formal organisational principle whereby the state's task responsibilities are delegated to non-central regional and local authorities up to the point which such authorities are no longer able to solve relevant problems. When that point is reached, the task in question is to be carried out by the next higher level.

Transnational patents:

Inventions for which, simultaneously, at least one patent application has been filed, via the PCT procedure, with the World Intellectual Property Organization (WIPO), and one application has been filed with the European Patent Office (EPO). For Germany's export-oriented industry, such patents are especially significant, because they make it possible to protect inventions outside of the home market.

Three-percent goal:

In Barcelona in 2002, the European Council decided that the EU's R&D expenditures should grow to three percent of GDP by 2010. In addition, so the relevant resolution, two-thirds of the relevant expenditures are to be financed by the private sector.

Unbundling:

Requirement applying to fixed-network providers, in the telecommunications sector, who have significant market power. It obligates such providers to offer subscriber lines separately from their own connection services.

Value creation:

Total of all factor income generated in a given period (wages, salaries, interest, rent, lease income, earnings from sales) and included in national accounts. The term is equivalent to national income (national product). In a business sense, value creation refers to the production value generated in a given period, less the value of the preliminary work/services received, in the same period, from other companies.

Vertical integration:

An economic entity is said to be vertically integrated if it comprises separate stages of production or trade.

Venture-capital funds:

Cf. also venture capital.

Capital investment companies who use capital, normally provided by institutional investors, to acquire shares in young, innovative companies. Like buyout funds, venture capital funds provide young, innovative companies with equity capital, in order to enable them to grow and carry out innovative, often highly risky, projects. As a rule, such investments are limited to a period of several years, after which the relevant company shares are sold.

Venture capital:

Venture capital is capital provided as initial capital for start-ups and young companies. It includes funding used to strengthen the equity capital bases of small and medium-sized enterprises, to enable such companies to expand and carry out innovative, even highly risky projects. For capital providers / investors, venture capital investments are also highly risky. For that reason, venture capital is also referred to as “risk capital”. Venture capital is often provided by special risk-capital companies (capital investment companies).

The Commission of Experts for Research and Innovation regularly commissions studies on topics relating to innovation policies. Such studies are published in the series “Studies on the German Innovation System”, which can be accessed via the EFI Web site (www.e-fi.de). The results of those studies enter into the reports of the Expert Commission.

Recent studies relative to the German innovation system

- 1-2011 Leszczensky, M.; Gehrke, B.; Helmrich, R. (2011): Bildung und Qualifikation als Grundlage der technologischen Leistungsfähigkeit Deutschlands, Berlin.
- 2-2011 Schasse, U.; Krawczyk, O.; Stenke, G.; Kladroba, A. (2011): FuE-Aktivitäten von Wirtschaft und Staat im internationalen Vergleich, Berlin.
- 3-2011 Cordes, A.; Gehrke, B. (2011): Außenhandel, Strukturwandel und Qualifikationsnachfrage: Aktuelle Entwicklungen in Deutschland und im internationalen Vergleich, Berlin.
- 4-2011 Belitz, H.; Clemens, M.; Gornig, M.; Mölders, F.; Schiersch, A.; Schumacher, D. (2011): Die deutsche forschungsintensive Industrie in der Finanz- und Wirtschaftskrise im internationalen Vergleich, Berlin: EFI.
- 5-2011 Schiersch, A.; Belitz, H.; Gornig, M.: Fortschreibung internationaler Wirtschaftsstrukturdaten für FuE-intensive Industrien, Berlin: EFI.
- 6-2011 Belitz, H. (2011): Globalisierung von FuE deutscher MNU im internationalen Vergleich, Berlin: EFI.
- 7-2011 Rammer, C.; Pesau, A. (2011): Innovationsverhalten der Unternehmen in Deutschland 2009, Aktuelle Entwicklungen – Bundesländerunterschiede – internationaler Vergleich, Berlin.
- 8-2011 Schmoch, U.; Mallig, N.; Neuhäusler, P.; Schulze, N. (2011): Performance and Structures of the German Science System in an International Comparison 2010 with a special analysis of public non-university research organisations, Berlin.
- 9-2011 Frietsch, R.; Schmoch, U.; Neuhäusler, P.; Rothengatter, O. (2011): Patent Applications – Structures, Trends and Recent Developments, Berlin.
- 10-2011 Müller, B.; Niefert, M.; Rammer, C.; Gottschalk, S. (2011): Unternehmensdynamik in der Wissenswirtschaft in Deutschland 2009, Gründungen und Schließungen von Unternehmen – Unternehmensdynamik in den Bundesländern – Internationaler Vergleich, Berlin.
- 11-2011 Alecke, B.; Breitfuss, M.; Cremer, W.; Hartmann, C.; Lagemann, B.; Mitze T.; Peistrup, M.; Ploder, M.; Rappen H.; Rothgang, M. (2011): Föderalismus und Forschungs- und Innovationspolitik, Berlin.
- 12-2011 Rammer, C.; Pesau, A.; Sellenthin, M. O. (2011): Europäische Dimension der Forschungs- und Innovationspolitik, Berlin: EFI.
- 13-2011 Daimer, S.; Edler, J.; Howells J. (2011): Germany and the European Research Area, Berlin.
- 14-2011 Dauchert, H.; Meurer, P. (2011): Netzneutralität und Innovationen im Internet, Berlin.
- 15-2011 Rammer, C.; Köhler, C.; Schwiebacher, F.; Murmann, M.; Kinkel, S.; Kirner, E.; Schubert, T.; Som, O. (2011): Innovation ohne Forschung und Entwicklung, Eine Untersuchung zu Unternehmen, die ohne eigene FuE-Tätigkeit neue Produkte und Prozesse einführen, Berlin.

ENDNOTES

- 1 In the following, cf. also Chapters C2 and C3 and the sources those chapters mention.
- 2 Innovation expenditures include R&D expenditures, expenditures for patents and licenses, expenditures for machinery and equipment needed for the innovation process, expenditures for product design and for market placement of new products and expenditures for other innovation-related goods and services.
- 3 While the electrical and automotive industries invested considerably less in research and experimental development than they had in the previous year, R&D expenditures in the pharmaceutical industry and in business-related services actually increased in 2009. In 2009, industry's internal and external R&D expenditures totalled EUR 55.9 billion, representing a decrease of 2.4 percent from the previous year. Internal R&D expenditures of the state and higher-education sectors, on the other hand, increased slightly, from EUR 20.5 billion in 2008 to EUR 21.5 billion in 2009. Cf. http://www.stifterverband.info/presse/pressemitteilungen/2010_12_08_forschung_und_entwicklung/index.html (last checked on 18 January 2011).
- 4 In October 2010, the value level reached by exports was 19.5 percent higher than it had been in October 2009 (own calculations; database: GENESIS-online, vgl. https://www-genesis.destatis.de/genesis/online.jsessionid=D020264F4FA6ECCE0CD8298095B86C04.tomcat_GO_1_1?operation=abrufabelleAbrufen&selectionname=51000-0002&levelindex=1&levelid=1286813837_118&index=2 (last checked on 18 January 2011).
- 5 Cf. http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Presse/pm/2011/01/PD11_010_811,templateId=renderPrint.psml (last checked on 18 January 2011).
- 6 Cf. Federal Employment Agency (Bundesagentur für Arbeit; 2010a).
- 7 Cf. http://www.stifterverband.info/presse/pressemitteilungen/2010_12_08_forschung_und_entwicklung/index.html (last checked on 18 January 2011).
- 8 Cf. Rammer und Pesau (2011).
- 9 Cf. ifo (2010) and KfW Bank Group (KfW Bankengruppe, 2010a).
- 10 Cf. German Council of Economic Experts (Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung; 2010)
- 11 Cf. with regard to the German Business Fund (Wirtschaftsfonds) <http://www.bmwi.de/BMWi/Navigation/Wirtschaft/Konjunktur/Konjunkturpakete-1-und-2/wirtschaftsfonds-deutschland,did=331986.html> (last checked on 18 January 2011).
- 12 As of the end of 2010, that fund had provided EUR 40 billion for the KfW Special Programme, funding which was used to provide working capital and investment loans for companies of all sizes, as well as global loans to banks for refinancing of company loans. As of the beginning of October 2010, the KfW Bank Group had received EUR 18.7 billion worth of individual applications for loans from the KfW Special Programmes; in addition, it had issued EUR 3.1 billion worth of global loans to banks. Cf. <http://www.kfw.de/Applications/PrintContent.jsp?oid=34338> (last checked on 14 October 2010).
- 13 Cf. KfW Bank Group (KfW Bankengruppe, 2010b).
- 14 Cf. Commerzbank (2010: 17–19).
- 15 For example, the KfW Bank Group and Commerzbank jointly established an equity fund for German small and medium-sized enterprises (SMEs), with a volume initially totalling nearly EUR 200 million. Deutsche Bank has established an “SME fund for Germany” (“Mittelstandsfonds für Deutschland”), with initial resources of EUR 300 million. The German Savings Banks Association (Deutscher Sparkassen- und Giroverband; DSGV) has announced that savings banks and regional banks, acting via their affiliated companies, will provide equity capital totalling EUR 550 million for companies. Cf. Commerzbank and KfW Bank Group (2010), http://www.db.com/medien/de/content/presse_informationen_2010_4845.htm (last checked on 18 January 2011) and cf. <http://www.dsgv.de/de/fakten-und-positionen/aktuelles/eigenkapital-mittelstand.html> (last checked on 18. January 2011).

- 16 According to the Savings Banks Association (Sparkassen- und Giroverband) in Berlin, by November 2010 about half of all provided funding had already drawn or requested for disbursement. Cf. <http://www.handelsblatt.com/eigenkapitalversorgung-neues-geld-fuer-die-region;2668364> (last checked on 18 January 2011).
- 17 Especially in the first and second quarters of 2010, venture-capital investments increased sharply, in spite of a decrease in the number of financed companies: from EUR 134 million to EUR 163 million. Cf. BVK: Deutscher Private Equity-Markt kehrt zur Normalität zurück (German private equity is back to normal), 24 August 2010, http://www.bvkap.de/privateequity.php/cat/144/aid/625/title/BVK:_Deutscher_Private_Equity-Markt_kehrt_zur_Normalitaet_zurueck (last checked on 18 January 2011). That dynamic development did not slow until the third quarter of 2010. The investment volume in that quarter, at EUR 126 million, returned almost to the level of the first quarter. Cf. BVK: “Private-Equity-Aktivitäten stabilisieren sich” (“Private equity activities stabilise”), 11 November 2010, http://www.bvkap.de/privateequity.php/cat/144/aid/645/title/BVK:_Private_Equity_Aktivitaeten_stabilisieren_sich (last checked on 18 January 2011). In spite of that recent decrease, venture-capital providers continue to be optimistic, and they are expecting the upward trend to continue in 2011. Cf. KfW, BVK: German Private Equity Barometer – 3rd quarter 2010, http://www.kfw.de/DE_Home/Research/KfW-Indika17/GermanPriv77/GPEB_Q3_2010_de_Internet_KfW.pdf (last checked on 14 December 2010).
- 18 The figure for venture-capital investments, as a share of gross domestic product, is here oriented to the locations of the companies that received the investments. Venture capital comprises the areas of seed, start-up and later stage venture. It does not include the areas of growth, rescue/turnaround, replacement capital and buyout. Own calculations; database: EVCA (2010) and Eurostat.
- 19 Cf. Achleitner et al. (2010: 22).
- 20 Cf. Achleitner et al. (2010: 61 ff.).
- 21 Cf. Achleitner et al. (2010: 65).
- 22 Cf. BMWi (Federal Ministry of Economics and Technology): Schlaglichter der Wirtschaftspolitik – Monthly report 7/2008, Heute investieren in die Märkte von morgen – Wagniskapital für junge innovative Unternehmen (Investing today in the markets of tomorrow – venture capital for young innovative companies), <http://www.bmwi.de/BMWi/Navigation/wirtschaft,did=254186.html> (last checked on 18 January 2011).
- 23 Cf. Meyer (2010)
- 24 Cf. Commission of the European Communities (2009).
- 25 With regard to hedge funds, buyout funds and venture capital funds, cf. the glossary.
- 26 The limit of EUR 500 million applies to managers of funds that are not leveraged, i.e. that are not financed with any outside capital. Where one manager manages several funds, attainment of the EUR 500 million threshold is determined in light of the total assets managed. A 2009 survey of managers of venture capital funds around the world found that 31 percent of the managers managed funds exceeding EUR 500 million in size. Cf. Deloitte Touche Tohmatsu (2009: 2). Between 2007 and 2009, the average size for international venture capital funds was about EUR 150 million. Cf. Weber and Liou (2010: 4). For managers of leveraged funds, the directive applies as soon as the pertinent funds reach a size of EUR 100 million.
- 27 The same applies to buyout funds.
- 28 Cf. Achleitner et al. (2010: 61 ff.).
- 29 For leveraged funds, the scope of application can also be expanded to include funds with less than EUR 100 million of managed assets.
- 30 Cf. <http://bmbf.de/de/96.php> (last checked on 18 January 2011).
- 31 The expenditures for additional study places resulting from discontinuation of conscription for military and alternative civilian service amount to EUR 0.9 to 1.5 billion through 2018. The cost of a study place, as under the Higher Education Pact, is figured at EUR 26,000. Plans call for the Federal Government and the *Länder* to share the costs equally. Cf. the dapd news agency report of 15 December 2010 “Bund übernimmt Hälfte der Kosten für zusätzliche Studienplätze. Einigung

- auf Ministerpräsidentenkonferenz – Auswirkungen der Wehrreform” (“The Federal Government to assume half of the costs for additional study places. Agreement reached at the conference of the minister-presidents of the *Länder* – impacts of the reform of military service”).
- 32 Cf. <http://www.bmbf.de/de/6142.php> (last checked on 18 January 2011).
- 33 The organisations are: Deutsche Forschungsgemeinschaft (German Research Foundation), Fraunhofer-Gesellschaft, Helmholtz Association of National Research Centres (HFG), Max Planck Society, Gottfried Wilhelm Leibniz Science Association (WGL). Cf. BMBF (2010a: 2).
- 34 The EUR 4.9 billion refer to the sum total of relevant federal and *Länder* funding. As a result of the financing key applying the Fraunhofer and Helmholtz institutes, the federal share is higher than the *Länder* share. What is more, the *Länder* share is subject to the availability of financing. The following declaration has been issued regarding the agreement: “Protocol declaration of the *Länder* Brandenburg, Bremen, Mecklenburg-West Pomerania, Saxony-Anhalt and Schleswig-Holstein: The Länder Brandenburg, Bremen, Mecklenburg-West Pomerania, Saxony-Anhalt and Schleswig-Holstein will be able to achieve the aimed-for rate of increase of five percent annually only if forecast tax revenue improves markedly again and if the additional costs can be borne without any new borrowing.” Cf. <http://www.gwk-bonn.de/fileadmin/Papers/Beschluss-RegChefs-04-06-2009.pdf> (last checked on 18 January 2011).
- 35 It is hardly possible to compare the expenditures internationally, since different countries have different bases for determining their total education and research expenditures. That said, a 2007 OECD comparison of different countries’ public-sector expenditures on education, as percentages of the relevant countries’ GDPs, shows that Germany’s expenditures, at 4.5 percent, are below the OECD average of 5.2 percent. Cf. OECD (2010: 276); cf. also Federal Statistical Office (Statistisches Bundesamt, 2010a).
- 36 The increase amounts to 13 points, from 484 to 497 points. The current OECD average for reading competence is 493 points. In addition, the differential between pupils with poor reading competence and those with good reading competence decreased. That can be attributed to improved performance in the lowest competence areas. Cf. Klieme et al. (2010); Stanat et al. (2002: 8 ff.). PISA 2009 focussed especially on determining reading competence.
- 37 The PISA consortium defined six competence levels that can be used to describe pupils’ performance. Competence levels V and VI are the highest levels. Pupils whose reading competence places them in these categories are outstanding / excellent readers. Similarly, young people who place into competence levels Ia and Ib or below make up the “at-risk group”. Cf. also Klieme et al. (2010: 26 ff.).
- 38 Cf. Klieme et al. (2010: 38).
- 39 Cf. Klieme et al. (2010: 47).
- 40 Cf. Klieme et al. (2010: 28).
- 41 Cf. Klieme et al. (2010: 63).
- 42 Cf. <http://www.bmbf.de/press/3008.php> (last checked on 18 January 2011). In this context, the establishment of a career-entry assistance measure for pupils, at selected secondary general schools (Hauptschulen) and special-education schools (Förderschulen), who are in danger of failing to graduate, needs to be mentioned. The measure is aimed at providing individual, ongoing support for adolescents making the transition from general-education school to vocational training. In the effort, so-called education guides (Bildungslotsen) help young people recognise their real potential and apply such recognition to vocational orientation. Since November 2010, a total of 500 education guides have been assisting up to 10,000 young people in transition from school to the workplace. The initiative calls for increasing the number of education guides to 1,000 by 2013.
- 43 In 2010, the new-students percentage is 46.1 percent (including students who did not earn their school qualifications in Germany). Cf. Federal Statistical Office (Statistisches Bundesamt, 2010b: 11).
- 44 The number of students who have not earned their school qualifications in Germany, at somewhat over 58,000, is at the same level it was in 2004. Since the total numbers of new students have been increasing, however, the number of such “education foreigners”, as a percentage of all new students in Germany, has been decreasing continually – since 2004 (2004: 16.2 percent; 2008: 14.7 percent).

- 45 Cf. Federal Statistical Office (Statistisches Bundesamt, 2011). This percentage does not include Germans who begin their studies abroad. In 2010, the Federal Statistical Office collected a first set of data on German new students abroad. Only 15 of 24 countries approached supplied the requested figures. In those 15 countries (NL, AU, CH, GB, SE, DK, NZ, NO, BE (Flemish), PL, IE, SF, CZ, PT, IS), a total of 24,229 Germans had enrolled as new students. Since corresponding figures are lacking from countries such as the U.S. and France, which rank 5th and 6th, respectively, in terms of popularity as countries for studies abroad, the total number of German new students abroad is likely to be considerably higher.
- 46 For example, the new-student percentages also increased as a result of conversion of vocational academies into universities of applied sciences, in Baden-Württemberg and in the Saarland, as of the 2008/2009 winter semester. For the year in question, that conversion led to a 2.3 percent increase in the new-students percentage. In addition, the double cohorts of pupils obtaining their higher education entrance qualifications (Abitur) are swelling the ranks of new students and of potential new students. In 2007, Saxony-Anhalt reduced the time pupils spend in grammar school (Gymnasium) from nine to eight years; in 2008 Mecklenburg-West Pomerania followed suit. In 2007, those changes already resulted in a 0.8 percent increase in the cohort percentage eligible for higher education and to a 0.3 percent increase in the new-students percentage. In 2008, then, the cohort percentage eligible for higher education increased by 0.5 percent, and the new-students percentage increased by 0.4 percent. Cf. Scharfe (2010: 555 ff.). It is not yet possible to assess how the elimination of tuition fees in the Saarland and in Hesse is affecting the numbers of new students. Cf. Autorengruppe Bildungsberichterstattung (2010: 118 ff.).
- 47 Cf. Federal Statistical Office (Statistisches Bundesamt, 2010c).
- 48 Cf. BMBF (2010b: 104).
- 49 Cf. BMBF (2010b: 96 f.), Heine et al. (2010: 28).
- 50 The 2010 HIS (Hochschul-Informationen-System) survey of persons with higher education entrance qualifications asked persons who had such qualifications, but who were not planning on enrolling in higher education, what aspects they thought made it inadvisable to study at a university or university of applied sciences. The most frequently cited reasons for not taking up studies included a desire to begin earning an income as quickly as possible; lacking financial resources; debt; and tuition fees. Cf. Heine et al. (2010: 36 ff.).
- 51 Cf. BMBF (2010b: 286).
- 52 Cf. Federal Statistical Office (Statistisches Bundesamt, 2010d: 15).
- 53 In each case, an additional payment of EUR 73 Euro is provided to defray the cost of health insurance and nursing-care insurance. The relevant deductible amounts (i.e. amounts deducted from income, in determining applicable income level) have been increased by three percent. What is more, deductible amounts apply to all relevant types of income, including the student's own, that of his or her spouse or life partner and that of his or her parents.
- 54 Previously, when a student changed his or her field for the first time, and for an important reason, he or she could obtain only a BAföG bank loan at the end of his or her new programme. Now, the regular BAföG rate is also paid for the additional semesters involved, i.e. a rate consisting of a subsidy (up to a 50 percent of the total) and an interest-free state loan (also up to 50 percent of the total). Cf. <http://www.das-neue-bafoeg.de/de/493.php> (last checked on 18 January 2011).
- 55 Cusanuswerk – Bischöfliche Studienförderung, Ernst Ludwig Ehrlich Studienwerk, Evangelisches Studienwerk e.V. Villigst, Friedrich-Ebert-Stiftung, Friedrich-Naumann-Stiftung für die Freiheit, Hanns-Seidel-Stiftung, Hans-Böckler-Stiftung, Heinrich-Böll-Stiftung, Konrad-Adenauer-Stiftung, Rosa-Luxemburg-Stiftung, Stiftung der Deutschen Wirtschaft, Studienstiftung des deutschen Volkes. Cf. <http://www.stipendiumplus.de> (last checked on 18 January 2011).
- 56 It was also decided to increase the monthly book allowance provided by gifted-students foundations from EUR 70 to EUR 150, as of 2011.
- 57 The programme's pilot phase in North Rhine-Westphalia, which began in 2009, has revealed that the grants are often not awarded until the student's second or third semester. At RWTH Aachen

- University and at the University of Duisburg-Essen, a total of 341 grants were awarded in the pilot phase, while only one grant was awarded at the Münster Academy of Fine Arts. In North Rhine-Westphalia, students in the fields of engineering, law, economic and social sciences received nearly 56 percent of all grants. The attractiveness of those subject areas for private donors is reflected in the statistics on distribution of grants by higher education institutions. Cf. http://www.innovation.nrw.de/studieren_in_nrw/studienstarter/finanzierung/nrw-stipendienprogramm/index.php (last checked on 18 January 2011).
- 58 Cf. Federal Statistical Office (Statistisches Bundesamt, 2010d: 34).
- 59 Cf. Leszczensky et al. (2011: 61).
- 60 Cf. Leszczensky et al. (2011: 74).
- 61 Bremen, Baden-Württemberg, Lower Saxony and Brandenburg. On 1 December 2010, the nine ARD broadcasting institutions announced that they were joining the National Pact for Women in MINT Careers.
- 62 Administrative agreement between the Federal Government and the *Länder* pursuant to Article 91b (1) No. 2 of the Basic Law on the Higher Education Pact 2020 (second programme phase). Cf. BMBF (2010c: 2).
- 63 Cf. Federal Statistical Office (Statistisches Bundesamt, 2010e: 8 and 28).
- 64 Cf. BMBF (2008: 51 ff.).
- 65 Cf. Autorengruppe Bildungsberichterstattung (2010: 129).
- 66 Cf. Fuchs and Zika (2010: 3).
- 67 Cf. Autorengruppe Bildungsberichterstattung (2010: 318); cf. also Fuchs and Zika (2010: 5 f.).
- 68 A study of the DIW (German Institute for Economic Research) that appeared in November 2010 concludes that no shortage of skilled people is apparent on the short-term horizon. At the same time, that study is oriented only to the situation in the next four to five years. Cf. Brenke (2010: p. 2 f.).
- 69 Cf. Allmendinger (2010).
- 70 Cf. Bade (2011).
- 71 The OECD's Frascati Manual contains important definitions of terms ("research", "experimental development" and others) as well as specifications of methods for collection and analysis of data on research and development. Cf. OECD (2002) and the glossary.
- 72 Commission Regulation (EC) No 753/2004 of 22 April 2004. The regulation also describes in detail what data must be provided.
- 73 The first results of each Mikrozensus survey become available by March of the year following the year in which the survey was carried out. In the past, the Mikrozensus survey regularly collected data on employees' place of work. Cf. the 2007 questionnaire for the Mikrozensus survey (question 56a/04): "What department or plant area is your job part of?" Answer option 04 is as follows: "Development, engineering, research, design, prototype construction". To date, such information has been collected every four years. Cf. http://www.gesis.org/fileadmin/upload/dienstleistung/daten/amtl_mikrodaten/mz/Grundfile/mz2007/MZ-Fragebogen_2007.pdf?download=true (last checked on 18 January 2011).
- 74 The R&D data for Germany are collected by a subsidiary of the Stifterverband für die Deutsche Wissenschaft (Donors' Association for the Promotion of Sciences and Humanities in Germany). The relevant surveys are jointly financed by the private sector and the state. The innovation survey is carried out by the Centre for European Economic Research (ZEW), under commission to the BMBF. The Federal Statistical Office (Statistisches Bundesamt), in the framework of its survey of cost structures, also collects data on companies' R&D activities.
- 75 Recent research has shown that answers to the question regarding level of R&D expenditures tend to be context-dependent. Cf. Sirilli (1998). While that source of discrepancies cannot be fully eliminated, differences in sampling or extrapolation procedures should not be permitted to cause systematic differences in the results.
- 76 The Oslo Manual defines different types of innovation and provides information relative to statistical surveys of the different types of innovation. Cf. OECD (2005) and the glossary.

- 77 Cf. Mairesse and Mohnen (2010: 1136 ff.).
- 78 For example, so-called vignettes can be used to gather information on the different ways in which the term innovation is understood. Vignette techniques are used, for example, in the English Longitudinal Survey of Aging (ELSA) and in the Survey of Health, Aging and Retirement in Europe (SHARE). The methodological advantages and disadvantages of such techniques are currently being intensively discussed. Cf. in this regard Kapteyn et al. (2007) and King et al. (2004).
- 79 Cf. <http://www.nsf.gov/pubs/2008/nsf08586/nsf08586.htm> (last checked on 18 January 2011).
- 80 Cf. in this regard also the proposals of Mairesse und Mohnen (2010), which call for even more systematic harmonisation of international innovation surveys and for collection of panel data.
- 81 This is substantiated by regular statements of the Industry-Science Research Alliance (Forschungsunion Wirtschaft – Wissenschaft) that have confirmed the importance of the five requirements areas. At prescribed intervals, strategic priorities are developed, and “action lines” are defined, for each of the five requirements areas.
- 82 The names of the framework programmes are not always directly in line with the names of the requirements areas. For example, the framework programme “Research for Sustainable Development” is grouped within the requirements area “Climate / Energy”.
- 83 In 2010, a total of four framework programmes were approved. For 2011, plans call for carrying out additional framework programmes within the requirement areas “Climate / Energy” (under the management of the BMWi) and “Security” (under the management of the BMBF). Additional planning of framework programmes is scheduled for 2012 – for example, in the area of “Mobility” (4th transport-research programme on mobility and transport, under the management of the BMWi).
- 84 In continuation of any funding programmes approved in the period 2006 to 2009, the key changes being introduced in the programmes should be highlighted. Funding programmes dating from the time prior to 2006 need to be evaluated, and the recommendations resulting from such evaluation need to be taken thoroughly into account in any continuation or reorientation.
- 85 The number of action lines differs from requirements area to requirements area. For example, the “Security” requirements area has 4 action lines, while the “Communication” requirements area has 12. Where a requirements area has 8 or more action lines, as is now occurring, strategically important action lines should be differentiated more clearly from lower-priority action lines. Cf. BMBF (2010d).
- 86 Future-oriented projects tend to be assigned primarily to one priority area. In some cases, however, a future-oriented project can be significant for two different priority areas. In such cases, additional co-ordination is required. Currently, a total of eleven future-oriented projects are in place. Cf. BMBF (2010d).
- 87 The Federal Government’s R&D planning system (Leistungsplansystematik) supports consistent classification and listing of all of the federal ministries’ R&D projects. At certain intervals, the system has to be adjusted to take account of technological changes, new ministerial responsibilities and changes of priorities. In particular, a need for such adjustments arises through allocation of R&D projects and funding programmes to newly defined requirements areas.
- 88 Changes in the Federal Government’s R&D planning system (Leistungsplansystematik) require a) time-consuming reconciliation accounting for relevant transition periods and b) programme restructuring. In each case, it must be assured that the new methods make it possible (without discontinuities) to quantitatively assess substantial improvements in, and focussing of, funding programmes. Transition-related problems should be eliminated as quickly as possible to ensure that past and new funding practices are comparable.
- 89 The major research organisations include the Fraunhofer-Gesellschaft (FhG), the Helmholtz Association of German Research Centres (HGF), the Max Planck Society (MPG) and the Gottfried Wilhelm Leibniz Science Association (WGL).
- 90 Important foreign companies that pursue strategically central innovation projects in Germany should be invited to serve as promoters and drivers for the innovation policies of the Federal Government,

- the EU and the *Länder*. This should be accomplished via suitable forums (such as discussion groups for innovation managers and R&D directors).
- 91 In recent years, research organisations (such as the Fraunhofer-Gesellschaft and Max Planck Society) have established locations abroad and reinforced their presences in leading centres for innovation. Such presences should be made use of systematically for innovation projects and start-up processes; their role should not be limited solely to research transfer and contract research.
 - 92 Internationally, the Federal Government (like the German *Länder*) has been active via a broad range of measures in the areas of export promotion and industrial and scientific co-operation. Such measures, responsibility for which is often distributed among several different institutions, have not yet been adequately oriented to new forms of international innovation policy. Other countries have been carrying out more effective measures in this regard, measures oriented to key focuses and regions.
 - 93 Cf. Trondsen (2010). That report examines bridge-building organisations in Silicon Valley.
 - 94 Cf. <http://www.swissnex.org> (last checked on 18 January 2011).
 - 95 With regard to relevant fee amounts and translation costs, and the impacts of such charges on efforts to obtain validation, cf. Harhoff et al. (2009).
 - 96 Cf. <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1880&format=HTML&aged=1&language=DE&guiLanguage=fr> (last checked on 18 January 2011).
 - 97 The proposal was based on the EPO's currently valid language policy. It called for patents awarded under the new EU-patent system to be reviewed and issued in one of the EPO's official languages – English, French or German. Cf. <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/870&type=HTML&aged=0&language=DE&guiLanguage=en> (last checked on 18 January 2011). On 10 November 2010, the Commission's efforts in this regard were declared failed.
 - 98 The countries were Denmark, Estonia, Finland, France, Germany, Lithuania, Luxembourg, the Netherlands, Poland, Slovenia, Sweden and the UK.
 - 99 Cf. http://ec.europa.eu/internal_market/indprop/docs/patent/COM%282010%29790-final_en.pdf -COM(2010) 790 final (last checked on 18 January 2011).
 - 100 More than half of all patent disputes in Europe are brought before German courts. Proceedings in Germany produce results relatively quickly, and they are cost-effective. Cf. Harhoff (2009).
 - 101 Cf. Griffith et al. (2010). According to that analysis, patent-box regulations are likely to reduce tax revenue even in those countries that introduce them. They could also reduce tax revenue in other countries as well. And such assessments do not take account of possible shifting of R&D activities.
 - 102 Even in 2010, a crisis year, the country's domestic automotive industry had a total of 768,000 employees subject to social-insurance requirements. Cf. Bundesagentur für Arbeit (2010b). When supply-industry jobs that indirectly depend on automobile manufacturing are added to that figure, the number of employees in the sector's workforce is almost two million. As a result, nearly one out of every six jobs in the manufacturing sector depends, either directly or indirectly, on automobile manufacturing. Cf. Legler et al. (2009). The automotive industry's gross value added, not including that contributed by suppliers, amounted to EUR 66 billion in 2008. Added value for the manufacturing sector as a whole amounted to a total of EUR 504.22 billion (2009: EUR 408.80 billion). Cf. Federal Statistical Office (Statistisches Bundesamt, 2010 f).
 - 103 The following remarks refer to vehicles powered by batteries only and to hybrid vehicles combining electric drive systems with fuel-burning systems with maximally low CO₂ emissions.
 - 104 For example, the Karlsruhe Institute of Technology (KIT), Baden-Württemberg's Centre for Solar Energy and Hydrogen Research and the University of Ulm have begun establishing a joint Helmholtz laboratory for electro-chemical energy-storage systems. In addition, the resources of the Fraunhofer-Gesellschaft in the area of electromobility have been combined within a "Competence Network for Electromobility System Research" (Kompetenznetzwerk Systemforschung Elektromobilität), with a view to bringing alternative drive technologies to market maturity quickly. In Erlangen, the Fraunhofer Institute for Integrated Systems and Device Technology IISB has opened a test

centre for electric cars. Furthermore, in October 2010 Technische Universität München, working in Singapore, began developing electromobility concepts for tropical metropolises.

- 105 According to Matthias Wissmann, head of the German Association of the Automotive Industry (VDA), German automakers plan to invest EUR 10 to 12 billion, over the next three to four years, in development of alternative drive systems. Such investments would represent 40 percent of all R&D investments in drive technologies. Cf. Handelsblatt (2010).
- 106 The lead-provider concept was first presented to the public in connection with the establishment of the National Platform for Electromobility on 3 May 2010. Cf. BMWi (2010a). When Prof. Henning Kagermann became chairman of the steering group of the National Electromobility Platform, the lead-provider concept was further detailed by the German Academy of Science and Engineering (acatech), in a position paper entitled *Wie Deutschland zum Leitanbieter für Elektromobilität werden kann* (how Germany can become a lead provider for electromobility), cf. acatech (2010).
- 107 GGEMO began its operations on 1 February 2010. It supports the Federal Government and the National Platform for Electromobility in implementing and enhancing the National Electromobility Development Plan. The aim in this connection is to have one million electric vehicles on Germany's roads by 2020. The joint office is being sponsored by Germany's ministries of economics, transport, environment and research. Germany's ministries of transport and economics are jointly responsible for the area of electromobility; the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) appoints the head of the GGEMO, while the Federal Ministry of Economics and Technology (BMWi) appoints the deputy head and networks with the relevant institutions.
- 108 Horizontal co-operation between European automakers, in the area of electromobility, takes place only in exceptional cases. The Expert Commission is aware of only one pertinent example. The Expert Commission is currently unable to assess whether that co-operation is significantly influencing Germany's position as a potential lead provider.
- 109 Execution of a transboundary fleet test, which the Franco-German "Electromobility" working group initiated at the beginning of 2010, represents a first hesitant step in that direction. The joint fleet test is aimed at making the publics of both countries aware that attractive, user-friendly solutions are already available in the areas of battery-charging, safety and payment. In addition, three existing German projects, "MeRegioMobil", "Future Fleet" and "Modellregion Stuttgart", are to be combined with the French project "Kleber". Cf. BMWi (2010b).
- 110 Cf. Görres and Meyer (2008).
- 111 Cf. Füssel and Leschinsky (2008).
- 112 Cf. BverfG (Federal Constitutional Court), AZ 2 BvG 1/55, Ziffer (numeral) 173.
- 113 Picht (1964), Dahrendorf (1965).
- 114 Mutert (2000).
- 115 Krieger (1987: 262).
- 116 KMK (1998).
- 117 For example, Article 91b GG, introduced in 1969, stated "the Federation and *Länder* may, pursuant to agreements, co-operate in educational planning and in the promotion of research institutions and projects of supra-regional importance. The apportionment of costs shall be regulated in the relevant agreements".
- 118 Scharpf (2009: 25 f.).
- 119 Scharpf (2009: 27).
- 120 Until 1994, the Basic Law spoke in terms of protecting the "uniformity" of living conditions. The 1994 amendment of the necessity clause (Bedürfnisklausel) speaks of an "equivalence" of living conditions.
- 121 Cf. Füssel and Leschinsky (2008: 164).
- 122 The Conference of Ministers of Education and Cultural Affairs (KMK) also developed an action programme. When the first PISA results were published, that programme was tailored accordingly. The relevant recommendations, which are still in place, are quite non-binding and general in their

- orientation; cf. <http://www.kmk.org/fileadmin/pdf/PresseUndAktuelles/2002/massnahmen.pdf> (last checked on 18 January 2011).
- 123 Programmes worthy of mention include a Programme for Enhancing Efficiency in Mathematics and Science Instruction (SINUS), a Programme for systematic Inclusion of Media, Information and Communications Technologies in Teaching and Learning Processes (SEMIK), a Programme for Improving Quality in Schools and School systems (QuiSS) and a Programme for Promoting Children and Adolescents with Migration Backgrounds (FörMig). For a detailed overview of the education programmes and individual projects jointly financed by the Federal Government and the *Länder* since 1998, cf. http://www.bildungsserver.de/pdf/blk_98.pdf (last checked on 18 January 2011).
- 124 Cf. http://www.ganztagsschulen.org/_downloads/Verwaltungsvereinbarung_IzBB.pdf (last checked on 18 January 2011).
- 125 Cf. <http://www.ganztagsschulen.org/1108.php> (last checked on 18 January 2011).
- 126 Unlike the programmes and model tests initiated by the BLK, the two all-day-school programmes are investment programmes pursuant to Article 104 a (4) GG (Basic Law). In the framework of such investment programmes, “the Federation may grant the *Länder* financial assistance for particularly important investments by the *Länder* or by municipalities, provided that such investments are necessary to avert a disturbance of the overall economic equilibrium, to equalize differing economic capacities within the federal territory, or to promote economic growth.” (Article 104b (4) Sentence 1 GG (Basic Law)).
- 127 Cf. <http://www.bmbf.de/de/1125.php> (last checked on 18 January 2011).
- 128 Cf. <http://www.ganztaegig-lernen.org/www/web43.aspx> (last checked on 18 January 2011).
- 129 Krieger (1987: 255 ff.).
- 130 “The joint task of university construction preceded the *Länder* agreement on financing of new universities of 1964. In the simultaneously concluded administrative agreement, between the Federation and the *Länder*, for funding of science and research, and in the relevant extension agreement of 1968, the Federation and the *Länder* entered into a number of mutual commitments in promotion of education and expansion of universities. As of 1964, the Federation assumed half of the costs of both tasks, as well as half of the funding for German Research Foundation (DFG) and the Max Planck Society (MPG). As a result of the importance of education expenditures, and of the large financial volumes involved, provisions for joint responsibilities were added to the Basic Law. The joint financing involved is not simply designed to be budgetary offsetting of defined financing shares; instead, it entails, in keeping with the substance of the relevant provisions, joint actions by the Federation and the *Länder* in substantive issues and budgetary matters, with the scope of such actions differing from task to task.” Cf. http://fm.fin-nrw.de/info/haushaltsverwaltung/Daten/html_dateien/hh13_bildungswissen.htm (last checked on 18 January 2011).
- 131 Kisker, G. (1971: 304). Cited pursuant to Krieger (1987: 256).
- 132 Cf. Lengwiler (2009: 20).
- 133 Cf. Lengwiler (2009: 20). On the other hand, during the 1973/74 recession, and during the economic downturns in the years thereafter, research investments were hardly expanded. (op. cit.).
- 134 “The Blue List organisations are autonomous research institutions, sponsor organisations or service institutions for research of supra-regional importance and national science-policy interest that are funded on the basis of the framework agreement of the Federation and the *Länder* on joint funding of research pursuant to Article 91b of the Basic Law of 28 November 1975 (Framework Agreement on Research Promotion).” Cf. Science Council (Wissenschaftsrat, 2000).
- 135 The entry of the Blue List institutions into the Gottfried Wilhelm Leibniz Science Association (WGL), following German reunification, enhanced co-operation, via regular information exchanges, improved co-ordination and use of available resources and representation of joint interests. Cf. <http://www.bmbf.de/de/243.php> (last checked on 18 January 2011).
- 136 The federalism reform was initiated with a view to assigning political responsibilities more clearly with regard to legislative authority, rights of co-operation and the financial relationships between the Federation and the *Länder*. In May 2004, in the context of deliberations of the Federalism

Commission I, the Minister-Presidents presented a joint position paper in which they called for comprehensive legislative authority for regulation of “regional life circumstances”. In addition to calling for retaining the responsibility of the *Länder* in, inter alia, the areas of active labour-market policy, environmental law and business law, they called for the Federation to withdraw completely from education and childcare policy. Initially, the Federation retained its responsibilities for the education sector. At the same time, its negotiating position with respect to the *Länder* was significantly weakened by a ruling of the Federal Constitutional Court of 27 July 2004. In that ruling, the federally introduced “junior professorships” were declared unconstitutional, since their creation overstepped the bounds of framework regulation, and since there was no “necessity” for a pertinent federal regulation pursuant to Article 72 (2) GG. That ruling changed the constellation for negotiations between the Federation and the *Länder*: now, the Federation required the consent of the *Länder* “even to constitutionally uphold that part of its current legislative authority that was completely undisputed politically. It was obvious that the Federation would have to offer something in order to obtain such consent.” Scharpf (2010: 29). While the federalism reform failed in December 2004, because the Federation was unwilling to give up the last of its authority in the area of education, the Bundestag elections of 2005 changed the relevant political constellation and balance of interests. The Federation then withdrew from the area of education policy, not least because a number of influential *Länder*-level politicians moved to the Federal level. Cf. Scharpf (2010: 28 ff.).

- 137 Avenarius (2009: 178).
- 138 Even after the introduction of the prohibition on co-operation, the Federation and the *Länder* have looked for ways (even circuitous ones) of making co-operation possible nevertheless and of cutting through the clear separation of responsibilities that was sought with the federalism reform. That is apparent in the successful efforts, of 2007, to establish a joint fund for expansion of education facilities and measures for young children. Cf. <http://www.kib-ol.de/Krippenkompromiss.pdf> (last checked on 18 January 2011).
- 139 Cf. Avenarius (2009: 186). Since 2006, the *Länder* have had sole responsibility for remuneration of teachers. That has been engendering competition between the *Länder* for teachers, a scarce “resource”. Since then, rich *Länder* have found it easier to recruit teachers, by offering either civil-servant status or high salaries. A good example for the extent of such competition is provided by the state of Land Baden-Württemberg, which has expended EUR 375,000 on a nationwide campaign for targeted recruitment of teachers. Cf. <http://bildungsklick.de/pm/66059/bundesweitewerbekampagne-zum-auftakt-der-2-und-3-tranche-der-stellenausschreibung-mit-plakaten-zeitungsannoncen-internet-werbespot-und-online-bannerwerbung> (last checked on 18 January 2011).
- 140 Cf. Scharpf (2009: 72).
- 141 This section touches neither on joint Federal-*Länder* project-oriented funding nor on research funding activities of the departmental research institutions of Federal and *Länder* ministries.
- 142 Attention needs to be called to a seemingly insignificant change in the wording of Article 91b, a change that, on closer inspection, has far-reaching implications for legal interpretation of the article: While the old Article 91b GG (the version in place prior to 2006) referred to Federal-*Länder* co-operation “in promoting institutions and projects for scientific research that have supra-regional importance” (emphasis of the Expert Commission), Sentence 2 No 2 of the new Article 91b GG (the version in place after 2006) now permits, in cases of supra-regional importance, Federal-*Länder* co-operation in funding of “science and research projects at higher education institutions” (emphasis of the Expert Commission). In the relevant jurisdiction and literature, it is undisputed that the term science comprises the areas of research and teaching at higher education institutions. The new Article 91b thus no longer rules out Federal involvement in the area of teaching, which previously lay exclusively in the responsibility of the *Länder*. That expanded possibility for Federal-*Länder* co-operation has already been made use in the Higher Education Pact and in the Federal-*Länder* agreement on improving the quality of teaching (Bund-*Länder*-Vereinbarung zur Verbesserung der Qualität der Lehre). On the other hand, the new Article 91b GG now no longer refers to Federal authority in funding scientific research institutions at higher education institutions, reflecting the

- fact that the Federation, via federalism reform, has lost its framework authority in the higher education sector and now is responsible solely for regulating higher-education entrance requirements and higher-education degrees in the area of competitive legislation pursuant to Article 74 (1) No 33 GG (Alecke et al. 2011: 54).
- 143 It should be mentioned that, via Article 91b (1) No 3, a new joint responsibility for funding of research facilities and large scientific equipment has been created.
- 144 Alecke et al. (2011: 163).
- 145 Cf. <http://www.gwk-bonn.de/fileadmin/Papers/gwk-abkommen.pdf> (last checked on 18 Januar 2011).
- 146 By way of example, we call attention to the execution agreement for the Max Planck Society (AV-MPG): http://www.gwk-bonn.de/fileadmin/Papers/AV_MPG.pdf (last checked on 18 Januar 2011).
- 147 The Königstein key defines the *Länder* share in joint financing of science research institutions. Calculated anew each year, it is based to a degree of two-thirds on tax revenue and to a degree of one-third on the populations of the *Länder*. Cf. http://fm.fin-nrw.de/info/haushaltsverwaltung/Daten/html_dateien/hh13_bildungwissen.htm (last checked on 18 Januar 2011). Regarding the pertinent details of the breakdown, cf. footnote 155.
- 148 Alecke et al. (2011: 60).
- 149 Of total joint Federal-*Länder* expenditures on research funding (amount to about EUR 6.3 billion), about 24.5 percent (about EUR 1.5 billion) go to the DFG and about 75.5 percent (about EUR 4.7 billion) go to the major non-university research institutions (own calculations).
- 150 Cf. EFI(2010).
- 151 Cf. Hornbostel and Simon (2010: 23).
- 152 Along with the financing key for the four major research organisations, financing keys need to be mentioned for institutions that the present report does not discuss in detail: the Academies Programme (Federal-*Länder* key: 50:50; breakdown of the relevant *Länder* share: host Land (state) of the office of the relevant Academies Programme project), German Academy of Science and Engineering (acatech) (Federal-*Länder* key: 50:50; breakdown of the relevant *Länder* share: Königstein key) and the German Academy of Natural Scientists Leopoldina (Federal-*Länder* key: 80:20; breakdown of the relevant *Länder* share: host Land).
- 153 The institutes of the Fraunhofer-Gesellschaft (FhG) are not financed exclusively via public funding; they also acquire industry funding (often on a considerable scale), on the strength of their explicit orientation to applied research. Consequently, FhG institutes differ from institutes of other research organisations in that they obtain only a certain share of their overall budgets from public funds. Fraunhofer institutes differ from each other in terms of the percentage amounts of public funding they receive (i.e. as percentages of their total budgets); those amounts depend on the amounts of third-party funding they are able to acquire. The funding requirements for an FhG institute consist solely of that share of the institute's budget that has to come from the public sector. When all of the FhG institutes located in a given Land (state) are considered together, then a pertinent relationship between public funding and third-party funding results for that Land. The so-defined relationship differs from Land to Land. In each case, it depends on how much third-party funding the Land's FhG institutes have been able to acquire with respect to the public funds the institutes have drawn. *Länder* whose FhG institutes (as a group) obtain large shares of third-party funding (especially industry funding) thus have lower funding requirements than *Länder* whose FhG institutes (as a group) have to rely more heavily on public funding. The lower the funding requirements for a given Land's FhG institutes, the lower the pertinent costs for the relevant Land. At the same time, it must be noted that the third-party funding acquired by FhG institutes does not consist exclusively of industry funding. This is the case in that FhG institutes also participate to a considerable degree in public project funding by Federal, *Länder* and European bodies, and they acquire some of their industrial funding via such funding programmes.
- 154 To that end, a "special fund for large-scale research" ("Sondervermögen Großforschung") had to be established to accept the financing shares from the Federation and the Land. That fund is a special fund of the Land (state) of Baden-Württemberg. The fund is managed by KIT, and it must be kept

separate from other assets of the Land (state) and of KIT, and from the rights and liabilities of those two entities. Cf. http://www.landtag-bw.de/wp14/drucksachen/4000/14_4340_d.pdf (last checked on 18 January 2011).

- 155 The Königstein key for 2010 breaks down joint-financing costs as follows among the *Länder*: North Rhine – Westphalia: 21.3 percent; Bavaria: 15.1 percent; Baden-Württemberg: 12.8 percent; Lower Saxony: 9.3 percent; Hesse: 7.2 percent; Saxony: 5.2 percent; Berlin: 5 percent; Rhineland-Palatinate: 4.8 percent; Schleswig-Holstein: 3.3 percent; Brandenburg: 3.1 percent; Saxony-Anhalt: 3 percent; Thuringia: 2.8 percent; Hamburg: 2.6 percent; Mecklenburg-West Pomerania: 2.1 percent; Saarland: 1.2 percent; Bremen: 0.9 percent. The Königstein key for the 2010 fiscal year is based on the tax revenues and population figures for the year 2008. Cf. <http://www.gwk-bonn.de/fileadmin/Papers/koenigsteiner-schlüssel-2010.pdf> (last checked on 18 January 2011); http://fm.fin-nrw.de/info/haushaltsverwaltung/Daten/html_dateien/hh13_bildungswissen.htm (last checked on 18 January 2011).
- 156 For example, the some EUR 12 million that the Land (state) of Schleswig-Holstein saves annually via the transfer of IFM-GEOMAR into the Helmholtz Association (HGF) are used for financing the department of medicine of the University of Lübeck. That department had been at serious risk of closure due to a lack of funding.
- 157 In many cases, the financing advantages accruing via conversion into HGF institutes are likely to be smaller than they would initially seem to be. The financial savings resulting from transfer of institutes into the Helmholtz Association (HGF) that receive equal shares of their financing from the Federation and the *Länder* must be seen in light of the potential loss of DFG funding. HGF institutes are not completely eligible to apply for DFG funding. Consequently, the more DFG third-party funding that a research institution acquires, the less transfer into the HGF is likely to pay off financially.
- 158 Such a unified approach was sought soon after reunification. The uncertain economic situation of the new German *Länder* was the reason it failed to materialise. Such an approach has already been implemented in the framework of DFG funding.
- 159 The joint Federal-*Länder* expenditures for financing of the major research organisations (HGF, FhG, MPG, WGL) currently amount to about EUR 4.7 billion. Of that share, the *Länder* bear about EUR 1.3 billion (28.2 percent), while the Federation bears about EUR 3.4 billion (71.8 percent). (reference years: HGF (including the Dresden-Rossendorf Research Centre, FZD), FhG: 2009; MPG: 2010; WGL: 2011; own calculations).
- 160 Deviations from this assumption are of only subordinate importance with regard to the overall result. With a Federal-*Länder* financing key of 70:30, the host Land would thus bear about nine percent of the total expenditures for a research institution.
- 161 For the MPG and WGL, a common host-Land share of 25 percent has been applied. No host-Land share applies for HGF institutes, as a result of the type of bilateral financing (financing by the Federation and the host Land) that applies. The host-Land share for the FhG has not been adapted, due to the complicated financing structure involved. For the Federation, expenditures would be reduced by EUR 85 million. That amount could be used to reduce the added expenditures of the affected *Länder*.
- 162 That is equivalent to an added burden of about six percent with respect to the current *Länder* expenditures for basic funding provided to non-university institutions.
- 163 The idea of strengthening the autonomy of non-university research institutions was discussed as early as August 2007. At the time, the Federal Government had decided to provide greater flexibility for non-university research institutions – in areas such as budgetary law, construction law and national and international networking – by adopting a Freedom of Science Act (*Wissenschaftsfreiheitsgesetz*). Cf. <http://dip21.bundestag.de/dip21/btd/17/008/1700894.pdf> (last checked on 18 January 2011). While that legislation failed to pass, as a result of disagreements between the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Finance, in summer 2008 some key aspects of the Freedom of Science Act initiative were adopted.

- Those aspects included prospects of allowing global budgets for science and research institutions. Cf. http://www.bmbf.de/pubRD/eckpunkte_wissenschaftsfreiheitsgesetz.pdf (last checked on 18 January 2011). In its coalition agreement, the current Federal Government has also announced plans for continuing the Freedom of Science initiative and to draft new legislation for a Freedom of Science Act. Cf. <http://dip21.bundestag.de/dip21/btd/17/008/1700894.pdf> (last checked on 18 January 2011).
- 164 While in Bavaria fewer than 36 percent of primary school pupils are transferred to grammar schools (Gymnasium) (2007), the corresponding figure for Bremen is 49 percent. In Bavaria, only 23 percent of the children in that age cohort go on to obtain a general higher education entrance qualification; the corresponding figure in Bremen is 34 percent.
- 165 The average value for reading competence in Bavaria, 509 points, is 40 competence points higher than the corresponding figure for Bremen which, with a score of 469 points, ranks last among all *Länder* in this category. In the area of spelling, the difference between these two *Länder* amounts to more than 60 competence points. In addition, the *Länder* differ considerably with regard to the homogeneity of performance levels: a look at the differences in performance between the highest five percent and the lowest five percent of all pupils considered – a readily appreciable measure for the heterogeneity of performance within a given Land – shows that Berlin had the largest such spread, amounting to 349 competence points, while Thuringia had the smallest, amounting to only 283 competence points. Cf. http://www.iqb.hu-berlin.de/aktuell/dateien/LV_ZF_0809b.pdf, page 6f. (last checked on 18 January 2011).
- 166 Cf. Helbig (2009).
- 167 Cf. Tillmann (2009: 23).
- 168 In 2004, after standards had already been adopted for the intermediate qualification in German, mathematics and a first foreign language, standards were adopted for the general certificate of secondary education (Hauptschulabschluss) in those subjects, for the primary level in German and mathematics and for the intermediate qualification in biology, chemistry and physics.
- 169 Wernstedt and John-Ohnesorg (2009: 6).
- 170 Vgl. Meyer-Hesemann (2009: 11), Hamburger Abendblatt (2010). At present, a number of Land-level politicians, such as Christoph Matschie, Thuringia's minister of education and the arts, Brigitta Wolf, Saxony-Anhalt's minister of education and the arts and Sylvia Löhrmann, North Rhine – Westphalia's minister for schools and continuing education, are calling for elimination of the prohibition on co-operation. Cf. <http://www.mdr.de/nachrichten/7932458.html> (last checked on 18. Januar 2011), http://www.rp-online.de/politik/deutschland/Loehrmann-Kooperationsverbot-aufheben_aid_895760.html (last checked on 18 January 2011).
- 171 Spitzer (2010).
- 172 At the same time, it must be noted that the Bund-*Länder* Commission for Educational Planning and Research Promotion (BLK) has also been unable to introduce standardised terms. The types of schools formerly in place included Regelschulen (regular schools, Thuringia), Mittelschulen (middle schools, Saxony), Sekundarschulen (secondary schools, Saxony-Anhalt) and Oberschulen (high schools", Brandenburg). In addition, Mecklenburg-West Pomerania introduced school structures unlike any found in other *Länder*.
- 173 For example, via targeted Federal funding allocations in municipalities with social problems. A social index, modelled after an index developed in Hamburg and in place there since 2005, could be used to guide such allocations. In Hamburg, the social index is used to calculate social-disadvantage levels of Hamburg schools, on the basis of special surveys that collect data on schools' pupils and on structures in relevant city districts (such as unemployment rates, numbers of people in each district living in subsidised social housing, etc.). That index can be used as a basis for targeted allocations to individual schools. Cf. <http://www.bildungsmonitoring.hamburg.de/index.php/article/detail/1504> (last checked on 18 January 2011).
- 174 This refers to the recipients of European research support: higher education institutions, non-university research institutions, business enterprises and individual scientists.

- 175 These included the European Organisation for Nuclear Research (CERN, founded in 1954), the European Southern Observatory (ESO; founded in 1962), the European Synchrotron Radiation Facility (ESRF; founded in 1988).
- 176 Cf. Daimer et al (2011: 2).
- 177 Cf.: http://europa.eu/legislation_summaries/research_innovation/general_framework/i23010_de.htm (last checked on 18 January 2011).
- 178 Cf. Rammer, Pesau und Sellenthin (2011: 17); the individual programmes have been entered in keeping with the average annual funding levels for the current planning period (2007–2013) and for the current budget years.
- 179 Among these are the Barcelona goal, from 2002, calling for each Member State's R&D expenditures to increase to three percent of its GDP. The private sector was called on to contribute two-thirds of the pertinent increase, and all Member States were called on to develop national innovation strategies.
- 180 European Commission (2007): 2 f.) and European Commission (2010b).
- 181 Since the programmes are based on different financing mechanisms (subsidies, institutional funding, loans / venture capital / guarantees), the funding allocations as listed are not always directly comparable and do not accord in every case with the EU's direct resources allocations. In the case of loans, for example, loan recipients repay funding amounts along with interest, and European budgets are burdened solely with the costs of any interest-rate subsidies and of any defaults. Cf. Rammer, Pesau und Sellenthin (2011: 17).
- 182 Cf. Rammer, Pesau und Sellenthin (2011: 19).
- 183 Cf. LSE (2009: 1).
- 184 By resolution of 26 May 2010, the committee is now known as the European Research Area Committee (ERAC), http://ec.europa.eu/research/era/docs/en/council-resolution-on-era-governance_26-05-10.pdf (last checked on 18 January 2011).
- 185 Cf. BMBF (2010e: 356).
- 186 Cf. the Federal Government's position paper on the planned "Innovation Union", a lead initiative in the framework of of the Europe 2020 strategy.
- 187 Cf. Technopolis (2008).
- 188 In 2000 prices.
- 189 The figures used in connection with the Framework Programme are based on information provided in Rammer, Pesau und Sellenthin (2011). That information, in turn, is based on analyses of data from evaluation of Germany's participation in the 6th Framework Programme (Grimpe et al. 2009), as well as on evaluations, carried out by the EU Bureau of the BMBF, relative to implementation to date of the 7th Framework Programme, on the basis of ECORDA databases of applications and contracts in the 7th Framework Programme (edition: 30. April 2010, with data status as of 25 March 2010). As a result, the data relative to the 7th Framework Programme show relevant implementation as of the programme's first three years.
- 190 Cf. Rammer, Pesau und Sellenthin (2010: 11 ff.).
- 191 Innovation activities, in the framework of the Structural Funds programmes, that fall within the category of expenditures for research, technological development and innovation have to do primarily with the following: RTD activities in research centres, RTD infrastructures and competence centres, technology transfer and improvement of co-operation networks, support for R&D investments in business enterprises (especially in small and medium-sized enterprises (SMEs)) and development of human resources in the area of research and innovation. Cf. European Commission (2008: 114).
- 192 BMBF (2007: 5).
- 193 In 2000 prices.
- 194 Cf. <http://www.eureka.dlr.de/de/174.php> (last checked on 18 January 2011).
- 195 With regard to the entire paragraph, cf. Daimer et al (2011: 11).
- 196 Cf. http://ec.europa.eu/cip/index_de.htm (last checked on 18 January 2011).

- 197 And it was one of the three European Communities. The other two were the European Coal and Steel Community (ECSC) and the European Economic Community (EEC), both of which have been subsumed within the EU's structures.
- 198 Cf. <http://public.web.cern.ch/public> (last checked on 18 January 2011).
- 199 Cf. http://www.esa.int/esaCP/SEMEU7W4QWD_Germany_0.html (last checked on 22 January 2011)
- 200 Cf. <http://eit.europa.eu/about-eit/funding.html> (last checked on 18 January 2011).
- 201 Cf. Rammer, Pesau und Sellenthin (2011: 17 ff.).
- 202 Cf. Rammer, Pesau und Sellenthin (2011: 20).
- 203 Cf. Rammer, Pesau und Sellenthin (2011: 20).
- 204 The figures provided in the following paragraph have been taken from Rammer, Pesau and Sellenthin (2011: 36 ff.).
- 205 When the EU support is seen in terms of the total R&D funding available to German higher education institutions – i.e. including third-party funding from industry and from abroad, and self-financing for R&D – the relevant quota amounts to only about 2.5 percent.
- 206 The ERC offers two types of support. ERC Starting Grants for young scientists and their teams (awarded 2 to 12 years after a scientist has earned his or her doctoral degree) provide support of up to EUR two million (with a term of five years). ERC Advanced Grants are awarded to leading researchers with at least ten years of experience and noteworthy research achievements (support of up to EUR 3.5 million; five-year term). In general, while support is also available to non-Europeans, the relevant research should be carried out in an EU Member State or an EU Associated State. Scientists working in all disciplines, and at both public and private research institutions, are eligible to apply; cf. http://erc.europa.eu/pdf/ERC_Guide_for_Applicant.pdf (last checked on 18 January 2011).
- 207 Cf. ERC (2007: 2).
- 208 This statement is based on a Mid-Term Review of the ERC (Freiberga et al 2009) and on anecdotal evidence from the EURECIA EU-project context, a context in which impacts analyses for the ERC are designed and, thus, the opinions of numerous actors are obtained. Cf. <http://www.eurecia-erc.net> (last checked on 18 January 2011), cited after: Daimer et al. (2011: 13).
- 209 This was apparent in the enormous oversubscriptions seen in 2007, the effort's first year (9,261 applications were received, for a total of 200 available grants). The numbers of applicants have decreased somewhat since then (2010: 427 grants, and 2,873 applications), as it has become clear that only truly outstanding scientists can succeed in the competitive application process.
- 210 In the last call for applications (carried out in 2010) for Starting Grants, i.e. for applications from scientists starting out on independent research careers, the top three positions, in terms of numbers of grants received, went to research institutions in Germany (64 projects), France (75) and the UK (79). A total of 83 German nationals were among the scientists receiving grants, however.
- 211 Currently, a joint programme-planning effort has been launched that is aimed at supporting the fight against neurodegenerative diseases. New thematic areas in this context include agriculture, food security and climate change, cultural heritage and global change, and healthy nutrition. Cf. http://ec.europa.eu/research/era/areas/programming/joint_programming_en.htm (last checked on 18 January 2011).
- 212 Cf. <http://www.forschungsrahmenprogramm.de/era-net.htm> (last checked on 18 January 2011).
- 213 Joint execution of national research programmes pursuant to Article 185 Treaty on the Functioning of the European Union (participation of the Community): "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."
- 214 Cf. Daimer et al (2011: 14); BMBF (2007: 26 f.).
- 215 Cf. European Commission (2010a:12 f.)

- 216 Cf. Daimer et al (2011: 14).
- 217 The Commission defines the OMC as follows: “The open method of co-ordination is used on a case by case basis. It is a way of encouraging co-operation, the exchange of best practice and agreeing common targets and guidelines for Member States, sometimes backed up by national action plans as in the case of employment and social exclusion. It relies on regular monitoring of progress to meet those targets, allowing Member States to compare their efforts and learn from the experience of others.” Cf. Commission of the European Communities (2001: 28).
- 218 Subsidiarity principle pursuant to Article 5 EC Treaty. “In areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of subsidiarity, only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community.”
- 219 Germany’s level of participation in these areas, especially in the ERA-Net measures, is gratifyingly high.
- 220 European Commission (2010c: 40).
- 221 Cf. EFI (2010: 20 ff.).
- 222 Cf. Prognos (2010: 211).
- 223 Cf. BMBF (2010f: 10).
- 224 Cf. HRK (2010: 6); Wissenschaftsrat (2010: 145).
- 225 Cf. European Commission (2010d: 571).
- 226 The network League of European Research Universities, which was established in 2002, is a useful example of such networks.
- 227 In all three funding lines, support is application-based and provided exclusively in accordance with scientific criteria. Cf. http://www.gwk-bonn.de/fi_leadadmin/Papers/exzellenzvereinbarung.pdf (last checked on 18 January 2011).
- 228 It is also proposed that the number of higher education institutions co-operating in any given network be tightly limited, with a view to preventing the sorts of co-ordination difficulties that arose in the framework of the Networks of Excellence (NoE) initiative. As a result of the large number of research partners that had to be integrated, structuring and co-ordinating NoE proved to be extremely difficult, leading the EU to consider discontinuing that funding model.
- 229 Cf. the current information relative to FP7 in, inter alia, European Commission (2010c: 29, 50), and, more generally, in: <http://www.trust-researchers.eu/docs/nature.pdf> (last checked on 18 January 2011).
- 230 Such instruments and strategies include tax-based research support.
- 231 This issue has to do with whether network providers should be able to collect fees only from their own Internet-service customers or whether they should also be able to impose charges on application / content providers who are not their own customers and who wish to reach their end customers.
- 232 In 2009, the EU amended its directives on electronic communications. These changes have produced transparency requirements whereby consumers, prior into entering into any relevant agreement, have to be informed about the precise type of services involved and about any applicable restrictions. In addition, efforts have sought to make it easier for consumers to switch access providers. Furthermore, the EU has authorised national regulatory authorities to require minimum quality levels for network-transmission services. In 2009, the European Commission (Europäische Kommission, 2009) issued a declaration on network neutrality. In a relevant passage, that declaration states as follows: “The Commission attaches high importance to preserving the open and neutral character of the Internet, taking full account of the will of the co-legislators now to enshrine network neutrality as a policy objective and regulatory principle to be promoted by national regulatory authorities, alongside the strengthening of related transparency requirements and the creation of safeguard powers for national regulatory authorities to prevent the degradation of services and the hindering or slowing down of traffic over public networks.

- The Commission will monitor closely the implementation of these provisions in the Member States, introducing a particular focus on how the “net freedoms” of European citizens are being safeguarded in its annual Progress Report to the European Parliament and the Council. In the meantime, the Commission will monitor the impact of market and technological developments on “net freedoms” reporting to the European Parliament and the Council before the end of 2010 on whether additional guidance is required, and will invoke its existing competition law powers to deal with any anti-competitive practices that may emerge.” Cf. in this regard http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/net_neutrality/index_en.htm (last checked on 18 January 2011).
- 233 In its coalition agreement, the governing coalition consisting of CDU, CSU and FDP (2009: 101) expresses its support for neutral data transmission within the Internet; the document states as follows: “We are confident that existing competition will provide for neutral data transmission in the Internet and in other new media (network neutrality); however, we will carefully monitor the relevant development and take counter measures to protect the aim of network neutrality if necessary.” With regard to the amended EU-directive provisions on electronic telecommunications, which are to be transposed into national law by the end of May 2011, in September 2010 the Federal Minister of Economics and Technology presented a ministerial draft bill for an amendment of the Telecommunications Act (TKG).
- 234 In March 2010, the German Bundestag (Deutscher Bundestag, 2010: 3) decided to establish an enquete commission on the topic of “the Internet and the digital society”. The aspects that that commission is charged with studying, so the relevant establishment agreement, include the importance of network neutrality with regard to neutral data transmission and to free and unhindered access to the Internet. A public hearing on that issue was held on 4 October 2010. The enquete commission is to present its results by the 2011 parliamentary summer break. And it is to present an interim report by Easter 2011.
- 235 Cf. Association of the German Internet Industry (eco) and Arthur D. Little GmbH (Verband der deutschen Internetwirtschaft [eco] and Arthur D. Little GmbH, o.J.). The economic importance of the Internet-based ICT industry cannot be adequately described in terms of official statistics. In the classification of economic sectors (Klassifikation der Wirtschaftszweige), 2008 edition (WZ 2008), the ICT sector is included in section J, “information and communication” (cf. Statistisches Bundesamt 2008)). However, Internet-based and non-Internet-based sectors are not differentiated throughout in that classification. For example, no distinction is made between standard / conventional software licensing and software as a service.
- 236 This put Germany ahead of the UK, the Netherlands, Italy and Japan. The highest rates were seen in Switzerland, Iceland and Korea. No comparable data are available for the U.S.. Cf. in this regard, and in the following, OECD Broadband Portal, cfl. http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html (last checked on 18 January 2011).
- 237 The highest rates were seen in Korea, Iceland and Sweden. The share of households with broadband access was also higher in the Netherlands and in the UK than it was in Germany. The rates in the U.S. and in Switzerland were about as high as those in Germany; those in Japan, France and Spain were lower. Cf. OECD Broadband Portal, http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html (last checked on 18 January 2011).
- 238 Cf. in the following Dauchert and Meurer (2011).
- 239 Differentiation in keeping with the Association of the German Internet Industry (eco) and Arthur D. Little GmbH (Verband der deutschen Internetwirtschaft [eco] und Arthur D. Little GmbH, o.J.).
- 240 Cf. van Schewick (2010a: 72–75, 217–218) and van Schewick (2010b).
- 241 Pursuant to a publication of Cisco (2010: 1), data volume in the Internet grew by 45 percent in 2009 alone.
- 242 Cf. Federal Statistical Office (Statistisches Bundesamt 2009: 23, 30).
- 243 Cf. van Schewick (2010a: 264 ff.).

- 244 Cf. BITKOM (2010).
- 245 Cf. in the following <http://www.itwissen.info/definition/lexikon/software-as-a-service-SaaS.html> (last checked on 8 January 2011).
- 246 Cf. Enzyklopädie der Wirtschaftsinformatik – Online Lexikon, cf. <http://www.enzyklopaedie-er-wirtschaftsinformatik.de/wi-enzyklopaedie/lexikon/technologien-methoden/Rechnernetz/Internet/Internet-der-Dinge> (last checked on 18 January 2011).
- 247 Cf. Gabriel et al. (2010).
- 248 Exclusion of politically undesired content or statements would also be conceivable. This brings up the issue of freedom of speech in the Internet, which is not discussed here in spite of its relevance. The remarks here focus instead on the relationship between network neutrality and innovation.
- 249 Cf. van Schewick and Farber (2009: 31, footnote b).
- 250 A comprehensive, systematic discussion of the possible motives of non-monopolistic, vertically integrated network providers is provided by van Schewick (2007a: 368 ff. and 2010a: 255 ff.). Cf. van Schewick (2010a: 275 ff.).
- 251 The basic cost structure of the application market is characterised by high fixed costs and low marginal costs. For application providers, that structure makes the cost of developing applications high. But once an application / service is available, the costs that additional users generate are relatively low; in fact, they can even reach zero. When demand increases, fixed costs can be distributed among more users, and thus, when marginal costs are low, the average costs decrease. Cf. van Schewick (2010a: 252 f.).
- 252 Mobile-network providers could see the need to protect their revenue from conventional mobile telephony as an incentive to keep Internet telephony users out of their mobile networks. DSL providers might exclude VoIP services as a way of protecting their revenue from fixed-network telephony. Cable-network providers could take a similar approach with Internet TV.
- 253 With regard to the costs of switching providers, cf. the detailed discussion in van Schewick (2010a: 259 ff.).
- 254 van Schewick (2010a: 264), referring to behavioural-economic studies, notes that even very low costs make customers hesitant to switch.
- 255 Cf. the detailed discussion in van Schewick (2010a: 264 ff.).
- 256 Cf. Enzyklopädie der Wirtschaftsinformatik – Online Lexikon, <http://www.itwissen.info/definition/lexikon/quality-of-service-QoS-Dienstguete.html> (last checked on 18 January 2011).
- 257 Cf. Kruse (2008: 5 ff.).
- 258 Cf., in the following, Schlauri (2010: 180 ff.).
- 259 Cf. van Schewick (2010b).
- 260 Cf. van Schewick (2010b).
- 261 For a detailed analysis of the impacts of different types of QoS on the values that net-neutrality rules are designed to protect, cf. van Schewick (2010b).
- 262 Cf. van Schewick (2010c), van Schewick (2010d); van Schewick (2010e: 4 ff.); in its “Open Internet Order”, the FCC, the U.S. regulatory authority, also linked the Internet’s innovative power to such characteristics. Cf. FCC (2010).
- 263 For an analysis of the problems incurred in connection with access fees, cf. van Schewick (2010c: 4 ff.); van Schewick (2010a: 278ff., 290 ff.).
- 264 According to a study carried out by Inimai Chettiar and J. Scott Holladay from the New York University School of Law, the reason why network providers have been so modest in their infrastructure investments is that they operate in an area with little competition – an area that, in this regard, differs completely from the content market. Cf. Chettiar and Holladay (2010). That assessment has to be modified somewhat with regard to population centres, however. In Germany, network competition has been functioning in such centres, with available bandwidth growing through action and reaction. In some cases, speeds of 100 Mbps are available in the access network.

- 265 If Internet users turn out to be largely insensitive to prices, and generally reluctant to switch providers, a promising strategy for network providers could be to stick to the available network capacity, to segment that capacity usefully and then to offer it in a framework of graduated rates. Under such strategies, applications would grow more and more expensive. In general, customers have little interest in switching providers. Cf. van Schewick (2010a: 264 ff.).
- 266 That is also the case when network providers expand their networks. Cf. van Schewick (2010a: 279 f.). Higher access rates would especially affect innovative, promising services that generate high data volumes, such as Internet TV services, cloud computing or future applications in the Internet of things. Companies and publishing houses would also find it less attractive to produce digital content for the network. As their audiences dwindled, smaller content providers, such as private bloggers, could find it necessary to terminate their activities. Cf. Chettiar and Holladay (2010).
- 267 Cf. van Schewick (2007b). That risk applies even if the network provider does not offer any competing products. Cf. van Schewick (2010a). Already, young companies are having to deal with difficult conditions for financing, since the possibility of discrimination against new applications has made investors considerably more wary. (For two examples, cf. van Schewick (2008: 2) and Zediva (2010).) While both small and large independent companies face risks of discrimination via network providers, the problem of growing difficulties in acquiring outside capital and equity capital is especially acute for small, young companies. Innovative applications of such companies would thus have considerably smaller chances of reaching the market than they now do. Cf. van Schewick and Farber (2009).
- 268 For numerous case studies relative to this phenomenon, cf. van Schewick, (2010a: 204 ff. u. 298 ff.); van Schewick (2010c: 2 ff.).
- 269 Cf. Kruse (2008: 5 ff.) and Dewenter (2007: 27).
- 270 Cf. Litan and Singer (2010) and Meyer et al. (2007).
- 271 Cf. in this regard an evaluation of studies, carried out by Dewenter et al. (2009), relative to the economic effects of network neutrality and network management.
- 272 Cf. Litan and Singer (2010) and Meyer et al. (2007).
- 273 Cf. van Schewick (2010a: 387 ff.) and van Schewick (2007a: 388).
- 274 Cf. Cheng et al. (2009) and Chettiar und Holladay (2010).
- 275 Examples of infrastructure-based innovations include a broad range of technical inventions and improvements that are now implemented in the various networks (conventional telephone network, cable-TV network, fibre-optic backbone networks, mobile networks, satellite-based Internet links, wireless local loop (WLL) and other wireless stationary access networks). In the “classical” fixed-network area, the list includes the access technologies ADSL (Asymmetric Digital Subscriber Line) and VDSL (Very High Speed Digital Subscriber Line). What is more, in recent years improved frequency-multiplex processes have been developed, procedures for seamless rate adaption have been implemented and more-efficient fault-correction mechanisms, using interleaving, have been invented.
- 276 Cf. van Schewick (2010d: 6); van Schewick (2010a: 349 ff.).
- 277 Cf. van Schewick (2010b).
- 278 Cf. van Schewick (2008: 2); van Schewick (2010a: 204 ff.).
- 279 Cf. Kuhn (2010).
- 280 Cf. European Commission: ImpactAssessment, SEC (2007), 1472, 13 November 2007, page 91, cf. http://www.europarl.europa.eu/registre/docs_autres_institutions/commission_europeenne/sec/2007/1472/COM_SEC%282007%291472_EN.pdf (last checked on 18 January 2011).
- 281 The signing of the new directives package, in November 2009, completed what was probably the EU’s most important legislative project in the area of telecommunications law. The package consists of: The amending directive Better Regulation, 2009/140/EC, which amends Directives 2002/21/EC (framework directive) on a common regulatory framework for electronic communications networks and services, 2002/19/EC (access directive) on access to, and interconnection

of, electronic communications networks and associated facilities, and 2002/20/EC (authorisation directive) on the authorisation of electronic communications networks and services. The amending directive Citizens' Rights, 2009/136/EC, which amends Directive 2002/22/EC (universal service directive) on universal service and users' rights relating to electronic communications networks and services, Directive 2002/58/EC (data privacy directive) concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws.

282 Cf. Holznagel (2010b: 98).

283 Cf. Holznagel (2010b: 99).

284 Under the new provision, Internet users, prior to concluding relevant agreements and regularly thereafter, have to be informed, in clear language, when providers restrict their access to legal content. In addition, national regulatory authorities can obligate network providers to publish comparison-supporting, suitable and current information, for end users, regarding the quality of their services. Furthermore, the European Commission reserves the right to formulate "minimum requirements pertaining to quality of services" in cases in which it determines that services quality has been worsening, and data traffic in networks has been slowing. Cf. Spies and Ufer (2010: 15).

285 Furthermore, so the TKG draft, "end users must be allowed the possibilities of retrieving and disseminating information and of using any applications and services." Article 2 (2) No 1 TKG draft. Cf. BMWi (2010c: 74).

286 Art. 43 a (1) No 2 TKG draft mandates that "network providers and providers of publicly accessible telecommunications services must provide users, in relevant agreements, and in a clear, comprehensive and easily understandable form, with descriptions of, and the most important performance data for, the telecommunications services being offered. Such characteristics, pursuant to Art. 43 a (2) TKG draft, also include information about all other restrictions with respect to access to, and use of, services and applications (No 2); the minimum quality of services being offered and, if necessary, of other defined parameters pertaining to quality of service (No 3); information about all of the procedures used by the pertinent company to measure and control data traffic, with a view to preventing full capacity use or overloading of a network connection (network-management techniques); and information relative to the possible effects of such procedures on quality of service (No 4) and about all of the provider-imposed restrictions on use of the terminal equipment he is providing (No 5). (...) in addition, providers can be obligated to inform consumers about subsequent changes that restrict use of services and applications (Art. 45n (4) No 3 TKG draft). Furthermore, they can be required to publish comparison-supporting, suitable and current information for end users regarding the quality of their services (Art. 45o (2) TKG draft)." In addition, users who are no longer satisfied with their network providers may initiate a switch, on the basis of such information, to another provider. "For this reason as well, switching of providers is facilitated (cf. Arts. 43 (1) No 8, 46 TKG draft). The draft moves considerably beyond the European requirements in this area." Cf. Holznagel (2010a: 765); BMWi (2010c: 25 ff.).

287 Furthermore, the Federal Network Agency may define the minimum standards only by agreement with the EU. Cf. Holznagel (2010b).

288 Cf. Schweda (2010: 83).

289 Cf. Holznagel (2010a: 767).

290 Cf. Holznagel (2010a: 766).

291 Deutsche Telekom, Vodafone and O2 / Telefonica. In the May 2010 auction of mobile-communications frequencies, E-Plus was unable to secure any of the frequency packages in the 800 megahertz range. Consequently, that company will find it difficult in future to offer nation-wide mobile data services.

- 292 That is why, originally, all mobile-services providers in Germany excluded Internet telephony in their contracts. In Canada, a majority of providers slow file-sharing applications during main-usage periods or even throughout the entire day. In the area of bandwidth management, the problem is exacerbated in that discriminatory network management carried out by a given vertically integrated network provider will automatically affect all access providers who are themselves customers of the network provider. Depending on applicable regulation, it may be impossible for an access provider to protect himself against such tactics, with the result that end users have no real choice between different providers, even though there is competition. Cf. van Schewick (2010a: 259). The problem described here occurred in Canada, for example, before the regulations described in Box 08 were issued. With regard to the problem of vertically integrated network providers, and to the relevant procedure in Canada, cf. van Schewick (2010a: 467, footnote 195).
- 293 Transparency will not necessarily help in this case either, since – as the often-discussed issue of data-privacy provisions shows – most customers do not take note of their agreement provisions or take the trouble to understand them. Cf. van Schewick (2010a: 260 f.).
- 294 Services packages (triple play) not only make it seem more complicated, and more expensive, to make a switch, they also truly add to the costs of switching for customers who change only their Internet access and retain the remaining services, thereby losing the discounts that package plans normally include. For a detailed discussion of the costs of switching, cf. van Schewick (2010a: 261 ff.).
- 295 In countries with strong competition between providers, providers' markups, between their own costs and prices for end users, are low. That increases incentives to exclude data-intensive applications, and to not stick to application-neutral bandwidth management. In the UK and Canada, non-application-neutral network management is common practice. It is thus instructive that Canada has issued strict rules on network management, although Canada does have competition between numerous access providers and network providers. Canada is thus more similar to Europe in this regard than it is to the U.S.. Interview with Barbara van Schewick on 15 Januar 2011.
- 296 Cf. van Schewick (2010a: 279 f.).
- 297 Cf. Holznagel (2010a: 766).
- 298 Cf. Federal Communications Commission: Internet Policy Statement, 5 August 2005, cf. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FOC-05-151A1.pdf (last checked on 18 January 2011).
- 299 Cf. Federal Communications Commission: Memorandum Opinion and Order, 1 August 2008, cf. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-183A1.pdf (last checked on 18 January 2011).
- 300 Cf. Holznagel (2010b: 97 f.).
- 301 For example, in April 2010 the Internet provider Comcast won an important victory over the FCC. In August 2008, the FCC had ordered Comcast to refrain from intentionally slowing peer-to-peer BitTorrent data transmissions. Comcast lodged an appeal against that order and won. The court ruled that the FCC had no legal authority to issue the order. Cf. Spies und Ufer (2010: 15 f.). The FCC had based its decisions on its fall-back authority under Title I of the Communications Act. While the court did not find the FCC's justification tenable, it left open the possibility for the FCC to argue differently in justifying its authority, under that title, to issue the order. Furthermore, the FCC has the option of reclassifying Internet-access services as telecommunications services in order to derive the authority for regulation of such services from Title II of the Communications Act.
- 302 Cf. FCC (2010). For an analysis, cf. van Schewick (2010b).
- 303 Providers may not unreasonably discriminate in transporting legal Internet traffic. The FCC decides on a case-by-case basis what discriminatory practices are unreasonable. As the wording of the order shows, the FCC determines the reasonableness of a discriminatory measure on the basis of three criteria: the extent to which the provider has informed the end user regarding the

measure (transparency); the extent to which the end user has control over the measure (end-user control); and the extent to which the measure is not tied to the type of use in question (for example, to use of certain applications, services, content, or classes of applications, services, content) (use-agnosticism). In the literature, the last criterion is often referred to as application-agnosticism. Cf. FCC (2010: 41 f.).

- 304 The rules against blocking and unreasonable discrimination do not apply to reasonable network management. To fall within this exception, a relevant affected measure must have a legitimate network-management aim (such as protection of network security or supporting of broadband management), it must be suitable for fulfillment of that aim and it must be tailored to that aim. In its decision as to whether a specific measure must be considered reasonable network management, the FCC uses the same criteria it uses in interpreting the non-discrimination rule (transparency, end-user control and use-agnosticism). Cf. FCC (2010).
- 305 In addition, the information must be detailed enough to enable end users to choose sensibly between competing Internet-access services, and to enable providers of Internet applications, services, content and terminal devices to develop, market and offer their products. Providers of mobile wireless Internet-access services are subject to less-stringent requirements. They may not block legal Web sites or applications that compete with their own (the network provider's) voice-telephony or video-telephony services. The above transparency obligations apply to them in the same manner that they apply to providers of fixed-line and stationary wireless services. The FCC plans to monitor developments in the mobile sector. It emphasises that its refraining from issuing farther-reaching regulations should not be understood as implicit approval of practices that would be impermissible in the fixed-line Internet.
- 306 Unbundling: Requirement whereby fixed-network providers with significant market power have to offer subscriber lines separately from their own connection services.
- 307 Cf. Canadian Radio-Television and Telecommunications Commission (2009: Art. 122).
- 308 Cf. Canadian Radio-Television and Telecommunications Commission (2009: Art. 36).
- 309 The decision also includes rules for network-management practices of vertically integrated network providers and for data privacy with respect to network-management practices.
- 310 Where a network provider has opted for a technical measure, he must prove that the problem cannot be solved in the same way via additional investments in network capacity or via economic measures such as changes in his price structures. Users can file complaints with the CRTC against network-management practices. The CRTC reviews such complaint cases for compliance with these requirements. Cf. Canadian Radio-Television and Telecommunications Commission (2009: Arts. 37–43).
- 311 Delaying of non-time-sensitive applications requires the regulatory authority's prior consent if the impacts of the delaying virtually amount to blocking of the application concerned. Cf. Canadian Radio-Television and Telecommunications Commission (2009: Arts. 117–128).
- 312 Cf. Canadian Radio-Television and Telecommunications Commission (2009: Arts. 59–62). Detailed transparency requirements also apply to network providers who also offer Internet access. Cf. Canadian Radio-Television and Telecommunications Commission (2009: Arts. 63–66).
- 313 Cf. Geist (2010).
- 314 Cf. Ufer (2010: 389), Holznagel (2010b: 98), Reding (2009).
- 315 Cf. Schrey and Frevert (2010: 597).
- 316 Art. 3 No 24 Telecommunications Act (TKG). Cf. Schrey and Frevert (2010: 597).
- 317 Cf. Schrey and Frevert (2010: 597 f.).
- 318 The traffic data function as license plates for data packets. For each packet, they show, inter alia, what sort of application/service is involved, and to what individual Internet access the packet can be allocated to. Cf. Schrey and Frevert (2010: 598).
- 319 Cf. Schrey and Frevert (2010: 598).
- 320 Cf. Holznagel (2010b: 98); Schnabel (2008: 26 ff.).

- 321 As long as they are transparent, are useful and comparable and do not create prohibitive information costs.
- 322 The adjective “experimental” is often omitted.
- 323 Cf. Chapter A4 for a discussion of the standard definitions of R&D found in the OECD’s Frascati Manual, and regarding the different forms of innovation defined in the OECD’s Oslo Manual.
- 324 Cf. Rammer, Köhler et al. (2011).
- 325 The term “manufacturing industry” includes the mining sector, as well as the manufacturing sector.
- 326 Cf. OECD (2002).
- 327 The study also defined a group of “innovation-active companies” that, although working on innovations, make no attempt to introduce them to the market. If that group is used as a reference, then higher shares of innovators without R&D result than emerge when “innovators” is used as the basic reference.
- 328 This means involvement with R&D on an ongoing basis – for example, by having employees regularly spend at least part of their work time engaged in R&D activities or by establishing an organisational unit that is responsible for carrying out R&D.
- 329 This means that R&D is carried out only when there is an occasion for doing so – for example, when a certain technological problem has to be solved or when a certain one-time technological-development step has to be taken in an innovation project.
- 330 Kleinknecht (1987) already called attention to this problem in the 1980s. In R&D statistics, these shortcomings can lead to considerable underestimation of the numbers of companies engaged in R&D. Such underestimation has no real consequences for determination of national R&D expenditures in the industry sector, however, since the companies concerned often spend little on R&D.
- 331 Cf. Rammer, Köhler et al. (2011: 58 f.). When the three previous years are included in the consideration, a total of 43 percent of innovators currently without R&D carry out R&D at least occasionally.
- 332 Of these, nearly half are companies that have just commenced their innovation activities. The share of companies that introduce innovations over prolonged periods, without ever relying on R&D results of their own, is then about 15 percent. For smaller companies, and for companies in services sectors, the share can be considerably higher, however.
- 333 Cf. OECD (2005).
- 334 Cf. Revermann and Schmidt (1999) and Grenzmann et al. (2010). For example, it is unclear what aspects of software development should be counted as R&D, or to what extent collection of sociological data, in market research, should be considered a routine activity or should be considered R&D. Intensive efforts are currently being made to improve survey techniques for the services sector.
- 335 Nearly half of all innovators without R&D indicate that “high quality” is important. In this respect, this group does not differ statistically from researching companies. Only about 20 percent of companies without R&D term “product prices” important. Among researching companies, the importance of product prices is significantly lower, however (Fig. 06).
- 336 Cf. EFI (2009: 54).
- 337 Cf. Kerst and Minks (2004), Gehrke et al. (2009).
- 338 This is additional evidence for the benefits of co-operation.
- 339 The innovation vouchers provided by the state of North Rhine-Westphalia are designed to serve as “tickets for entry into the research laboratories of the best European universities and institutes”. Through 2012, that state plans to provide innovation vouchers worth a total of EUR 14.4 million. The value per voucher ranges from EUR 5,000 to EUR 10,000. The programme funds 50 percent of the costs for external consulting, research and development services. Cf. http://www.innovation.nrw.de/wissenstransfer/kleine_und_mittlere_unternehmen/innovationsgutschein/index.php (last checked on 18 January 2011). Initial results of relevant evaluation are now available. Cf.

<https://www.innovationsgutscheine.de/de/Zwischenergebnisse.php> (last checked on 18 January 2011). In 2009, Bavaria launched a programme entitled “innovation vouchers for small companies / crafts companies” (“Innovationsgutscheine für kleine Unternehmen / Handwerksbetriebe”), aimed at providing rapid support for SMEs. That programme is designed to be suitable especially for companies that maintain no R&D staff of their own. The state funds a total of 50 percent of expenditures incurred in commissioning research at external R&D institutions. In May 2010, the Federal Ministry of Economics and Technology (BMWi) launched an innovation-vouchers programme (go-inno) aimed at supporting SMEs in eliminating deficits in their innovation management, with the help of external consultants. In that effort, the BMWi funds half of the costs for external consulting services provided by “consulting companies authorised by the BMWi”. Cf. <http://www.inno-beratung.de/foepro/go/index.php?navanchor=1710006> (last checked on 18 January 2011).

340 Cf. Leszczensky et al. (2011).

341 Cf. OECD (2010).

342 Cf. Schasse et al. (2011).

343 Cf. Rammer and Pesau (2011).

344 Cf. Federal Statistical Office (Statistisches Bundesamt, 2008). Cf. also <http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Klassifikationen/GueterWirtschaftsklassifikationen/Content75/KlassifikationWZ08,templateId=renderPrint.psml> (last checked on 18 January 2011).

345 Cf. Rammer (2009).

346 BACH: Bank for the Accounts of Companies Harmonised, cf. <http://www.bachesd.banque-france.fr> (last checked on 18 January 2011).

347 Cf. EVCA (2010).

348 Cf. Blind (2004).

349 Cf. ISO (2010) and ISO (2000).

350 These include structural variables for companies, such as sector classification, size, age, market oriented and capital resources.

351 It must be remembered that the planning figures were provided at a time when the economic forecasts for 2010 and 2011 were still cautious. Since the economy has picked up markedly since then, the planning figures are likely to accord with the lowest possible estimate of the current development in innovation expenditures.

352 The data are based on samples that only take account of stock corporations and thus are not representative. Samples are identical only in two successive years (two-year sliding samples).

353 “Basel II” refers to the equity regulations that have applied to all banks in the EU since 2007. The Basel II provisions introduced new aspects with regard to quantification of credit risks. Since their introduction, banks have had to orient their activities more closely to actual default risks. The relevant factors that enter into classification of credit risks include companies’ capital structures. Cf. <http://wirtschaftslexikon.gabler.de/Definition/basel-ii.html>; http://www.bundesbank.de/bankenaufsicht/bankenaufsicht_basel.php (last checked on 18 January 2011).

354 Cf. European Committee of Central Balance Sheet Data Offices (2005); Mouriaux and Foulcher-Darwish (2006).

355 Cf. <http://wirtschaftslexikon.gabler.de/Definition/venture-capital.html> (last checked on 18 January 2011).

356 Cf. Blind (2002).

357 Cf. Müller et al. (2011).

358 Cf. Federal Statistical Office (Statistisches Bundesamt, 2008). Cf. also <http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Klassifikationen/GueterWirtschaftsklassifikationen/Content75/KlassifikationWZ08,templateId=renderPrint.psml> (last checked on 18 January 2011).

359 Cf. Gehrke et al. (2010).

- 360 Cf. Brixy et al. (2010).
- 361 For example, by helping to locate equipment or sites, organise the founding team, develop a business plan, or provide capital.
- 362 The GEM differentiates between start-ups established due to a lack of employment alternatives and start-ups established in order to exploit market opportunities.
- 363 Cf. Brixy et al. (2010: 18).
- 364 PCT: Patent Cooperation Treaty.
- 365 WIPO: World Intellectual Property Organization.
- 366 The German Patent and Trademark Office (DPMA) defines the term “patent family” as follows: A patent family is a group of patent applications and issued patents, and registered designs, that are linked, either directly or indirectly, via a common priority. Cf. http://www.deutsches-patentamt.de/service/glossar/n_r/index.html (last checked on 18 January 2011). In other words, a patent family comprises all the patent documents that are needed to protect an invention in different markets.
- 367 Priority year: year beginning with the first application, worldwide, for a patent.
- 368 USPTO: United States Patent and Trademark Office.
- 369 “High technology” refers to high-value-technology goods for which more than 2.5 percent, but not more than 7 percent, on an annual average of relevant revenue are spent on R&D. The corresponding level – i.e. the “R&D intensity” – for high technology is more than 7 percent.
- 370 “Medium-high technology” refers to goods for which more than 2.5 percent, but not more than 7 percent, on an annual average, of relevant revenue are spent on R&D.
- 371 Cf. specialisation indexes: comparisons of countries on the basis of patents, publications, production or foreign trade, and in light of absolute numbers, are of limited use, because such numbers implicitly reflect country size, geostrategic situation and other country-specific factors. For this reason, specialisation indexes are often used. They express the weight of a specific field or sector of a country in relation to a general reference – usually the relevant world average. Specialisation indexes are dimensionless; the relevant average or neutral value is usually set to “0”. Mathematically, the indexes are set up so that values showing above-average specialisation are positive and values showing below-average specialisation are negative, and the overall range is grouped symmetrically around the neutral value. Often, upper and lower boundaries for the value range are defined, in order to limit the impacts of extreme values on the data. Because comparisons are made in relation to the world average, increasing activities in a special area lead to a higher index value only if most other countries are not increasing their pertinent activities to the same degree, at the same time.
- 372 It must be remembered that the planning figures were provided at a time when the economic forecasts for 2010 and 2011 were still cautious. Since the economy has picked up markedly since then, the planning figures are likely to accord with the lowest possible estimate for the current development in innovation expenditures.
- 373 Cf. footnote 371.
- 374 Cf. Schmoch et. al. (2011).
- 375 In the 2010 report, the analysis was carried out with the Science Citation Index (SCI), which covers the largest sub-sector of the Web of Science. The WoS also includes publications in the areas of the humanities and social sciences, although those account for only 7.4 percent of all publications of 2009 included in the database.
- 376 Citations cannot be tallied until after a publication has appeared. For this reason, some time normally has to elapse before an adequate number of citations becomes available for statistical analyses. For country comparisons, three-year windows have proven useful, which is why 2007 is the most recent year for which the IA and SR citation indicators can now be determined.
- 377 Cf. footnote 376.
- 378 The data for the period 2002 to 2007 were collected in accordance with the WZ03 classification; the data for 2008 were collected in accordance with the WZ03 classification and then again in

accordance with WZ08; and the figures for 2009 were collected only in accordance with WZ08. The data sets for a) WZ03 and b) WZ08 are each based on different, although substantially similar, definitions of knowledge-intensive and non-knowledge-intensive economic sectors. Differentiation on the basis of WZ 2003 is in keeping with Legler/Frietsch (2006), while differentiation pursuant to WZ 2008 is in keeping with the new list pursuant to Gehrke et al. (2010).

379 Cf. EFI (2009: Chapter B 5).

380 Cf. Gehrke et al. (2010).

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